Actuarial Notes for

Spring 2014 CAS Exam5

Syllabus Section A

Ratemaking, Classification Analysis, Miscellaneous Ratemaking Topics

Volume 1a

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Exam 5 – Volume 1a: Ratemaking – Part 1

Notes:

The predecessor papers to the CAS 2011 syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous.

Past CAS questions and our solutions to those questions associated with those readings that are within this volume, remain relevant to understanding the content covered in these chapters.

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Chapter 1 - Introduction

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Introduction and Rating Manuals 1 - 1

Insurance and Non-insurance Product Pricing:

The price of a product should reflect its costs as well as an acceptable profit. This leads to the following relationship between price, cost, and profit:

Price = Cost + Profit.

For non-insurers, production cost is known before the product is sold, and thus the price can be set so that the desired profit per unit of product can be obtained.

For insurers, the ultimate cost of an insurance policy is not known before the product is sold, which introduces complexity for the insurer when setting prices.

Rating Manuals

In general, premiums are based on a rate per unit of risk exposed.

- Rating manuals contains information to classify and calculate the premium for a given risk.
- Chapter 2 contains more detailed information and specific examples of rating manuals.

The ratemaking process allows one to modify existing rating manuals or create new ones.

2 Basic Insurance Terms 1 - 5

Exposure

An exposure is a unit of risk that underlies the premium. Different exposures are used when making rates for different lines of business (e.g. annual payroll in hundreds of dollars is the typical exposure unit for U.S. workers compensation insurance).

Four ways insurers measure exposures are as follows:

- **Written exposures** are the total exposures arising from policies issued during a specified time period (e.g. a calendar year or quarter).
- **Earned exposures** are the portion of written exposures for which coverage has already been provided (as of a certain point in time).
- **Unearned exposures** are the portion of written exposures for which coverage has not yet been provided (as of that point in time).
- **In-force exposures** are the number of units exposed to loss at a given point in time.

See chapter 4 for more examples on how exposure measures are used for ratemaking.

Premium

Four types of premiums are as follows:

- **Written premium:** Total premium from policies issued during a specified period.
- **Earned premium:** The portion of written premium for which coverage has already been provided (as of a certain point in time).
- **Unearned premium:** The portion of written premium for which coverage has yet to be provided.
- **In-force premium:** The full-term premium for policies in effect at a given point in time.

See chapter 5 for examples of premium measures and how they are used for ratemaking.

Claim

A claim is a demand for indemnification for the financial consequences of an event covered by a policy.

- The claimant can be an insured or a third party alleging damages covered by a policy.
- The *date of loss* or *accident date* (a.k.a. occurrence date) is the date of the loss event.
- Claims not known by the insurer are unreported claims or incurred but not reported (IBNR) claims.

After the claim is reported to the insurer, the claim is a reported claim.

Until the claim is settled, the reported claim is an open claim.

Once the claim is settled, it is a closed claim.

If further activity occurs after the claim is closed, the claim may be re-opened.

Loss

Loss is the amount paid or payable to the claimant under the policy.

The authors use the term claim to refer to the demand for compensation, and loss to refer to the amount of compensation.

Paid losses are amounts that have been paid to claimants.

Case reserves are estimates of the amount needed to settle a claim and excludes any payments already made.

Reported loss (or case incurred loss) is the sum of paid losses and the current case reserve for a claim:

Reported Losses = Paid Losses + Case Reserve.

Ultimate loss is the amount to close and settle all claims for a defined group of policies.

Two reasons why reported losses and ultimate losses are different:

1. When there are unreported claims, the estimated amount to settle these claims is known as incurred but not reported (IBNR) reserve.
2. The incurred but not enough reported (IBNER) reserve (a.k.a. development on known claims) is the difference between the aggregate reported losses at the time the losses are evaluated and the aggregate amount estimated to ultimately settle these reported claims.

Ultimate Losses = Reported Losses + IBNR Reserve + IBNER Reserve.

Loss Adjustment Expense (LAE)

LAE represent insurer expenses in settling claims, and can be separated into:

Allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE):

LAE = ALAE + ULAE.

ALAE are directly attributable to a specific claim (e.g. fees for outside legal counsel hired to defend a claim).

ULAE cannot be directly assigned to a specific claim (e.g. salaries of claims department personnel not assignable to a specific claim).

See Chapter 6 to see how loss and LAE data are used in the ratemaking purposes.

Underwriting Expenses (U/W expenses)

U/W expenses (a.k.a. operational and administrative expenses) are related to acquiring and servicing policies. Four categories for classifying these expenses are:

1. ***Commissions and brokerage*** are:
   - amounts paid to insurance agents or brokers as compensation for generating business.
   - paid as a percentage of premium written.
   - vary between new and renewal business
   - based on the *quality of the business written* or the *volume of business written* or *both*.
2. ***Other acquisition costs*** (other than commissions and brokerage expenses) include costs associated with media advertisements and mailings to prospective insureds.
3. ***General expenses*** include the remaining expenses associated with the insurance operations and other miscellaneous costs (e.g. costs associated with the general upkeep of the home office).
4. ***Taxes, licenses, and fees*** include all taxes and miscellaneous fees paid by the insurer *excluding federal income taxes* (e.g. premium taxes and licensing fees)

Underwriting Profit (UW Profit)

Since premiums may be insufficient to pay claims and expenses, capital must be maintained to support this risk, and the insurer is entitled to earn a reasonable expected return (profit) on that capital.

Two main sources of profit for insurers are UW profit and investment income (II).

1. UW profit (i.e. operating income) is the total profit from all policies (a.k.a. income minus outgo).
2. II is generated from funds invested in securities held by the insurer.

See chapter 7 to see how UW expense provisions are derived and how it's incorporated in the ratemaking process.

3 Fundamental Insurance Equation 5 - 7

Price = Cost + Profit. As it applies to the insurance industry:

- Premium is the "price" of the insurance product.
- "Cost" is the sum of the losses, LAE, and UW expenses.
- UW profit is income minus the outgo from issuing policies.

  Note: Profit is also derived from II

The prior formula transformed into the fundamental insurance equation is:

Premium = Losses + LAE + UW Expenses + UW Profit.

The goal of ratemaking: To assure that the fundamental insurance equation is balanced (e.g. rates should be set so premium is expected to cover all costs and achieve the target UW profit).

- This goal is stated in the 2nd principle of the CAS "Statement of Principles Regarding P&C Ratemaking" which states "A rate provides for all costs associated with the transfer of risk."
- Two key points in achieving balance in the fundamental equation are:
  1. Ratemaking is prospective.
  2. Balance should be attained at the aggregate and individual levels.

1. Ratemaking is Prospective

Ratemaking involves estimating the components of the fundamental insurance equation to determine whether or not the estimated premium is likely to achieve the target profit during the period the rates will be in effect.

While ratemaking uses historical experience to estimate future expected costs, this does not mean premiums are set to recoup past losses.

Recall that the first principle in the CAS "Statement of Principles Regarding P&C Insurance Ratemaking" states that "A rate is an estimate of the expected value of future costs"

Factors that impact the components of the fundamental insurance equation and may necessitate a restatement of the historical experience are:

- Rate changes
- Operational changes
- Inflationary pressures
- Changes in the mix of business written
- Law changes

2. Overall and Individual Balance

The fundamental insurance equation must be in balance at both an overall level as well as at an individual/segment level when considering rate adequacy.

If proposed rates are either too high or too low to achieve the targeted profit, decreasing or increasing rates uniformly should be considered.

Two methods for calculating the overall adequacy of current rates are discussed in Chapter 8.

Principle 3 of the CAS "Statement of Principles Regarding P&C Insurance Ratemaking" states "A rate provides for the costs associated with an individual risk transfer"

Failure to recognize differences in risk will lead to rates that are not equitable.

Chapters 9 - 11 discuss how insurers vary rates to recognize differences between insureds.

4 Basic Insurance Ratios 7 - 11

Insurers, insurance regulators, rating agencies, and investors rely on a set of basic ratios to monitor and evaluate the appropriateness of an insurer's rates.

Frequency (a measure of the rate at which claims occur): $Frequency = \dfrac{Number\ of\ Claims}{Number\ of\ Exposures}$

Assume the number of claims is 100,000 and the number of earned exposures is 2,000,000.

Then frequency is 5% (= 100,000 / 2,000,000).

Analyzing changes in claims frequency can help identify:

- industry trends associated with the incidence of claims
- utilization of insurance coverage.
- the effectiveness of specific underwriting actions.

Severity (a measure of the average cost of claims): $Severity = \frac{Total\ Losses}{Number\ of\ Claims}$

Assume total loss dollars are \$300,000,000 and the number of claims is 100,000.
Then severity is \$3,000 (= \$300,000,000 / 100,000).

Values used in the numerator and denominator do vary: For example:

- Paid severity is calculated using paid losses on closed claims divided by closed claims.
- Reported severity is calculated using reported losses and reported claims.
- ALAE may be included or excluded from the numerator.

Analyzing changes in severity:

- provides information about loss trends and
- highlights the impact of any changes in claims handling procedures.

Pure Premium (or Loss Cost or Burning Cost): (a measure of the average loss per exposure)

$$Pure\ Premium = \frac{Total\ Losses}{Number\ of\ Exposures} = Frequency\ x\ Severity$$

Pure premiums are the portion of the risk's expected costs that is "purely" attributable to loss.
Assume total loss dollars are \$300,000,000 and the number of exposures is 2,000,000.
Then pure premium is \$150 (= \$300,000,000 / 2,000,000) = 5.0% x \$3,000.

Pure premium is often calculated using reported losses (or ultimate losses) and earned exposures, and reported losses may or may not include ALAE and/or ULAE.

Changes in pure premium show industry trends in overall loss costs due to changes in both frequency and severity.

Average Premium

While the pure premium focuses on the loss portion of the fundamental insurance equation, the average premium focuses on the premium side of the ratio. $Average\ Premium = \frac{Total\ Premium}{No.\ of\ Exposures}$

Let total premium equal \$400,000,000 and total exposures equal 2,000,000
Then average premium is \$200 (=\$400,000,000 / 2,000,000).
Note: premium and exposures must be on the same basis (e.g., written, earned, or in-force).

Changes in average premium, adjusted for rate changes, show changes in the mix of business written (e.g., shifts toward higher or lower risk characteristics reflected in rates).

Loss Ratio (a measure of the portion of each premium dollar used to pay losses):

$$Loss\ Ratio = \frac{Total\ Losses}{Total\ Premium} = \frac{Pure\ Premium}{Average\ Premium}$$

Assume total loss dollars equal $300,000,000 and total premium equal 400,000,000.
Then the loss ratio is 75% (= $300,000,000 / $400,000,000).

The ratio is typically total reported losses to total earned premium. However, other variations include LAE in the calculation of loss ratios (commonly referred to as loss and LAE ratios).

The loss and LAE ratio is a measure of the adequacy of overall rates.

LAE Ratio (a measure of claim-related expense to total losses):

$$LAE\ Ratio = \frac{Total\ Loss\ Adjustment\ Expenses}{Total\ Losses}$$

LAE includes both allocated and unallocated loss adjustment expenses.
Insurers differ as to whether paid or reported (incurred) figures are used.
The Loss and LAE ratio equals the Loss ratio x [1.0 + LAE ratio].

Insurers may use this ratio to:

- determine if costs associated with claim settlement procedures are stable or not.
- compare its ratio to those of other insurers as a benchmark for its claims settlement procedures.

Underwriting Expense Ratio (a measure of the portion of each premium dollar to pay for UW expenses)

$$UW\ Expense\ Ratio = \frac{Total\ UW\ Expenses}{Total\ Premium}$$

U/W expenses are divided into expenses incurred at the onset of the policy (e.g. commissions, other acquisition, taxes, licenses, and fees) and expenses incurred throughout the policy (e.g. general expenses).

i. Expenses <u>incurred at the onset of the policy are related to written premium</u> and expenses <u>incurred throughout the policy are related to earned premium.</u>

ii. This is done to better match expense payments to premiums associated with expenses and to better estimate what % of future policy premium should be charged to pay for these costs.

Individual expense category ratios are summed to compute the overall UW expense ratio.

Insurers review the UW expense ratio:

- over time and compare actual changes in the ratio to expected changes based on inflation.
- to compare its ratio to other insurer ratios as a benchmark for policy acquisition and service expenses.

Operating Expense Ratio (OER is the portion of the premium dollar to pay for LAE and UW expenses)

$$OER = UW\ Expense\ Ratio + \frac{LAE}{Total\ Earned\ Premium}$$

OER is used to monitor operational expenditures and is key to determining overall profitability.

Combined Ratio (a combination of the loss and expense ratios)

$$Combined\ Ratio = Loss\ Ratio + \frac{LAE}{Earned\ Premium} + \frac{Underwriting\ Expenses}{Written\ Premium}$$

i. The loss ratio should not include LAE or it will be double counted.

ii. For insurers that compare UW expenses incurred at the onset of the policy to earned premium rather than to written premium, the Combined Ratio = Loss Ratio + OER.

The combined ratio measures the profitability of a book of business.

Retention Ratio (a measure of the rate at which existing insureds renew their policies upon expiration)

$$Retention\ Ratio = \frac{Number\ of\ Policies\ Renewed}{Number\ of\ Potential\ Renewal\ Policies}$$

If 100,000 policies are anticipated to renew in a given month and 85,000 of the insureds choose to renew, then the retention ratio is 85% (= 85,000 / 100,000).

Retention ratios are:

- used to gauge the competitiveness of rates and are closely examined following rate changes or major changes in service.
- a key parameter in projecting future premium volume.

Close Ratio (a.k.a. hit ratio, quote-to-close ratio, or conversion rate is a measure of the rate at which prospective insureds accept a new business quote)

$$Close\ Ratio = \frac{Number\ of\ Accepted\ Quotes}{Number\ of\ Quotes}$$

Example: If an insurer makes 300,000 quotes in a month and generates 60,000 new policies from those quotes, then the close ratio is 20% (= 60,000 / 300,000).

Close ratios and changes in the close ratios are monitored by product management and marketing departments.

Closed ratios are used to determine the competitiveness of rates for new business.

5 Key Concepts 11 - 11

1. Relationship between price, cost and profit

2. Rating manuals

3. Basic insurance terms
   a. Exposure
   b. Premium
   c. Claim
   d. Loss
   e. Loss adjustment expense
   f. Underwriting expense
   g. Underwriting profit

4. Goal of ratemaking
   a. Fundamental insurance equation
   b. Ratemaking is prospective
   c. Overall and individual balance

5. Basic insurance ratios
   a. Frequency
   b. Severity
   c. Pure premium
   d. Average premium
   e. Loss ratio
   f. Loss adjustment expense ratio
   g. Underwriting expense ratio
   h. Operating expense ratio
   i. Combined ratio
   j. Retention ratio
   k. Close ratio

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 1990 exam

4. (1 point) According to the Study Note Reading - Foundations of Casualty Actuarial Science, Chapter 1, "Ratemaking," which of the following are true?
   1. The description of the goal of the ratemaking process includes consideration of generating a reasonable-return on funds provided by investors.
   2. Regulatory review generally requires that rates shall not be inadequate, excessive or unfairly discriminatory between risks of like kind and quality.
   3. The two basic approaches used in manual ratemaking are the pure premium method and the loss ratio method. (see chapter 8)

A. 1. B. 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Questions from the 2008 exam

13. (2.0 points) Define the following terms.
   a. Written premium
   b. Earned premium
   c. Unearned premium
   d. In-force premium

Questions from the 2010 exam

11. (2 points)
   a. (0.75 point) Explain how the standard economic formula, Price = Cost + Profit, relates to the fundamental insurance equation.
   b. (1.25 points) Company ABC replaced inexperienced adjusters with experienced adjusters who have a greater knowledge of the product. Explain the impact of this change on each component of the fundamental insurance equation.

12. (1 point) Given the following information:
   - 2008 earned premium = $200,000
   - 2008 incurred losses = $125,000
   - Loss adjustment expense ratio = 0.14
   - Underwriting expense ratio = 0.25

   Calculate the combined ratio.

Questions from the 2011 exam

8. (1.25 points) Given the following information:

	Calendar Year 2010
Written premium	$280.00
Earned premium	$308.00
Commissions	$33.60
Taxes, licenses and fees	$9.80
General expenses	$36.96
LAE ratio (to loss)	8.2%
Combined ratio	100%

Calculate the 2010 operating expense ratio.

Questions from the 2012 exam

10. (2.5 points) The fundamental insurance equation is:

Premium = Losses + Loss Adjustment Expense + Underwriting Expenses + Underwriting Profit

a. (1 point) Werner and Modlin state that "It is important to consider the [fundamental insurance] equation at the individual or segment level" in addition to the aggregate level.

   Discuss two reasons it would be acceptable to maintain an imbalance in the fundamental insurance equation at the individual or segment level.

b. (1.5 points) Reconcile an imbalance in the fundamental insurance equation with the following quote from the Statement of Principles Regarding Property & Casualty Insurance Ratemaking: "A rate provides for the costs associated with an individual risk transfer."

Chapter 1 - Introduction

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

The predecessor papers to the current syllabus reading “Basic Ratemaking” by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Solutions to questions from the 1990 exam:

Question 4.

1. T
2. T
3. T

Answer E.

Solutions to questions from the 2008:

Model Solution - Question 13

a. Written Premium are the dollar amounts charged by an insurer for policies written during a specific time period. The total policy premium is included in the written premium.

b. Earned Premium is the amount of the policy premiums that have been exposed to risk during a specified time period. Earned Premium is directly proportional to the portion of the policy period covered by the insurer during the specified time period.

c. Unearned Premium is the portion of policy premium that has yet to be exposed to risk as it covers a future time period during which the policy will be in-effect.

d. In-force Premium is the total written premium of all policies in effect at a specific point in time.

Solutions to questions from the 2010:

Question 11

a. Explain how the standard economic formula, Price = Cost + Profit, relates to the fundamental insurance equation.

$$\underset{\text{Price}}{\underset{\uparrow}{\text{Premium}}} = \underbrace{\text{Loss + Loss adjustment expense + UW expense}}_{\text{Cost}} + \underset{\text{Profit}}{\underset{\uparrow}{\text{UW profit}}}$$

b. Explain the impact of using experienced adjusters on each component of the fundamental insurance equation.

* Losses will decrease due to better (more judicious) claims adjusting
* Loss adjustment expenses will increase due to a larger fee paid to more experienced claims adjusters
* UW expense will remain the same as they cover the costs incurred at the onset of the policy (e.g. commissions, other acquisition, taxes, licenses, and fees) and expenses incurred throughout the policy (e.g. general expenses), which are not impacted by the use of more experienced adjusters

Comments: The following only makes sense if the reduction in losses is greater than the increase in LAE (which is a reasonable assumption since losses comprise a very large percentage of premiums).

* Premium will decrease if the UW profit is to remain the same
* UW profit will increase if the Premium is to remain the same

Solutions to questions from the 2010 (continued):

Question 12: Calculate the combined ratio, using the given data in the problem.

Step 1: Write an equation to determine the combined ratio

$$Combined\ Ratio = Loss\ Ratio + \frac{LAE}{Earned\ Premium} + \frac{Underwriting\ Expenses}{Written\ Premium} = Loss\ Ratio + OER$$

$$Loss\ Ratio = \frac{Total\ Losses}{Total\ Premium}$$

$$LAE\ Ratio = \frac{Total\ Loss\ Adjustment\ Expenses}{Total\ Losses}$$

$$UW\ Expense\ Ratio = \frac{Total\ UW\ Expenses}{Total\ Premium}$$

$$OER = UW\ Expense\ Ratio + \frac{LAE}{Total\ Earned\ Premium}$$

Step 2: Using equations in Step 1, and the data given in the problem, solve for the components of the combined ratio

Loss ratio = 125,000/200,000 = 0.625

LAE = LAE ratio * Incurred Losses = 0.14 x 125,000 = 17,500

Operating expense ratio = OER = UW expense ratio + LAE/Earned Premium

= .25 + 17,500/200,000 = .3375

Combined ratio = Loss ratio + OER = 0.625 + .3375 = .9625 = 96.25%

Solutions to questions from the 2011:

8. Calculate the 2010 operating expense ratio.

Question 8 – Model Solution 1

Combined ratio = Loss Ratio + LAE/EPremium + UW Expense Ratio

OER = LAE/EPremium + UW Expense Ratio

UW Expense Ratio = TaxesLicFee/WP + Comm/WP + General/EP

= (9.80 + 33.6)/280 + 36.96/308 = .275

LR * (1+LAE ratio) = 1 - UW Expense Ratio = 1 - .275 = .725

CR = 1.0 = L/EP + .082L/EP + .275; since .082 = LAE/L, LAE = .082L

Solve for L: L = LR*EP/(1+LAE). L= .725*308/1.082 = 206.377

Solve for LAE: LAE = .082 * L = .082 * 206.377 = 16.923

OER = 16.923/308 +.275 = .32994

Question 8 – Model Solution 2

Combined ratio = Loss Ratio + OER = LR * (1+LAE ratio) + U/W Expense Ratio

Solve for the LR: 100% = LR * (1+8.2%) + (33.60 + 9.80)/280 + 36.96/308; LR = 67%

OER = Combined Ratio – Loss Ratio = 100% - 67% = 33%

Solutions to questions from the 2011

Question 8 – Model Solution 3

OER = LAE/E Premium + UW Expense Ratio

Underwriting expense ratio = 33.60/280 + 9.8/280 + 36.96/308 = **0.275**

Combined ratio = Loss Ratio (1 + 0.082) + UW Expense/Written premium

UW Expense/Written Premium = [33.60 + 9.8 + 36.96]/280 = 0.287

Combined ratio = LR(1.082) + 0.287

Solve for LR: LR = 0.65896

CR = 1.0 = 0.65896 + LAE/Earned premium + 0.287

Solve for LAE/EP: LAE/Earned Premium = **0.054**

So operating expense ratio = 0.054 + 0.275 = 0.329

Questions from the 2012 exam

10a. (1 point) Werner and Modlin state that "It is important to consider the [fundamental insurance] equation at the individual or segment level" in addition to the aggregate level.

Discuss two reasons it would be acceptable to maintain an imbalance in the fundamental insurance equation at the individual or segment level.

Question 10 Model - Solution 1 – part a

1. Maintain competitive position. If changing rates would hurt your competitive position then it may be acceptable to take less of a change and have an unbalanced Fund. Ins Equation -> In other words hurting retention enough to offset increase.
2. If the relative cost of the change outweighs the benefit. If the operational cost of changing rating algorithms or data collection processes outweigh the change in premiums associated with the change then it could be appropriate to have an unbalanced Fund. Ins Equation

Question 10 Model - Solution 2 – part a

1. It might due to a regulatory constraint. The regulator restrict the rate change (e.g. capped at +/- 25%)
2. Marketing Constraint. If the company's marketing objective is to increase the market share on age group 50-55 drivers, it may reduce rate to attract this group of insureds. Company may have look at the long term profitability of the book using an asset share pricing technique.

Examiners Comments

This part of question was generally answered well. Common answers that received credit included marketing considerations (riding the market cycle, competitor pressure), regulatory considerations (e.g. cap on rate changes, restrictions on rating variables), and an asset share pricing approach that anticipates future profits at the expense of initial costs.

Questions from the 2012 exam

10b. (1.5 points) Reconcile an imbalance in the fundamental insurance equation with the following quote from the Statement of Principles Regarding Property & Casualty Insurance Ratemaking: "A rate provides for the costs associated with an individual risk transfer."

Question 10 - Model Solution – part b

An actuarially sound indication many not always be implemented since an insurance company needs to balance other objectives, such as marketing, then actuarially balancing premium and loss.

The actuary is allowed to deviate from this principle under influence of management, with the proper disclosure.

Additionally asset sharing pricing techniques have demonstrated that under certain circumstances, it is ultimately profitable to write business that currently produce a net loss.

Examiners Comments

Part b was not answered well.

By far the most common response was a mathematical balancing of the fundamental insurance equation, either by raising the premium or lowering expenses. However, the question was asking candidates to justify their reasoning for an imbalanced fundamental insurance equation from part A in light of the actuarial standards of practice.

Successful candidates acknowledged that actuarial rate indications can balance the fundamental insurance equation but that management may decide to choose premiums that differ from actuarial indications, or that regulatory restrictions supersede all actuarial standards of practice.

1 Rating Manuals and Rules 13 - 14

Rating manuals are used by insurers to classify risks and calculate the premium for a given risk.

This chapter describes what is contained in rate manuals and gives examples of different rating components for various lines of business.

For most lines of business, the following is necessary to calculate the premium for a given risk:

- Rules — Found in the insurer's rating manual
- Rate pages (i.e. base rates, rating tables, and fees) — Found in the insurer's rating manual
- Rating algorithm — Found in the insurer's rating manual
- Underwriting guidelines — Found in the insurer's UW manual

RULES

Rating manual rules:

- contain *qualitative* information to apply to the *quantitative* rating algorithms contained in the manual.
- begin with definitions of the risk being insured (e.g. rules for a homeowners insurer may define what is considered a primary residence)
- provides a summary of policy forms offered to the insured (if more than one form is offered)
- summarize what is covered (e.g. types of liability or damage)
- outline limitations or exclusion of coverage.
- outline premium determination considerations (e.g. minimum premium, down payments, and refunds in the event of cancellation).

Rules define how to classify a risk before the rating algorithm can be applied.

Class ratemaking groups risks with similar characteristics (represented by rating variables) and varies the rate accordingly.

Rules also contain optional insurance coverage information (a.k.a. endorsements or riders), which:

- describe the optional coverage, any restrictions on such coverage, and any applicable classification rules.
- may contain the rating algorithm for the optional coverage as well.

In addition to rules, insurers use UW guidelines to specify additional acceptability criteria (e.g. an insurer may choose not to write a risk with two or more convictions of driving under the influence).

UW guidelines are usually found in a separate underwriting manual.

2 Rate Pages 14 - 15

Rate pages contain inputs (e.g. base rates, rating tables, and fees) to calculate premium.

A **base risk** is a risk profile pre-defined by the insurer.

The base risk can be a set of common risk characteristics or can be chosen based on marketing objectives.

Example 1: The base risk for personal auto collision coverage may be an adult, married male, with a $500 deductible, who lives in a very populated area, etc.

- The insurer may have an objective to encourage new insureds to purchase a deductible of $500 or higher (even though it may have more policies with a $250 deductible).

  If the base is set at the $500 deductible, it will be used in the initial premium quote. But if the insured requests a comparison quote with a $250 deductible, a higher premium will result (relative to using a base set at a $250 deductible), which may deter the insured psychologically.

Example 2: A multi-product discount for homeowners who have an auto policy with the same insurer.

- If the insurer sets the base equal to those who qualify for the discount, then there will be an increase in premium for those who do not qualify for the discount.

  Although the premium charged is the same whether buying a single or multi-product discount, a discount has more positive appeal than an increase in premium.

The **base rate** is the rate that applies to the base risk (and is usually not the average rate).

If the product contains multiple coverages priced separately (as in personal auto insurance), then there is a separate base risk, base rate, and rating tables for each coverage.

Rates for all risk profiles, other than the base profile, will vary from the base rate.

The rate variation for different risk characteristics occurs by modifying the base rate (e.g. applying multipliers, addends, etc. in the rating algorithm).

- Characteristics are rating variables (a.k.a. discounts/surcharges or credits/debits) and the rate variations are contained in rating tables.
- The variations from the base rate are referred to as relativities, factors, or multipliers (if applied to the rating algorithm multiplicatively) or addends (if applied to the base rate or some other figure in an additive or subtractive manner).

Rating Variables for various lines of insurance are as follows:

Type of Insurance	Rating Variables
Personal Automobile	Driver Age and Gender, Model Year, Accident History
Homeowners	Amount of Insurance, Age of Home, Construction Type
Workers Compensation	Occupation Class Code
Commercial General Liability	Classification, Territory, Limit of Liability
Medical Malpractice	Specialty, Territory, Limit of Liability
Commercial Automobile	Driver Class, Territory, Limit of Liability

Rate pages contain all the components needed to calculate rates.

Expenses:

The premium charged must consider expenses incurred in acquiring and servicing policies.

- Some expenses vary by the amount of premium (e.g. commission is usually a % of the premium)
- Some expenses are fixed regardless of the premium (e.g. the cost of issuing a policy).

An insurer may include an explicit expense fee in the rating algorithm to account for fixed expenses and incorporate a provision within the base rate to account for variable expenses.

Otherwise, an insurer may incorporate all expenses via a provision within the base rates.

In this case, the insurer may have a minimum premium so that the premium charged is adequate to cover expenses and an amount for minimal expected losses.

3 Rating Algorithms 15 - 16

Rating algorithms describes how to combine the components in the rules and rate pages to calculate the premium charged for any risk not pre-printed in a rate table.

The algorithm includes instructions such as:

- the order in which rating variables should be applied
- how rating variables are applied in calculating premium (e.g. multiplicative, additive, or some unique mathematical expression)
- maximum and minimum premiums (or in some cases the maximum discount or surcharge to be applied)
- specifics with how rounding takes place.

Separate rating algorithms by coverage may apply (if the product contains multiple coverages).

A few examples are included in this chapter for illustrative purposes.

4 Underwriting Guidelines 16 - 17

UW guidelines criteria are used to specify:

- **Decisions to accept, decline, or refer risks**. (e.g. risks with a certain set of characteristics (e.g., a household with two or more losses in the last 12 months) may not be eligible for insurance or the application must be referred to a senior underwriter).
- **Company placement**.

  An insurance group may have one of its companies provide personal auto insurance to preferred/low-risk drivers and another to provide insurance to nonstandard/high-risk drivers.

  Establishing separate companies to achieve this purpose is due to either:

  i. regulatory issues (cannot get approval for the full spectrum of rates within one company) or

  ii. different distribution systems (one company selling through agents and another selling directly to the consumer).
- **Tier placement**. Jurisdictions may permit insurers to charge different rates within a single company to risks with different underwriting characteristics.

  i. UW guidelines specify the rules to assign the insured to the correct tier.

  ii. The rating algorithm and rate pages specify how the tier placement affects the premium calculation.
- **Schedule rating credits/debits** (used in commercial lines products to vary premium from manual rates).

  SR applies credits and debits depending on the presence or absence of characteristics.

  i. SR may be specific and no judgment is required or permitted.

  ii. SR may allow the underwriter to use subjective factors in applying credits or debits.

Note: While UW criteria has been historically subjective in nature, there has been a trend over time (especially for personal lines products) to designate new explanatory variables as UW criteria, which can then be used for placement into rating tiers or separate companies.

The trend to designate new explanatory variables as UW criteria has given some companies a competitive advantage by reducing the transparency of the rating algorithm.

Examples of Underwriting Characteristics used in Various Lines of Insurance

Type of Insurance	Underwriting Characteristics
Personal Automobile	Insurance Credit Score, Homeownership, Prior Bodily Injury Limits
Homeowners	Insurance Credit Score, Prior Loss Information, Age of Home
Workers Compensation	Safety Programs, Number of Employees, Prior Loss Information
Commercial General Liability	Insurance Credit Score, Years in Business, Number of Employees
Medical Malpractice	Patient Complaint History, Years Since Residency, Number of Weekly Patients
Commercial Automobile	Driver Tenure, Average Driver Age, Earnings Stability

5 Homeowners Rating Manual Example 17 - 23

The following is an example of a rating algorithm for a homeowners policy issued by the Wicked Good Insurance Company (Wicked Good or WGIC).

WGIC's homeowners rating manual is used to calculate the premium for a homeowners insurance policy.

The following are excerpts from WGIC's homeowners rating manual.

Base Rates

The exposure base for homeowners insurance is a home insured for one year.

The base rate (an all-peril base rate) for WGIC is shown below.

Coverage	Base Rate
All Perils Combined	$500

Rating and Underwriting Characteristics

Amount of Insurance (AOL)

AOI:

- is a key rating variable for homeowners insurance.
- represents the amount of coverage purchased to cover damage to the dwelling and is the maximum amount the insurer expects to pay to repair or replace the home.

The table below shows rate relativities to apply to WGIC's base rate depending on the AOI purchased.

Note that the base rate corresponds to a home with an amount of insurance of $200,000, and thus has a AOI rate relativity of 1.00.

Amount of Insurance (AOI) Rating Table

AOI (in thousands)	Rate Relativity
$ 80	0.56
$ 95	0.63
:::	:::
$170	0.91
$185	0.96
$200	**1.00**
$215	1.04
:::	:::
$410	1.51
$425	***1.54***
$440	1.57
$455	1.60
$470	1.63
$485	1.66
$500	1.69
Additional $15K	0.03

If a policyholder purchases $425,000 of insurance for his home, a rate relativity of 1.54 is applied to the base rate. Straight-line interpolation is used for values not listed in the table.

Territory

The location of the home is a key rating variable.

- Homeowners insurers group similar geographic units (e.g. zip codes) to form rating territories.
- WGIC grouped zip codes into five distinct rating territories (with rate relativities shown below).
- Territory 3 is the base territory (and thus has a relativity of 1.00) and all other territories are expressed relative to Territory 3.

Territory	Rate Relativity
1	0.80
2	0.90
3	**1.00**
4	1.10
5	1.15

Protection Class and Construction Type

WGIC's homeowners rates vary by fire protection class and construction type.

- Class 1 indicates the highest quality protection while class 10 refers to the lowest quality protection.
  Within each class, there is a separate relativity based on construction type (frame and masonry). Frame construction is more susceptible to loss than masonry and therefore frame relativities are higher than the masonry relativities across every protection class.
- The base rate for this two-way variable is Protection Class 1-4 Frame (although Protection Class 5 Masonry coincidentally has a relativity of 1.00).

Protection Class / Construction Type Rating Table

Protection Class	Construction Type	
	Frame	Masonry
1-4	**1.00**	**0.90**
5	1.05	1.00
6	1.10	1.05
7	1.15	1.10
8	1.25	1.15
9	2.10	1.75
10	2.30	1.90

Underwriting Tier

WGIC uses UW characteristics (used to place insurance policies into one of four distinct underwriting tiers based on the overall riskiness of the exposure to loss) that are not explicitly shown in the rating manual.

Underwriting Tier Rating Table

Tier	Rate Relativity
A	0.80
B	0.95
C	**1.00**
D	1.45

Tier D is considered the most risky and has the highest rate relativity.

Deductible

Policyholders choose their deductible. Rate relativities for each deductible are shown in the table below.

Deductible	Rate Relativity
$250	**1.00**
$500	0.95
$1,000	0.85
$5,000	0.70

Miscellaneous Credits

Wicked Good offers the following discounts:

Miscellaneous Credit	Credit Amount
New Home Discount	20%
5-Year Claims-Free Discount	10%
Multi-Policy Discount	7%

Insurers offering a large number of discounts will have a maximum discount percentage that can be used, however Wicked Good does not limit the overall cumulative discount.

Additional Optional Coverages

The basic homeowners policy includes:

i. a $100,000 limit for liability coverage and a $500 limit for medical coverage (this split limit is often expressed as $100,000/$500).

ii. a $2,500 inside limit to jewelry losses within the contents coverage.

The following tables show the additional premium charged if the policyholder elects to purchase additional higher limits:

Jewelry Coverage Rate	
Limit	Additive
$ 2,500	**Included**
$ 5,000	$35
$10,000	$60

Liability/Medical Rate	
Limit	Additive
$100,000/$500	**Included**
$300,000/$1,000	$25
$500,000/$2,500	$45

Expense Fee

WGIC has an explicit expense fee to cover fixed expenses incurred in the acquiring and servicing policies.

The expense fee is $50 per policy as shown in the table below.

Policy Fee
$50

Homeowners Rating Algorithm for WGIC

The rating algorithm to calculate the final premium for a homeowners policy for WGIC is:

Total Premium = All-Peril Base Rate x AOI Relativity
x Territory Relativity
x Protection Class / Construction Type Relativity
x Underwriting Tier Relativity
x Deductible Credit
x [1.0 - New Home Discount – Claims-Free Discount]
x [1.0 - Multi-Policy Discount]
+ Increased Jewelry Coverage Rate
+ Increased Liability/Medical Coverage Rate
+ Policy Fee.

Rounding is common and WGIC rounds to the penny after each step and to the whole dollar at the final step.

Homeowners Rate Calculation Example for WGIC

WGIC is preparing a renewal quote for a homeowner with the following risk characteristics:

- Amount of insurance = $215,000
- The insured lives in Territory 4.
- The home is frame construction located in Fire Protection Class 7.
- Based on the insured's credit score, tenure with the company, and loss history, the policy is in UW Tier C.
- The insured opts for a $1,000 deductible.
- The home falls under the definition of a new home as defined in Wicked Good's rating rules.
- The insured is eligible for the five-year claims-free discount.
- There is no corresponding auto or excess liability policy written with WGIC.
- The insured is eligible for the five-year claims-free discount.
- There is no corresponding auto or excess liability policy written with WGIC.
- The policyholder opts to increase coverage for jewelry to $5,000 and to increase liability/medical coverage limits to $300,000/$1,000.

Entries from Rating Manual	
Base Rate	$500
AOI Relativity	1.04
Territory Relativity	1.10
Protection Class / Construction Type Relativity	1.15
Underwriting Tier Relativity	1.00
Deductible Credit	0.85
New Home Discount	20%
Claims-Free Discount	10%
Multi-Policy Discount	0%
Increased Jewelry Coverage Rate	$35
Increased Liability/Medical Coverage Rate	$25
Expense Fee	$50

The rating algorithm from the rating manual can be applied to calculate the final premium for the policy:

$$\$501 = \$500 * 1.04 * 1.10 * 1.15 * 1.00 * 0.85 * [1.0 - 0.20 - 0.10] * [1.0 - 0] + \$35 + \$25 + \$50.$$

6 Medical Malpractice rating Manual Example 23 - 28

The following a rating algorithm for a medical malpractice (MM) policy issued by WGIC for its Nurses Professional Liability program. WGIC's rating manual (with excerpts shown below) is used to calculate the premium.

Base Rates

The exposure base for MM insurance is a medical professional insured for one year.

Wicked Good's rating manual shows base rates for annual MM coverage for its nurses program, which vary depending on whether the professional is employed or operates his or her own practice.

Base Rates

	Annual Rate Per Nurse
Employed	$2,500
Self-Employed	$3,000

Rating and Underwriting Characteristics

Specialty Factor

Wicked Good varies malpractice premium based on specialties shown in the table below.

Specialty Rating Table

Specialty	Rate Relativity
Psychiatric	0.80
Family Practice	**1.00**
Pediatrics	1.10
Obstetrics	1.30
All Other Specialties	1.05

Nurses practicing in obstetrics have the highest rate relativity due to higher exposure to loss.

Part-time Status

Professionals who work 20 hours or less per week are part-time professionals, and WG has determined that the rate should be 50% of the base rate shown in the table below.

Part-time Rating Table

	Rate Relativity
Full-time	**1.00**
Part-time	0.50

Territory

Rate relativities also apply to the base rate to calculate the rate for a nurse in a specific territory.

Territory	Rate Relativity
1	0.80
2	**1.00**
3	1.25
4	1.50

Claims-free Discount

Individual insureds who have been with WGIC for at least three consecutive years preceding the effective date of the current policy may qualify for a claims-free discount.

- To qualify, the individual insured cannot have cumulative reported losses in X/S of $5,000 over the prior 3 years.
- The amount of the claims-free discount is 15%.

Schedule Rating (SR)

Commercial lines insurers incorporate SR into their rating algorithms to adjust manual premium based on objective criteria or underwriter judgment.

WGIC's schedule rating plan includes the following credits and debits.

A. Continuing Education – A credit of up to 25% for attendance at approved continuing education courses and seminars. The total hours spent at courses and seminars must be at least 15 hours in the prior 12 months.

B. Procedure – A debit of up to 25% for nurses who have professional licenses and/or scope of practice in high-risk exposure areas such as invasive surgery or pediatric care.

C. Workplace Setting – A debit of up to 25% for nurses that work in high-risk workplace settings (e.g. surgical centers and nursing homes).

A maximum aggregate schedule rating credit or debit of 25% is used by WGIG.

Limit Factors

WGIC offers different per claim and annual aggregate limits for its Nurse's Professional Liability program. The following are relativities corresponding to each limit option:

Limit Rating Table

Limit Option	Rate Relativity
$100K/$300K	0.60
$500K/$1M	0.80
$1M/$3M	**1.00**
$2M/$4M	1.15

WGIC pays all ALAE in addition to the limit shown.

Deductible

Deductible options available to the insured reduce premium and the associated credit are shown below.

Deductible Rating Table

Deductible (Per Claim)	Credit
None	0%
$1,000	5%
$5,000	8%

Claims-made Factor

WGIC writes claims-made MM policies as opposed to occurrence policies.

- For CM policies, the coverage trigger is the date the claim is reported rather than the date the event occurs.
- A policyholder who buys a CM policy for the first time is only offered coverage for *claims occurring after the start of the policy* and *reported* during the year.
- When the CM policy is renewed, coverage is provided for claims occurring after the original inception date and reported during the policy period.
- Also, an extended reporting endorsement covers claims that occur during the coverage period but are reported after the policy terminates (e.g. a doctor who retires may purchase an extended reporting endorsement to cover claims reported after the MM policy terminates).

  The extended reporting endorsement factors adjust the premium based Years of Prior Claims-made Coverage. See Chapter 16 for more details on CM coverage.

Claims-Made Maturity Factors

Maturity	Factor
1st Year	0.200
2nd Year	0.400
3rd Year	0.800
4th Year	0.900
5th Year	0.950
6th Year	0.975
Mature	1.000

Extended Reporting Endorsement Factors

Years of Prior Claims-made Coverage	Factor
12 Month	0.940
24 Month	1.700
36 Month	2.000
48 Month	2.250
60 Month	2.400

Group Credit

The size of the credit depends on the number of nurses that are insured under the policy.

Group Credit

Number of Nurses	Credit
1	0%
2 – 14	5%
15+	10%

The final premium (including the group credit) should be calculated for <u>each nurse</u> and <u>aggregated for all professionals</u> to determine the premium for the group policy.

Minimum Premium

The rating manual specifies that the minimum premium for each nurse, after all discounts, is $100.

Medical Malpractice Rating Algorithm for WGIC

- Rating variables are applied multiplicatively, not additively, in consecutive order.
- Premium is rounded to the nearest penny after each step and to the nearest dollar amount at the end to determine the final premium per professional.

Total Premium per Professional = [Max of Min Premium in the rating manual of $100 or

(Base Rate per Nurse
x Specialty Relativity
x Part-time Status Relativity
x Territory Relativity
x (1.0 - Claims-free Discount)
x (1.0 +/- Schedule Rating Debit/Credit) x Limit Relativity
x (1.0 - Deductible Credit)
x Claims-made Factor
x (1.0 - Group Credit))]

The total policy premium for a policy with multiple professionals is the sum of the premium for the individual professionals on the policy.

Medical Malpractice Rate Calculation Example for WGIC

A practice of five nurses applied for MM coverage with WGIC.

Quoted premium was $6,500 for a single policy covering the five professionals.

The practice has recently added a psychiatric nurse, and has requested a new quote from WGIC to cover all six professionals on a single policy. Assume the following characteristics:

- The new nurse is an employed professional who works 15 hours per week.
- He was previously covered by an occurrence policy and is applying for a CM policy with WGIC.
- He practices in Wicked Good's Territory 3.
- He attended five hours of approved continuing education courses in the prior 12 months.
- He holds a professional license in senior care, which is considered high risk. He also works in a senior care facility. The underwriter has chosen to apply debits of 25% for each of these criteria, but the maximum aggregate debit allowable is 25%.
- The policy has $1M/$3M of coverage with a $1,000 deductible per claim.

The following rating tables from WGIC's rating manual is used to calculate the premium

Entries from Rating Manual	
Employed Annual Rate	$2,500
Specialty Relativity	0.80
Part-time Status Relativity	0.50
Territory 3 Relativity	1.25
Schedule Rating (subject to 25% maximum)	0%+25%+25% (capped at 25%)
Limit Relativity for $1M/$3M	1.00
Credit for $1000 Deductible	5%
Claims-made Factor	0.20
Group Credit	5%
Minimum Premium	$100

Using the rating manual's rating algorithm, the premium for the individual nurse is calculated as follows:

$282 = $2,500 x 0.80 x 0.50 x 1.25 x [1.00 + 0.25] x 1.00 x [1.00 - 0.05] x 0.20 x [1.00 - 0.05].

Since this premium is greater than the minimum premium per nurse of $100, it applies

The total premium for the six individuals combined is $6,782 = $6,500 + $282.

7 U. S. Workers Compensation Rating Manual Example 29 - 34

Workers compensation (WC) insurance is a heavily regulated line of business, and insurers are required to submit statistical information on WC losses and premium in detail to the National Council on Compensation Insurance (NCCI), which collects and aggregates the data for ratemaking purposes.

NCCI is the licensed rating and statistical organization for most states, but several states have independent bureaus or operate as monopolistic plans.

NCCI provides WC insurers with loss cost (the portion of the rates that covers the expected future losses and LAE for a policy) estimates.

WC insurers calculate their own rates by adjusting the NCCI loss costs to account for their UW expenses and any perceived difference in loss potential.

The WC ratemaking process produces a rate manual showing the manual premium for each risk.

The premium collected by the insurer is net premium (manual premium adjusted for premium discounts, individual risk rating modifications (e.g. schedule rating, experience rating), and expense constants).

WGIC writes WC insurance for small companies with 50 employees or less, relies on NCCI for the overall loss costs and rating tables, but is able to determine its expense provision needed to profitably write business.

Class Rate

The classification system groups employers with similar operations and similar loss exposures based on job duties performed by the employees.

The table below shows class rates for specific operations (in this case, retirement centers) that WGIC writes, and are based on the NCCI class rates, adjusted for WGIC's expenses and perceived differences in loss potential.

Class Rates

Class	Rate per $100 of Payroll
8810-Clerical	0.49
8825-Food Service Employees	2.77
8824-Health Care Employees	3.99
8826-All Other Employees	3.79

To calculate manual premium:

- determine which classes best describe the activities of the company seeking insurance.
- estimate the amount of exposure ($100s of payroll) expected for each class during the policy period using the insured's data.
- multiply the rate per $100 of payroll by the estimated payroll for each class, and aggregate across all classes for which the prospective insured has exposures to compute manual premium.

Rating and Underwriting Characteristics

Experience Rating (ER)

Manual rates are averages reflecting the usual conditions found in each class.

Manual rates are adjusted using ER to reflect that each risk within a class is different to some extent in terms of loss potential.

- ER applies for larger policies (which are believed to have more stable loss experience) and NCCI designates minimum aggregate manual premium for a company to be eligible for ER.
- Regulators mandate that ER be used if the employer meets the industry eligibility requirements.

When using ER, manual premium is adjusted upward if the actual losses for the company are higher than expected and vice versa. See Chapter 15 for more information on ER.

WGIC only insures small companies and thus ER is not applicable to its insureds.

Schedule Rating (SR)

WGIC has a set of credits and debits that require the underwriter to apply judgment in the UW process.

The underwriter uses judgment (based on experience and internal guidelines) to select a value between the maximum and minimum for each attribute that may apply for an insured's workplace operations.

The range of schedule credits and debits that WG's underwriters can apply is shown below:

- The overall maximum credit or debit that an underwriter can apply to a single policy is 25%.
- The policy must have an annual manual premium of at least $1,000 to qualify for schedule rating.

Schedule Rating

Range of Modification					
Premises	Classification Peculiarities	Medical Facilities	Safety Devices	Employees — Selection, Training, Supervision	Management — Safety Organization
+/-10%	+/-10%	+/-5%	-5% - 0%	+/-10%	+/-5%

Premium Credits

Additional premium credits can be offered to insureds for other factors that may reduce the risk of a WC claim or limit the cost of a claim once an injury has occurred.

- These credits are <u>not</u> subject to any overall maximum credit.

Premium Credits

Factor	Credit
Pre-employment Drug Screening	5%
Employee Assistance Program	10%
Return-to-Work Program	5%

Expenses

Expense Constant

- A fixed fee (expense constant, and in WG's case equal to $150 per policy) can be added to all policies to cover expenses common to all WC policies.
- This fee does not vary by policy size and covers expenses that are not included in the manual rate.

Premium Discount (for administrative expenses that vary with policy size)

- Not all expenses increase uniformly as the premium increases (e.g. a company with $200,000 of payroll may not generate twice the administrative expenses for the insurer as a $100,000 payroll insured).
- WC insurers reduce the premium for large insureds by using premium discounts to adjust for expense savings.

Since WG writes only policies for small companies, it does not offer premium discounts.

Minimum Premium

The WC rating manual specifies that the minimum premium for any policy is $1,500.

Workers Compensation Rating Algorithm for WGIC

The rating algorithm to calculate the final premium for a given policy using the aforementioned rating manual variables is as follows:

Total Premium = Higher of

$$[\sum_{i=1}^{N}(Class_i rate\ x\ \$Payroll\ for\ class_i / 100) \quad where\ N = number\ of\ classes$$

x (1.0+ Schedule Rating Factor)
x (1.0- Pre-Employment Drug Screening Credit)
x (1.0- Employee Assistance Program Credit)
x (1.0- Return-to-Work Program Credit)
+ Expense Constant]

and, the Minimum Premium specified in the rating manual ($1,500 in WGs case).

Premium is rounded to the nearest penny after each step and to the nearest dollar amount at the end to determine the total premium (as stated in the manual)

ER factors and premium discounts do not appear in WGIC's rating algorithm because these rating variables do not apply to its book of business.

Workers Compensation Rate Calculation Example for WGIC

A retirement living center with the following employee classes groups has requested a quote.

Payroll by Class

Class	Payroll
8810 – Clerical	$35,000
8825 - Food Service Employees	$75,000
8824 - Health Care Employees	$100,000
8826 - All Other Employees & Salespersons, Drivers	$25,000

- The center has trained its entire staff in first aid and first aid equipment is available in the building.
- The center has been inspected by Wicked Good and the premises are clean and well-maintained.
- The center requires all employees to be drug-tested prior to employment.

Steps in computing manual premium.

Step 1: Compute aggregate manual premium.

Manual Premium by Class

Class	Payroll	Payroll/$100	Rate per $100 of Payroll	Class Manual Premium
	(1)	(2)=(1)/100	(3)	(4)=(2)*(3)
8810 Clerical	$35,000	$350	0.49	$171.50
8825 - Food Service Employees	$75,000	$750	2.77	$2,077.50
8824 - Health Care Employees	$100,000	$1,000	3.99	$3,990.00
8826 - All Other Employees	$25,000	$250	3.79	$947.50
Total	$235,000			$7,186.50

Total manual premium for the policy is $7,186.50 = $171.50 + $2,077.50 + $3,990.00 + $947.50.

Step 2: Underwriter determination of the following credits that should apply based on the retirement living center's characteristics:

Schedule Rating Modifications

Modification					
Premises	Classification Peculiarities	Medical Facilities	Safety Devices	Employees — Selection, Training, Supervision	Management —Safety Organization
-10%	0%	0%	-2.5%	-5%	0%

The total credit (reduction to manual premium) for SR is 10% + 2.5% + 5% = 17.5%.

- The credit takes into account the first aid equipment, staff training, and cleanliness of the premises.
- Since the credit is less than the maximum allowable credit of 25%, the entire 17.5% credit is applied to the manual premium.

The schedule rating factor applied to manual premium is 0.825 =1.000 - 0.175.

Step 3: Determine the following other factors that apply to the policy:

Entries from Wicked Good's Rating Manual

Entries from Rating Manual	
Pre-employment Drug Screening Credit	5%
Employee Assistance Program Credit	0%
Return-to-Work Program Credit	0%
Expense Constant	$150

The Employee Assistance Program credit and Return-to-Work credit do not apply to the policy because the center does not have those programs.

Thus, the total premium for the policy is $5,782 = $7,186.50 x 0.825 x (1.0 - 0.05) x (1.0 - 0) x (1.0 - 0) + $150.

Since $5,782 is greater than the minimum premium per policy of $1,500, the total premium for the policy is $5,782.

8 Key Concepts 34 - 34

1. Basic components of a rate manual
   a. Rules
   b. Rate pages
   c. Rating algorithm
   d. Underwriting guidelines

2. Simple rating examples
   a. Homeowners
   b. Medical malpractice
   c. U.S. workers compensation

Chapter 3 – Ratemaking Data

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Introduction and Internal Data 36 - 42

The quality of the final rates depends on the quality and quantity of data available.

Ratemaking involves analyzing rate adequacy for various insurance products.

Insurers use internal historical data or industry historical data to compute rates.

Collection and maintenance of relevant and consistent historical data is critical to the process.

Use of relevant external or internal data that has some relationship to a new product offering is key when pricing a new insurance product.

This chapter focuses on:

- describing high-level specifications for ratemaking data
- discussing various data aggregation methods
- providing insights on external data.

INTERNAL DATA

Data requirements depend upon the type of ratemaking analyses being performed. Examples:

- A full multivariate classification analysis requires historical detail about each item being priced (e.g. an individual risk, policy, or class of policies).
- Conducting an overall analysis of the adequacy of rates does not require a detailed understanding of the individual characteristics for each policy

Two types of internal data involved in a ratemaking analysis are:

- *risk information* (e.g. exposures, premium, claim counts, losses, and claim or policy characteristics).
- *accounting information* (e.g. UW expenses and ULAE, and often available only at an aggregate level).

Data retrieval processes for ratemaking analysis vary from insurer to insurer.

Actuaries may have access to:

- a database specifically designed for ratemaking analyses.
- general databases containing detailed transactional information and then manipulate the data to make it appropriate for ratemaking analysis.

The following sections describe a particular set of database specifications for risk information and accounting information. The actuary should review the:

- key coverages of the individual insurance product and the type of ratemaking analysis to be performed to conclude whether existing data specifications are adequate.
- available data for appropriateness for its intended purpose, reasonableness and comprehensiveness of the data elements.

Risk Data

Insurer databases record policy exposure and premium separately from losses in a claims database, however the ratemaking analysis ultimately requires linking this information for ratemaking purposes.

Policy Database

A policy database captures *records* (i.e. individual policies or some subdivision of the policy) and *fields* (i.e. explanatory information about the record).

A record is defined in a product's policy database depending upon what <u>exposure measure</u> is used and how <u>premium is calculated</u>.

Examples of policy database organization for different lines of business:

- In homeowners insurance, a record may be a *home for an annual policy period*.
- In U.S. WC insurance, rating is based on the *payroll of industry classes* so separate records are maintained at the class level.
- In personal auto insurance, separate records are created for:
  i. *each coverage* (though this could be handled via a coverage indicator field in the database).
  ii. *each auto on a policy* (if multiple autos are insured on one policy) or separate records may be maintained for individual operators on each auto.

  Example: An auto policy insuring two drivers on two cars for six coverages could involve 24 records (or four records if coverage is handled as a field).

In addition, records are also subdivided according to any changes in the risk(s) during the policy period (i.e. if a policy is amended during the policy term, separate records are created for the partial policy periods before and after the change). See the examples provided later in this summary to better illustrate this.

Fields often present for each record in the policy database are:

- **Policy identifier**
- **Risk identifier(s)**: When there are multiple risks on a policy, unique risk identifiers are required (e.g. vehicle number and operator number may be necessary for personal auto databases).
- **Relevant dates**: While each record contains the effective and expiration dates for the policy or coverage, separate records are maintained for individual risks and/or individual coverages on the policy, and the start date of each risk/coverage is recorded.

  (e.g. if collision coverage for a new car is added to an existing auto policy, a record is added with the relevant start date noted).
- **Premium**: If the line of business has multiple coverages, premium is recorded by coverage as a separate record or via a coverage indicator field.

  (e.g. personal auto databases track premium separately for bodily injury, property damage, comprehensive, collision and earned and in-force premium can be calculated from the data on record).
- **Exposure**: Is typically the written exposure but it can be recorded by coverage.
- **Characteristics**: Include rating variables, UW variables, etc. Some characteristics describe the policy as a whole (e.g., the policy origination year), while others describe individual risks (e.g. make/model of automobile) and consequently vary between different records on the same policy.

Example: Homeowners policies used to construct a policy database:

- Policy A is written on 1/1/2010 with an annual premium of $1,100. The home is located in Territory 1 and the insured has a $250 deductible. The policy remains unchanged for the full term of the policy.
- Policy B is written on 4/1/2010 with an annual premium of $600. The home is located in Territory 2 and the insured has a deductible of $250. The policy is canceled on 12/31/2010.
- Policy C is written on 7/1/2010 with an annual premium of $1,000. The home is located in Territory 3 and has a deductible of $500. On 1/1/2011, the insured decreases the deductible to $250. The full annual term premium after the deductible change is $1,200.

Policy database construction:

Policy A can be represented with one record since expired at its original expiration date and had no changes.

Policy B is represented by two records because it was canceled before the policy expired.

The first record for contains information known at policy inception (e.g. one exposure and $600 in WP).

The second record represents an adjustment for the cancellation such that when aggregated, the two records show a result net of cancellation. As the policy was canceled 75% of the way through the policy period, the second record should show -0.25 exposure and -$150 (=25% x -$600) of written premium.

Policy C is represented by three records since it has a mid-term adjustment

The first record includes all the information at policy inception.

The second record negates the portion of the original policy that is unearned at the time of the amendment (i.e. -0.50 exposure and -$500 premium and deductible equal to $500).

The third record represents the information applicable to the portion of the policy written with the new deductible (i.e. +0.50 exposure and +$600 premium and deductible equal to $250).

Policy Database

Policy	Original Effective Date	Original Termination Date	Transaction Effective Date	Ded	Terr	Other Chars	Written Exposure	Written Premium
A	01/01/10	12/31/10	01/01/10	$250	1	…	1.00	$1,100
B	04/01/10	03/31/11	04/01/10	$250	2	…	1.00	$600
B	04/01/10	03/31/11	12/31/10	$250	2	…	-0.25	-$150
C	07/01/10	06/30/11	07/01/10	$500	3	…	1.00	$1,000
C	07/01/10	06/30/11	01/01/11	$500	3	…	-0.50	-$500
C	07/01/10	06/30/11	01/01/11	$250	3	…	0.50	$600

This is ordered by policy rather than transaction effective date.

In a more sophisticated data capture, information for:

- Policy B would be aggregated to one record that shows a “net” exposure of 0.75 and “net” written premium of $450.
- Policy C would be aggregated to two records representing before and after the deductible change.

  The first record would reflect the period of time with the $500 deductible and would have a “net” exposure of 0.50 and “net” written premium of $500.

  The second record reflecting the period of time with the $250 deductible would be identical to the third record in the original example. The exposure is 0.50 and written premium is $600. This type of transaction aggregation is required for statistical ratemaking analysis (e.g. GLMS see Chapter 10).

Claims Database

Each record represents a transaction tied to a specific claim (e.g. a payment or a change in reserve).

Claims involving multiple coverages or causes of loss may be represented as separate records or via indicator fields.

Fields often present for each record in a claims database are as follows:

- **Policy identifier**
- **Risk identifier(s)**: If relevant, the claim database contains a way to identify the risk that had the claim. This will be necessary to match the claim to the corresponding record in the policy database.
- **Claim identifier**: The claim database contains a unique identifier for each specific claim. This same identifier is used if the claim has multiple claim transaction records.
- **Claimant identifier**: The claim database contains a unique identifier for each specific claimant on a particular claim.
- **Relevant loss dates**: includes fields for the date of loss, the date the company was notified of the loss (i.e. the report date), and the date of the transaction for the specific record (e.g. date of a loss payment, reserve change, or claim status change).
- **Claim status**: Tracks whether the claim is open (i.e. still an active claim) or closed (i.e. has been settled). For some policies, it may be common for claims to be re-opened, and it may be advantageous to add the re-opened and re-closed status descriptions.
- **Claim count**: Identifies the number of claims by coverage associated with the loss occurrence. Alternatively, if each record or a collection of records defines a single claim by coverage, aggregating claim counts can be accomplished without this explicit field.
- **Paid loss**: Captures the payments made for each claim record. If there are multiple coverages, perils or types of loss, the loss payments can be tracked in separate fields or separate records.

  If the product is susceptible to catastrophic losses (e.g. hurricanes for property coverage), then catastrophic payments are tracked separately either through a separate record or an indicator included on the record.
- **Event identifier**: Identifies any extraordinary event (e.g. catastrophe) involving this particular claim.
- **Case reserve**: Includes the case reserve or the change in the case reserve at the time the transaction is recorded (e.g. if a payment of $500 is made at a particular date, and this triggers a simultaneous change in the case reserve, a record is established for this transaction and the paid loss and case reserve fields are populated)

  The case reserve is recorded in separate fields or records by coverage, peril or type of loss and by catastrophe or non-catastrophe claim, if applicable (as with paid losses).
- **Allocated loss adjustment expense**:

  If ALAE can be subdivided into finer categorization, additional fields may be used accordingly.

  Insurers may not set ALAE reserves and only payments are tracked on the database.

  If a case reserve for ALAE is set, it is maintained in the database, captured separately by coverage or peril and by catastrophe or non-catastrophe, if applicable.

  ULAE cannot be assigned to a specific claim and are handled elsewhere.
- **Salvage/subrogation**: If an insurer replaces property, it assumes ownership of the damaged property, which may then be reconditioned and sold to offset part of the payments made for the loss; these recoveries are called salvage. When an insurer pays for an insured's loss, the company receives the rights to subrogate (i.e. to recover any damages from a third party who was at fault to the loss event). Any salvage or subrogation that offsets the loss is tracked and linked to the original claim, if possible.
- **Claim characteristics**: Insurers may collect characteristics associated with the claims (e.g. type of injury, physician information). While studying the impacts of these characteristics on average claim size may be interesting for certain purposes (e.g. loss reserve studies), only characteristics known for every policyholder at the time of policy quotation are usable in the rating algorithm. V

Example: Homeowners policies used to construct a claims database:

The following example policies can help clarify the data requirements.

- Policy A: A covered loss occurs on 1/1/2010. The claim is reported to the insurer on 1/15/2010, and an initial case reserve of $10,000 is established. An initial payment of $1,000 is made on 3/1/2010, with a corresponding $1,000 reduction in the case reserve. A final payment of $9,000 is made on 5/1/2010, and the claim is closed.
- Policy B: No claim activity.
- Policy C: A covered loss occurs on 10/1/2010, is reported on 10/15/2010, and a case reserve of $18,000 is established. The insurer makes a payment of $2,000 on 12/15/2010, and reduces the case reserve to $17,000. An additional payment of $7,000 is made on 3/1/2011, and the case reserve is reduced to $15,000. The claim is closed on 3/1/2012, when the insurer makes a final payment of $15,000 and receives a $1,000 salvage recovery by selling damaged property.
- Policy C: A second loss occurs on 2/1/2011. The claim is reported on 2/15/2011, and an initial reserve of $15,000 is set. On 12/1/2011, the company pays a law firm $1,000 for fees related to the handling of the claim. The claim is closed on that date with no loss payments made.

Claims database construction:

The claim from Policy A generates 3 separate records:

- one when the claim is reported and the initial reserve is set,
- one when the first payment is made,
- one when the last payment is made.

There are no claim records for Policy B as no claims were reported.

The two claims from Policy C generate six records:

- For claim 1, one record when the claim is reported and the initial reserve is set, and three for the three different dates that payments and reserve adjustments are made.
- For claim 2, one record on the date it is reported and the initial reserve is set and a subsequent record on the date the claim is closed.

Claim Database

Policy	Claim Number	Accident Date	Report Date	Transaction Date	Claim Status	Claim Chars	Loss Payment	Case Reserve	Paid ALAE	Salvage/ Subro
A	1	01/10/10	01/15/10	01/15/10	Open	…	$	$10,000	$	$
A	1	01/10/10	01/15/10	03/01/10	Open	…	$1,000	$9,000	$	$
A	1	01/10/10	01/15/10	05/01/10	Closed	…	$9,000	$	$	$
C	2	10/01/10	10/15/10	10/15/10	Open	…	$	$18,000	$	$
C	2	10/01/10	10/15/10	12/15/10	Open	…	$2,000	$17,000	$	$
C	2	10/01/10	10/15/10	03/01/11	Open	…	$7,000	$15,000	$	$
C	2	10/01/10	10/15/10	03/01/12	Closed	…	$15,000	$	$	$1,000
C	3	02/01/11	02/15/11	02/15/11	Open	…	$	$15,000	$	$
C	3	02/01/11	02/15/11	12/01/11	Closed	…	$		$1,000	$

This is ordered by policy rather than transaction date.

Accounting Information

Some required data for ratemaking is not specific to any one policy.

- The salary of the CEO is an expense that cannot be allocated to line of business or individual policy.
- UW expenses and ULAE fall into this category and should be tracked at the aggregate level.

UW expenses (incurred in acquiring and servicing policies) include general expenses, other acquisition expenses, commissions and brokerage, and taxes, licenses, and fees.

- Commissions can be assigned to specific policies.
- General expenses (e.g. costs associated with the company's buildings, and other acquisition expenses like advertising costs) cannot be assigned to a specific claim and are tracked at the aggregate level.

Loss adjustment expenses (LAE) are expenses incurred in the process of settling claims.

- Allocated loss adjustment expenses (ALAE) are directly attributable to a specific claim and are captured on the claim record.
- Unallocated loss adjustment expenses (ULAE) cannot be assigned to a specific claim, and include items like the cost of a claim center or salaries of employees responsible for maintaining claims records. Since ULAE cannot be assigned to a specific claim, these are tracked at the aggregate level.

Insurers track UW and ULAE expenses paid by *calendar year*.

Subdivision to line of business (LOB) and state may be approximated.

Aggregate figures are used to determine expense provisions used in the ratemaking process.

2 Data Aggregation 42 - 44

Policy, claim, and accounting databases must be aggregated for ratemaking purposes.

Three objectives when aggregating data for ratemaking purposes are:

1. Accurately matching losses and premium for the policy
2. Using the most recent data available
3. Minimizing the cost of data collection and retrieval.

Four data aggregation methods are **calendar year (CY)**, **AY (AY)**, **policy year (PY)**, and **report year (RY)**.

- Each method differs in how well it achieves the above listed objectives.
- Annual accounting periods are used although other periods (e.g. monthly, quarterly) can be used too.
  The annual period does not need to be a CY (e.g. 1/1 to 12/31) but could be a fiscal year (e.g. 7/1/ to 6/30), however CY, by definition needs to be 1/1/XX – 12/31/XX.

CY aggregation captures premium and loss transactions during a 12-month CY (without regard to policy effective date, accident date, or report date of the claim).

- CY earned premium (EP) and earned exposure are those earned during a 12 month period. At CY end, ***all premium and exposures are fixed.***
- CY paid losses include all loss paid during the CY regardless of occurrence date or report date.
- CY Reported losses = paid losses + the change in case reserves during that twelve-month CY. ***At the end of the CY, all reported losses are fixed.***

Advantage of CY aggregation: data is quickly available at CY end. CY data is used for financial reporting so there is no additional expense to aggregate the data this way for ratemaking purposes.

Disadvantage of CY aggregation: the mismatch in timing between premium and losses.

CY EP come from policies in force during the year (written either in the previous or the current CY).

Losses, however, may include payments and reserve changes on claims from policies issued years ago.

CY year aggregation for ratemaking analysis may be most appropriate for lines of business or individual coverages in which losses are reported and settled relatively quickly (e.g. homeowners).

AY aggregation of premium and exposures follows the same precept as CY premium and exposures, and thus the method is often referred to as CY-AY or FY-AY.

AY aggregation of losses considers losses for accidents that have occurred during a twelve-month period, regardless of when the policy was issued or the claim was reported.

AY paid losses include loss payments only for those claims that occurred during the year.

AY reported losses = loss payments + plus case reserves only for those claims that occurred during the year.

At AY end, reported losses change as additional claims are reported, claims are paid, or reserves are changed.

Advantage: AY aggregation provides a *better* match of premium and losses than CY aggregation.

Losses on accidents occurring during the year are compared to EP on policies during the same year.

Since the AY is not closed (fixed) at year end, future development on known losses needs to be estimated.

Selecting a valuation date several months after year end allows the emergence of some development in the data which may improve the estimation of ultimate losses.

PY aggregation (a.k.a. UW year) considers all premium and loss transactions on policies that were written during a 12-month period, regardless of when the claim occurred or was reported, reserved, or paid.

- All premium and exposures earned on policies written during the year are part of that policy year's earned premium and earned exposures.
- Premium and exposures are fixed after the expiration date of all policies written during the year.
- PY paid losses include payments made on those claims covered by policies written during the year.
- PY reported losses = payments + case reserves only for those claims covered by policies written during the year.

  At PY end, losses change as additional claims occur, claims are paid, or reserves are changed.

Advantage: PY aggregation represents the *best* match between losses and premium (since losses on policies written during the year are compared with premium earned on those same policies).

Disadvantage: Data takes longer to develop than both CY and AY, since PY exposures for a product with an annual policy term are not fully earned until 24 months after the start of the PY.

RY aggregation is:

- similar to CY-AY except losses are aggregated according to when the claim was ***reported*** (as opposed to when the claim *occurred*).
- used for commercial lines products using claims-made policies (e.g. medical malpractice). See Chapter 16.

Overall versus Classification Analysis

When reviewing the adequacy of the overall rate level, the premium, losses, and exposures can be highly summarized (aggregated by CY, AY, PY, or RY for the product and location (e.g. state) being analyzed).

If a class analysis is being performed, then the data must be at a more refined level.

- For a univariate classification analysis, the data can be aggregated by year (AY or PY) for each level (e.g. territory) of the rating variable being studied.
- For a multivariate analysis, it is preferable to organize data at the individual policy or risk level.

Limited Data

Actuaries are sometimes required to perform ratemaking analysis and work with the data that is available and use actuarial judgment to overcome the data deficiencies (e.g. if EP by territory normally used for an analysis of auto territorial relativities is not available actuary may use in-force premium by territory to estimate the earned premium by territory).

3 External Data 44 - 47

When pricing an existing line of business, it is helpful to supplement internal data with external data.

When pricing a new line of business, using external data may be necessary.

The most commonly used sources of external information are described below.

A. Statistical Plans

U.S. property and casualty (P&C) insurance is regulated at the state level, and regulators require insurers to file statistical data that is consistent in format and summary-based.

Examples:

1. The Texas Private Passenger Automobile Statistical Plan.
   - TX used a benchmark rate system for setting personal auto premiums from which insurers could deviate.
   - The benchmark rates were determined based on an analysis of statistical data provided by insurers writing in Texas, with data aggregated by territory, deductible, and driver class.
   - The data was also publicly available and was used by insurers to supplement internal analyses.

2. National Council for Compensation Insurance (NCCI) and Insurance Services Office, Inc (ISO) are two organizations that meet the U.S. industry's need for aggregated data.
   - These organizations collect, summarize and analyze the aggregated data and make the results of the analysis available to the participating insurers.
   - Participating insurers may be able to request the aggregated data to perform their own independent analysis.
   - These statistical plans collect data at the transactional level, allowing insurers and actuaries to have the flexibility to perform in-depth analysis at both the overall and segment levels.

State regulators may initiate *ad hoc data calls* to address a specific need (e.g. several state regulators have requested closed claim information on medical malpractice claims, and medical malpractice insurers may request the data to supplement their own data.

B. Other Aggregated Industry Data

Many insurers voluntarily report data to various organizations to be aggregated and used by the insurance industry and by regulators, public policy makers, or the general public. Examples:

1. A large percentage of U.S. personal lines insurers report quarterly loss data for the "Fast Track Monitoring System", used by insurers and U.S. state regulators to analyze loss trends.
2. The Highway Loss Data Institute (HLDI) sponsored by U.S. personal auto insurance insurers:
    - compiles member insurer data and provides detailed loss information by type of car to member insurers and public policy makers.
    - provides highly summarized information useful to insurers as well as the general public (e.g. information on which make and model cars have the highest incident of auto injury).

C. Competitor Rate Filings/Manuals

Competitor rate filings may be available to the public (depending on the jurisdiction).

U.S. insurers may be required to submit rate filings (which include actuarial justification for rate changes and the manual pages needed to rate a policy) to the appropriate regulatory body when changing rates.

- A filed rate change may only involve a change to base rates only. However, the filing may still include helpful information related to overall indicated loss cost levels and trends in losses and expenses.
- However, if the insurer is making changes to rating variable differentials (e.g. driver age relativities) the filing may also include information about the indicated relationships between the different levels for each rating variable undergoing a change.

Insurers may be required to include the manual pages necessary to rate policies. Recall that a manual contains the rules, rating structures, and rating algorithms used to estimate the overall average premium level charged and the premium differences due to different characteristics.

- However it can be very difficult to get a complete copy of a competitor's rate manual.
    i. Insurers do not file a complete manual with each change, but rather file only the pages that are changing (it may take several filings to piece together a complete manual).
    ii. Insurers often create underwriting tiers, which have a significant impact on the final premium, and the rating manual without the underwriting rules is incomplete information.
- An insurer must take great care when relying on information from a competitor's rate filing.

    Each company has different insureds, goals, expense levels, and operating procedures, and if differences are material, competitor information may not be relevant (e.g. a personal automobile insurer specializing in writing preferred or super-preferred drivers t has different rates and rating variables than a non-standard personal automobile insurer).

D. Other Third-Party Data (not specific to insurance)

The most commonly used types are:

1. Economic data (e.g. Consumer Price Index (CPI))

   Insurers may examine the CPI at the component level (e.g. medical cost and construction cost indices) to find trends relevant to the insurance product being priced.

2. Geo-demographic data (i.e. average characteristics of a particular area).
   i. Population density can be a predictor of accident frequency.
   ii. Weather indices, theft indices, and average annual miles driven.

3. Credit data is used by insurers to evaluate the insurance loss experience of risks with different credit scores.

   Insurers feel credit is an important predictor of risk and began to vary rates accordingly.

4. Other information related to different insurance products include:
   - Personal automobile insurance: vehicle characteristics, department of motor vehicle records
   - Homeowners insurance: distance to fire station
   - Earthquake insurance: type of soil
   - Medical malpractice: characteristics of hospital in which doctor practices
   - Commercial general liability: type of owner (proprietor, stock)
   - Workers compensation: OSHA inspection data.

4 Key Concepts 47 - 47

1. Internal data
   a. Policy database
   b. Claim database
   c. Accounting data

2. Data aggregation
   a. Calendar year (CY)
   b. Accident year (AY)
   c. Policy year (PY)
   d. Report year (RY)

3. External data
   a. Data calls and statistical plans
   b. Other insurance industry aggregated data
   c. Competitor information
   d. Other third-party data

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 1993 exam

49. (4 points) Incurred losses can be related to earned premiums using several different time measurements as follows: i. Calendar year ii. Calendar/accident year iii. Policy year iv. Report year

a. (2 points) Provide one advantage and one disadvantage of each for use in ratemaking.
b. (1 point) Name a line of insurance which uses each time measurement. Your answer should be restricted to the material on the syllabus.
c. (1 point) For each line named in part b, state why the choice of time measurement is appropriate.

Questions from the 2006 exam:

32. (2 points)

a. (1.5 points) For both premium and loss data, describe the following methods for grouping ratemaking experience:
   - Policy Year
   - Calendar Year
   - Accident Year

b (0.5 point) For purposes of ratemaking, which method in part a. above is most responsive and which method is least responsive?

Questions from the 2007 exam:

53. (2.5 points)

a. (1.5 points) Briefly define policy year, calendar year, and accident year loss experience.
b. (0.5 point) Which of the three performs the best with respect to responsiveness? Explain.
c. (0.5 point) Which of the three performs the best with respect to matching premiums and losses? Explain.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 1993 Exam:

Question 49.

a. Calendar year data (premiums and losses) for ratemaking is readily available from annual statement page 14. However, it is susceptible to changes in reserve level adequacy from year to year.

   Calendar/accident year data is also readily available after the end of the year. However, AY losses at the end of the 1st year are immature and may require substantial development to determine an estimate of its ultimate value.

   Since policy year data is not available until two calendar years after the date of the 1st policy written, the data is more mature than the prior types mentioned. However, its delay in availability makes it less responsive to identifying any form of change in the experience.

   Report year data is convenient for claims made pricing, since the number of claims reported are frozen at the end of the report period. Not very useful for pricing occurrence coverage.

b. CY data is used in Auto Physical Damage ratemaking (Chernick), off the current syllabus), CY/ AY data is used in Automobile ratemaking (Stern, off the current syllabus), PY data is used in Commercial General Liability (Graves, off the syllabus), and RY data is used in CM ratemaking (Marker/Moh, off the syllabus).

c. CY data is appropriate due to the short tailed nature of auto physical damage, CY/AY data is appropriate for auto liability since it is responsive to change and since development does not exceed 63 months, PY data is stable and more mature, which is appropriate for long-tailed liability lines, and RY data is appropriate for traditional claims made analysis.

Solutions to questions from the 2006 exam:

32. (2 points)

a. (1.5 points) For both premium and loss data, describe the following methods for grouping ratemaking experience: Policy Year Calendar Year Accident Year

b (0.5 point) For purposes of ratemaking, which method in part a. above is most responsive and which method is least responsive?

Initial comments

Review of the following comments made by different authors is helpful prior to answering the question.

McClenahan on PY: Policy year data is based upon the year in which the policy giving rise to exposures, premiums, claims and losses is effective.

Graves on PY: For the premises and operations lines of insurance, policy year data is used for ratemaking. The main reason for this is that these lines of insurance tend to have long pay-out patterns (tails). Claims are not reported to insurers as quickly as in other lines. This creates a problem when trying to match incurred losses with the premiums from which they arise. This task of matching incurred losses to earned premiums is achieved through the use of policy year data.

McClenahan on AY: Generally insurers maintain claim data based upon accident date—the date of the occurrence which gave rise to the claim, and report date—the date the insurer receives notice of the claim. Claim data can then be aggregated based upon these dates. For example, the total of all claims with accident dates during 2001 is the accident year 2001 claim count:

Feldblum on RM: Ratemaking should balance the considerations of stability, responsiveness, and equity. Policy year experience, being the most homogeneous, represents stability; calendar year experience, being the most recent, represents responsiveness.

Feldblum on CY: Development factors are needed for policy year premium, but not necessarily for calendar year premium. Calendar year premiums include audit premiums from past policies. If the premium volume is steady, then the current year's audits, which actually relate to past exposures, are about equal to next year's audits, which relate to the current exposures.

Tiller on ratemaking responsiveness when using experience rating:

The length of the experience rating period usually ranges from two to five years. The shorter the period, the more responsive the plan will be to changes that truly affect loss (and ALAE) experience, such as changes in the risk control program, and the more subject to unusual fluctuations in loss (and ALAE) experience. Conversely, a longer period will result in less responsiveness to changes and to unusual or catastrophic occurrences.

CAS Model Solution

Part a.

Policy Year – Group premium and losses based upon policies issued during a given block of time.

Calendar Year – Experience for a give block of time.

Premiums = written premium during the period + unearned premium reserve at beginning of period – unearned premium reserve at end of period.

Losses = paid losses during period + reserves at end of period – reserves at beginning of period.

Accident Year – Premiums are the same as calendar year. Losses are grouped based upon accidents occurring during the period.

Part b. Calendar Year data is the most responsive because it is the most mature. Policy year is the least responsive because it is the least mature.

Solutions to questions from the 2007 exam:

53. (2.5 points)

   a. (1.5 points) Briefly define policy year, calendar year, and accident year loss experience.
   b. (0.5 point) Which of the three performs the best with respect to responsiveness? Explain.
   c. (0.5 point) Which of the three performs the best with respect to matching premiums and losses? Explain.

CAS Model Solution

a. PY: Losses are allocated to the year in which the policy was written.

   CY: Losses are allocated to the year in which payments were made and reserves were changed.

   AY: Losses are allocated to the year in which the accident occurred.

b. Calendar year is the most recent and responsive because there is no delay due to developing losses.

c. Policy year matches premiums and losses best because the losses are generated by the same policies for which premium was collected.

Chapter 4 – Exposures

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Criteria For Exposure Bases 49 - 51

Base rates are expressed as a rate per exposure (see chapter 2). Premium is calculated as the base rate multiplied by the number of exposures and adjusted by the effect of rating variables and other fees.

CRITERIA FOR EXPOSURE BASES (EB)

A good exposure base should meet the following 3 criteria. It should:

1. be ***directly proportional to expected loss***
2. be ***practical***
3. ***consider preexisting exposure bases used*** within the industry.

1. Proportional to Expected Loss

The expected loss of a policy with two exposures should be twice the expected loss of a policy with one exposure.

This does not mean that the exposure base is the only item by which losses vary.

Expected loss varies by factors used as rating or underwriting variables to reflect risk level differences.

The factor with the most direct relationship to the losses should be selected as the exposure base (which makes it more easily understood by the insured).

Example: Should homeowners insurance exposure base be number of house years or amount of insurance?

i. The expected loss for one home insured for 2 years is two times the expected loss of the same home insured for 1 year.

ii. The expected loss for homes also varies by amount of insurance purchased.

While the expected loss for a $200,000 home is higher than that for a $100,000 home, it may not necessarily be two times higher.

Since the EB should be the factor most directly proportional to the expected loss, number of house years is the preferred EB, and amount of insurance should be used as a rating variable.

The exposure base should be responsive to any change in exposure to risk. For some insurance lines, the exposure base can be responsive to even small changes in exposure.

Example:

Payroll is the commonly used exposure base for WC insurance. As the number of workers increases (decreases) or the average number of hours worked increases (decreases), both payroll and the risk of loss increase (decrease) too.

Thus, the EB (i.e., payroll) moves in proportion to expected losses, and the premium will change with this exposure base change as well.

2. Practical

The exposure base should be practical, meaning it should be:

1. objective
2. relatively easy to use and
3. inexpensive to obtain and verify.

The EB will be consistently measured by meeting these criteria.

A well-defined and objective exposure should not be able to be manipulated (by policyholders and producers/underwriters).

Moral Hazard Example:

Asking a personal auto policyholder to state their estimated **annual miles driven** provides opportunity for dishonesty more so than the use of **car-years** as the exposure base.

However, advances in technology may change the choice of EB for personal auto insurance.

Example: Onboard diagnostic devices can accurately track driving patterns and transmit this data to insurers.

Thus, some commercial long haul trucking carriers have implemented ***miles driven*** as an EB.

For products liability, ***products currently in use*** is the exposure base that is most proportional to expected loss.

However, it is difficult for most firms to accurately track how many of their products are actually being used during the period covered by the insurance policy.

Therefore, ***gross sales*** is used as the EB as it is a reasonable and practical proxy for products in use.

3. Historical Precedence

If there is a more accurate or practical EB than the one currently in use (e.g. miles driven versus car years), consider the following before implementing it.

1. Any change in the EB can lead to large premium swings for individual insureds.
2. A change in EB will require a change in the rating algorithm, which may require a significant effort to adjust the rating systems, manuals, etc.
3. Since ratemaking analysis is based on several years of data, a change in EB may necessitate significant data adjustments for future analyses.

   Example: WC has historically used ***payroll*** as an EB.

   In the 1980s, there was pressure to change the EB to ***hours worked*** for medical coverage to correct perceived inadequacies of the EB for union companies with higher pay scales.

   - Although hours worked made intuitive sense, the EB was not changed at that time, given concerns regarding the transition.
   - Instead, the rating variables and rating algorithm were adjusted to address the inequities (note that the debate over the choice of WC EB continues to reemerge).

EBs currently used for different lines of business are shown below:

Line of Business	Typical Exposure Bases
Personal Automobile	Earned Car Year
Homeowners	Earned House Year
Workers Compensation	Payroll
Commercial General Liability	Sales Revenue, Payroll , Square Footage, Number of Units
Commercial Business Property	Amount of Insurance Coverage
Physician's Professional Liability	Number of Physician Years
Professional Liability	Number of Professionals (e.g., Lawyers or Accountants)
Personal Articles Floater	Value of Item

2 Exposures For Large Commercial Risks 51 -51

Large commercial risks present challenges for the use more conventional EBs. The amount of exposure for each separate coverage is difficult to track.

Thus, ratemaking is often done via composite rating and loss-rated composite rating.

In *composite rating*, the premium is initially calculated using estimates for each exposure measure along with relevant rating algorithms for each coverage (e.g. commercial multi-peril policies use different exposure measures for each coverage part (e.g. ***sales revenue for general liability***, ***amount of insurance or property value for commercial business property***)).

Since these individual exposure estimates are expected to change over the policy term, a proxy measure is used to gauge the overall change in exposure to loss (e.g. if property value is chosen as the proxy exposure measure, a 20% increase in property value during the policy term would trigger a premium adjustment of 20% for the whole policy's premium), rather than auditing each exposure measure.

In *loss-rated composite rating*, premium is calculated based on the risk's historical loss experience, with the implicit exposure base being the risk itself (See Chapter 15 for more detail).

3 Aggregation of Exposures 51 – 61

Methods of Aggregation for Annual Terms

Two methods to aggregate exposures are CY (the same as Calendar-AY) and PY.

Recall the 4 common methods of data aggregation are CY, AY, PY, and RY.

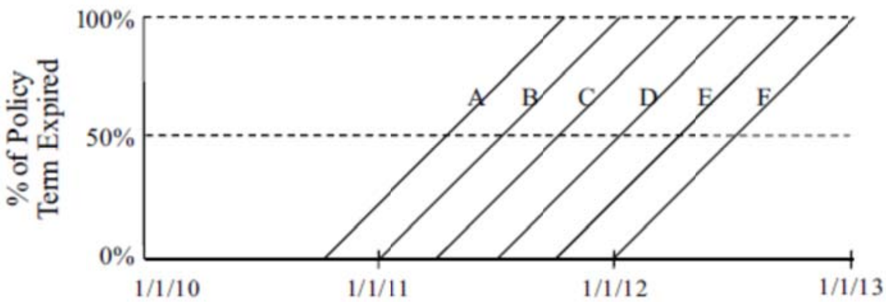
Homeowners policies are used to demonstrate these concepts for which there is one exposure per policy with an annual policy period. Base data for the example:

Policies

Policy	Effective Date	Expiration Date	Exposure
A	10/01/10	09/30/11	1.00
B	01/01/11	12/31/11	1.00
C	04/01/11	03/31/12	1.00
D	07/01/11	06/30/12	1.00
E	10/01/11	09/30/12	1.00
F	01/01/12	12/31/12	1.00

Note: Examples using semi-annual terms are provided later in this chapter.

These policies are represented pictorially below.



The x-axis represents time and the y-axis represents the percentage of the policy term that has expired (this representation is not applicable to products like warranty that don't earn evenly).

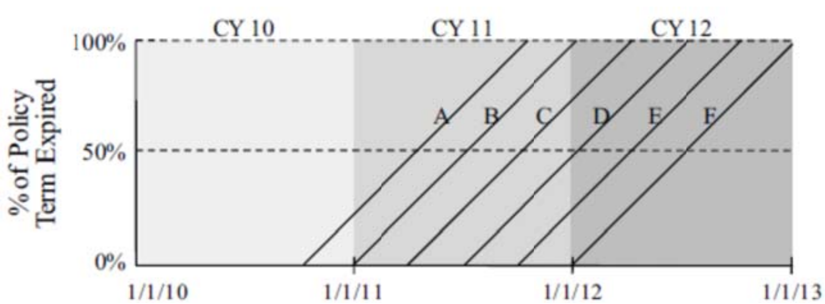
Each diagonal line represents a different policy.

- At policy inception, 0% of the policy term has expired, and that point is on the lower x-axis at the effective date.
- At policy expiration, 100% of the policy term has expired, and that point is located on the upper x-axis at the expiration date.
- The line connecting the effective and expiration points depicts the % of the policy term expired at each date.

CY and AY Aggregation consider all exposures during the 12-month CY without regard to the date of policy issuance. Since CY and AY exposures are generally the same (excluding policies that undergo audits), the text uses the term CY exposure.

- At the end of the CY, all exposures are <u>fixed</u>.
- Since CY captures transactions occurring on or after the first day of the year, and on or before the last day of the year, CY is represented graphically as a **square** (as shown below).

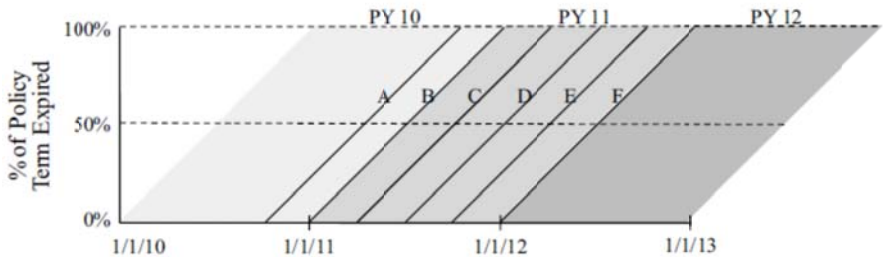
Calendar Year Aggregation



PY (a.k.a. UW year) aggregation considers all exposures on policies with effective dates during the year.

PY is represented graphically using a **parallelogram** starting with a policy written on the first day of the PY and ending with a policy written on the last day of the PY.

Policy Year Aggregation



Since PY data takes longer to capture, most ratemaking analysis focuses on CY exposures.

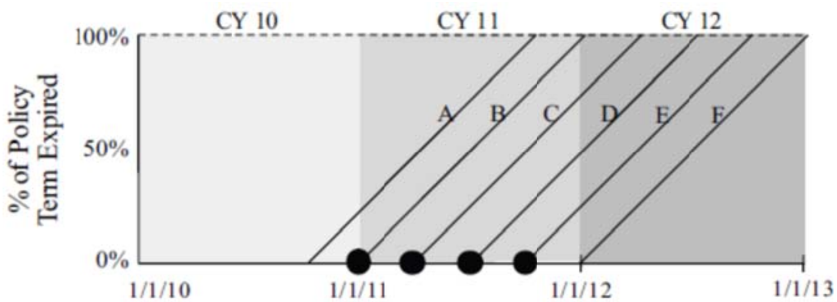
Four types of exposures

1. **Written exposures** arise from policies issued (i.e. underwritten or written) during a specified period of time (e.g. a calendar quarter or a CY).

   CY 2011 written exposures are the sum of the exposures for all policies that had an effective date in 2011.

   - Since policies B, C, D and E all have effective dates (shown as large circles on the horizontal axis) in 2011; their entire exposure contributes to CY 2011 written exposure.
   - However, policies A and F have effective dates in years 2010 and 2012, and thus do not contribute to CY 2011 written exposure.

   CY Written Exposures



Distribution of Calendar Year Written Exposures a/o 12/31/12

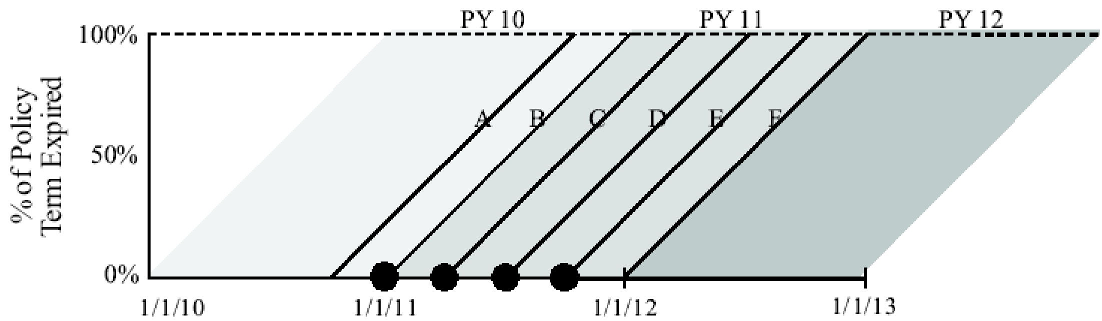
				Written Exposures		
Policy	Effective Date	Expiration Date	Exposure	CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	1.00	*1.00*	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	*1.00*
Total			6.00	1.00	4.00	1.00

Policy contribution to CY:

- Each policy contributes a written exposure to a single CY in this example.
- However, if a policy cancels midterm, the policy will contribute a written exposure to two different CYs if the policy cancellation date is in a different CY year than the original policy effective date. Example:

  If Policy D is cancelled on 3/31/2012 (i.e. after 75% of the policy has expired), then Policy D will contribute 1 written exposure to CY 2011 and -0.25 written exposure to CY 2012.

PY Written Exposure



Distribution of PY Written Exposures a/o 12/31/12

				Written Exposures		
Policy	Effective Date	Expiration Date	Exposure	PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	1.00	1.00	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	1.00	4.00	1.00

In case of cancellation, the original written exposure and the written exposure due to the cancellation are all booked in the same PY (since PY written exposures are aggregated by policy effective dates).

This contrasts with CY written exposure and cancellation exposure which can apply to two different CYs depending on when the cancellation occurs.

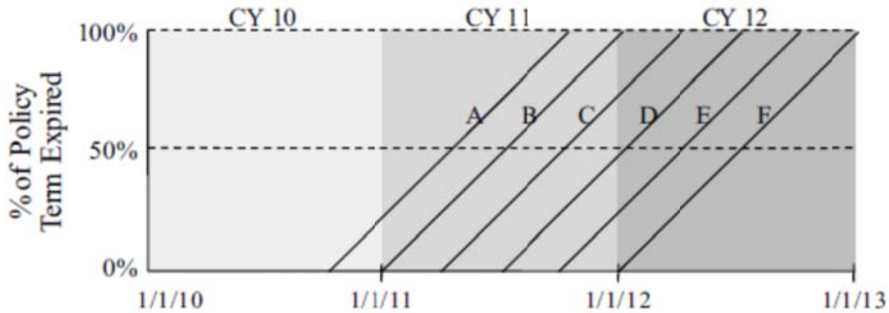
2. **Earned exposures** are the portion of written exposures for which coverage has already been provided as of a certain point in time.

   Assume the probability of a claim is evenly distributed throughout the year.

   If all policies are written on 1/1 for one year, earned exposures as of 5/31/XX are 5/12 of written exposures.

To better understand the difference between CY and PY earned exposures, look at the CY diagram:

CY Earned Exposure

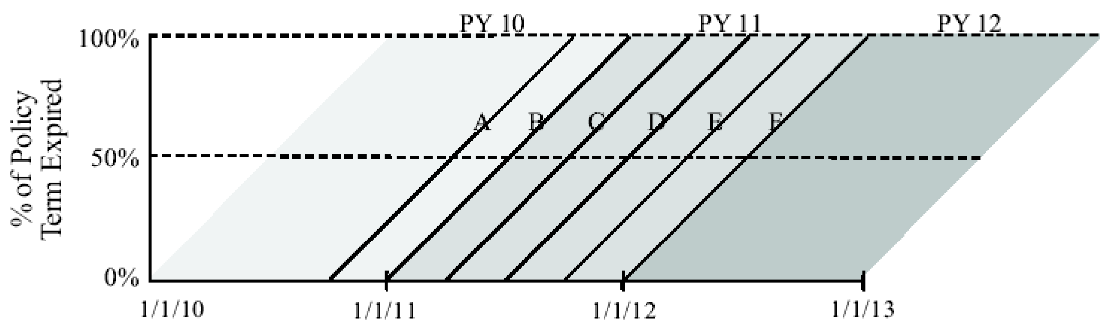


For Policy C, 75% of the policy period is earned in 2011 and 25% of the policy period is earned in 2012. Policy C contributes 0.75 (75% * 1.00) of earned exposure to CY 2011 and 0.25 earned exposure to CY 2012.

Distribution of Calendar Year Earned Exposures a/o 12/31/12

				Earned Exposures		
Policy	Effective Date	Expiration Date	Exposure	CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	1.00	0.25	0.75	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	***0.75***	***0.25***
D	07/01/11	06/30/12	1.00	0.00	0.50	0.50
E	10/01/11	09/30/12	1.00	0.00	0.25	0.75
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	0.25	3.25	2.50

Consider **PY Earned Exposure**



- Earned exposure is assigned to the year the policy was written and increases over time.
- At the end of a PY (i.e. 24 months after the start of a PY having annual policies), PY earned and written exposures are equivalent.
- ***Unlike CY earned exposure, exposure for one policy cannot be earned in two different PYs.***

Distribution of PY Earned Exposures a/o 12/31/12

				Earned Exposures		
Policy	Effective Date	Expiration Date	Exposure	PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	1.00	1.00	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	1.00	4.00	1.00

Note: An even earning pattern assumption is not appropriate for lines such as warranty and those affected by seasonal fluctuations in writings (e.g. boat owners insurance).

Earning pattern assumptions are usually based on historical experience.

3. **Unearned exposures** are the portion of written exposures for which coverage has not yet been provided as of that point in time (and applies to individual policies and groups of policies).

   Written Exposures = Earned Exposures + Unearned Exposures.

   For groups of policies, the formula depends on the method of data aggregation.
   * For PY aggregation as of a certain point in time, the formula above applies.
   * For CY aggregation, the formula becomes
     CY Unearned Exposures = CY Written Exposures – CY Earned Exposures + Unearned Exposures as of the beginning of CY.

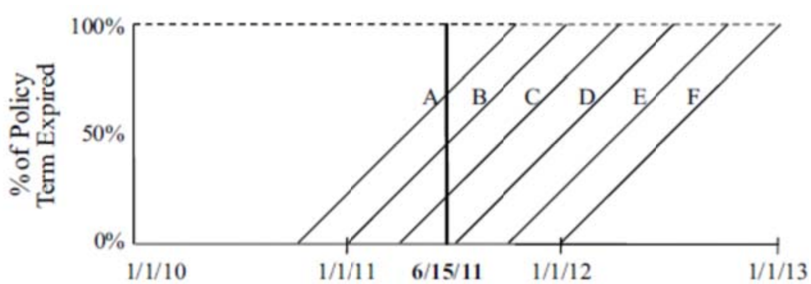
4. **In-force exposures** are the number of insured units exposed to having a claim at a given point in time.

   Example: The in-force exposure as of 6/15/2011 is the sum of full-term exposures for all policies that have an inception date on or before 6/15/2011 and an expiration date after 6/15/2011.

   A vertical line drawn at the valuation date will intersect the policies that are in-force on that date.

   Policies A, B, and C are in effect on 6/15/11 and each contributes to 6/15/11 in-force exposures.

In-Force Exposure



In-force Exposure by Date

				In-Force Exposure a/o		
Policy	Effective Date	Expiration Date	Exposure	01/01/11	06/15/11	01/01/12
A	10/01/10	09/30/11	1.00	1.00	1.00	0.00
B	01/01/11	12/31/11	1.00	1.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	1.00
D	07/01/11	06/30/12	1.00	0.00	0.00	1.00
E	10/01/11	09/30/12	1.00	0.00	0.00	1.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	2.00	3.00	4.00

Policy Terms Other Than Annual

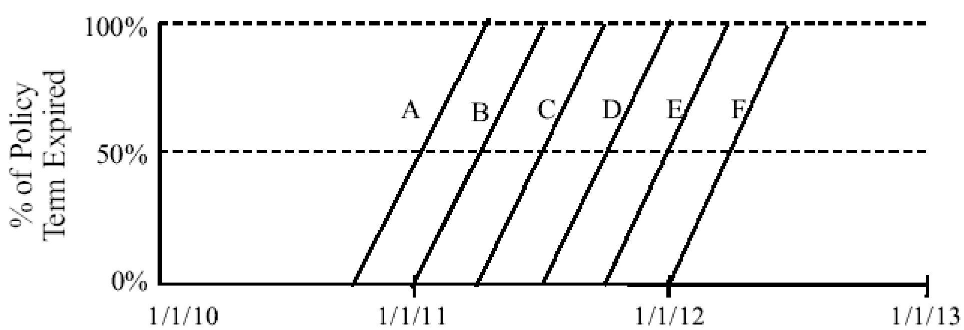
When policy terms are shorter or longer than a year, then aggregation for each type of exposure is calculated differently.

If the policies are six-month policies, each policy would represent one-half of an exposure

Six-Month Policies

Policy	Effective Date	Expiration Date	Exposure
A	10/01/10	03/31/11	0.50
B	01/01/11	06/30/11	0.50
C	04/01/11	09/30/11	0.50
D	07/01/11	12/31/11	0.50
E	10/01/11	03/31/12	0.50
F	01/01/12	06/30/12	0.50

Example Policies



<u>CY Written</u> Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Written Exposures CY 2010	CY 2011	CY 2012
A	10/01/10	03/31/11	***0.50***	***0.50***	0.00	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.50	0.00
F	01/01/12	06/30/12	*0.50*	0.00	0.00	*0.50*
Total			3.00	0.50	2.00	0.50

CY <u>Earned</u> Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposure CY 2010	CY 2011	CY 2012
A	10/01/10	03/31/11	0.50	***0.25***	***0.25***	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.25	0.25
F	01/01/12	06/30/12	0.50	0.00	0.00	0.50
Total			3.00	0.25	2.00	0.75

Policy Written Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Written Exposures PY 2010	PY 2011	PY 2012
A	10/1/2010	3/31/2011	0.50	0.50	0.00	0.00
B	1/1/2011	6/30/2011	0.50	0.00	0.50	0.00
C	4/1/2011	9/30/2011	0.50	0.00	0.50	0.00
D	7/1/2011	12/31/2011	0.50	0.00	0.50	0.00
E	10/1/2011	3/31/2012	0.50	0.00	0.50	0.00
F	1/1/2012	6/30/2012	0.50	0.00	0.00	0.50
Total			3.00	0.50	2.00	0.50

Policy Year Earned Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposures PY 2010	PY 2011	PY 2012
A	10/1/2010	3/31/2011	0.50	0.50	0.00	0.00
B	1/1/2011	6/30/2011	0.50	0.00	0.50	0.00
C	4/1/2011	9/30/2011	0.50	0.00	0.50	0.00
D	7/1/2011	12/31/2011	0.50	0.00	0.50	0.00
E	10/1/2011	3/31/2012	0.50	0.00	0.50	0.00
F	1/1/2012	6/30/2012	0.50	0.00	0.00	0.50
Total			3.00	0.50	2.00	0.50

Assuming insured units are “number of homes” insured at a point in time, each semi-annual policy contributes one in-force exposure.

In-force Exposure by Date

Policy	Effective Date	Expiration Date	No. of Houses Insured	In-Force Exposures a/o CY 2010	CY 2011	CY 2012
A	10/1/2010	3/31/2011	1.00	1.00	0.00	0.00
B	1/1/2011	6/30/2011	1.00	1.00	1.00	0.00
C	4/1/2011	9/30/2011	1.00	0.00	1.00	0.00
D	7/1/2011	12/31/2011	1.00	0.00	0.00	0.00
E	10/1/2011	3/31/2012	1.00	0.00	0.00	1.00
F	1/1/2012	6/30/2012	1.00	0.00	0.00	1.00
Total			6.00	2.00	2.00	2.00

Calculation of Blocks of Exposures

Insurers may have policy information summarized on a monthly or quarterly basis and need to calculate exposures for a block of policies using this summarized data. In such a case:

- it is customary to treat all policies as if they were written on the mid-point of the period.
- when summarizing on a monthly basis, all policies are assumed to be written on the 15th of the month. (i.e. this is known as “15th of the month” rule or the “24ths” method.)
- this approximation applies as long as policies are written uniformly during each time period.
- if this approach is applied to longer periods (e.g. quarters or years), the assumption of uniform writings is less likely to be reasonable.

To demonstrate how the rule applies, assume an insurer begins writing annual policies in 2010 and writes 240 exposures each month.

It is reasonable to assume that <u>some</u> of the 240 exposures written in July were in-force as of the first day of the month.

However, the “15th of the month” rule assumes that <u>none</u> of the exposures from the July policies contribute to in-force exposures as of 7/1/2010 because the rule assumes all the July policies are written on 7/15.

(see the table below and look at *in-force exposures as of 7/1/2010* and ***at 7/10/2010 written exposures)***.

Aggregate In-force Calculation

Written Month	Exposure	Assumed Effective Date	**07/01/10**	01/01/11	07/01/11
Jan 10	240	01/15/10	240	240	0
Feb 10	240	02/15/10	240	240	0
Mar 10	240	03/15/10	240	240	0
Apr 10	240	04/15/10	240	240	0
May 10	240	05/15/10	240	240	0
June 10	240	06/15/10	240	240	0
July 10	240	**07/15/10**	**0**	240	240
Aug 10	240	08/15/10	0	240	240
Sep 10	240	09/15/10	0	240	240
Cot 10	240	10/15/10	0	240	240
Nov10	240	11/15/10	0	240	240
Dec 10	240	12/15/10	0	240	240
Total	2,880		1,440	2,880	1,440

Earned Exposure %'s calculation:

Since policies for a given month are assumed to be written on the 15th of the month, the written exposures for annual policies will be earned over a 13-month calendar period:

- 1/24 of the exposure will be earned in the second half of the month in which it was written
- 1/12 (or 2/24) of the exposure will be earned in each of the next 11 months (i.e. months 2-12) and
- 1/24 of the exposure will be earned in the first half of month 13.

Distribution of earned exposures to CYs 2010 and 2011:

1	2	3	4	5	(6) = (2) x (4)	(7) = (2) x (5)
			Earned %		Earned Exposures	
Written Month	Exposures Written	Assumed Effective date	2010	2011	2010	2011
Jan 10	240	01/15/10	23/24	1/24	230	10
Feb 10	240	02/15/10	21/24	3/24	210	30
Mar 10	240	03/15/10	19/24	5/24	190	50
Apr 10	240	04/15/10	17/24	7/24	170	70
May 10	240	05/15/10	15/24	9/24	150	90
Jun 10	240	06/15/10	13/24	11/24	130	110
Jul 10	240	07/15/10	11/24	13/24	110	130
Aug-10	240	08/15/10	9/24	15/24	90	150
Sep-10	240	09/15/10	7/24	17/24	70	170
Oct 10	240	10/15/10	5/24	19/24	50	190
Nov 10	240	11/15/10	3/24	21/24	30	210
Dec 10	240	12/15/10	1/24	23/24	10	230
Total	2,881				1,440	1,440

(4) = Portion of exposure earned in 2010. (5) = Portion of exposure earned in 2011.

The same principles apply when using the "15th of the month" rule on PY aggregation.

4 Exposure Trend 61 - 62

For some lines of business, the exposure measure is inflation sensitive (e.g. payroll and sales revenue are influenced by inflationary pressures).

These trends can be measured via internal insurance company data (e.g. WC payroll) or via industry indices (e.g. average wage index).

The way in which exposure trend impacts the calculation of the overall rate level indication depends on:

- whether the loss ratio or pure premium method is employed and
- how loss trends are calculated

These are discussed in Chapters 5 and 6.

5 Key Concepts 63 - 63

1. Definition of an exposure

2. Criteria of a good exposure base
   a. Proportional to expected loss
   b. Practical
   c. Considers historical precedence

3. Exposure bases for large commercial risks

4. Exposure aggregation
   a. Calendar year v. policy year
   b. Written, earned, unearned, in-force

5. Calculation for blocks of exposure ("15th of the month" rule)

6. Exposure trend

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Criteria for Exposure Bases

Questions from the 1992 exam

53. In the Study Note Reading "Exposure Bases Revisited", Bouska discusses Causes and Controversy Involved in Changing Exposure Bases.
    (a) (1 point) What are the three desirable traits of an exposure base?
    (b) (1.5 points) Discuss the issues surrounding Workers Compensation with regard to using hours worked versus payroll.

Question from the 1995 exam

36. According to McClenahan, chapter 2, "Ratemaking," Foundations of Casualty Actuarial Science, the specific exposure unit used for a given type of insurance should depend on several factors.
    (a) (2 points) List and briefly describe the four factors he discusses.
    (b) (1 point) Based on the four factors in (a), discuss the use of the following exposure units for automobile ratemaking: 1) car years 2) miles driven per year.

Question from the 1997 exam

25. A. (1 point) According to the "Statement of Principles Regarding Property and Casualty Ratemaking," what are three desirable features for exposure units to have?

    C. (2 points) According to Bouska, "Exposure Bases Revisited," the standard exposure bases are often not used for large risks. Briefly describe two alternative rating plans used for large risks that modify the usual exposure base.

Questions from the 2009 exam

17. (2 points) An insurance company is considering changing the personal automobile exposure base from earned car years to number of miles driven.
    a. (1 point) Identify four desirable characteristics of an exposure base.
    b. (1 point) Discuss whether or not the change to a miles-driven exposure base should be made, referencing each of the four characteristics identified in part a, above.

Questions from the 2010 exam

16. (2 points)
    a. (1 point) Identify and briefly describe two criteria for a good exposure base.
    b. (0.5 point) Evaluate "market value of the house" as an exposure base for homeowners insurance using the two criteria identified in part a. above.
    c. (0.5 point) Provide two reasons why a change in exposure base may be difficult.

Questions from the 2011 exam

2. (1.5 points) An insurer is considering changing the exposure base used to price personal auto from earned car years to annual miles driven. Evaluate the merits of this change based on each of three different criteria of a good exposure base.

Questions from the 2012 exam:

2. (1.5 points) An insurance company is considering changing its exposure base for workers compensation from payroll to number of employees. Evaluate the merits of this change based on each of three different criteria of a good exposure base.

Section 2: Computing Exposures

Questions from the 2000 exam

38. (4 points) Based on McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below.

Personal Automobile Liability Data:

Calendar Year 1997		Calendar Year 1998	
Effective Date	Number of Autos Written on Effective Date	Effective Date	Number of Autos Written on Effective Date
January 1, 1997	100	January 1, 1998	900
April 1, 1997	300	April 1, 1998	1,100
July 1, 1997	500	July 1, 1998	1,300
October 1, 1997	700	October 1, 1998	1,500

Assume:

- All policies are twelve-month policies.
- Written premium per car during calendar year 1997 is $500.
- A uniform rate increase of 15% was introduced effective July 1, 1998.

a. (1/2 point) Calculate the number of in-force exposures on January 1, 1998. (chapter 4)

b. (1 point) Calculate the number of earned exposures for calendar year 1998. (chapter 4)

c. (1/2 point) List the two methods McClenahan describes that are used to adjust earned premiums to a current rate level basis. (chapter 5)

d. (1 point) Which of the two methods listed in part c. above would be more appropriate to use for this company's personal automobile liability business? Briefly explain why. (chapter 5)

e. (1 point) Using your selected method from part d. above, calculate the on-level earned premium for calendar year 1998. (chapter 5)

Questions from the 2010 exam:

17. (2 points) Given the following activity on five annual personal automobile policies as of June 30, 2009:

Policy	Effective Date	Original Expiration Date	Mid-term Cancellation Date
1	July 1, 2007	June 30, 2008	N/A
2	October 1, 2007	September 30, 2008	March 31, 2008
3	January 1, 2008	December 31, 2008	N/A
4	March 1, 2008	February 28, 2009	June 30, 2008
5	July 1, 2008	June 30, 2009	N/A

The exposure base is earned car years.

a. (0.5 point) Calculate the 2008 calendar year written exposure.

b. (0.5 point) Calculate the 2008 calendar year earned exposure.

c. (0.5 point) Calculate the 2007 policy year written exposure.

d. (0.5 point) Calculate the in-force exposure as of April 1, 2008.

Questions from the 2011 exam:

3. (1.25 points) Given the following:

- Each policy insures only one car
- Policies are earned evenly throughout the year

Policy	Effective Date	Original Expiration Date	Cancellation Date
A	February 1, 2009	July 31, 2009	
B	May 1, 2009	October 31, 2009	
C	August 1, 2009	January 31, 2010	
D	November 1, 2009	April 30, 2010	January 31, 2010
E	January 1, 2010	June 30, 2010	
F	July 1, 2010	December 31, 2010	

a. (0.25 point) Calculate the written car years in calendar year 2010.
b. (0.25 point) Calculate the written car years in policy year 2010.
c. (0.25 point) Calculate the earned car years in calendar year 2010.
d. (0.25 point) Calculate the earned car years in policy year 2010.
e. (0.25 point) Calculate the number of in-force policies as of January 1, 2010.

Questions from the 2012 exam:

3. (1.5 points) Given the following information:

- An insurance company started writing business on January 1, 2011.
- All policies are one-year term.

Policy Effective Dates	Exposures
January 1 through March 31	100
April 1 through June 30	200
July 1 through September 30	300
October 1 through December 31	400

a. (1 point) Calculate the 2011 earned exposures assuming policies are written uniformly during each quarter.
b. (0.5 point) Discuss the appropriateness of the assumption in part a. above given the exposure data.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Criteria for Exposure Bases

Solutions to questions from the 1992 exam

53. (a) 1. An accurate measure of the exposure to loss.
2. Easy to determine for the insurer.
3. Difficult to manipulate by the insured.

Present Day Update: While the above 3 criteria were the right answers in 1992, the current reading by Werner and Modlin, list them differently:

1. **Proportional to expected loss: The selected EB should be the factor most directly proportional to loss and be responsive to any change in exposure to risk.**
2. **Practical – Objective and Easy to Obtain/verify**
3. **Historical Precedence – changes in historical EB can cause large premium swings, changes in rating algorithms, and necessitate adjustments to historical data analyses.**

(b) It was caused by discontent among insureds over the inequities in the rating mechanism.

If a unionized company pays more per employee, it will have higher payroll and pay more for its WC coverage.

1. To the extent that the unionized company's indemnity losses are higher, the premium difference is correct.
2. To the extent that losses are from medical payments, or are capped by max benefits, use of payroll is not justified.

Solutions to questions from the 1995 exam

Question 36.

a1. Reasonableness: the exposure unit should be a reasonable measure of the exposure to loss.

2. Ease of Determination: the exposure unit must be subject to accurate determination.

3. Responsiveness to Change: It should react to change in the true exposure to loss.

4. Historical Practice: A change in an exposure unit could render the prior history unusable.

Present Day Update: The list according to Werner and Modlin is a little different:

1. **Proportional to expected loss: The selected EB should be the factor most directly proportional to loss and be responsive to any change in exposure to risk.**
2. **Practical – Objective and Easy to Obtain/verify**
3. **Historical Precedence – changes in historical EB can cause large premium swings, changes in rating algorithms, and necessitate adjustments to historical data analyses.**

b. Reasonableness: Car-years are a reasonable measure of the exposure to loss, but doesn't differentiate by type of vehicle. It is easy to determine and somewhat responsive to change. Historically, it has been the industry measure for some time.

Reasonableness: Miles driven are a reasonable measure of the exposure to loss, but doesn't account for the location of the driving (urban or rural). It is not easy to determine since it subject to audit by the insurance company. It is responsive to change, since the relative exposure to loss increases as miles driven increases. It would be difficult to implement and would render the prior history unusable.

Solutions to questions from the 1997 exam

Question 25.

A Exposure units should:

1. Vary with the hazard.
2. Be practical.
3. Be verifiable.

Present Day Update: The list according to Werner and Modlin is:

1. **Proportional to expected loss: The selected EB should be the factor most directly proportional to loss and be responsive to any change in exposure to risk.**
2. **Practical – Objective and Easy to Obtain/verify**
3. **Historical Precedence – changes in historical EB can cause large premium swings, changes in rating algorithms, and necessitate adjustments to historical data analyses.**

B. Question no longer applicable to the content in this chapter.

C. Large Risks are usually subject to either Composite Rating or Loss Rating.

1. Composite Rating is used to simplify the rating for insureds with multiple exposures (hundreds of vehicles in their auto fleets or many insured locations).
   - First, a proxy exposure base (such as receipts or mileage for long haul trucking) is selected.
   - Next, the rate per proxy unit is determined by dividing the risk's premium, calculated normally, by proxy exposure base.

   The simplified equation for charged premium = (Number of **expected** proxy units) * (Rate per proxy unit).

   After policy expiration, the firm's receipts are audited, so that the actual number of actual proxy units can be used to determine the firm's final premium.
2. Under Loss rating, the exposure base is the risk itself, and the rate is its expected losses.

   The equation for charged premium = Expected Losses + Expense Load, for a very large risk.

Solutions to questions from the 2009 exam

Question 17

a1. varies with the hazard (WM would say be directly proportional to expected loss)
2. verifiable (WM would say this is a characteristic of being practical)
3. not subject to manipulation (WM would say this is a characteristic of being practical)
4. practical

Present Day Update: The Werner and Modlin text uses the following list:

1. **Proportional to expected loss: The selected EB should be the factor most directly proportional to loss and be responsive to any change in exposure to risk.**
2. **Practical – Objective and Easy to Obtain/verify**
3. **Historical Precedence – changes in historical EB can cause large premium swings, changes in rating algorithms, and necessitate adjustments to historical data analyses.**

b1. Miles driven certainly varies with the hazard; the more you drive the more likely you are to get in an accident.
2. Verifiable - may not be easy to verify. Someone would have to inspect each car at the end of the year to read the odometer.
3. Certainly subject to manipulation. If the insured was asked how many miles driven in a year without verification, he could easily lie. Even if the number was verified, there are still ways to turn the numbers on an odometer back.
4. Miles driven is practical and intuitive. Most insured would understand that miles driven would be directly correlated to probability of accidents.

Overall, the change to miles driven should not be made since the downsides of costly verification and possibility of manipulation out weigh the benefits of varying with the hazard and practicality.

Solutions to questions from the 2010 exam

Question 16

a. (1 point) Identify and briefly describe two criteria for a good exposure base.

b. (0.5 point) Evaluate "market value of the house" as an exposure base for homeowners insurance using the two criteria identified in part a. above.

c. (0.5 point) Provide two reasons why a change in exposure base may be difficult.

a1. 1. Directly proportional to loss. The exposure should have direct relationship to loss and vary proportionally to it (i.e. the expected loss of a policy with two exposures should be twice the expected loss of a similar policy with one exposure).

a2. Practical. Exposure should be
- Objective, not subjective, and definitively measurable
- Verifiable. Can be checked

b1. No. A house with $ 200K market value does not have 2 times expected loss than house with $100K market value.

b2. No. Market value is somewhat subjective. No definite measure.

c1. Rates are likely to change substantially when an exposure base changes. Insured may not be happy with changes.

c2. System limitations: hard to build new system based on new exposure, and may not even have data for it.

Solutions to questions from the 2011 exam:

Question 2 – Model Solution 1

Car year to annual miles driven, 3 criteria:

1. Proportional to expected loss:

   Should select variable with the most direct relationship to loss. Should adjust based on modifications to exposure of the risk to a loss.

   Annual miles driven seems a better choice, since the more you drive, the more at risk you are to have a loss.

2. Practical: Should be objective, well-defined, and relatively easy to obtain and verify.

   Miles driven are objective and a well-defined exposure, but can be expensive to send inspectors to verify odometer. Also, if ask client, it is subject to moral hazard.

3. Historical precedent: Car years have historically been used. Changing to miles driven could cause: -significant variation in premium

   -need to modify systems

   -need to collect new data (cost of survey or inspections)

   Based on the 3 criteria, the costs of implementing this new structure and practical issues overweight the benefits of the 1st one. Should keep earned car years as exposure base.

Question 2 – Model Solution 2

Exposure base should be:

1. proportional to loss
2. practical (verifiable, objective, easy to admin)
3. Have historical precedence

Annual miles driven satisfies 1 in that it is proportional to loss. More miles driven = more exposure.

Annual miles driven does not satisfy 2 in that it is difficult to verify and can be easily manipulated.

Annual miles driven does not satisfy 3 since it hasn't been used in the past. Changing the exposure base may cause prem. swings. Also, the data needed may not be readily available to create a database.

Questions from the 2012 exam:

2. (1.5 points) An insurance company is considering changing its exposure base for workers compensation from payroll to number of employees. Evaluate the merits of this change based on each of three different criteria of a good exposure base.

Question 2 (Exam 5A Question 2)

1. Directly proportional to expected loss: Number of employees does reflect exposure to loss, but payroll is more reflective of exposure loss. For example, having twice as many employees does not mean that the expected losses will double, but only that frequency of loss would double (severity would depend on the payroll distribution). Payroll is responsive to changes in both frequency and severity.
2. Practical: Numbers of employees is a well-defined and objective measure. However, it may not be as easy to obtain as payroll information because payroll is tracked for numerous financial reports whereas number of employees is not. It may be harder to administer because insured could manipulate information regarding number of employees more easily than that regarding payroll.
3. Considers historical precedence: Number of employees does not meet this criteria because payroll has been used historically as the exposure base for WC. Changing to numbers of employees may lead to the following issues:
    1. Lead to large premium swings.
    2. Require significant systems changes.
    3. Require a change in rating algorithm.
    4. Necessitate significant data adjustments for future ratemaking analysis.

CONCLUSION: Given these constraints, I would NOT recommend changing the exposure base to number of employees.

Examiner Comments

Candidates scored well on this question. Some candidates lost points for either not supporting the reason or restating the criteria as the reason.

Section 2: Computing Exposures

Solutions to questions from the 2000 exam

Question 38.
Parts a and b. the number of in-force exposures on January 1, 1998, and earned exposures for CY 1998.

Effective Date	Number of Autos Written on Effective Date	Number of Inforce Exposures **on 1/1/98**	1998 Earned Factor	1998 Earned Exposures
	(1)	(2)	(3)	(4)=(1)*(3)
January 1, 1997	100	0	0.0	0
April 1, 1997	300	300	.25	75
July 1, 1997	500	500	.50	250
October 1, 1997	700	700	.75	525
January 1, 1998	900	900	1.0	900
April 1, 1998	1,100	0	.75	825
July 1, 1998	1,300	0	.50	650
October 1, 1998	1,500	0	.25	375
Total		2,400		3,600

* In-force exposures are the number of insured units exposed to having a claim at a given point in time.
Inforce exposure counts a full car year for each 12 month policy in force as of 1/1/98, regardless of the length of the remaining term.

* Earned exposures are the portion of written exposures for which coverage has already been provided as of a certain point in time. For example:
3 of the 12 months of coverage for the 300 exposures written on 4/1/97 occur during CY 1998. Assuming there are no policy cancellations, this portion (3/12) of the total exposures written will be earned during CY 1998, and thus the 1998 Earned Factor is .25.

Parts c., d. and e. See Chapter 5.

Solutions to questions from the 2010 exam:

Question 17. Compute CY, PY and In-force Exposures

Initial comments:

* CY captures transactions occurring on or after the first day of the CY, and on or before the last day of the CY.
* Ex. CY 2011 written exposures are the sum of the exposures for all policies that had an effective date in 2011.
* Earned exposures are the portion of written exposures for which coverage has already been provided as of a certain point in time.
* PY (a.k.a. UW year) aggregation considers all exposures on policies with effective dates during the year.
* In-force exposures are the number of insured units exposed to having a claim at a given point in time.
* If a policy cancels midterm, the policy will contribute written exposure to two different CYs if the date of the cancellation is in a different calendar year than the original effective date (positively or negatively, respectively)

CAS Model Solution "Un-Edited" shown below.

A. Policy	08 CY WE	B. Policy	08 CY EE
1	0	1	0.5
2	-0.5	2	0.25
3	1	3	1.0
4	1-2/3	4	0.333
5	1	5	0.5
	1.833		2.583

C. Policy	07 PY WE	D. Policy	In-Force 4/1/08
1	1.0	1	1
2	0.5	2	0
3	0	3	1
4	0	4	1
5	0	5	0
	1.5		3

Solutions to questions from the 2011 exam:

Question 3

Policy	Effective Date	Original Expiration Date	Cancellation Date
A	February 1, 2009	July 31, 2009	
B	May 1, 2009	October 31, 2009	
C	August 1, 2009	January 31, 2010	
D	November 1, 2009	April 30, 2010	January 31, 2010
E	January 1, 2010	June 30, 2010	
F	July 1, 2010	December 31, 2010	

a. (0.25 point) Calculate the written car years in calendar year 2010.
b. (0.25 point) Calculate the written car years in policy year 2010.
c. (0.25 point) Calculate the earned car years in calendar year 2010.
d. (0.25 point) Calculate the earned car years in policy year 2010.
e. (0.25 point) Calculate the number of in-force policies as of January 1, 2010.

Initial comments:

- Since we are asked to compute CY and PY written car years, CY and PY earned car years and in-force policies for six different policies, it is best to set up a table similar to the one below to answer the question in the most efficient way possible.
- Since the given policies are six-month policies, each would represent one-half of a written exposure.
- Since insured units are defined as number of autos insured at a point in time, each semi-annual policy can contribute to one in-force exposure.
- Since the exposures needing to be calculated are associated with 2010, it is clear that policy A and policy B contribute 0 exposures to questions a., b. c. d. and e.

Definitions of the type of exposures being asked to compute are as follows:

Written exposures arise from policies issued (i.e. underwritten or written) during a specified period of time (e.g. a calendar quarter or a CY). CY 2011 written exposures are the sum of the exposures for all policies that had an effective date in 2011.

If a policy cancels midterm, the policy will contribute a written exposure to two different CYs if the policy cancellation date is in a different CY year than the original policy effective date.

Policy D is cancelled on 1/31/2010, one half way through its policy period. Policy D will contribute 1/2 written exposure to CY 2009 and -(1/2)*(1/2) = -0.25 written exposure to CY 2010.

Earned exposures are the portion of written exposures for which coverage has already been provided as of a certain point in time.

The % of Policy C earned in CY 2010 is 1/6 (January only). Thus, Policy C contributes 1/2*1/6 = 1/12 earned exposures to CY 2010.

The % of Policy D earned in CY 2010 is 1/6 (January only). Thus, Policy D contributes 1/2*1/6 = 1/12 earned exposures to CY 2010.

Note: Unlike CY earned exposure, exposure for one policy cannot be earned in two different PYs.

In-force exposures are the number of insured units exposed to having a claim at a given point in time.

Policies A and B are not exposed to loss as of 1/1/2010 (due to policy expiration). Policy F is not exposed to loss as of 1/1/2010 (since it is not effective until 7/1/2010).

Solutions to questions from the 2011 exam:

Question 3 – CAS Model Solution

Policy	(a)	(b)	(c)	(d)	(e)
A	0	0	0	0	0
B	0	0	0	0	0
C	0	0	1/12	0	1
D	-1/4	0	1/12	0	1
E	1/2	1/2	1/2	1/2	1
F	1/2	1/2	1/2	1/2	0
Total	.75	1	14/12	1	3

Assume that a full policy = ½ car year (semi annual)

(a) .75 = -1/4 + 1/2 + 1/2

(b) 1 = 1/2 + 1/2

(c) 14/12 = 1/12 + 1/12 + 1/2 + 1/2

(d) 1 = 1/2 + 1/2

(e) 3 = 1 + 1 + 1 (recall that each semi-annual policy can contribute to one in-force exposure).

Questions from the 2012 exam:

3a. (1 point) Calculate the 2011 earned exposures assuming policies are written uniformly during each quarter.
3b. (0.5 point) Discuss the appropriateness of the assumption in part a. above given the exposure data.

Question 3 – Model Solution 1 (Exam 5A Question 3)

a. Pol Eff dates	Avg eff date	% yr rem	exp	EE
(1)	(2)	(3)	(4)	(5)=(3)*(4)
1/1 thru 3/31	2/15	0.875	100	87.5
4/1 thru 6/30	5/15	0.625	200	125.0
7/1 thru 9/30	8/15	0.375	300	112.5
10/1 thru 12/31	11/15	0.125	400	50.0
				375.0

2011 Earned Exposures: 375.0
3/12=.25/2=.125. [6/12+3/12]/2 = [.5+.25]/2=.375. [9/12+6/12]/2 = [.75+.5]/2=.625.
[12/12+9/12]/2 = [1.0+.75]/2=.875.

b The assumption of uniform writings throughout the quarter seems inappropriate, given that there is such a dramatic increase in writings from one quarter to the next. It's more likely that writings increase throughout the quarter as well.

Question 3 – Model Solution 2 (Exam 5A Question 3)

Proportion Earned

Jan– 23/24	
F - 21/24	100
M - 19/24	
A - 17/24	
M - 15/24	200
J - 13/24	
J- 11/24	
A - 9/24	300
S - 7/24	
O - 5/24	
N - 3/24	400
D - 1/24	

2011 Earned Exposure = Avg No. of Policies Written per month * monthly Proportion Earned by year end
= 100/3 [(23 +21+19) /24] + 200/3[(17+15+13)/24] + 300/3 [(11+9+7)/24] + 400/3 [(5+3+1)/24]
= 87.5 + 125 + 112.5 + 50 = 375

b. Exposure is increasing each quarter. It is likely that this is the case within quarter ie March has more exposure than January. We assume uniform exposure which does not appear correct with this increasing observed exposure trend.

Solutions to questions from the 2012 exam

Question 3 – Model Solution 3 (Exam 5A Question 3)

a

Policy eff dates	exposures	Average written	Earned year	earned
1/1 – 3/31	100	2/15	10.5/12	87.5
4/1 – 6/30	200	5/15	7.5/12	125
7/1 – 9/30	300	8/15	4.5/12	112.5
10/1 – 12/31	400	11/15	1.5/12	50.
				375
				(Answer for a))

b. Appropriate to assume that policies are written uniformly during each quarter?

→ As written exposures are steadily increasing.
It won't be appropriate to assume policies are uniformly written during the year.
→ Quarterly periods are fairly granular enough to assume that polices are written uniformly in the period.

Examiners Comments

Candidates scored well on this question. Some candidates used the same assumptions but applied/calculated on a monthly basis. This was given full credit as well. Common mistakes include making the exposures uniform throughout the year and effective at the beginning of the month instead of uniform throughout the quarter.

1 Premium Aggregation 63 - 70

The goal of ratemaking is to balance the fundamental insurance equation:

Premium = Losses + LAE + UW Expenses + UW Profit.

The ratemaking process begins with applying a series of adjustments to historical premium.

1. Bring historical premium to the rate level currently in effect.
   Without this adjustment, any rate changes during or after the historical period with not be fully reflected in the premium and will distort the projections
2. Develop premium to ultimate levels if the premium is still changing.
3. Project the historical premium to the premium level expected in the future.
   This accounts for changes in the mix of business that have occurred or are expected to occur after the historical experience period.
   Appendices A, C, and D provide examples from various lines of business of the premium adjustments made in ratemaking analysis.

Two approaches to evaluate the adequacy of rates underlying an insurer's premium are the:

- Pure premium approach and
- Loss ratio approach.
  The loss ratio approach requires that premium to be collected during a future time period be estimated (this is not the case when using the pure premium approach). When using the pure premium approach, the adjustments in this chapter are not needed.

This chapter covers:

- ways to define and aggregate premium
- techniques used to adjust historical premium to current rate level
- techniques used to develop historical premium to ultimate level
- techniques used to measure and apply premium trend

Methods of Aggregation for Annual Terms

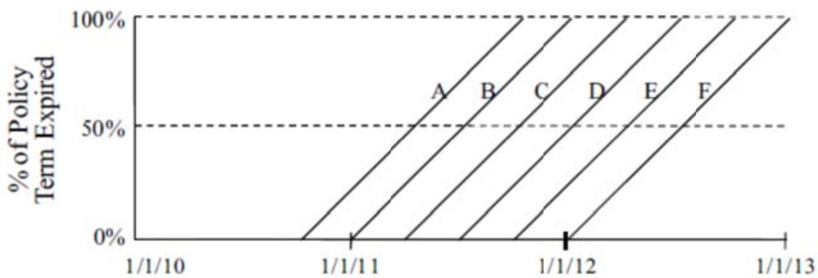
Two methods to aggregate premiums are CY (the same as Calendar-AY) and PY.

Recall the 4 common methods of data aggregation are CY, AY, PY, and RY.

Homeowners policies are used to demonstrate these concepts

Policy	Effective Date	Expiration Date	Premium
A	10/01/10	09/30/11	$200
B	01/01/11	12/31/11	$250
C	04/01/11	03/31/12	$300
D	07/01/11	06/30/12	$400
E	10/01/11	09/30/12	$350
F	01/01/12	12/31/12	$225

These policies are illustrated below.

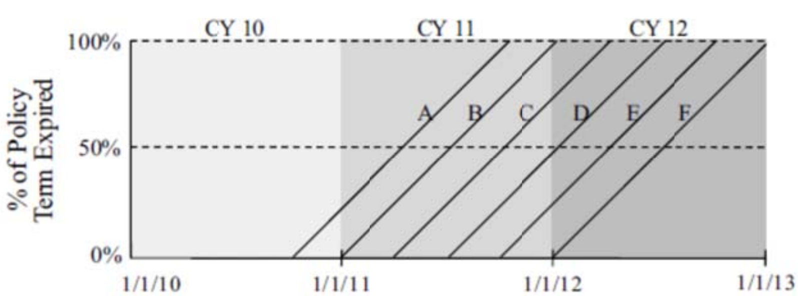


The x-axis represents time and the y-axis represents the percentage of the policy term that has expired (this representation is not applicable to products like warranty that don't earn evenly).

CY and AY Aggregation consider all premium transactions during the 12-month CY without regard to the date of policy issuance (since CY and AY premiums are equivalent, the text uses the term CY premium).

- At the end of the CY, CY premiums are fixed.
- Since CY captures transactions occurring on or after the first day of the year, and on or before the last day of the year, CY is represented graphically as a **square** (as shown below).

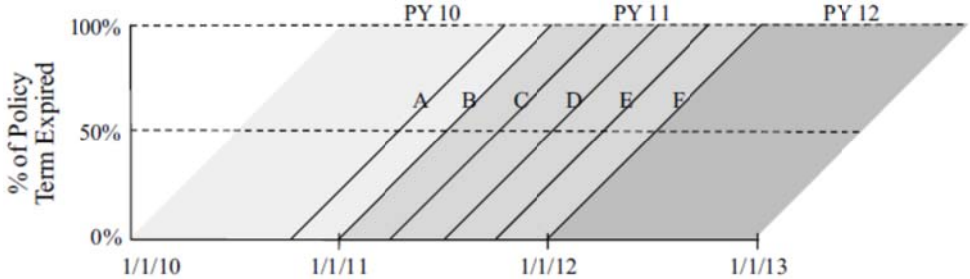
CY Aggregation



PY (a.k.a. UW year) aggregation considers all premiums on policies with effective dates during the year.

PY is represented graphically using a **parallelogram** starting with a policy written on the first day of the PY and ending with a policy written on the last day of the PY.

PY Aggregation



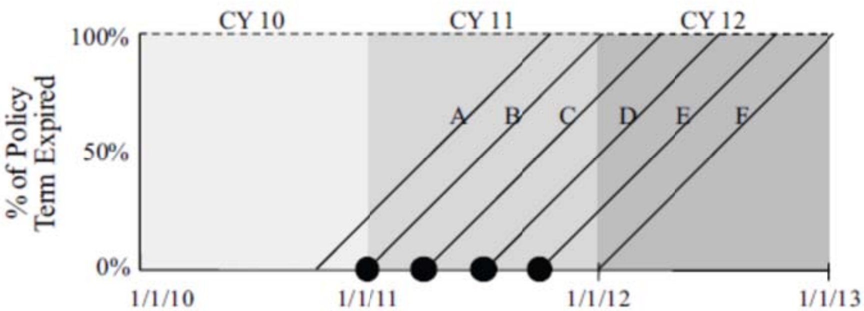
Since a PY takes 24 months to complete, and CY premium is fixed at 12 months, most ratemaking analysis focuses on CY premiums (and AY losses).

Four types of premium

1. **Written premium** arise from policies issued (i.e. underwritten) during a specified period of time (e.g. a calendar quarter or a CY).

   CY 2011 written premium is the sum of premiums for policies having an effective date in 2011.
   - Since policies B, C, D and E all have effective dates (shown as large circles on the horizontal axis) in 2011, their entire premium contributes to CY 2011 written premium.
   - However, policies A and F have effective dates in years 2010 and 2012, and thus do not contribute to CY 2011 written premium.

CY Written Premium



The distribution of written premium to each calendar year is shown below:

Calendar Year Written Premium a/o 12/31/12

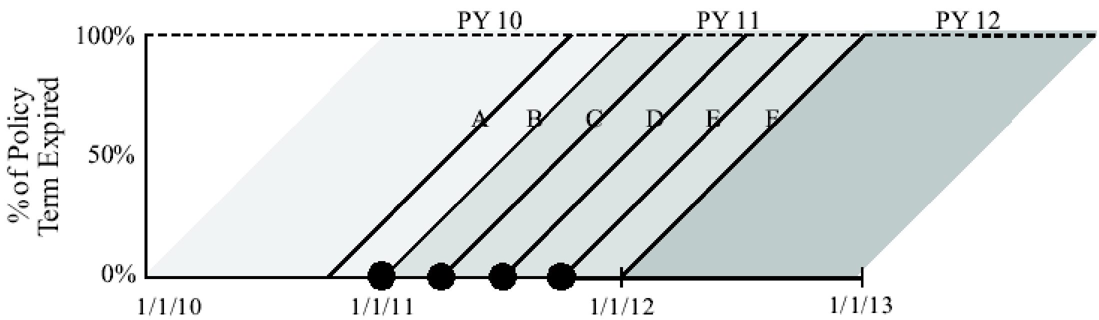
Policy	Effective Date	Expiration Date	Premium	Written Premium CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	$200.00	$200.00		
B	01/01/11	12/31/11	$250.00		$ 250.00	
C	04/01/11	03/31/12	$300.00		$ 300.00	
D	07/01/11	06/30/12	$400.00		$ 400.00	
E	10/01/11	09/30/12	$350.00		$ 350.00	
F	01/01/12	12/31/12	$225.00			$225.00
Total			$1725.00	$200.00	$1,300.00	$225.00

Policy contribution to CY:

- Each policy contributes written premium to a single CY in this example.
- However, if a policy cancels midterm, the policy will contribute written premium to two different CYs if the policy cancellation date is in a different CY year than the original policy effective date.

  If Policy D is cancelled on 3/31/2012 (i.e. after 75% of the policy has expired), then Policy D will contribute $400 of written premium to CY 2011 and -$100= (-$400 *.25) of written premium to CY 2012.

PY Written Premium



Distribution of PY Written Premium a/o 12/31/12

	Effective	Expiration		Written Premium		
Policy	Date	Date	Premium	PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	$200.00	$200.00		
B	01/01/11	12/31/11	$250.00		$250.00	
C	04/01/11	03/31/12	$300.00		$300.00	
D	07/01/11	06/30/12	$400.00		$400.00	
E	10/01/11	09/30/12	$350.00		$350.00	
F	01/01/12	12/31/12	$225.00			$225.00
Total			$ 1,725.00	$200.00	$1,300.00	$225.00

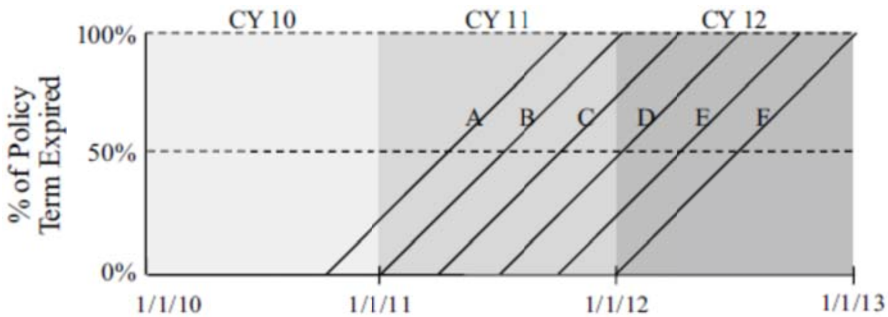
In case of cancellation, the original written premium and the written premium due to the cancellation are booked to the same PY (since PY written premium are aggregated by policy effective dates).

This contrasts with CY written premium and cancellation premium which can apply to two different CYs depending on when the cancellation occurs.

2. **Earned premium** are the portion of written premium for which coverage has been provided and the insurer is entitled to retain as of a certain point in time.

   To better understand the difference between CY and PY earned exposure, look at the CY diagram:

CY Earned premium

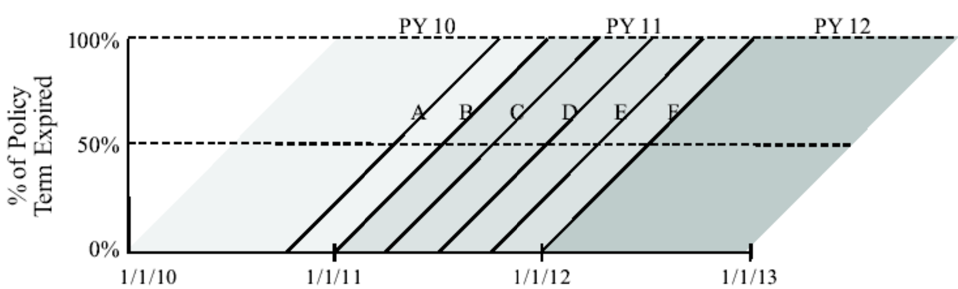


For Policy C, 75% of the policy period is earned in 2011 and 25% of the policy period is earned in 2012.
Policy C contributes $225 (75% * $300) of earned premium to CY 2011 and $75 earned premium to CY 2012.

Distribution of CY Earned Premium a/o 12/31/12

Policy	Effective Date	Expiration Date	Premium	Earned Premium CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	$200.00	$50.00	$150.00	
B	01/01/11	12/31/11	$250.00		$250.00	
C	04/01/11	03/31/12	$300.00		***$225.00***	***$75.00***
D	07/01/11	06/30/12	$400.00		$200.00	$200.00
E	10/01/11	09/30/12	$350.00		$87.50	$262.50
F	01/01/12	12/31/12	$225.00			$225.00
Total				$50.00	$912.50	$762.50

PY Earned Premium:



- Earned premium is assigned to the year the policy was written and increases over time.
- At the end of a PY (i.e. 24 months after the start of a PY having annual policies), PY earned and written premium are equivalent.
- ***Unlike CY earned premium, premium for one policy cannot be earned in two different PYs.***
- Premiums for lines subject to premium audits continue to develop after the end of the policy period.

PY Earned Premium a/o 12/31/12

Policy	Effective Date	Expiration Date	Premium	Earned Premium PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	$200.00	$200.00		
B	01/01/11	12/31/11	$250.00		$250.00 $	-
C	04/01/11	03/31/12	$300.00		$300.00	
D	07/01/11	06/30/12	$400.00	-	$400.00	
E	10/01/11	09/30/12	$350.00	-	$350.00	
F	01/01/12	12/31/12	$225.00			$225.00
Total			$1,725.00	$200.00	$1,300.00	$225.00

3. **Unearned premium** is the portion of written premium for which coverage has not yet been provided as of that point in time (and applies to individual policies and groups of policies).

   Written Premium = Earned Premium + Unearned Premium (ok when PY aggregation is used)

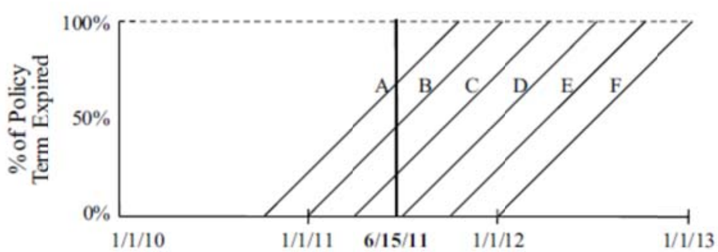
   CY Unearned Premium = CY WP – CY EP + Unearned Premium as of the beginning of the CY.
4. **In-force premiums** are the number of insured units exposed to having a claim at a given point in time.

   Example: The in-force premium as of 6/15/2011 is the sum of full-term premium for all policies that have an inception date on or before 6/15/2011 and an expiration date after 6/15/2011.

   A vertical line drawn at the valuation date will intersect the policies that are in-force on that date.

   Policies A, B, and C are in effect on 6/15/11 and each contributes to the 6/15/11 in-force exposures.

In-Force Premium



In-force Premium by Date

Policy	Effective Date	Expiration Date	Premium	In-Force Premium a/o 01/01/11	06/15/11	01/01/12
A	10/01/10	09/30/11	$200.00	$200.00	$200.00	$--
B	01/01/11	12/31/11	$250.00	$250.00	$250.00	--
C	04/01/11	03/31/12	$300.00		$300.00	$300.00
D	07/01/11	06/30/12	$400.00			$400.00
E	10/01/11	09/30/12	$350.00			$350.00
F	01/01/12	12/31/12	$225.00			$225.00
Total			$1,725.00	$450.00	$750.00	$1,275.00

Calculation of in-force premium (in case of a mid-term adjustment):

- Assume Policy D is changed on 1/1/2012 and full-term premium increases from $400 to $800.
- The policyholder will pay $600 (=$400 x 0.5 + $800 x 0.5).
- The in-force premium is $400 for an in-force date between 7/1/2011 and 12/31/2011 and $800 for an in-force date between 1/1/2012 and 6/30/2012.
- The in-force premium is the best estimate of the insurer's mix of business as of a given date. The most recent in-force premium is used to measure the impact of a rate change on an existing portfolio.

Policy Terms Other Than Annual

When policy terms are not annual the concepts are the same. See chapter 4 for the techniques involved. Caution is needed when interpreting in-force premium when considering portfolios with policies of different terms.

Calculation of Blocks of Policies

Insurers may have policy information summarized on a monthly or quarterly basis and need to calculate exposures for the block of policies using this summarized data. In such a case,

- it is customary to treat all policies as if they were written on the mid-point of the period.
- when summarizing on a monthly basis, all policies are assumed to be written on the 15th of the month. (i.e. this is known as "15th of the month" rule)
- this approximation applies as long as policies are written uniformly during each time period.
- if this approach is applied to longer periods (e.g. quarters or years), the assumption of uniform writings is less likely to be reasonable.

2 Adjustments To Premium 70 - 87

To project future premium, historical premium must be:

- **brought to current rate level**. This involves adjusting premium for rate increases (decreases) that occurred during or after the historical experience period.

  This is known as adjusting the premium "to current rate level" or putting the premium "on-level".

  Two current rate level methods are extension of exposures and the parallelogram method.
- **developed to ultimate**. This is relevant when an analyzing incomplete policy years or premium that has yet to undergo audit.
- **adjusted for actual or expected distributional changes**. This is done through premium trending, and both the one-step and two-step trending are discussed in this section.

Current Rate Level

Consider a case in which all policies were written at a rate of $200 during the historical period.

- After the historical period, there was a 5% rate increase so the current rate in effect is $210.
- Assume the "true" indicated rate for the future ratemaking time period is $220.

  i. If the historical rate (i.e. $200) is compared to the indicated rate (i.e. $220) without considering the 5% increase already implemented, the conclusion that rates need to be increased by 10% is reached, resulting in a new indicated rate of $231 (= $210 x 1.10), which is excessive.

  ii. If instead, historical premium were restated to the present rate level of $210 and compared to the indicated rate, the correct rate need of 4.8% (= $220/210 - 1.00) is reached.

The extension of exposures method and the parallelogram method bring premium to the current rate level are discussed below.

Simple Example

Assume policies have annual terms and premium is calculated according to the following rating algorithm:

Premium = Exposure x Rate per Exposure x Class Factor + Policy Fee.

The class factor has three values, or levels (X, Y, and Z), each with a distinct rate differential. The following three rate changes occurred during or after the historical experience period.

- 7/1/2010: the base rate was increased and resulted in an overall average rate level increase of 5%.*
- 1/1/2011: the base rate and policy fee were adjusted resulting in an overall average rate level increase of 10%.
- 4/1/2012: the policy fee and class Y and Z rate relativities were changed resulting in an overall average rate level decrease of -1%.

* The reader may be confused by the overall average rate changes provided in this example [e.g., how a 5.6% (=950/900-1.00) change in rate per exposure results in an overall average rate change of 5.0%]. The overall average rate change considers the average change in the total premium per policy, which is a function of the rate per exposure, the number of exposures per policy, the applicable class factors, and the policy fee. These detailed inputs have not been provided; the overall average rate change should be taken as a given for the purpose of illustrating premium at current rate level techniques.

Rate Change History

Rate Level Group	Effective Date	Overall Average Rate change	Rate Per Exposure	Class Factor X	Class Factor Y	Class Factor Z	Policy Fee
1	Initial	--	$900	1.00	0.60	1.10	$1,000
2	07/01/10	5.0%	$950	1.00	0.60	1.10	$1,000
3	01/01/11	10.0%	$1,045	1.00	0.60	1.10	$1,100
4	04/01/12	-1.0%	$1,045	1.00	0.70	1.10	$1,090

Method 1: Extension of Exposures

This method rerates every policy to restate historical premium to the amount that would be charged under the current rates.

Advantage: It is the most accurate current rate leveling method, given the level of current computing power to perform the number of calculations required to rerate each policy.

Disadvantage: The rating variables, risk characteristics and rating algorithm needed to rerate each policy during the historical period are often not readily available.

Assume the following:

- We wish to adjust the historical premium for PY 2011 to the current rate level.
- One such policy was effective on 3/1/2011 and had 10 class Y exposures.
- The actual premium charged for the policy was based on the rates effective on 1/1/2011, and was $7,370 (= 10 x $1,045 x 0.60 + $1,100).

To put the premium on-level:

- Substitute the current base rate, class factor, and policy fee in the calculations; this results in an on-level premium of $8,405 (= 10 x $1,045 x 0.70 + $1,090).
- Perform the same calculation for every policy written in 2011 and then aggregate across all policies.

Notes: Policies with the exact same rating characteristics can be grouped for the purposes of the extension of exposures technique, but is only relevant in lines with simple rating algorithms and few rating variables. In commercial lines products, where subjective debits and credits can be applied to manual premium, complicates the use of the extension of exposures technique since it may be difficult to determine what debits and credits would be applied under today's schedule rating guidelines.

Method 2: Parallelogram Method (a.k.a. the geometric method)

The parallelogram method:

- is performed on a group of policies
- is less accurate than extension of exposures.
- assumes that premium is written evenly throughout the time period
- involves adjusting aggregated historical premium by an average factor to put the premium on-level.
- application varies by policy term, method of aggregation (CY vs. PY), and whether the rate change affects policies midterm or only policies with effective dates occurring after the change.

Standard Calculations

The objective: Replace the average rate level for a given historical year with the current rate level.

The major steps are as follows:

1. Determine the timing and amount of the rate changes during and after the experience period and group the policies into rate level groups according to the timing of each rate change.
2. Calculate the portion of the year's earned premium corresponding to each rate level group.
3. Calculate the cumulative rate level index for each rate level group.
4. Calculate the weighted average cumulative rate level index for each year.
5. Calculate the on-level factor as the ratio of the current cumulative rate level index and the average cumulative rate level index for the appropriate year.
6. Apply the on-level factor to the earned premium for the appropriate year.

For the parallelogram method, exact rates are not required.

Step 1: Obtain the effective date and overall rate changes for the policies under consideration.

Recall that annual policies have been issued and rate changes apply to policies effective on or after the date (i.e. do not apply to policies in mid-term).

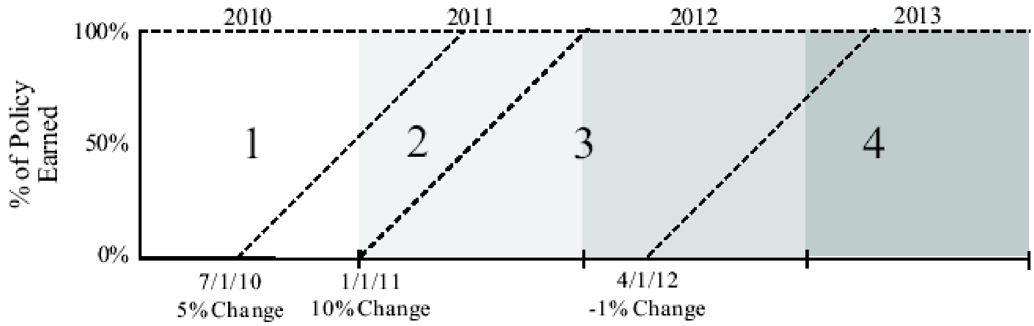
Rate Level Group	Effective Date	Overall Average Rate
1	Initial	
2	07/01/10	5.0%
3	01/01/11	10.0%
4	04/01/12	-1.0%

Step 2: View these rate changes in graphical format.

Assume the actuary is trying to adjust each CY's EP premium to current rate level.

- CYs are represented by squares.
- Each rate change is represented by a diagonal line, the slope of which depends on the term of the policy (which is annual in this case)
- The numbers 1, 2, 3, and 4 represent the rate level group in effect.

Rate Changes assuming CY EP with Annual Policies



Next calculate the portion of each CY's EP (the area within the square) that corresponds to each rate level.

For CY 2011, there are three areas representing EP on policies written:

- after 1/1/2010 and prior to the 7/1/2010 rate change (area of rate level group 1 in CY 2011).
- on or after 7/1/2010 and before 1/1/2011 (area of rate level group 2 in CY 2011).
- on or after 1/1/2011 and before 1/1/2012 (area of rate level group 3 in CY 2011).

Geometry and the assumption that the policies written are uniformly distributed are used to calculate the portion of the square represented by each rate level area.

Note: The following geometric formulae may be used in the parallelogram method:

Area of a triangle: ½ x base x height

Area of a parallelogram: base x height

Area of a trapezoid: ½ x (base1 + base 2) x height

Area 1 in CY 2011 is a triangle with area equal to ½ x base x height.

The base and height are both 6 months (1/1/2011 to 6/30/2011) so the area (in months) is 18 (= ½ x 6 x 6).

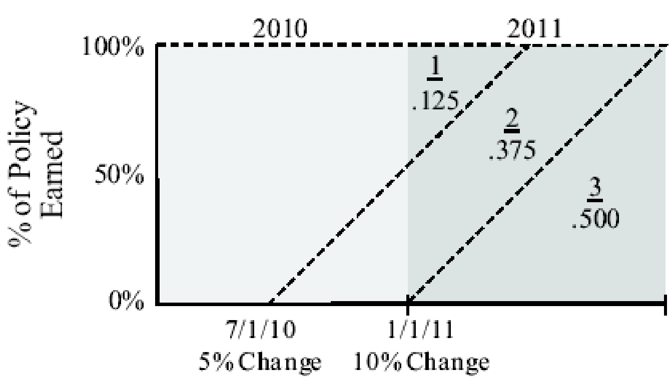
This area's portion of the entire CY square is 0.125 (=18 /(12 x 12)).

Simplify by restating the base and height as portions of a year (0.125 = ½ x ½ x ½).

In some areas (e.g. area 2 in CY 2011), it is easier to calculate as 1.0 - the sum of the remaining areas.

CY 2011 rate levels area are shown below:

Area 1 in CY 2011:	0.125	=0.50 x 0.50 x 0.50
Area 2 in CY 2011:	0.375	=1.00 - (0.125 + 0.500)
Area 3 in CY 2011:	0.500	=0.50 x 1.00 x 1.0



Step 3: Calculate the cumulative rate level index for each rate level group.

- The first rate level group is assigned a rate level of 1.00.
- The cumulative rate level index of each subsequent group is the prior group's cumulative rate level index multiplied by the rate level for that group.
  - i. the cumulative rate level index for the second rate level group is 1.05 (= 1.00 x 1.05).
  - ii. the cumulative rate level index for the third rate level group is 1.155 (= 1.05 x 1.10).

	1	2	3	4
Rate Level Group	Effective Date	Overall Average Rate Change	Rate Level Index	Cumulative Rate Level Index
1	Initial	--	1.00	1.0000
2	7/1/10	5.0%	1.05	1.0500
3	1/1/11	10.0%	1.10	1.1550
4	4/1/12	-1.0%	0.99	1.1435

(4)= (Previous Row 4) x (3)

Step 4: Calculate the average rate level index for each year (i.e. the weighted average of the cumulative rate level indices in Step 3, using the areas calculated in Step 2 as weights).

The average rate level index for CY 2011 is 1.0963 =1.000 x 0.125 + 1.0500 x 0.375 + 1.1550 x 0.500.

Step 5: Calculate the on-level factor as follows:

$$On\text{-}Level\ Factor\ for\ Historical\ Period = \frac{Current\ Cumulative\ Rate\ Level\ Index}{Average\ Rate\ Level\ Index\ for\ Historical\ Period}$$

- The numerator is the most recent cumulative rate level index
- The denominator is the result of Step 4.

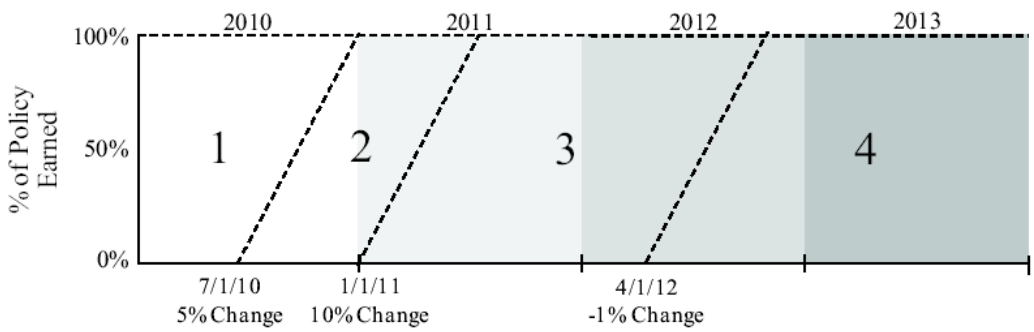
The on-level factor for CY 2011 EP (assuming annual policies) is $1.0431 = \frac{1.1435}{1.0963}$

Step 6: The on-level factor is applied to the CY 2011 EP to bring it to current rate level.

CY 2011 EP at current rate level= CY 2011 EP x 1.0431.

Standard CY Calculations for Six-Month Policies

If the policy term is six months (common in personal automobile coverage), then the rate level groups can be depicted as follows:



Step 2: The areas for CY 2011 are:

Area 1 in CY 2011: N/A

Area 2 in CY 2011: 0.250 = 0.50 x 0.50 x 1.00

Area 3 in CY 2011: 0.750 = 1.00 - 0.250

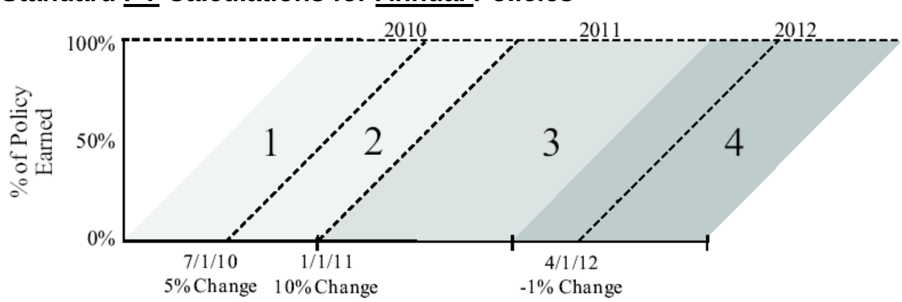
Step 3: The cumulative rate level indices are the same as those used for the annual policies.

Step 4: The average rate level index for CY 2001 assuming semi-annual policies:

1.1288 = 1.0500 x 0.250 + 1.1550 x 0.750

Step 5: The on-level factor to adjust CY 2011 EP to current rate level is: $1.0130 = \frac{1.1435}{1.1288}$ *(and is smaller than for annual policies because the semi-annual rate changes earn more quickly).*

Standard PY Calculations for Annual Policies



Since PY 2011 only had one rate level applied to the whole year, PY 2012 will be reviewed.

The area of each parallelogram is base x height.

Area 3 in Policy Year 2012 has a base of 3 months (or 0.25 of a year) and the height is 12 months (or 1.00 year).

Step 2: The relevant areas for PY 2012 are as follows:

- Area 3 in PY 2012: 0.25 = 0.25 x 1.00
- Area 4 in PY 2012: 0.75 = 0.75 x 1.00

Step 3: The cumulative rate level indices are the same as those used in the CY example.

Step 4: The average rate level index for PY 2012 is: 1.1464 = 1.1550 x 0.25 + 1.1435 x 0.75.

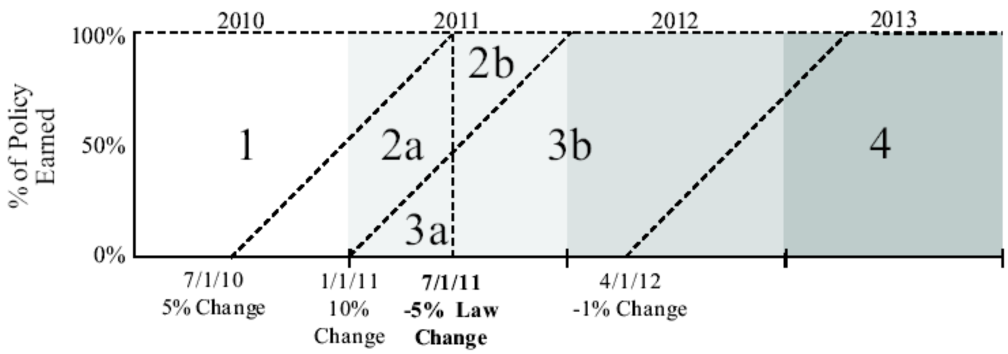
Step 5: The on-level factor to adjust PY 2012 EP to current rate level is $0.9975 = \frac{1.1435}{1.1464}$

Rate Changes Mandated by Law

Rate changes mandated by law changes apply the rate change to all policies on or after a specific date (including those in-force).

The rate level change is represented as a vertical line.

Assume a law change mandates a rate decrease of 5% on 7/1/2011 applicable to all policies.



The vertical line splits rate level groups 2 and 3 into two pieces each.

The -5% law change impacts rate level indices associated with the portion of areas 2b, 3b, and 4.

The areas for CY 2011 are as follows:

- Area 1 in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 2a in CY 2011: 0.250 = 0.50 - 0.125 - 0.125
- Area 2b in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3a in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3b in CY 2011: 0.375 = 0.50 - 0.125

The cumulative rate level indices associated with each group are as follows:

Step 3 (with Benefit Change)

Rate Level Group	Cumulative Rate Level Index
1	1.0000
2a	1.0500
2b	0.9975
3a	1.1550
3b	1.0973
4	1.0863

CY 2011 on-level factor:

$$1.0171 = \frac{1.0863}{1.0000\ x\ 0.125\ + 1.0500\ x\ 0.250\ +\ 0.9975\ x\ 0.125\ + 1.1550\ x\ 0.125\ + 1.0973\ x\ 0.375}$$

Comments on the Parallelogram Method

Two problems with the parallelogram method:

1. The method is not useful if the assumption that policies are evenly written throughout the year is not true.

   Example: Boat owners policies are usually purchased prior to the start of boat season and thus are not uniformly written throughout the year.

   Ways to partially circumvent the need for uniform writings:

   a. Use a more refined period of time than a year (e.g. quarters or months).
   b. Calculate the actual distribution of writings and use these to determine more accurate weightings to compute the historical average rate level.

      Aggregate policies based on which rate level was applicable rather than based on a time period, and the premium for each rate level group is adjusted together based on subsequent rate changes.

2. Premium for certain classes will not be on-level if the implemented rate changes vary by class.

   Even if the overall premium may be adjusted to a current rate level, adjusted premium will not be appropriate for class ratemaking.

   This major shortcoming has caused insurers to favor of the extension of exposures approach.

Premium Development

When working with an incomplete year of data or when premiums for a line of business are subject to premium audits, premium development methods are used for ratemaking purposes.

To incorporate responsiveness into the ratemaking analysis, the actuary may choose to use data for a year that is not yet complete (more common for PY analysis due to the time it takes for the PY to close).

Assume a ratemaking analysis is performed on PY 2011 data as of 12/31/2011.

- While WP is known, it is not known which policies may have changes or will be cancelled during the policy term.
- To estimate how premium will develop to ultimate, historical patterns of premium development are analyzed to understand the effect of cancellations and mid-term adjustment on PY premium.

For Lines that utilize premium audits:

- The insured will pay premium based on an estimate of the total exposure.
- Once the policy period is complete and the actual exposure is known, the final premium is calculated. For example, WC premium depends on payroll and the final WC premium is determined by payroll audits that occur 3 - 6 months after the policy expires.

Premium development depends on several factors including:

- The type of plan (permitted by the jurisdiction or offered by the carrier).
- The stability between the original premium estimate and the final audited premium.
- Internal company operations (e.g. auditing procedures, marketing strategy, accounting policy, etc.).

PY Premium Development Example:

- A WC carrier writes one policy per month in 2011.
- Estimated premium for each policy is booked at policy inception for $500,000.
- Premium develops upward by 8% at the first audit (6 months after the policy expires).

At 12/31/2012, the six policies written in the first half of 2011 have completed their audits, but the six policies written in the second half of the year have not.

PY 2011 premium as of 12/31/2012 is: $6,240,000 = 6 x $500,000 x 1.08 + 6 x $500,000

At 12/31/2013, all twelve policies have completed their final audits and premium is final.

PY 2011 premium as of 12/31/2013 is: $6,480,000 = 12 x $500,000 x 1.08

From 12/31/2012 (24 months after the start of the PY) to 12/31/2013 (36 months after the start of the PY), the premium development factor is 1.0385 (= $6.48 million / $6.24 million).

Premium development does not typically apply to CY premium since CY premium is fixed. However, some actuaries may adjust CY premium if audit patterns are changing and a CY analysis is being performed.

Note: Rates changes, Inflationary changes and Policy Characteristic Distributional changes impact the average premium level

Exposure Trend

The average premium level can change over time due to inflation in lines of business with exposure bases that are inflation-sensitive, like payroll (for WC and GL) or receipts (GL).

Trends are used to project inflation-sensitive exposures (and thus premium) and are determined using internal company data (e.g. WC payroll data) or industry or government indices (e.g. average wage index).

Premium Trend

The average premium level can change over time due to changes in the characteristics of the policies written (a.k.a. distributional changes) and the resulting change in average premium level is known as premium trend.

Examples that can cause changes in the average premium level:

- ***A rating characteristic can cause average premium to change*** (e.g. HO premium varies based on the amount of insurance purchased, which is indexed and increases automatically with inflation; therefore, average premium increases as well).
- ***Moving all existing insureds to a higher deductible*** (e.g. if an insurer moves each insured to a higher deductible upon renewal, and renewals are spread throughout the year, there will be a decrease in average premium over the entire transition period).

  Trend is not necessary once the transition is complete.
- ***Acquiring the entire portfolio of another insurer writing higher policy limits*** (e.g. a HO insurer acquires a book of business that includes predominantly high-valued homes, the acquisition will cause a very abrupt increase in the average premium due to the increase in average home values).

  After the books are consolidated, no additional shifts in the business are expected.

To adjust for premium trend, the actuary needs to:

- determine how to measure any changes that have occurred
- decide whether observed distributional shifts were caused by a one-time event or a shift that is expected to continue in the future
- judgmentally incorporate any additional shifts that are reasonably expected to happen in the future.

Actuaries examine changes in historical average premium per exposure to determine premium trend.

Average premium should be calculated on an exposure basis rather than a policy basis, using the exposure base underlying the rate.

A decision to use earned or written premium must be made.

Written premium is a leading indicator of trends that will emerge in earned premium and the trends observed in written premium are appropriate to apply to historical earned premium.

Assuming adequate data is available, the actuary will ***use quarterly average written premium*** (as opposed to annual average written premium) to make the statistic as responsive as possible.

Data used to estimate premium trend due to distributional changes: Change in Average WP

(1)	(2)	(3)	(4)	(5)
Quarter	Written Premium at Current Rate	Written Exposures	Average Written Premium at Rate Level	Annual Change
1Q09	$323,189.17	453	$713.44	--
2Q09	$328,324.81	458	$716.87	--
3Q09	$333,502.30	463	$720.31	--
4Q09	$338,721.94	468	$723.76	--
1Q 10	$343,666.70	472	$728.11	2.1%
2Q10	$348,696.47	477	$731.02	2.0%
3Q10	$353,027.03	481	$733.94	1.9%
4Q10	$358,098.58	485	$738.35	2.0%
1Q11	$361,754.88	488	$741.30	1.8%
2Q11	$367,654.15	493	$745.75	2.0%
3Q11	$372,305.01	497	$749.10	2.1%
4Q11	$377,253.00	501	$753.00	2.0%

(4) = (2) / (3)

(5) = (4) / (Prior Year4) - 1.0

Changes in the *quarterly average WP* are used to determine the amount historical premium needs to be adjusted for premium trend.

Note the premium used has been adjusted to the current rate level (if this is not done, the data will show an abrupt change in the average written premium corresponding to the effective date of the rate change).

Two methods for adjusting historical data for premium trend: one-step and two-step trending.

One-Step Trending

The trend factor adjusts historical premium to account for expected premium levels from distributional shifts in premium writings.

The Process: Using the annual changes from the prior table, the actuary may select a trend factor of 2% (the amount average premium is expected to change annually).

Next: Determine the trend period.

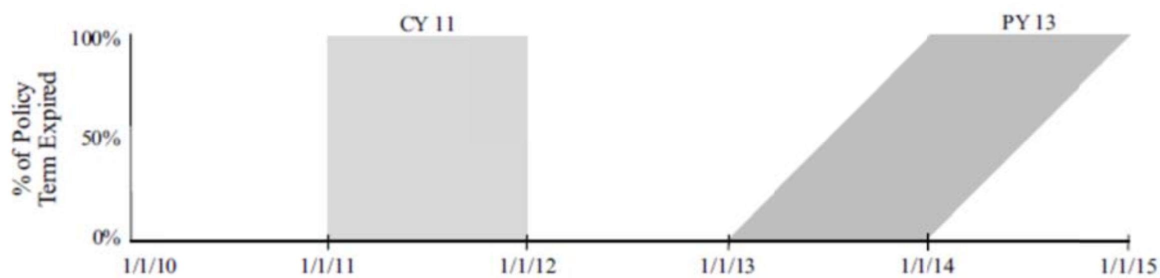
Assume: WP is used as the basis of the trend selection and EP for the overall rate level indications

Compute: The trend period as the length of time from the average written date of policies with premium earned during the historical period to the average written date for policies that will be in effect during the time the rates will be in effect.*

* Some insurers determine the trend period as the average date of premium earned in the experience period to the average date of premium earned in the projected period. This simply shifts both dates by the same amount, so the trend period is the same length.

Example: Assume CY 2011 EP is being used to estimate the rate need for annual policies that are to be in effect from 1/1/2013 – 12/31/2013.

The historical and projected periods can be represented as follows:



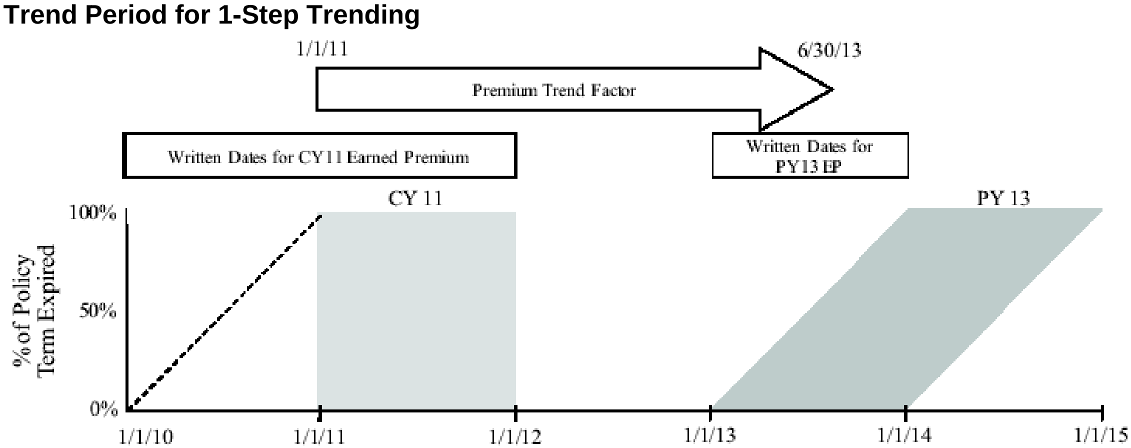
Historical period: CY 2011 EP contains premium from policies written 1/1/2010 to 12/31/2011.
Thus, the average written date for premium earned is **1/1/2011**.

Projected period: Policies will be written from 1/1/2013 – 12/31/2013.
Thus, the average written date during the projected period is **6/30/2013**.

Therefore, the trend period is 2.5 years (i.e. 1/1/2011 - 6/30/2013).

The adjustment to account for premium trend is: 1.0508 (= $(1.0 + 0.02)^{2.5}$).

Trend Period for 1-Step Trending

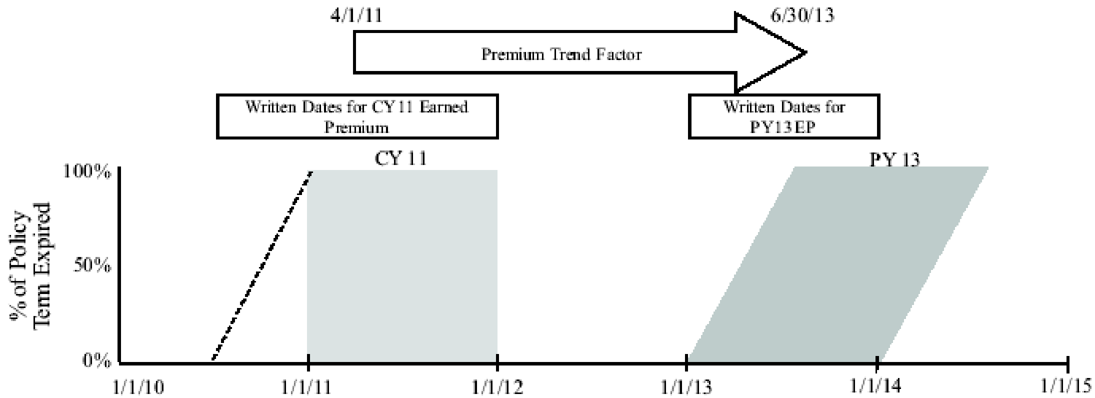


Items affecting the length of the trend period:

1. **If the historical period consists of policies with terms other than 12 months**, the "trend from" date will be different than discussed above.

   Example: If the policies in the prior example were six-month policies, then the "trend from" date is 4/1/2011. The "trend to" date is unchanged.

   Trend Period for 1-Step Trending with 6-Month Policies



2. **If the historical premium is PY 2011** (rather than CY 2011) then the "trend from" date is later and corresponds to the average written date for PY 2011 (i.e. 7/1/2011).
3. If the **proposed rates are expected to be in effect for more or less than one year**, then the "trend to" date will be different (e.g. if the proposed rates are expected to be in effect for two years, then the "trend to" date will be 12/31/2013).

One-step trending process is not appropriate to use when:

- changes in average premium vary significantly year-by-year and/or
- historical changes in average premium are very different than the changes expected in the future.

  Example: If the insurer forced all insureds to a higher deductible at their first renewal on or after 1/1/2011, the shift would have been completed by 12/31/2011, and the observed trend would not continue into the future.

  When situations like this occur, companies may use a two-step trending approach.

Two-Step Trending

Two-step trending is used when the insurer expects premium trend to change over time.

Adjust the historical premium to the level present at the end of the historical period, and then apply a separate adjustment to project premium into the future.

Two step trending may be used by a homeowners' insurer that observes large increases in amount of insurance during the experience period that are not expected to continue into the future.

Step 1: Adjust the historical premium to the current trend level using the following adjustment factor:

$$Current\ Premium\ Trend\ Factor = \frac{Latest\ Average\ WP\ at\ Current\ Rate\ Level}{Historical\ Average\ EP\ at\ Current\ Rate\ Level}$$

If average EP for CY 2011 is $740.00 and the average WP for the latest available quarter (Calendar Quarter 4Q 2011) is $753.00, then the current premium trend factor is **1.0176** (= 753.00/740.00).

The latest average WP is for the fourth quarter of 2011; thus, the average written date is 11/15/2011 (this will be "trend from" date for the second step in the process).

If the average been based on the average WP for CY 2011 (as opposed to the fourth quarter), then the average written date would have been 6/30/2011.

When average premium is volatile, select a current trend versus using the actual change in average premium.

The current trend factor is calculated by trending (1.0 + selected current trend) from the average written date of premium earned in the experience period (i.e. 1/1/2011) to the average written date of the latest period in the trend data (i.e. 11/15/2001).

Step 2: Compute the projected premium trend factor.

Select the amount the average premium is expected to change annually from the "trend from" date to the projected period.

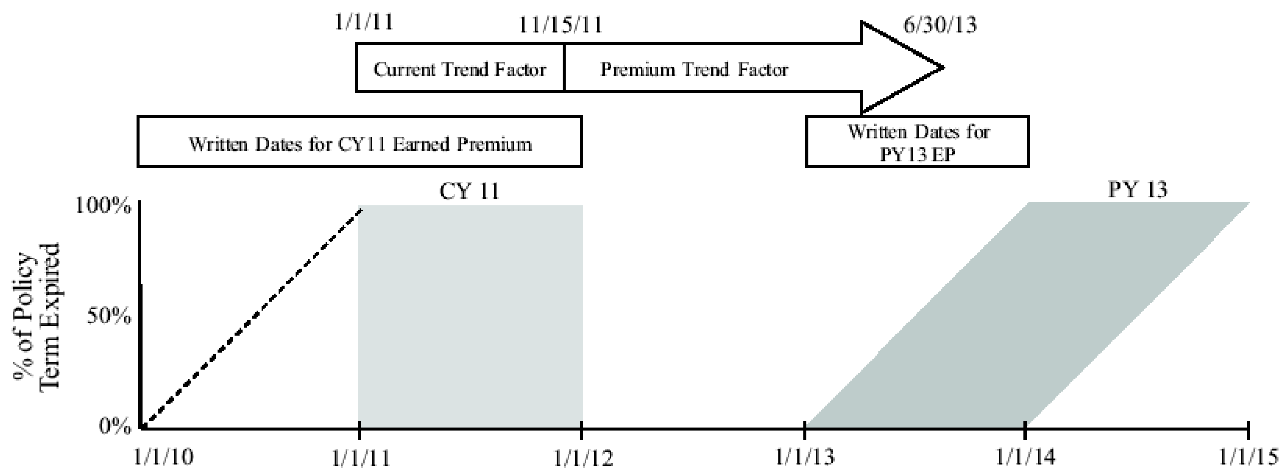
The "trend from" date is 11/15/2011.

The "trend to" date is the average written date during the period the proposed rates are to be in effect, which is still 6/30/2013.

Thus, the projected trend period is 1.625 years long (11/15/2011 to 6/30/2013).

Given a projected annual premium trend of 2%, the projected trend factor is **1.0327** (= $(1.0 + 0.02)^{1.625}$).

Trend Period for 2-Step Trending



The total premium trend factor for two-step trending is the product of the current trend factor and the projected trend factor (i.e. 1.0509 (= 1.0176 x 1.0327)).

That number is applied to the average historical EP at current rate level to adjust it to the projected level:

CY11 EP at projected rate level = CY11 EP at current rate level x Current Trend Factor x Projected Trend Factor.

Two-Step Trending

(1) CY 2011 Earned Premium at Current Rate Level	$1,440,788
(2) CY 2011 Earned Exposures	1,947
(3) CY 2011 Average Earned Premium at Current Rate Level	$740.00
(4) 4th Quarter of 2011 Average Written Premium at Current Rate Level	$753.00
(5)Step 1 Factor	***1.0176***
(6) Selected Projected Premium Trend	2.0%
(7) Projected Trend Period	1.6250
(8) Step 2 Factor	***1.0327***
(9) Total Premium Trend Factor	**1.0509**
(10) Projected Premium at Current Rate Level	$1,514,124

(3) = (1) / (2)
(5) = (4) / (3)
(8) = $(1.0 + (6))^{(7)}$
(9) = (5) x (8)
(10)= (1) x (9)

Appendices A-D provide realistic examples of ratemaking analysis, including the premium adjustments, intended to reinforce the concepts covered in this chapter.

3 Key Concepts 88 - 88

1. Premium aggregation
   a. Calendar year v. policy year
   b. In-force v. written v. earned v. unearned premium

2. Premium at current rate level
   a. Extension of exposures
   b. Parallelogram method

3. Premium development

4. Exposure trend

5. Premium trend
   a. One-step trending
   b. Two-step trending

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Premium Aggregation – In General

Questions from the 1989 Exam:

43. (3 points) You are given the following data.

Personal Lines Automobile - State A

Rate level history: +10% effective 7/1/86
+10% effective 7/1/88

Assume that exposures are uniformly distributed throughout the year.

Using the parallelogram method described in McClenahan's chapter on ratemaking (Study Note 16) and "A Refined Model for Premium Adjustment" by Miller and Davis (*note: the latter is no longer on the syllabus*), calculate the on-level factors needed to bring calendar year 1987 and 1988 earned premiums to current rate level.

a. (1.5 points) Assume policies are annual (each policy has a 12 month term.)

b. (1.5 points) Assume policies are semiannual (each policy has a six month term.)

Questions from the 1991 exam

For the next three questions use the parallelogram method as described in Chapter 2 of the CAS textbook Foundations of Casualty Actuarial Science and assume exposures are written uniformly throughout the year. You are given the following data:

Effective Date	Rate Change
7/1/88	+ 8.0 %
1/1/89	+ 10.0 %
7/1/89	+ 5.0 %
7/1/90	+ 2.0 %
1/1/91	+ 2.0 %

14. Assume all policies have a **six month term**. The on-level factor for **calendar year** 1989 earned premium is in which of the following ranges?

A. < 1.05 B. $\geq$ 1.05 but < 1.09 C. $\geq$ 1.09 but < 1.13 D. $\geq$ 1.13 but < 1.17 E. $\geq$1.17

15. Assume all policies have a **six month term.** The on-level factor for **policy year** 1989 earned premium is in which of the following ranges?

A. < 1.05 B. $\geq$ 1.05 but < 1.09 C. $\geq$ 1.09 but < 1.13 D. $\geq$ 1.13 but < 1.17 E. $\geq$ 1.17

16. Assume all policies have a **twelve month term**. The on-level factor for **calendar year** 1989 earned premium is in which of the following ranges?

A. < 1.05 B. $\geq$ 1.05 but < 1.09 C. $\geq$ 1.09 but < 1.13 D. $\geq$ 1.13 but < 1.17 E. $\geq$ 1.17

Questions from the 1994 exam

1. An insurer writes the following policies during 1992:

Effective Date	Policy Term	Premium
May 1	6 months	$6,000
August 1	12 months	$12,000
November 1	6 months	$2,400

What is the insurer's unearned premium reserve on December 31, 1992?

A. <$6,000 B. ≥$6,000 but <$7,000 C. ≥$7,000 but <$8,000 D.≥ $8,000, but < $9,000 E. ≥ $9,000.

Questions from the 1996 exam

Question 30. (4 points) You are given:

Wisconsin Personal Automobile Bodily Injury

20/40 Basic Limits					
Calendar/ Accident Year	Ultimate Loss & ALAE	Written Premium	Earned Premium	Rate Level History: Effective Date	Rate Level History: % Rate Change
1992	325,000	750,000	375,000	1/1/91	+7.0%
1993	575,000	1,000,000	875,000	10/1/93	+5.0%
1994	800,000	1,250,000	1,125,000	7/1/94	+3.0%
Combined	1,700,000	3,000,000	2,375,000	1/1/95	+5.0%

- Target Loss and ALAE ratio 69.0%
- Countrywide 20/40 Indicated +5.0%
- Proposed effective date 1/1/96
- The filed rate will remain in effect for one year.
- All policies are annual.
- Annual 20/40 severity trend 5.0%
- Annual 20/40 frequency trend -1.0%
- Statewide credibility 50.0%

Using the techniques described by McClenahan, chapter 2, "Ratemaking," Foundations of Casualty Actuarial Science:

(a) (2 points) Calculate the on-level earned premium for the experience period 1992-1994.

Questions from the 1997 exam

19. You are given:

Effective Date	Rate Change
4/1/94	+5.0%
7/1/95	+13.0%
4/1/96	-3.0%

- All policies are 12 month policies.
- Policies are written uniformly throughout the year.

Using the parallelogram method described by McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, in what range does the on-level premium factor fall, to bring calendar year 1995 earned premium to current rate level?

A. < 1.07 B. ≥ 1.07 but < 1.09 C. ≥ 1.09 but < 1.11 D. ≥ 1.11 but < 1.13 E. ≥ 1.13

Questions from the 1998 exam

41. (2 points)
You are given the following information for your company's private passenger automobile line of business.

Calendar Year	Earned Premium	Overall Rate Change	Effective Date
1994	$1,000	+5.0%	9/1/94
1995	$1,200	+10.0%	1/1/95
1996	$1,400	-5.0%	1/1/96
		+15.0%	4/1/97

Assume all policies are semi-annual and that all months have the same number of days.

Using the parallelogram method as described in McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, compute the calendar year 1995 earned premium at present rates.

Questions from the 1999 exam

58. (2 points) Using the Loss Ratio method described in McClenanhan's "Ratemaking" chapter 2 of Foundations of Casualty Actuarial Science, you have performed a rate review for your company's Homeowners line of business which issues annual policies. You have calculated a Rate Level Adjustment Factor (RLAF) of 1.080 for Calendar Year 1998 Earned Premium. The only rate change in the past few years was one that you assumed to be effective 1/1/98. However, upon further review, you realize that the effective date is incorrect and that the rate change was actually implemented effective 3/1/98.

    Recalculate the RLAF using the 3/1/98 effective date. Assume that all months have an equal number of days and that premium writings are evenly distributed through the year.

Questions from the 2000 exam

38. (4 points) Based on McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below. Personal Automobile Liability Data:

Calendar Year 1997		Calendar Year 1998	
Effective Date	No. of Autos Written on Effective Date	Effective Date	No. of Autos Written on Effective Date
January 1, 1997	100	January 1, 1998	900
April 1, 1997	300	April 1, 1998	1,100
July 1, 1997	500	July 1, 1998	1,300
October 1, 1997	700	October 1, 1998	1,500

Assume:
- All policies are twelve-month policies.
- Written premium per car during calendar year 1997 is $500.
- A uniform rate increase of 15% was introduced effective July 1, 1998.

a. (1/2 point) Calculate the number of in-force exposures on January 1, 1998. (chapter 4)
b. (1 point) Calculate the number of earned exposures for calendar year 1998. (chapter 4)
c. (1/2 point) List the two methods McClenahan describes that are used to adjust earned premiums to a current rate level basis. (chapter 5)
d. (1 point) Which of the two methods listed in part c. above would be more appropriate to use for this company's personal automobile liability business? Briefly explain why. (chapter 5)
e. (1 point) Using your selected method from part d. above, calculate the on-level earned premium for calendar year 1998. (chapter 5)

Questions from the 2000 exam

40. (4 points) Using the techniques described by McClenahan in "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below.

You are given the following information for your company's homeowners business in a single state:

Calendar/ Accident Year	Ultimate Loss and ALAE	Written Premium	Earned Premium
1997	635,000	1,000,000	975,000
1998	595,000	1,050,000	1,000,000

Effective Date	Rate Change
July 1, 1996	+4.0%
January 1, 1998	+1.8%
July 1, 1999	+3.0%

Target Loss and ALAE Ratio	0.670
Proposed effective date	July 1, 2000
Effective period for rates	One year
Credibility	0.60
Alternative indication	0.0%
Policy period	Twelve months
Severity trend	+3.0%
Frequency trend	+1.0%

a. (1 1/2 points) Calculate the on-level factors for each of the two calendar years 1997 and 1998. (chapter 5)

b. (1 1/2 points) Calculate the trended projected ultimate on-level loss and ALAE ratio for the combined experience period 1997-1998. (chapter 6)

c. (1 point) Calculate the credibility-weighted indicated rate level change. (chapter 8)

Questions from the 2001 exam

Question 38**.** (2 points) Using the parallelogram method described by McClenahan in "Ratemaking," chapter 2, Foundations of Casualty Actuarial Science, determine the calendar year 1999 on-level earned premium. Show all work.

Calendar Year	Earned Premium	Effective Date	Rate Change
1997	$10,000	July 1, 1997	+5.2%
1998	$11,500	No Change	No Change
1999	$14,000	April 1, 19999	+7.4%

- All policies are 2-year policies.
- Policies are written uniformly throughout the year.

Questions from the 2002 exam

17. (4 points) Based on McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below. Show all work.

Projected rates to be effective January 1, 2003 and in effect for 1 year.

Target loss and ALAE ratio is 65%.

Experience is from the accident period January 1, 2000 to June 30, 2001.

Developed accident period loss and ALAE is $21,500.

Annual trend factor is 3%.

All policies have one-year terms and are written uniformly throughout the year.

The rate on January 1, 1999 was $120 per exposure.

Effective Date	Rate Change
January 1, 2000	+10%
January 1, 2001	-15%

Year	Written Exposures
1998	200
1999	200
2000	200
2001	200

a. (1 point) Calculate the experience period trended developed loss and ALAE. (chapter 6)

b. (2 points) Calculate the experience period on-level earned premium. (chapter 5)

c. (1 point) Calculate the indicated statewide rate level change. (chapter 8)

Questions from the 2003 exam

10. A 12-month policy is written on March 1, 2002 for a premium of $900. As of December 31, 2002, which of the following is true?

	Calendar Year 2002 Written Premium	Calendar Year 2002 Earned Premium	Inforce Premium
A.	$900	$900	$900
B.	$750	$750	$900
C.	$900	$750	$750
D.	$750	$750	$750
E.	$900	$750	$900

Questions from the 2005 exam:

38. (1.5 points) The parallelogram method is used to adjust calendar year 2003 earned premium to current rate level. Given the following information, will the parallelogram method understate, overstate, or accurately state the on-level factor applied to calendar year 2003 earned premium? Explain your answer.
    - There was a 10% rate increase effective on January 1, 2003.
    - The written exposures grew 5% each month in 2003.

Questions from the 2006 exam:

28. (3 points) Company XYZ reduced rates 8% effective May 1, 2004, which was their first rate change since January 1, 2000. Assume all policies have annual terms.
    a. (1 point) Using the parallelogram method, calculate the 2005 on-level factor. Show all work.
    b. (0.5 point) Assume that this change was for a boatowners line and that 50% of the policies are written uniformly throughout May and June, with the other 50% written uniformly throughout the rest of the year. Is the calculation above reasonable for this line? Explain.
    c. (1.5 points) Based on the assumptions given in part b. above, calculate the 2005 on-level factor. Show all work.

Questions from the 2007 exam:

34. (2.0 points) You are given the following information for four policies with annual policy terms:

Policy	Effective Date	Premium
A	January 1, 2004	$1,200
B	July 1, 2004	2,400
C	November 1, 2004	3,600
D	April 1, 2005	600

Based on these four policies, calculate:
a. (0.5 point) 2004 written premium.
b. (0.5 point) 2004 earned premium.
c. (0.5 point) 2004 policy year premium.
d. (0.5 point) Premium in-force as of March 31, 2005.

Show all work.

Questions from the 2008:

14. (2.5 points) Assume a -8% rate change was implemented effective March 1, 2005 and that all policies have annual terms.
    a. (1.0 point) Calculate the on-level factors for calendar years 2005 and 2006 earned premiums using the parallelogram method.
    b. (1.0 point) Calculate the on-level factors for policy years 2005 and 2006 earned premiums using the parallelogram method.
    c. (0.5 point) Briefly describe the extension of exposure method and briefly explain why it may be preferable to the parallelogram method for determining on-level premiums.

Questions from the 2009 exam:

18. (2 points) The following is the premium associated with five annual policies, where premium is earned uniformly throughout the year:

Policy	Effective Date	Premium
1	January 1, 2007	$750
2	April 1, 2007	$1,200
3	July 1, 2007	$900
4	October 1, 2007	$800
5	January 1, 2008	$850

a. (0.5 point) Calculate the total calendar year 2007 written premium.
b. (0.5 point) Calculate the total calendar year 2008 earned premium.
c. (0.5 point) Calculate the total policy year 2007 earned premium as of March 31, 2008.
d. (0.5 point) Calculate the total in-force premium as of July 1, 2008.

Questions from the 2011 exam:

4. (1.5 points) Company ABC began writing annual personal automobile policies on January 1, 2010, using the following rating structure:

- Policy Premium = Base Rate x Class Factor + Policy Fee
- Base Rate = $1,000
- Policy Fee = $50

Class	Class Factor
Teens	2.00
Adults	1.00

On July 1, 2010, the company increased the base rate to $1,100 and revised the class factor for adults to 0.90.
Company ABC writes 10 policies per quarter, each with an effective date of the beginning of the quarter.
The company writes an even distribution of teen and adult classes each quarter.

a. (1 point) Calculate the calendar year 2010 earned premium.
b. (0.5 point) Calculate the on-level factor that applies to the calendar year 2010 earned premium to bring premiums to current rate level.

Questions from the 2012 exam:

4. (2 points) Explain whether the following statements are correct or incorrect.

a. (0.5 point) Calendar year 2011 written premium will be fixed (i.e. not change) at December 31, 2011.
b. (0.5 point) Calendar year 2011 earned premium will be fully earned (i.e. not change) at December 31, 2011.
c. (0.5 point) Policy year 2011 written premium will be fixed (i.e. not change) at December 31, 2011.
d. (0.5 point) Policy year 2011 earned premium will be fully earned (i.e. not change) at December 31, 2011.

Questions from the 2012 exam:

5. (1 point)

   a. (0.5 point) Discuss whether or not it is appropriate to perform a classification ratemaking analysis using premiums adjusted with aggregate on-level factors.

   b. (0.5 point) State one advantage and one disadvantage of the parallelogram method relative to the extension of exposures method.

Section 2: Premium Aggregation – For Workers' Compensation

Questions from the 1994 exam

48. (3 points) Answer this question using the Feldblum Study Note Reading, "Workers Compensation Ratemaking," and the information below.

The adjustments to rates that affect the experience period are shown below.

- Experience rate change of 10% on 7/1/92.
- Law amendment change of 2% on 1/1/93.
- Experience rate change of 15% on 7/1/93.
- Law amendment change of 3% on 1/1/94.

Premium writings are evenly distributed throughout the year.

(a) (1.5 points) What adjustment factor is needed to bring calendar year 1993 premiums to current level? (Show a diagram representing the appropriate time periods.)

(b) (1.5 points) What adjustment factor is needed to bring policy year 1993 premiums to current level? (Show a diagram representing the appropriate time periods.)

Questions from the 1996 exam

Question 36. (3 points)

Rate Change	Implementation Date	Type of Change
+8%	5/1/94	Experience
+15%	7/1/95	Law Amendment
-10%	7/1/95	Experience
+5%	4/1/96	Experience

- Policies are written uniformly throughout the year.

According to Feldblum, "Workers' Compensation Ratemaking:"

(a) (2 points) Calculate the premium adjustment factor to bring policy year 1995 premium to current rate level.

(b) (1 point) How are experience rate changes and law amendment rate changes different in their purpose and their effect?

Questions from the 1997 exam

12. You are given:

- Full estimated policy premium is booked at inception.
- Premium develops upward by 7% at final audit, six months after the policy expires.
- All policies are written for an annual period.
- Premium is written uniformly throughout the year.

Based on Feldblum, "Workers' Compensation Ratemaking," in what range does the policy year premium development factor fall for 24 to 36 months?

A. < 1.01 B. $\geq$ 1.01 but < 1.02 C. $\geq$ 1.02 but < 1.03 D. $\geq$ 1.03 but < 1.04 E. $\geq$ 1.04

Questions from the 1999 exam

37. (2 points) Based on Feldblum, 'Workers' Compensation Ratemaking," answer the following.

a. (1 point) Using the information shown below, calculate the policy year premium development factor from 24 to 36 months.

- Initial estimates of policy year premium are $1 million per month from January through June and $1.1 million per month for the remainder of 1 year.
- Final audit occurs six months after policy expiration.
- Premium develops upward by 20% at the final audit.
- All policies are annual.

b. (1 point) Feldblum states that while development factors are necessary for policy year data, premium development factors may not need to be applied to calendar year premiums. Explain why.

Questions from the 2001 exam

Question 15. Based on Feldblum, "Workers' Compensation Ratemaking," and the following information, compute the policy year reported premium development factor from 12 to 24 months.

- Final audit occurs 3 months after policy expiration.
- On average, audits result in 15% additional premium.
- Premium writings are even throughout the year.
- All policies are annual.

A. < 1.050 B. $\geq$ 1.050 but < 1.075 C. $\geq$ 1.075 but < 1.100 D. $\geq$ 1.100 but < 1.125 E. $\geq$ 1.125

Question 47. (3 points) Feldblum, "Workers' Compensation Ratemaking," describes three different types of experience periods by which insurance data is compiled.

a. (1½ points) Describe how premiums and losses are compiled under each of the three experience periods:

- Policy Year
- Calendar Year
- Calendar/Accident Year

b. (1½ points) State one advantage and one disadvantage associated with each type of experience period.

Questions from the 2002 exam

27. (6 points) Based on Feldblum, "Workers' Compensation Ratemaking," and the information shown below, answer the following questions. Show all work.

- Through the use of deviations and schedule rating, your company has been charging 25% below its manual rates for workers compensation.
- Policy year 2000 earned premium as of December 31, 2001 = $90 million.
- Policy year 2000 reported loss as of December 31, 2001 = $40 million.
- Written premium is distributed uniformly by month.
- Policy term is 12 months.
- Policy audits occur 6 months after expiration and produce a 10% increase in premium.
- The following rate changes have been implemented:

Date	Amount
July 1, 1999	- 6.0%
July 1, 2000	+10.0%
July 1, 2001	+ 7.0%

- There was a 5% increase in the benefit levels effective January 1, 2001. There was no rate change to account for this.
- Loss development factor = 1.80.
- Annual loss trend = 8%.
- Annual wage trend = 4%.
- The effective date for this analysis is July 1, 2002.
- Rates will be effective for a period of one year.
- Loss adjustment expense = 20% of loss.
- The target loss and loss adjustment expense ratio is 72%.

a. (2 points) What is the policy year 2000 earned premium after all appropriate adjustments for premium development, current rate level, premium trend, and benefit changes? (chapter 5)

b. (2 points) What are the policy year 2000 losses after the appropriate adjustments for loss development, loss trend, and benefit changes? (see chapter 6, but will be computed in this chapter)

c. (½ point) What is the projected loss and loss adjustment expense ratio for policy year 2000? (See chapter 6), but this will be computed in this chapter)

d. (½ point) What is the indicated rate change based on experience from policy year 2000? (See chapter 8 for the computations needed to answer this question)

e. (1 point) What should the ratio of charged to manual premium be in order to produce the target loss and loss adjustment expense ratio? (See chapter 8)

Questions from the 2003 exam

33. (2 points) Using the information shown below, calculate the factor needed to adjust policy year 2002 written premium to current level. Show all work.
    - Policies are written uniformly throughout the year and have a term of 12 months.
    - The law amendment change affects all policies in force.

    Assume the following rate changes:
    - Law amendment change on July 1, 2002 = +10%
    - Experience rate change on October 1, 2002 = +5%
    - Experience rate change on January 1, 2003 = +7%

Questions from the 2004 exam

11. Given the following data, calculate the policy year 2001 premium development factor from 24 to 36 months.
    - Full estimated policy year premium is booked at inception, $10 million a month in 2001.
    - Premium develops upward by 5% at the final audit, three months after the policy expires.
    - All policies are annual.

    A. < 1.010 B. $\geq$ 1.010 but < 1.015 C. $\geq$ 1.015 but < 1.020 D. $\geq$ 1.020 but < 1.025 E. $\geq$ 1.025

31. (4 points) Given the following information, answer the questions below. Show all work.
    - Policies are written uniformly throughout the year.
    - Polices have a term of 12 months.
    - The law amendment change affects all policies in force.

    Assume the following rate changes:
    - Experience rate change on October 1, 2001 =+7%
    - Experience rate change on July 1, 2002 =+10%
    - Law amendment change on July 1, 2003 = -5%

    a. (2 points) Calculate the factor needed to adjust calendar year 2002 earned premium to current level.
    b. (2 points) Calculate the factor needed to adjust policy year 2002 earned premium to current level.

Questions from the 2007 exam

37. (2.0 points) Assume the following information about a worker's compensation insurer:
  - All policies are annual.
  - April 1, 2004: The company implemented a 10% experience rate change.
  - October 1, 2004: The company implemented a 5% rate change due to a law change that impacted all in-force policies.

a. (1.0 point) Draw the diagram underlying the calculation of the current rate level factor used to adjust policy year 2004 premium to current rate level.
  - Label the starting and ending dates of the historical period.
  - Label the rate change and law change.
  - Calculate the relative rate level of each area and label the diagram.
  - Do not calculate the percentage each area represents of the year.

b. (1.0 point) Draw the diagram underlying the calculation of the current rate level factor used to adjust calendar year 2004 earned premium to current rate level.
  - Label the starting and ending, dates of the historical period.
  - Label the rate change and law change.
  - Calculate the relative rate level of each area and label the diagram.
  - Do not calculate the percentage each area represents of the year.

Show all work.

Questions from the 2009 exam

19. (2.5 points) Given the following information:
  - All policies are semi-annual.
  - A +5% rate change was implemented effective October 1, 2007.
  - A benefit change of +10% was enacted affecting premium on all outstanding policies on July 1, 2008.

a. (0.75 point) Draw and label a diagram of the parallelogram method for calendar year 2008 earned premium.

b. (1.25 points) Calculate the on-level factor for calendar year 2008 earned premium.

c. (0.5 point) Explain why the parallelogram method may not be appropriate for calculating on-level factors for snowmobile insurance.

Questions from the 2010 exam

19. (3 points) Given the following information for Company XYZ book of business in State X:
  - All policies are semi-annual.
  - A law change is effective on July 1, 2008 and applies to all in-force and future policies. The estimated overall premium impact of the law change is +10%.
  - A 5% overall rate increase is implemented on October 1, 2008.
  - 2008 calendar year earned premium is $1,000,000.

a. (1 point) Draw and fully label a diagram for calendar year 2008 earned premium reflecting the parallelogram method.

b. (1 point) Calculate the on-level factor for calendar year 2008 earned premium.

c. (1 point) Draw and fully label a diagram for policy year 2008 earned premium reflecting the parallelogram method.

Section 3: Premium Aggregation – Using the One and Two Step Procedures

Questions from the 2003 exam

11. Given the information below, determine the written premium trend period.
    - Experience period is April 1, 2001 to March 31, 2002
    - Planned effective date is April 1, 2003
    - Policies have a 6-month term
    - Rates are reviewed every 18 months
    - Historical premium is earned premium

    A. < 1.8 years B. ≥ 1.8 years, but < 2.1 years C. ≥ 2.1 years, but < 2.4 years
    D. ≥ 2.4 years, but < 2.7 years E. ≥ 2.7 years

Questions from the 2004 exam:

35. (3 points) You are given the following information. Using a two-step trending procedure as described in Jones, "An Introduction to Premium Trend," answer the questions below. Show all work.
    - The experience period is January 1, 2001 through December 31, 2003.
    - Planned effective date is July 1, 2005.
    - Rates are reviewed annually.
    - Policies have a 6-month term.
    - The trend will apply to calendar-accident year 2002 earned premium at current rate level.

    a. (1 point) Calculate the beginning and ending dates for each of the Step 1 and Step 2 trend periods, assuming the selected trend is based on average written premium.
    b. (1 point) Calculate the beginning and ending dates for each of the Step 1 and Step 2 trend periods, assuming the selected trend is based on average earned premium.
    c. (1 point) Describe a situation when it may be more appropriate to use a two-step trending procedure, rather than a one-step trending procedure.

Questions from the 2005 exam:

37. (4 points)

Given the information below, answer the following questions. Show all work.

Calendar/Accident Year	Average Written Premium
2002	$1,000.00
2003	$933.33
2004	$882.00

- The planned effective date for a rate change is January 1, 2006.
- Rates are reviewed every 18 months.
- All policies are annual, and are written uniformly throughout the year.
- A 20% rate decrease was implemented effective July 1, 2003.
- A separate analysis has determined that a shift in the limit distribution from 2002-2004 has resulted in a +3% annual premium trend. This shift is not expected to continue past 2004.

a. (3.5 points) Using two-step trending, determine the total premium trend factors for each year above.

b. (0.5 point) Why is two-step trending a more suitable procedure for trending premium than for trending loss frequency or severity?

Questions from the 2006 exam:

26. (3.5 points) As the actuary for Company XYZ, you are performing a physical damage rate review for State X. Use the following information to answer the questions below.

- Experience period consists of calendar year premium for 2002 through 2004.
- Current level earned premium for calendar year 2002 is $42,500,000.
- Planned effective date of rate revision is June 1, 2006.
- Anticipate annual rate revisions every 12 months.

Each year, insureds purchase newer, more expensive vehicles, resulting in upward premium drift. Historically, the premium drift has averaged 5% through 2004. However, given current trends and expectations regarding future car sales, the insurer expects a 3% premium drift in the future. The insurer uses exponential premium trend.

a. (1.5 points) Assume all policies have a six-month term. Use 2-step trending with average written premium to calculate the trended premium for calendar year 2002. Show all work.

b. (1.5 points) Assume all policies have an annual term. Use 2-step trending with average written premium to calculate the trended premium for calendar year 2002. Show all work.

c. (0.5 point) Explain one advantage of using 2-step trending in this example over 1-step trending.

27. (1 point)

a. (0.5 point) Explain why using average premiums is better than total premiums when analyzing premium trend.

b. (0.5 point) Give one argument for using average earned premiums in the premium trend analysis and one argument for using average written premiums.

Questions from the 2007 exam:

36. (3.0 points) You are given the following information:

- All policies are annual.
- The future policy period begins January 1, 2007.
- The future annual premium trend is 3% per year.
- The proposed rates will be in effect for one year.

Calendar Year	Earned Exposures	Average Written Premium At Current Rate Level	Average Earned Premium At Current Rate Level
2003	1.000	$3,777	$3,605
2004	1,050	3,688	3,749
2005	1,100	3,998	3,899

Calculate the trended premium for each year, using the two-step trending method. Show all work.

Questions from the 2008 exam:

15. (2.0 points)

a. (0.75 point) Question no longer applicable to the content covered in this chapter.

b. (1.25 points) You are given the following information.

Accident Year	Average Earned Premium at Current Rate Level	Average Written Premium at Current Rate Level
2004	$ 98	$100
2005	$102	$104
2006	$106	$108
2007	$110	$112

- The projected premium trend is 4%.
- The proposed effective date of new rates is January 1, 2009.
- The proposed rates will remain in effect for one year.
- All policies are semi-annual.

Calculate the premium trend factor needed to project 2006 calendar/accident year earned premium to prospective rate levels, using the two-step trending procedure.

Questions from the 2010 exam:

18. (2 points) Given the following information:

Calendar Year	Earned Exposures	Written Exposures	On-Level Earned Premium	On-Level Written Premium
2008	1,000	1,100	$ 487,500	$ 550,000
2009	1,200	1,300	$ 615,000	$ 682,500

- All policies are annual.
- Proposed effective date is January 1, 2011.
- Rates are expected to be in effect for one year.
- Projected premium trend is 5%.

Calculate the calendar year 2008 earned premium at prospective levels using two-step trending.

Questions from the 2011 exam:

5. (2.25 points) Given the following information:

- Policy term: six months
- Proposed rates in effect: January 1, 2012, to June 30, 2013
- Selected projected premium trend: 5%

Calendar Year	Average Earned Premium at Current Rate Level	Average Written Premium at Current Rate Level
2009	$375	$380
2010	$390	$395

a. (2 points) Calculate the total premium trend factor for each of calendar years 2009 and 2010 using two-step trending.

b. (0.25 point) Briefly discuss when it is appropriate to use two-step trending.

Questions from the 2012 exam:

6. (2 points) Given the following information for a Homeowners company:

- The 4th Calendar Quarter of 2011 (4Q11) Average Written Premium is $560.
- The proposed effective date of the next rate change is July 1, 2012.
- Assume a +5% prospective annual premium trend.
- Rate review is performed every 2 years.

Calendar Year Ending	Earned Exposures (House-Years)	Earned Premium at Current Rates
December 31, 2009	10,000	$5,000,000
December 31, 2010	10,000	$5,250,000
December 31, 2011	10,000	$5,512,500

a. (1 point) Use the two-step trending method to calculate the projected earned premium for the calendar year ending December 31, 2009.

b. (1 point) After completing the analysis, the actuary determines that the assumed annual increase in the amount of insurance to account for inflation was materially reduced post-January 1, 2012. Discuss any necessary adjustments to the completed analysis in part a. above

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Premium Aggregation – In General

Solutions to questions from the 1989 Exam:

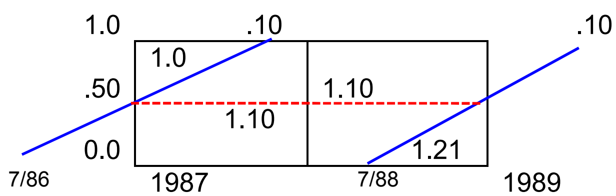
Question 43.

Step 1: Draw a unit square for each calendar year and diagonal lines at points in time representing historical rate changes.

Step 2: Calculate the numerator of the on-level factor. This is the product of all rate changes.

Step 3: Calculate the average rate level factor for each calendar year. This is a weighted average of the rate level factors in each calendar year. The weights will be relative proportions of each square. First calculate the area of all triangles (area = .5*base*height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

Step 4: Divide the result of step 1 by the result of step 3:



On- Level Factor

a. Assuming annual policies: CY 1987: $\frac{1.1*1.1}{.125*(1)+.875(1.1)}=\frac{1.21}{1.0875}=1.112$

CY 1988 $\frac{1.1*1.1}{.875*(1.1)+.125(1.21)}=\frac{1.21}{1.11375}=1.086$

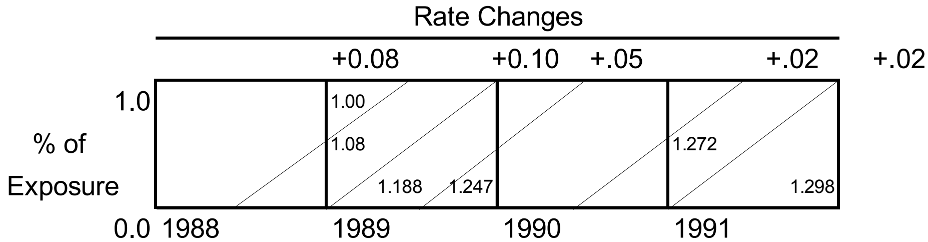
b. Assuming semi-annual policies: CY 1987: $\frac{1.1*1.1}{1.1}=\frac{1.21}{1.1}=1.1$

CY 1988 $\frac{1.1*1.1}{.75*(1.1)+.25(1.21)}=\frac{1.21}{1.1275}=1.073$

Solutions to questions from the 1991 exam

Note: View the earning of **CY** EP using a unit square. View the earning of **PY** EP using a parallelogram.

Compute on-level factors as follows: [Current rate level factor / average rate level factor (during the period in question).



Step 1: Current rate level factor=1.08 * 1.10 * 1.05 * 1.02 * 1.02 = 1.298. This is the numerator for each on-level factor.

Step 2: Calculate the denominators for each on-level factor. The denominators are the average rate level factor for each calendar/ policy year. This is a weighted average of the rate level factors in each calendar / policy year. The weights will be relative proportions of each square / parallelogram. First calculate the area of all triangles (area = .5*base*height) within a unit square / parallelogram and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

Question	Average rate level factor	On-level factor	Answer
14	.25(1.08)+.50*(1.188)+.25*(1.247) = 1.176.	1.298/1.176 = 1.104	C
15	.50(1.188)+.50*(1.247) = 1.218	1.298/1.218 = 1.066	B
16	.125(1.00)+.375*(1.08)+.375*(1.188)+.125(1.247) = 1.131	1.298/1.131 = 1.147	D

Solutions to questions from the 1994 exam

Question 1.

The premium for the policy effective 5/1 is fully earned by 11/1/92. There is no unearned premium at 12/31/92.

5/12 ths of the premium for the policy effective 8/1 is earned by 12/31/92.

The unearned premium is = (7/12) * $12,000 = $7,000.

2/6 ths of the premium for the policy effective 11/1 is earned by 12/31/92.

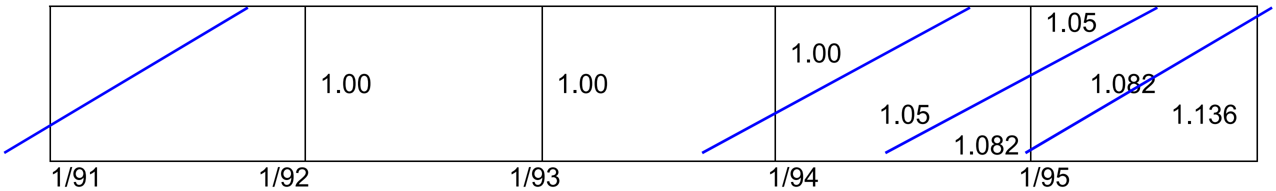
The unearned premium is = (4/6) * $2,400 = $1,600.

Thus, the total unearned premium = $7,000 + 1,600 = 8,600. Answer D.

Solutions to questions from the 1996 exam

Question 30

(a) To calculate the on-level earned premium for the experience period 1992-1994, CY on-level factors must be computed first.



(i) The rate change in 1991 is not relevant to the calculation.

(ii) Calculate the numerator of the on-level factor. This is equal to (1.05)(1.03)(1.05) = 1.136

(iii) Calculate the average rate level factor for the calendar year. This is a weighted average of the rate level factors in the **calendar year**. The weights will be relative proportions of the **square**. First calculate the area of all triangles (area = .5*base*height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

(iv) For CY 1992, the average rate level factor = 1.00. The on-level factor = 1.136 / 1.00 = 1.136.

(v) For CY 1993, the average rate level factor = (1/2)(.25)(.25)*1.05 + (1.0 - .0325)*1.00 = 1.002. The on-level factor = 1.136 / 1.002 = 1.134

(vi) For CY 1994, the average rate level factor = (1/2)(.75)(.75)*1.00 + (1/2)(.5)(.5)*1.082+ (1.0 - .40625)*1.05 = 1.04 The on-level factor = 1.136 / 1.04 = 1.092

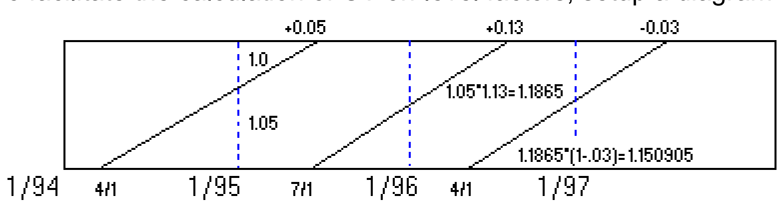
(vii) Thus, the on-level premium is computed as

CY	EP	On level factor	On level EP
1992	375,000	1.1355	425,812
1993	875,000	1.1337	991,987
1994	1,125,000	1.0920	1,228,500
Total			2,646,299

Solutions to questions from the 1997 exam

Question 19.

(a) To facilitate the calculation of CY on-level factors, setup a diagram similar to the one below:



Calculate the numerator of the on-level factor. This is equal to (1.05)*(1.13)*(1-.03) = 1.150905.

Calculate the average rate level factor for the **calendar year**. This is a weighted average of the rate level factors in the **calendar year**. The weights will be relative proportions of the **square**.

First calculate the area of all triangles (area = .50 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

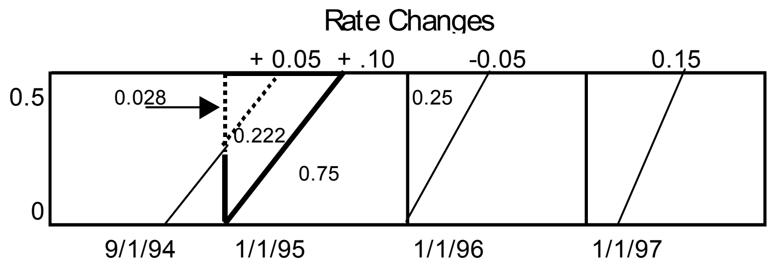
For CY 1995, the average rate level factor = (1/2)(3/12)(3/12)*1.0 + (1/2)(1/2)(1/2)*1.1865+ (1.0 - .15625)*1.05
= .03125 + .1483125 + .8859375 = 1.0655

The on-level factor = 1.150905 / 1.0655 = 1.0801549. **Answer B.**

Solutions to questions from the 1998 exam

Question 41.

Note: View the earning of **CY** EP using a unit square. View the earning of **PY** EP using a parallelogram.
Compute on-level factors as follows: [Current rate level factor / average rate level factor (during the period in question).



Step 1: Current rate level factor =1.05 * 1.10 * .95 * 1.15 = 1.262. This is the numerator for each on-level factor.

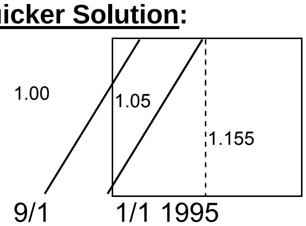
Step 2: Calculate the denominators for each on-level factor. The denominators are the average rate level factor for each calendar/ policy year. This is a weighted average of the rate level factors in each calendar / policy year. The weights will be relative proportions of each square / parallelogram. Note: It may be convenient to think of CY 95 with a base of 12 units and a height of 6 units. To compute the relative proportion of the unit square, calculate the areas of as many triangles as possible, and then compute the remaining area by subtracting the sum of the areas of the two triangles from 1.0.

Shape	Area	Rate Level
Dotted Triangle	(1/2) * (2/12) * (2/6) = .028	1.0
Bold Triangle	(1/2) * (6/12) * (6/6) = .25	
Difference	.25 - .028 = .222	1.05
Remainder	1 - .028 - .222 = .75	1.155

Step 3: Compute EP at present rates by multiplying EP by the CY on-level factor.

a. The weighted rate level for 1995 is 1.0 * (.028) + 1.05 * (.222) +1.155 * (.75) = 1.127
b. The 1995 CY on-level factor is 1.262 / 1.127 = 1.120
c. CY 1995 On-Level EP = $1,200 * 1.120 = $1,344

<u>Quicker Solution</u>:



The dotted line refers to the 6 month term.
Focus on only the 1995 square.
As above, numerator is 1.00 * 1.05 * 1.155 = 1.262
Note that small area is ½ * 2/12 * 4/12 = 1/36
Denominator is 1.155(.75) + 1.00(1/36) * 1.05 (1-0.75-1/36) = 1.127
1.262/1.127 = 1.12 (on-level factor for 1995)

<u>1.12 * 1200 = 1,344</u>.

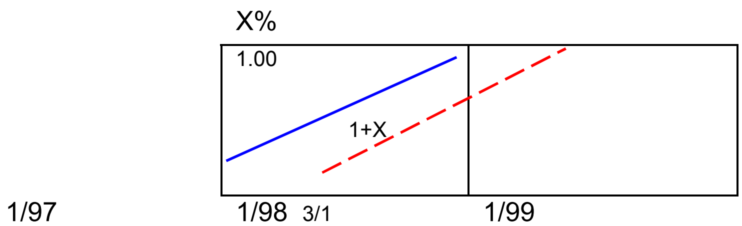
Solutions to questions from the 1999 exam:

Question 58. Given:

- The Company issues annual policies, calculated an RLAF of 1.080 for CY 1998 earned premium
- It was assumed that the only rate change that took place in the last few years was effective 1/1/98, but it was later determined that it was actually effective 3/1/98.
- It is assumed that all months have an equal number of days and that premium writings are evenly distributed through the year.

Step 1: Based on the given information, construct a diagram similar to the one below:

To recalculate the RLAF using the 3/1/98 effective date, first calculate the rate change at 1/1/98.



(during the period in question) $RLAF = \dfrac{Current\ Rate\ Level\ Factor}{Avg\ Rate\ Level\ Factor}$

Since we are assuming only one rate change effective 1/1/98, the current rate level factor is 1+X.

The average rate level factor for the calendar year is the weighted average of the rate level factors in the **calendar year**. The weights will be relative proportions of the **square**. Solve for X.

Thus, $1.08 = \dfrac{1+X}{[(.50*1.00)+(.50*1+X)]}$, .54 + .54(1+X)= (1+X). .08 = .46X; X = .174

Step 2: To recalculate the RLAF using the 3/1/98 effective date, re-compute the average rate level factor.

$$RLAF = \frac{1.174}{[.50(.10/12)(.10/12)*1.174+(1.0-.50(10/12)(10/12))*1.00]} = \frac{1.174}{1.0604} = 1.1071$$

Solutions to questions from the 2000 exam:

Question 38.

c. List two methods used to adjust earned premiums to a current rate level basis.

1. Extension of Exposure:	The best method. Re-rate each policy using current rates.
2. Parallelogram:	a. Assumes exposures are uniformly written over the Calendar Year (CY) b. Each CY of EP is viewed as a unit square, 1 year wide, 100% of exposure high.

d. The more appropriate method to use for this company's personal automobile liability business would be the extension of exposures method. The company's writings show an increasing trend in written exposures which violates the parallelogram method's assumption that exposures are uniformly written over the calendar year.

e. Using your selected method from part d. above, calculate the on-level earned premium for calendar year 1998. When using the extension of exposure technique, on-level earned premium equals current rate per unit of exposure * number of earned exposures. In this example:

the current rate per unit of exposures is \$500 * 1.15 = \$575

the number of earned exposures in 1998 = 3,600

Thus, on-level earned premium for calendar year 1998 equals \$575 * 3,600 = \$2,070,000

Solutions to questions from the 2000 exam:

Question 40.

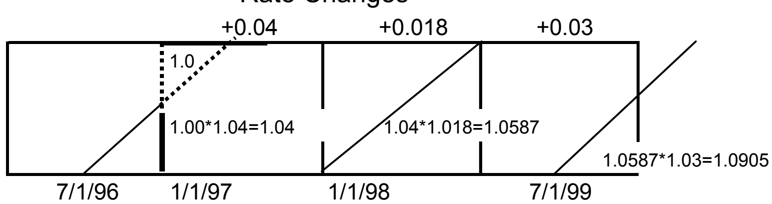
a. Calculate the on-level factors for each of the two calendar years 1997 and 1998.

Step 1: Draw a unit square for each calendar year and diagonal lines at points in time representing historical rate changes.

Step 2: Calculate the numerator of the on-level factor. This is the product of all rate changes.

Step 3: Calculate the average rate level factor for each calendar year. This is a weighted average of the rate level factors in each calendar year. The weights will be relative proportions of each square. First calculate the area of all triangles (area = .50 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

Step 4: Divide the result of step 1 by the result of step 3:



On-level factor for CY 1997:

$$\frac{1.04*1.018*1.03}{(1/2)*(6/12)*(6/12)*(1)\ +\ (1.0-36/288)*(1.04)}=\frac{1.0905}{1.035}=1.0536$$

On-level factor for CY 1997 equals 1.0536 * 975,000 = 1,027,260

On-level factor for CY 1998:

$$\frac{1.04*1.018*1.03}{(1/2)*(12/12)*(12/12)*(1.04)+(1/2)*(1)*(1)*(1.0587)}=\frac{1.0905}{1.0494}=1.0392$$

On-level factor for CY 1998 equals 1.0392 * 1,000,000 = 1,039,200

<u>Quicker Solution</u>:

Numerator is 1.04 * 1.018 * 1.03 = 1.0905

1997 Denominator : (1/8) 1.00 + (7/8) 1.04 = 1.035 On-level factor = 1.0905/1.035 = 1.054

1998 Denominator: (1/2) 1.04 + (1/2) 1.0587 = 1.049 On-level factor = 1.0905/1.049 = 1.039

Solutions to questions from the 2001 exam:

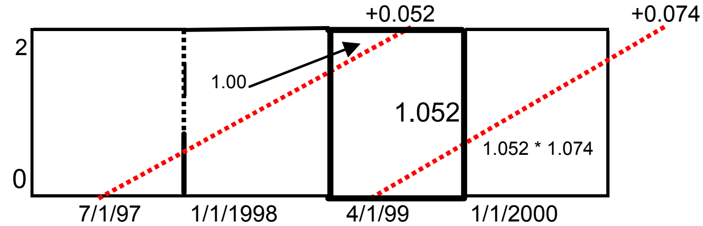
Question 38**.** (2 points) Using the parallelogram method described by McClenahan in "Ratemaking," determine the calendar year 1999 on-level earned premium. Show all work.

Step 1: Draw a rectangle (normally a unit square if 1-year policies were issued) for each calendar year and diagonal lines at points in time representing historical rate changes.

Step 2: Calculate the numerator of the on-level factor. This is the product of all rate changes.

Step 3: Calculate the average rate level factor for calendar year 1999. This is a weighted average of the rate level factors in calendar year 1999. The weights will be relative proportions of each rectangle. First calculate the area of all triangles (area = .5 * base * height) within a unit rectangle and then determine the remaining proportion of the rectangle by subtracting the sum of the areas of the triangles from 1.0. Note: Since 2-year policies are issued, the ratio of the height to the base is 2:1.

Step 4: Divide the result of step 1 by the result of step 3:



Area of triangle: 1/2 * base * height

Rate level	**Area**	
1.00	1/2 * 6/12 * 6/24 =	0.0625
1.129848	1/2 * 9/12 * 9/24 =	0.140625
1.052	1.0 - 0625 - .140625 =	0.7968750

On-level factor for CY 1997:

$$\frac{1.052*1.074}{(1/2)*(6/12)*(6/24)*(1.0)\ +\ (1/2)*(9/12)*(9/24)*(1.129848)+(.796875)*(1.052)}=\frac{1.129848}{1.0596974}=1.0661987$$

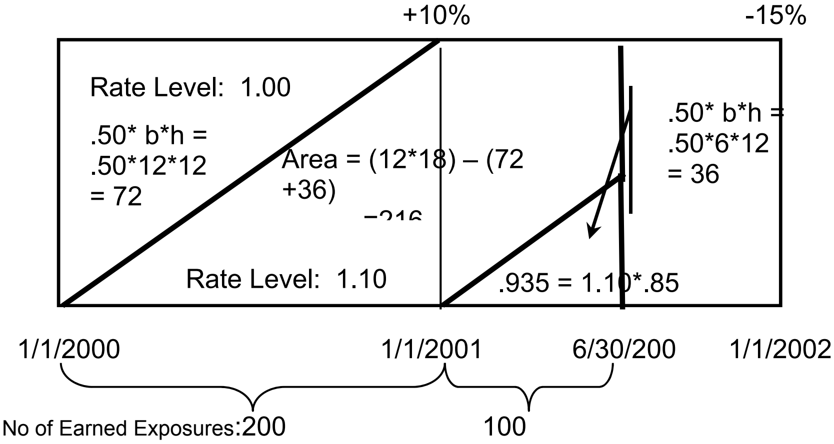
On-level earned premium for CY 1999 equals 1.0661987 * $14,000 = $14,927

Solutions to questions from the 2002 exam:

Question 17.

b. (2 points) Calculate the experience period on-level earned premium.

Step 1: Draw a rectangle (normally a unit square for a calendar year if 1-year policies were issued) for each period and diagonal lines at points in time representing historical rate changes.



Step 2: Calculate the rate level at various levels during the experience period. This is the product of all rate changes at a given point in time (i.e. 1.00; 1.00 * 1.10 = 1.10; 1.10 * .85 = .935).

Step 3: Calculate the on-level factor for the experience period. This is the current rate level divided by the weighted average of the rate level factors in the experience period. The weights will be relative proportions of each rectangle or triangle. First calculate the area of all triangles (area = .5 * base * height) within a unit rectangle and then determine the remaining proportion of the rectangle by subtracting the sum of the areas of the triangles from 1.0.

$$AvgRateLevel\ Factor = \frac{(.50*12*12)*1.0+(.50*6*6)*.935+(216-72-36)*1.10}{12*18} = 1.0529$$

Experience Period On-level Factor = .935/1.0529=.888

Step 4: Calculate the experience period on-level earned premium.

Exposures Writtten in CY	Exposures Earned in Experience Period	Rate Level	Rate	Earned Premium	Experience Period Onlevel Factor	Experience Period Earned Premium
1999	100	1.000	120	12,000	0.888	10,656
2000	100	1.100	120	13,200	0.888	11,722
2000	75	1.100	120	9,900	0.888	8,791
2001	25	0.935	120	2,805	0.888	2,491
				37,905		**33,660**

Question 17.

Alternatively, on-level EP = Current Rate * Earned Exposures = ($120*1.1*.85) * (200+100) = **33,660.**

Solutions to questions from the 2003 exam:

10. A 12-month policy is written on March 1, 2002 for a premium of $900. As of December 31, 2002, which of the following is true?

Step 1: Answering this question is best understood in terms of exposures

Written exposures are those units of exposures on policies written during the period in question,

Earned exposures are the exposure units actually exposed to loss during the period, and

Inforce exposures are those exposure units exposed to loss at a given point in time.….

Step 2: Based on the definitions in Step 1, only earned premium differs from written premium and inforce premium and therefore needs to be computed.

Thus, earned premium at 12/31/02 equals $900 * 10/12 = $750. **Answer E.**

Solutions to questions from the 2005 exam:

38. (1.5 points) The parallelogram method is used to adjust calendar year 2003 earned premium to current rate level. Given the following information, will the parallelogram method understate, overstate, or accurately state the on-level factor applied to calendar year 2003 earned premium? Explain your answer.

- There was a 10% rate increase effective on January 1, 2003.
- The written exposures grew 5% each month in 2003.

The parallelogram method assumes a uniform distribution of policies is written over an entire calendar year.

Using the parallelogram method, the on-level factor for CY 2003 is computed as

$$\frac{\textit{Current Rate Level}}{\textit{Average Rate Level}} = \frac{1.10}{.50*(1.0)+.50*(1.1)} = 1.048$$

However, if exposures are growing 5% each month, more weight should be given to the current rate level factor, 1.10.

For example, the on-level factor could be computed as $\frac{1.10}{z*(1.0)+(1-z)*(1.1)}$, where z is less than 50%.

This would produce a lower on-level factor compared to that produced by the traditional method.

Hence, the parallelogram method would overstate the on-level factor applied to CY 2003 premiums.

Solutions to questions from the 2006 exam:

28. (3 points) Company XYZ reduced rates 8% effective May 1, 2004, which was their first rate change since January 1, 2000. Assume all policies have annual terms.

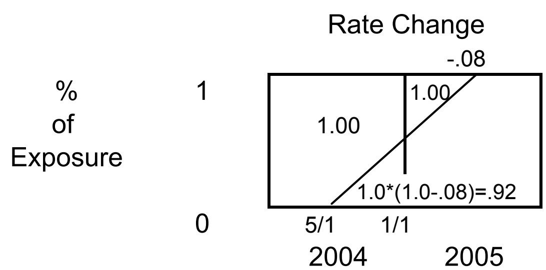
a. (1 point) Using the parallelogram method, calculate the 2005 on-level factor. Show all work.

b. (0.5 point) Assume that this change was for a boatowners line and that 50% of the policies are written uniformly throughout May and June, with the other 50% written uniformly throughout the rest of the year. Is the calculation above reasonable for this line? Explain.

c. (1.5 points) Based on the assumptions given in part b. above, calculate the 2005 on-level factor. Show all work.

a. The parallelogram method assumes a uniform distribution of policies is written over an entire calendar year.

Step 1: Draw a unit square to represent a calendar year, since 1-year policies were issued, for each period under consideration and draw diagonal lines at points in time representing historical rate changes.



Step 2: Calculate the rate level at points in time when the rate level change during the experience period. This is the product of all rate changes at a given point in time (i.e. 1.0; 1.0 * (1.0* -.08) = .92)

Step 3: Calculate the on-level factor for the experience period. This is the current rate level divided by the weighted average of the rate level factors in the experience period. The weights will be relative proportions of each square or triangle. First calculate the area of all triangles (area = .5 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

$$OLF = \frac{Current\ Rate\ Level\ Factor}{Avg\ Rate\ Level\ Factor}$$

$$OLF = \frac{.92}{[.50(4/12)(4/12)*1.00+(1.0-[.50(4/12)(4/12)*1.00])*.92]} = \frac{.92}{[.0556*1.0+.9444*.92]} = \frac{.92}{.9244} = .9952$$

b. No, the calculation is not reasonable because the parallelogram method assumes uniform distribution of written policies throughout the year. Since 50% of the total policies written during CY 2004 occurred in May and June, more weight will be given to the current rate level in the calculation of the average rate level factor for 2005, raising the on-level factor closer to 1.0.

c. Initial comments:

We must determine the % of policies written between January and April (inclusive 2004) and the proportion of those policies, by month, earned in CY 2005 as a % of total policies earned in 2005.

Since 50% of the policies were written in May and June of 2004, and assuming uniform writings in all other months, 50% policies of the remaining policies were written evenly throughout the remaining 10 months of CY 2004. This implies that on average, 5% of the total policies written during 2004 were written during each month, other than during the months of May and June.

Solutions to questions from the 2006 exam:

Question 28 (part c. continued):

Now, consider a policy year divided into twenty four equal parts, with the first month and the last month of the policy year earning only 1/24 of the premium (earned premium is spread over thirteen months).

Thus, we assume that the average policy for each month was written in the middle of the month, such that only 1/24th of the January 2004 policies were still unearned as of 1/1/2005, 3/24th of the February 2004 policies were still unearned as of 1/1/2005, 5/24th of the March 2004 policies were still unearned as of 1/1/2005 and 7/24th of the April 2004 policies were still unearned as of 1/1/2005.

Therefore, the proportion of CY 2005 earned exposures from policies written in 2004 at a 1.00 rate level can be computed as follows:

January 2004 policies: .05 * (1/24) = 0.0021

February 2004 policies: .05 * (3/24) = 0.0063

March 2004 policies: .05 * (5/24) = 0.0104

April 2004 policies: .05 * (7/24) = 0.0146

Total = 0.0021 + 0.0063 + 0.0104 + 0.0146 = 0.0334

Average Rate Level for 2005 = 0.0334(1.00) + .9666(0.92) = 0.9227

Current Rate Level = 0.92

On-level Factor for 2005 = 0.92/0.9227 = 0.9971

Finally compare .9227 to .9244, which was computed in part a, and commented on in part b.

Solutions to questions from the 2007 exam:

34. Calculate:
    a. (0.5 point) 2004 written premium.
    b. (0.5 point) 2004 earned premium.
    c. (0.5 point) 2004 policy year premium.
    d. (0.5 point) Premium in-force as of March 31, 2005.

Model Solution

a. WP includes all premium written during a calendar period. Thus, 2004 WP = 1,200+ 2,400 + 3,600 = 7,200

b. EP includes that portion of calendar year written premium which has been earned as of 12/31 of the calendar year. 2004 EP = 1,200 + 2,400(1/2) + 3,600(1/6) = 3,000

c. PY premium includes all premium associated with policies issued during a given time period. Policy year data is based upon the year in which the policy giving rise to exposures, premiums, claims and losses is effective. Thus, 2004 PY Premium = 1,200 + 2,400 + 3,600 = 7,200

d. In-force premium includes the full-term premium for each policy that has not expired at a point in time. All individual policy premiums are aggregated to arrive at a total in-force premium for the insurer. Inforce Premium as of 3/31/05 = 2,400 + 3,600 = 6,000

Solutions to questions from the 2008:

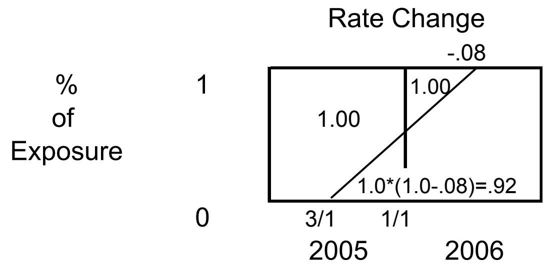
Model Solution - Question 14

14. (2.5 points) Assume a -8% rate change was implemented effective March 1, 2005 and that all policies have annual terms.
    a. (1.0 point) Calculate the on-level factors for calendar years 2005 and 2006 earned premiums using the parallelogram method.

Initial comments. Note that the question fails to state whether policies are uniformly written throughout the policy period. When computing on-level factors using the parallelogram method, such an assumption must be made. Therefore if the question does not state that polices are uniformly written throughout the policy period, it is wise to state that on your answer sheet prior to solving the problem.

a. Calculate the on-level factors for CYs 2005 and 2006 earned premiums using the parallelogram method.

Step 1: Draw a unit square to represent a calendar year, since 1-year policies were issued, for each period under consideration and draw diagonal lines at points in time representing historical rate changes.



Step 2: Calculate the rate level at points in time when the rate level change during the experience period. This is the product of all rate changes at a given point in time (i.e. 1.0; 1.0 * (1.0* -.08) = .92)

Step 3: Calculate the on-level factor for the experience period. This is the current rate level divided by the weighted average of the rate level factors in the experience period. The weights will be relative proportions of each square or triangle. First calculate the area of all triangles (area = .5 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

$$OLF = \frac{Current\ Rate\ Level\ Factor}{Avg\ Rate\ Level\ Factor}$$

$$CY\ 05\ OLF = \frac{.92}{[.50(5/6)(5/6)*0.92+(1.0-[.50(5/6)(5/6)*1.00]]} = \frac{.92}{[.3194+.6528]} = .9463$$

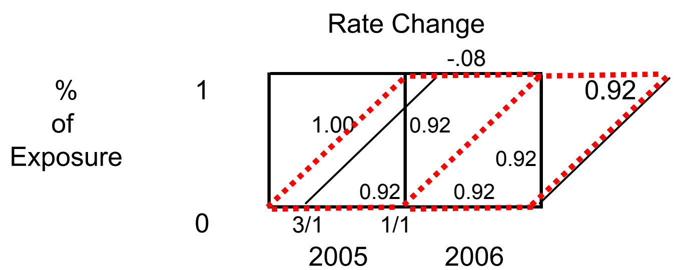
$$CY\ 06\ OLF = \frac{.92}{[.50(1/6)(1/6)*1.00+(1.0-[.50(1/6)(1/6)*.92]]} = \frac{.92}{[.0139+.9072]} = .9988$$

Solutions to questions from the 2008 (continued):

Model Solution - Question 14 (continued):

b. (1.0 point) Calculate the on-level factors for policy years 2005 and 2006 earned premiums using the parallelogram method.

Step 1: Draw a parallelogram to represent a policy year, since 1-year policies were issued. For PYs 2005 and 2006, draw diagonal lines at points in time representing historical rate changes.



Step 2: Calculate the on-level factor for the experience periods. This is the current rate level divided by the weighted average of the rate level factors in the experience period. Calculate the average rate level factor for the **policy year**. This is a weighted average of the rate level factors in the policy year. The weights will be relative proportions of the **parallelogram**.

Note for the period 1/1 – 3/1, the rate level factor is 1.0. The relative area of the parallelogram at a 1.0 rate level is 1.0 * (1/6)(1.0) = 1/6.

The remaining area of the parallelogram at a 0.92 rate level is .92 * [1.0 - (1/6)(1.0)] = .92 * (5/6) = .7667.

The average rate level factor for the policy year = (1/6)*1.0 + (5/6)*.92 =.9333

$$PY\ \ 05\ OLF = \frac{.92}{[.1667 + .7667]} = \frac{.92}{.9334} = .9857$$

Note: Upon review of the above diagram, the PY 2006 parallelogram shows a 0.92 rate level throughout the entire policy period. Therefore:

$$PY\ \ 06\ OLF = \frac{.92 * 1.0}{1 * .92} = 1.00$$

c. (0.5 point) Briefly describe the extension of exposure method and briefly explain why it may be preferable to the parallelogram method for determining on-level premiums.

Extension of exposure method re-rates each policy at current rate level. This may be preferable to the parallelogram method since it does not require policies to be written uniformly throughout policy period.

Solutions to questions from the 2009 exam:

Question#: 18

a. WP includes all premium written during a calendar period.
Thus, CY 2007 WP = 750 + 1,200 + 900 + 800 = $3,650

b. EP includes that portion of calendar year written premium which has been earned as of 12/31 of the calendar year. CY 2008 EP = 1,200 (3/12) + 900 (6/12) + 800 (9/12) + 850 = 300 + 450 + 6 00 + 850 = $2,200

c. PY EP premium includes all premium associated with policies, issued during a given time period, as of a given evaluation date. Thus, PY 2007 earned premium as of 3/31/08
= 750 + 1,200+ 900 (9/12)+ 800(6/12) = 750 + 1,200+ 675 + 400 = $3,025

d. In-force premium includes the full-term premium for each policy that has not expired at a point in time.
All individual policy premiums are aggregated to arrive at a total in-force premium for the insurer.
In - force premium as of 7/1/08 = 800 + 850 = $1,650

Solutions to questions from the 2011 exam:

4a. (1 point) Calculate the calendar year 2010 earned premium.

4b. (0.5 point) Calculate the on-level factor that applies to the calendar year 2010 earned premium to bring premiums to current rate level.

Question 4 – Model Solution 1

Givens: Policy Premium = Base Rate x Class Factor + Policy Fee; Base Rate = $1,000; Policy Fee = $50
Class Teens: Class factor = 2.00; Class Adults: Class factor = 1.00
ABC writes 10 policies per quarter, each with an effective date of the beginning of the quarter.
On 7/1, the company increased the base rate to $1,100 and revised the class factor for adults to 0.90.
The company writes an even distribution of teen and adult classes each quarter.

a. 10 pols issued per quarter equally = 5 adult and 5 teen policies issued each quarter
Quarter 1: Adult = 1000 * (1) + 50 = 1050; * 5 policies = 5,250
Teens = 1000 * (2) + 50 = 2050; * 5 policies = 10,250
Quarter 2: same as quarter 1
Quarter 3: Adult = 1100 * (.90) + 50 = 1040; * 5 policies = 5,200
Teens = 1100 * (2) + 50 = 2250; * 5 policies = 11,250
Quarter 4: same as quarter 3
2010 EP = (5,250 + 10,250) + (5,250 + 10,250) * .75 + (5200 + 11250) * .5 + (5200+11250) * .25
= 15,500 + 11,625 + 8,225 + 4,112.50 = **39,462.50**

b. **EP for 2010 if all** @ **CRL** = [Latest EP for Adult and Teens] * % earned per quarter
= (5200 + 11250)(1 + .75 + .5 + .25) = (16450)*(2.5) = **41,125**
OLF = EP @CRL/CY 2010 EP = 41,125/39,462.5 = 1.0421286

Question 4 – Model Solution 2

a. Q1 EP: (1000 * 2 + 50) * 5 + (1,000 * 1 + 50) * 5= 15,500
Q2 EP: 15,500 * 3/4 = 11625
Q3 EP: [(1,100 * 2 + 50) * 5 + (1,100 * .9 + 50) * 5] * 1/2 = 16,450 * 1/2 = 8,225
Q4 EP: 16450 * 1/4 = 4112.5
2010 EP = 15,500 + 11,625 + 8,225 + 4,112.5 = 39,462.5

b. 16450 * (1 + ¾ + ½ + ¼) = 41,125
On level factor = 41,125/ 39,462.5 = 1.042

Solutions to questions from the 2012 exam:

4a. (0.5 point) Calendar year 2011 written premium will be fixed (i.e. not change) at December 31, 2011.
4b. (0.5 point) Calendar year 2011 earned premium will be fully earned (i.e. not change) at 12/31/ 2011.
4c. (0.5 point) Policy year 2011 written premium will be fixed (i.e. not change) at December 31, 2011.
4d. (0.5 point) Policy year 2011 earned premium will be fully earned (i.e. not change) at December 31, 2011.

Question 4 – Model Solution 1 (Exam 5A Question 4)

a. True, because calendar year written premium is based off of transactions that occur in that year. For example, if a policy that was effective in 2011 is cancelled sometime in 2012 before expiration, this would not impact calendar year 2011 written premium, but would be reflected in calendar year 2012 written premium.
b. True, because calendar year earned premium comes from policy transactions that are effective before 1/1/2012. Similar to part (a), if a policy that was effective in 2011 is cancelled in 2012 (prior to expiration), this would not impact CY 2011 Earned Premium, but would be reflected in CY 2012 Earned Premium.
c. False, because Policy Year 2011 written premium is based off all transactions for policies that were effective in 2011. So, if a policy written in 2011 is cancelled in 2012 prior to expiration, this would be reflected in PY 2011 written premium (it would not impact PY 2012 written premium).
d. False, because Policy Year 2011 earned premium accounts for all transactions for policies that were effective in 2011 (regardless of transaction date). Same would hold true for Earned Prem as holds true for written premium in the example from part (c).

Question 4 – Model Solution 2 (Exam 5A Question 4)

a. True – CY WP is fixed at year end.
CY WP includes all transactions in the calendar period.
b. True – CY EP is fixed at year end.
CY EP = CY WP + Starting UEPR – Ending UEPR. All these are fixed at year end.
c. False – PY11 WP is not fixed @ 12/31/2011.
Endorsements and audit premiums in CY2012 and (possibly) beyond will change WP.
d. False – PY11 EP cannot be fully earned at 12/31/2011.
A policy written 12/1/2011 is only 1/12 earned a/o 12/31/11.

Question 4 – Model Solution 3 (Exam 5A Question 4)

a. Yes. Includes new prem written + midterm adjustments during calendar year 2011.
b. True, calendar year earned premium is premium associated with coverage provided during calendar year 2011.
c. Policy year 2011 written premium will not be fixed as of 12/31/2011, because any midterm changes associated with policies effective during 2011, even if change happens in 2012 or later, should be included. E.g. policy effective 7/1/2011, add a new vehicle on 4/1/2012, this contributes to PY 2011 written.
d. PY 2011 earned prem will not be fixed as of 12/31/11. This is the earned premium associate with all policies with effective dates in 2011. If they are annual policies, all coverage has not been provided

Solutions to questions from the 2012 exam:

Examiners Comments - Exam 5 Question 4 (Exam 5A Question 4)

a. Many candidates answered this correctly. However, some just repeated the question explaining that calendar year 2011 written premium will be fixed at 12/31/11, which isn't enough for the explanation. There were also candidates who mentioned this includes premium written in 2011 and any cancellations, which isn't enough of an explanation as need to give some indication as to when cancellation occurred to differentiate from policy year premium. Many candidates mentioned that any transactions occurring for in 2012 will count towards calendar year 2012 written premium, which is enough of an explanation.

b. Many candidates answered this correctly. However, some just repeated the question explaining that calendar year 2011 earned premium will be fixed at 12/31/11, which isn't enough for the explanation. Some candidates mentioned what is earned afterwards in 2012 will go towards calendar year 2012 earned premium, which is enough of an explanation. Similar to a), occasionally a candidate would explain that calendar year data is fixed, which is not enough of an explanation, because need to indicate when it is fixed (i. e. at end of year).

c. Of all the parts, part c. was the one most frequently answered incorrectly. Many candidates answered this correctly. However, there were also a significant amount of candidates who did not indicate when the cancellation or midterm adjustment occurred, which is not enough of an explanation as it does not differentiate from calendar year premium. Many times a candidate would say this part is correct because it only includes premium written during the year, which receives 0 points. Occasionally a candidate would say this is fixed at 12/31/12, which isn't enough of an explanation to receive full credit as it is not necessarily true (i.e. audits).

d. Many candidates answered this correctly. Some candidates said this was incorrect because any cancellation or mid-term adjustments would change policy year 2011 earned premium, which is not enough of an explanation to receive full credit as it does not differentiate from calendar year premium (need to mention when cancellation or mid-term adjustment occurs).

Questions from the 2012 exam:

5a. (0.5 point) Discuss whether or not it is appropriate to perform a classification ratemaking analysis using premiums adjusted with aggregate on-level factors.

5b. (0.5 point) State one advantage and one disadvantage of the parallelogram method relative to the extension of exposures method.

Exam 5 Model Solution 1 – Part a (Exam 5A Question 5a)

No. If a rate change disproportionately effects a certain class more than others, the on-level factors will vary by class. Therefore aggregate OLF should not be used.

Exam 5 Model Solution 2 – Part a (Exam 5A Question 5a)

It would be appropriate only if all classes have had the same rate change history. If not, then we need rate change info for each class, so that the true rate adjustment for each class can be determined.

Examiner's Comments:

The answers to part (a) often lacked sufficient detail to demonstrate the candidates understanding of why the aggregate on level factors may/may not be appropriate for class ratemaking.

Questions from the 2012 exam:

5a. (0.5 point) Discuss whether or not it is appropriate to perform a classification ratemaking analysis using premiums adjusted with aggregate on-level factors.

5b. (0.5 point) State one advantage and one disadvantage of the parallelogram method relative to the extension of exposures method.

Exam 5 Model Solution 1 – Part b (Exam 5A Question 5b)

Advantage: Parallelogram method is much simpler + requires much less calculations + computing power. It is much quicker to use.

Disadvantage: It assumes uniform premium writings throughout the year. When this assumption does not hold, it is not accurate. Extension of exposures is more accurate.

Exam 5 Model Solution 2 – Part b (Exam 5A Question 5b)

Advantage: Easy to calculate.

Disadvantage: Not so accurate.

Exam 5 Model Solution 3 – Part b (Exam 5A Question 5b)

Parallelogram

Advantage: Does not require individual policies, only need aggregate data.

Disadvantage: If different classes have different rate changes over time, then applying aggregate on level factors to aggregate premium will likely not produce the correct on-level premium.

Examiner's Comments

The majority of the candidates answered part (b) of the question well.

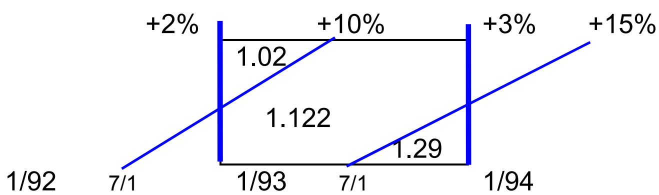
Section 2: Premium Aggregation – For Workers' Compensation

Solutions to questions from the 1994 exam

(a) (1.5 points) What adjustment factor is needed to bring calendar year 1993 premiums to current level? (Show a diagram representing the appropriate time periods.)

(b) (1.5 points) What adjustment factor is needed to bring policy year 1993 premiums to current level? (Show a diagram representing the appropriate time periods.)

48.



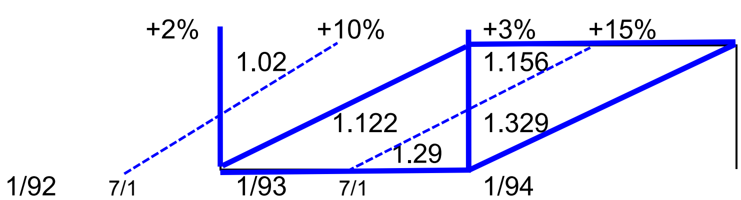
(a) Calculate the numerator of the on-level factor. This is equal to (1.02)(1.10)(1.15)(1.03) = 1.329. Calculate the average rate level factor for the calendar year. This is a weighted average of the rate level factors in the **calendar year**. The weights will be relative proportions of the **square**. First calculate the area of all triangles (area = .5*base*height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

The average rate level factor for the calendar year = (1/2)(.5)(.5)*1.02 + (1/2)*.5*.5*1.29 + (1.0 - .25)*1.122 = 1.130.

The on-level factor = 1.329 / 1.130 = 1.176.

(b). Calculate the numerator of the on-level factor. This is equal to (1.02)(1.10)(1.15)(1.03) = 1.329. Calculate the average rate level factor for the **policy year**. This is a weighted average of the rate level factors in the policy year. The weights will be relative proportions of the **parallelogram**. First calculate the area of all triangles (area = .5*base*height) within the parallelogram and then determine the remaining proportion of the parallelogram by subtracting the sum of the areas of the triangles from 1.0.

The average rate level factor for the policy year = (1/2)(.5)(.5)*1.290 + (1/2)(.5)(.5)*1.156 + (1.0 - (1/4))*1.122*.50 + (1.0 - (1/4))*1.329*.50 = 1.225.



The on-level factor = 1.329 / 1.225 = 1.085.

Solutions to the questions from the 1996 exam

Question 36.

(a). The premium adjustment factor is also known as an on-level factor. The numerator of the on-level factor considers rate changes which impact both PY 1995, represented by the parallelogram below, and rate changes up and through the current level. The denominator of the on-level factor considers only those rate changes which impact PY 1995.

Calculate the numerator of the on-level factor. This is equal to (1.0)(1.15)(.90)(1.05) = . 1.08675

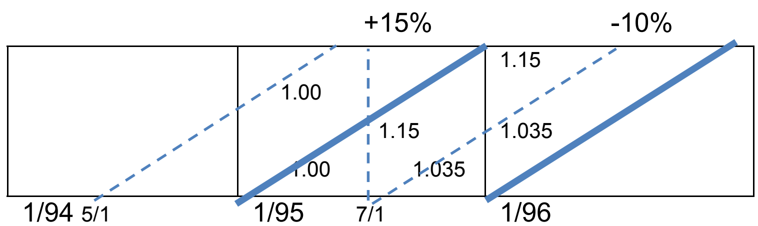
Calculate the average rate level factor for the **policy year**. This is a weighted average of the rate level factors in the policy year. The weights will be relative proportions of the **parallelogram**.

First calculate the area of all triangles (area = .50 * base * height) within the parallelogram and then determine the remaining proportion of the parallelogram by subtracting the sum of the areas of the triangles from 1.0.

Notice the area of the parallelogram at the 1.035 level.

Its area is calculated as base * height = .50*1.0 = .50.

The average rate level factor for the policy year = (1/2)(.5)(.5)*1.0 + (1/2)(.5)(.5)*1.15 +.50*1.0*1.035 + (1.0 - .125 - .125 - .50)*1.15 = 1.07375.



The on-level factor = 1.08675 / 1.07375 = 1.012.

(b) Experience rate changes are represented graphically as diagonal lines, and are computed to adjust current rates for changes anticipated in projected experience level. These affect new and renewal policies only.

Law amendment changes are represented graphically as straight lines, and since they affect **all** policies in-force at a given point in time. These changes adjust premiums for statutory modifications to benefits.

Solutions to questions from the 1997 exam

Question 12. Assume that policy year 199X premium is being booked at $P per month.
Developed premium, due to final audits, is not known until 6 months after the policy expires.
At 12/31/9X+1, developed premium for only those policies issued during the 1st 6 months of PY 199X is known.
At 12/31/9X+2, developed premium for all policies issued during PY 199X is known.

	Reported Premium for polices issued during the		
Evaluation Date	1st 6 months of PY 199X	Last 6 months of PY 199X	Total PY 199X
12/31/9X	6 months * ($P/month)	6 months * ($P/month)	12P
12/31/9X+1	6 * P * 1.07	6 * P	12.42P
12/31/9X+2	6 * P * 1.07	6 * P * 1.07	12.84P

Therefore, the PY premium development factor for 24 to 36 months is 12.84P/12.42P = 1.034 **Answer D.**

Solutions to questions from the 1999 exam

Question 37
Note: At 12/31/9X+1, premium for PY 199X is at 24 months of development.
At 12/31/9X+2, premium for PY 199X is at 36 months of development.
a.

	Reported Premium for polices issued during the		
Evaluation Date	1st 6 months of PY 199X	Last 6 months of PY 199X	Total PY 199X
12/31/9X	6 months * ($1M/month)	6 months * ($1.1M/month)	12.6M
12/31/9X+1	6 * ($1M/month)*.20		12.6M + 1.2M = 13.8M
12/31/9X+2		6 * ($1.1M/month)*.20	13.8M + 1.32M =15.12M

Therefore, the PY premium development factor for 24 to 36 months is 15.12M/13.8M = 1.096

b. CY premiums include audit premium from past policies. As long as premium volume remains steady, next year's audit premiums associated with current exposures should approximate this year's audit premiums due to from prior year's exposures, so the PDF is approximately = 1.00

Solutions to questions from the 2001 exam

Question 15. Compute the policy year reported premium development factor from 12 to 24 months.

Assume that policy year 199X premium is being booked at $P per month.

- Final audit occurs 3 months after policy expiration.
- On average, audits result in 15% additional premium.

Developed premium, due to final audits, is not known until 3 months after the policy expires.
At 12/31/9X+1, developed premium for policies issued during the 1st 9 months of PY 199X is known.
At 12/31/9X+2, developed premium for all policies issued during PY 199X is known.

	Reported Premium for polices issued during the		
Evaluation Date	1st 9 months of PY 199X	Last 3 months of PY 199X	Total PY 199X
12/31/9X	9 months * ($P/month)	3 months * ($P/month)	12P
12/31/9X+1	9 * P * 1.15	3 * P	13.35P
12/31/9X+2	9 * P * 1.15	3 * P * 1.15	13.80P

Therefore, the PY premium development factor for 12 to 24 months is 13.35P÷12.00P = 1.1125 **Answer D.**

Solutions to the questions from the 2001 exam

Question 47.

a. Describe how premiums and losses are compiled under each of the three experience periods:

1. Policy year experience compiles premiums and losses arising from policies issued in a given period (typically a one year period). Thus, premiums and losses arising from a given block of policies can be directly matched.
2. Calendar year experience reflects financial statement transactions for a given year. Earned premium is defined as written premium for the year plus the unearned premium reserve at beginning of this year minus UEP reserve at end of the year. Calendar year incurred losses are paid losses during the year plus loss reserves at the end of the year minus loss reserves at the beginning of the year.
3. Calendar/Accident year – Premiums are computed as calendar year earned premiums or can be adjusted for audits or earned but not reported (EBNR) premium changes. Losses include payments and reserves for accidents occurring in a given period.

b. (1½ points) State one advantage and one disadvantage associated with each type of experience period.

Experience period	Advantage	Disadvantage
Policy year	It matches premiums and losses from a given block of policies	Policy year experience is less “mature” than similarly aged calendar year or cal/acc year experience.
Calendar year	It is more “mature” than similarly aged policy year or cal/acc year experience.	It is not available for individual classifications and premium and loss experience are not related to a given block of policies.
Calendar/Acc year	Accident year losses can be matched to the corresponding exposure year earned premium.	Premium must be adjusted for exposure audits or retrospective adjustments

Solutions to questions from the 2002 exam

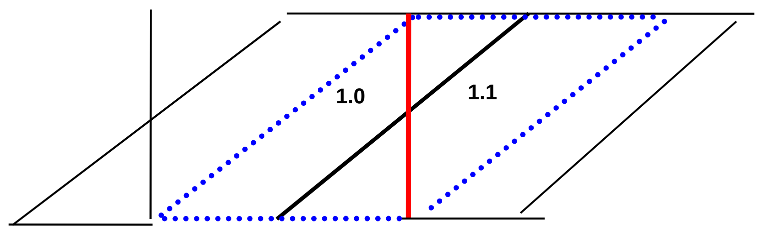
Question 27.

a. (2 points) What is the policy year 2000 earned premium after all appropriate adjustments for premium development, **current rate level**, premium trend, and benefit changes?

Step 1: Draw a diagram similar to the one below which identifies periods in time in which rate changes take place.

Benefit level change +5%

Rate change -6% 10% 7%



7/1/99 1/1/2000 7/1/00 1/1/2001 7/1/01

Policy year 2000 is represented by the dashed line parallelogram. Further, rate level changes are shown separately from benefit level changes, since the problem states that although a 5% increase in benefit levels were effective 1/1/01, no rate change to account for the benefit level change took place.

Step 2: To determine **premium development**, a development factor to account for premium audits needs to be determined. At 12/31/01, policies issued between 1/1/00 – 6/30/00 have completed their audits whereas policies issued between 7/1/00 – 12/31/00 have not. At 12/31/01, the factor to account for future premium development is $\frac{1.10}{.5(1.10)+.5(1.0)} = \frac{1.1}{1.05} = 1.047619$

Step 3: To determine the current rate level, we can ignore the -6% rate level change that was effective 7/1/99, establish a base rate level of 1.0, and determine that the **current** rate level is (1.0 * 1.10 * 1.07) 1.177. The **average** rate level for policy year 2000 is 1.05 (.50*1.0+.50*1.10) and therefore:

The on-level factor for policy year 2000 is $\frac{\text{Current Rate Level}}{\text{Average Rate Level}} = \frac{1.177}{1.050} = 1.121$

Step 4: To determine the **premium trend period**, one must determine the time between the average date of writing during policy year 2000 (7/1/00) and the corresponding projected date in the forecast period. Since we are told that the effective date of the analysis is 7/1/02, and that rates will be effective for a period of one year, average written date during the forecast period is 1/1/03. Thus, the premium trend period is 2.5 years (7/1/00 – 1/1/03), and the premium trend factor is $1.04^{2.5} = 1.103$.

Step 5: Using the policy year 200 earned premium given in the problem, and the results of Steps 2 – 4, compute on-leveled, developed and trended earned premium.

On-leveled, developed and trended policy year 2000 earned premium is
90M * 1.0476 * 1.121 * 1.103 = **116.58M**

Solutions to questions from the 2002 exam (continued)

b. (2 points) What are the policy year 2000 losses after the appropriate adjustments for loss development, loss trend, and benefit changes?

Step 1: A development factor to account for benefit level changes needs to be determined. Since a 5% increase in benefit levels affects all policies inforce as of its effective date (shown as the solid vertical line at 1/1/01 in the graph above), the factor to account for this benefit level change is

$$\frac{1.05}{.5(1.0)+.5(1.05)} = 1.024$$

Step 2: To determine the **loss trend period**, one must determine the time between the average accident during the experience period (which for policy year 2000 is 1/1/01) and the average accident date during the effective period of the rates (which for a one year effective period beginning 7/1/02 is 7/1/03). Thus, the loss trend factor is $1.08^{2.5}$ = 1.212

Therefore, losses adjusted for development, benefit changes, trend and loss adjustment expenses are 40M * 1.80 * 1.024 * 1.212 * 1.20 = **107.28M**

c. (½ point) What is the projected loss and loss adjustment expense ratio for policy year 2000?

The projected loss and LAE ratio for policy year is the ratio of the result from questions (b) to (a) above: $\frac{107.28}{116.58} = .92$

d. (½ point) What is the indicated rate change based on experience from policy year 2000?

The indicated rate change based on experience from policy year 2000 is the ratio of the projected loss and LAE ratio to the garget loss and LAE ratio minus one: $\frac{.92}{.72} - 1 = .278$

e. (1 point) What should the ratio of charged to manual premium be in order to produce the target loss and loss adjustment expense ratio?

Since the company has been charging 25% below its manual rates for workers compensation, and since the target loss and loss adjustment expense ratio is based on the anticipated expense costs during the future policy period, the ratio of charged to manual premium to produce the target loss and loss adjustment expense ratio should be 1.278 * (1.0 - .25) = .96

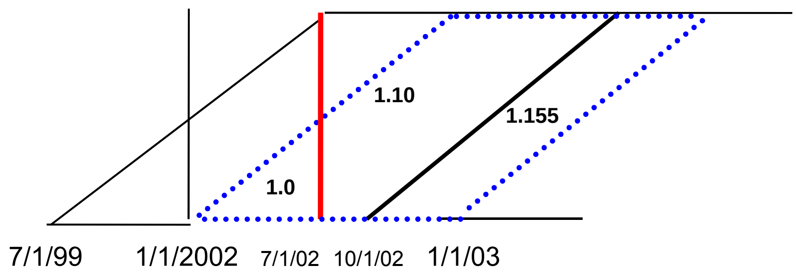
Solutions to questions from the 2003 exam

33. (2 points) Calculate the factor needed to adjust policy year 2002 written premium to current level. Show all work.

Step 1: Draw a diagram similar to the one below which identifies periods in time in which rate changes take place.

Law amendment change +10%

Rate change + 5% +7%



Policy year 2002 is represented by the dashed line parallelogram. Further, rate level changes are shown separately from law amendment changes.

Step 2: To determine the current rate level, establish a base rate level of 1.0, and determine that the **current** rate level is (1.10 * 1.05 * 1.07) 1.236.

Since PY 2002 had 3 rate levels in effect, we need to determine the respective area weights to apply to the rate levels. For the 1/1/02 level, the weight is ½ *½ *½ = 1/8. For the 10/1/02 level, the weight is ¼ * 1.0 = ¼. Thus, the weight for the 7/1/02 level is 1.00 – 1/8 – ¼ = 5/8.

The **average** rate level for policy year 2002 is (1/8 * 1.0 + 5/8 * 1.10 + ¼ * 1.155) 1.101.

Therefore, the on-level factor for policy year 2002 is $\frac{Current\ Rate\ Level}{Average\ Rate\ Level} = \frac{1.236}{1.101} = 1.122$

Solutions to questions from the 2004 exam

11. Given the following data, calculate the policy year 2001 premium development factor from 24 to 36 months.
    - Full estimated policy year premium is booked at inception, $10 million a month in 2001.
    - Premium develops upward by 5% at the final audit, three months after the policy expires.
    - All policies are annual.

We are told that developed premium, due to final audits, is not known until 3 months after the policy expires.
At 12/31/02, developed premium for policies issued during the 1st 9 months of PY 2001 is known.
At 12/31/03, developed premium for all policies issued during PY 2001 is known.
This can be demonstrated mathematically as follows:

	Reported Premium for polices issued during the		
Evaluation Date	1st 9 months of PY 2001	Last 3 months of PY 2001	Total PY 2001
12/31/01	9 months * $10M/month	3 months * $10M/month	120M
12/31/02	9 * $10M * 1.05	3 * 10M	124.5M
12/31/03	9 * $10M * 1.05	3 * $10M * 1.05	126M

Therefore, the PY premium development factor for 24 to 36 months is $126M/$124.5M = 1.012

Answer B: $\geq$ 1.010 but < 1.015

Solutions to questions from the 2004 exam (continued):

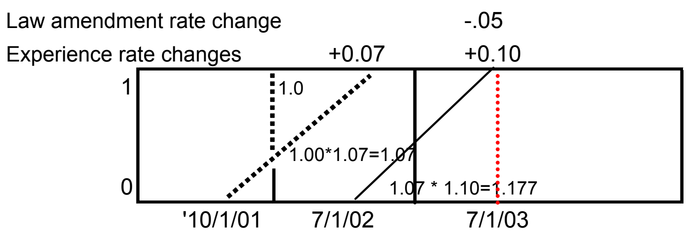
31. (4 points) Given the following information, answer the questions below. Show all work.
   - Policies are written uniformly throughout the year.
   - Polices have a term of 12 months.
   - The law amendment change affects all policies in force.

   Assume the following rate changes:
   - Experience rate change on October 1, 2001 =+7%
   - Experience rate change on July 1, 2002 =+10%
   - Law amendment change on July 1, 2003 = -5%

   a. (2 points) Calculate the factor needed to adjust calendar year 2002 earned premium to current level.

Step 1: Draw a diagram similar to the one below which identifies periods in time in which rate changes (both experience rate and law amendment rate) take place.

View the earning of **CY** 2002 EP using a unit square.



Step 2: Compute the current rate level factor, the product of the experience and law amendment rate changes. This is the numerator of the CY 2002 on-level factor.

Current rate level factor = 1.00 * 1.07 * 1.10 * (1.00 - .05) = 1.1182.

Step 3: Calculate the denominator for the CY 2002 on-level factor. The denominator is the average rate level factor for the CY. This is a weighted average of the varying rate levels in effect. The weights are the relative proportions of the CY 2002 square.

First calculate the area of all triangles (area = .5 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

Since CY 2002 had 3 experience and amendment rate levels in effect, we need to determine the respective area weights to apply to these rate levels. Prior to the 10/1/01 experience rate change level, the relative weight associated with the 1.0 rate level during CY 2002 is .50 * .75 * .75 = .28125. Subsequent to the 7/1/02 experience rate change, the relative weight applied to the 1.177 rate level is .50 * .50 * .50 = .125. Therefore, the relative weight associated with the 1.07 rate level for the remaining portion of CY 2002 is 1.00 - .28125 - .125 = .59375.

The **average** rate level for CY 2002 is (.28125 * 1.00 + .125 * 1.177 + .59375 * 1.07) = 1.0637

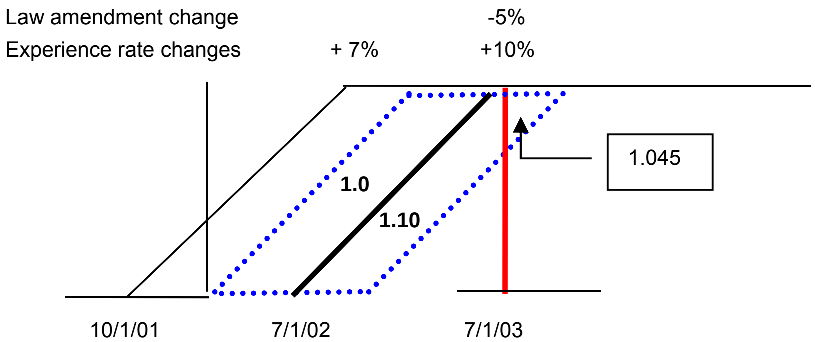
Therefore, the on-level factor for calendar year 2002 is $\frac{\textit{Current Rate Level}}{\textit{Average Rate Level}} = \frac{1.1182}{1.0637} =$ **1.051**

Solutions to questions from the 2004 exam (continued):

Question 31 (continued):

b. (2 points) Calculate the factor needed to adjust policy year 2002 earned premium to current level.

Step 1: Draw a diagram similar to the one below which identifies periods in time in which rate changes take place.



Policy year 2002 is represented by the dashed line parallelogram. Further, rate level changes are shown separately from law amendment changes.

Step 2: To determine the current rate level, establish a base rate level of 1.0, and determine that the **current** rate level is (1.00 *01.10 * .95) = 1.045.

Since PY 2002 had 3 rate levels in effect, we need to determine the respective area weights to apply to the rate levels. Prior to the 7/1/02 experience rate change, the weight associated with the PY 2002, 1.0 rate level, is .50 (half the area of the parallelogram). The relative weight associated with the 7/1/03 law amendment change, with a rate level of 1.10 * .95 = 1.045, is ½ *½ *½ = 1/8. Thus, the weight for the 7/1/02,1.10 rate level, is 1.00 – 1/8 – 1/2 = 3/8.

The **average** rate level for policy year 2002 is (.50 * 1.00 + .375 * 1.10 + .125 * 1.045) = 1.0431.

Therefore, the on-level factor to adjust policy year 2002 earned premium to current level is

$$\frac{\textit{Current Rate Level}}{\textit{Average Rate Level}} = \frac{1.045}{1.0431} = \mathbf{1.002}$$

Solutions to questions from the 2007 exam:

37. (2.0 points)

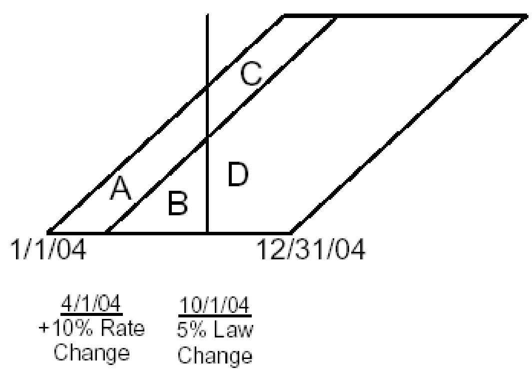
a. (1.0 point) Draw the diagram underlying the calculation of the current rate level factor used to adjust policy year 2004 premium to current rate level.

b. (1.0 point) Draw the diagram underlying the calculation of the current rate level factor used to adjust calendar year 2004 earned premium to current rate level.

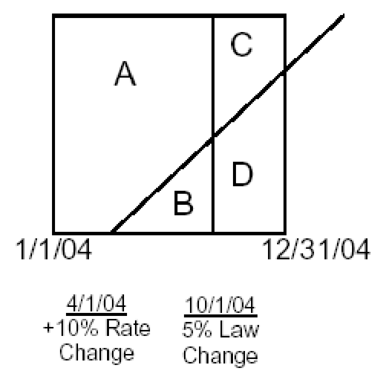
Note: Policy years are represented graphically by a **parallelogram**. Calendar years are represented graphically by a **square**.

The relative rate levels are the multiplicative product of (1.0 + rate level changes) and (1.0 + law amendment changes).

a. PY04



b. CY04 EP



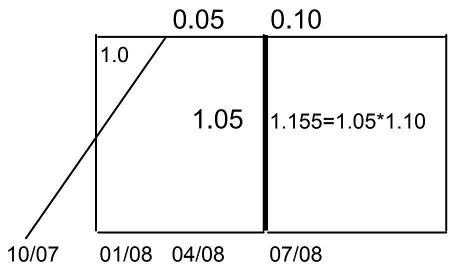
A=1.00	A=1.00
B=1.00 * 1.10 =1.10	B = 1.00 * 1.10=1.10
C=1.00 * 1.05 =1.05	C = 1.00 * 1.05=1.05
D=1.00 * 1.10 * 1.05 =1.155	D = 1.00 * 1.10* 1.05=1.155

Solutions to questions from the 2009 exam:

Question 19:

a. Since a rate change was effective on 10/1/07 and applies to all future policies sold, a diagonal line is drawn at 10/1 to graphically depict the impact of the change when computing the on-level factor.

Since a law change was effective on 7/1/08 and applies to all in-force and future policies, a solid vertical line is drawn at 7/1 to graphically depict the impact of the change when computing the on-level factor.



b. $OLF = \dfrac{Current\ Rate\ Level\ Factor}{Avg\ Rate\ Level\ Factor}$

The current rate level factor equals the product of all rate changes occurring during CY 2008

CRLF = 1.0 * 1.05 * 1.10 = 1.155

The average rate level factor is a weighted average of the varying rate levels that occurred in CY 2008. The weights will be relative proportions of the CY square. First calculate the area of all triangles (area = .5 * base * height) or rectangles within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles and rectangles from 1.0.

Since all policies are semi-annual, the diagonal line is representative of a policy written 10/1/2007 and expiring 3/31/2008.

CY 2008 Average rate level = (.50)(3/12)(6/12) * 1.0 + [(1/2) - (.50)(3/12)(6/12)] * 1.05 + (.50)*1.155

= .0625 +.459375 +.5775 = 1.099375

On-level factor for 2008 CY EP = 1.155/1.099375 = 1.05059693

c. Snowmobile insurance is not uniformly earned throughout the year. The parallelogram method assumes uniform earnings.

Solutions to questions from the 2010 exam:

Question 19

a. (1 point) Draw and fully label a diagram for CY 2008 earned premium reflecting the parallelogram method.

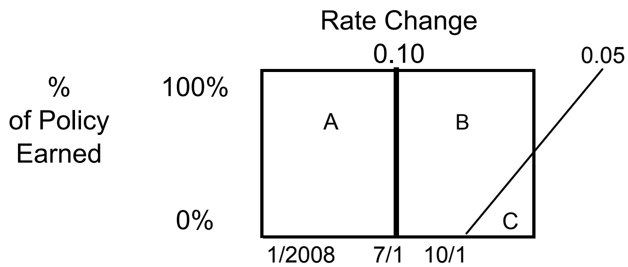
b. (1 point) Calculate the on-level factor for CY 2008 earned premium.

c. (1 point) Draw and fully label a diagram for PY 2008 earned premium reflecting the parallelogram method.

a. Since a law change was effective on 7/1/08 and applies to all in-force and future policies, a solid vertical line is drawn at 7/1 to graphically depict the impact of the change when computing the on-level factor.

Since a rate change was effective on 10/1/08 and applies to all future policies sold, a diagonal line is drawn at 10/1 to graphically depict the impact of the change when computing the on-level factor.

Areas A, B and C represent portions of CY 2008 that correspond to the three rate levels in effect.



b. $OLF = \frac{Current\ Rate\ Level\ Factor}{Avg\ Rate\ Level\ Factor}$

The current rate level factor equals the product of all rate changes occurring during CY 2008

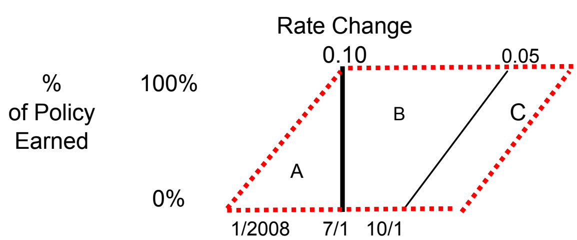
CRLF = 1.0 * 1.10 * 1.05 = 1.155

The average rate level factor is a weighted average of the varying rate levels that occurred in CY 2008. The weights will be relative proportions of the CY square. First calculate the area of all triangles (area = .5 * base * height) or rectangles within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles and rectangles from 1.0.

Area	Rate Level	Weight	
A	1.00	.50 * 1.0 =	.50
C	1.155	½(1/4)(1/2)=	.0625
B	1.10	1.0 - .50 - .0625=	.4375

$$CY\ 08\ OLF = \frac{1.155}{[.50(1.0)+.4375(1.10)+.0625(1.155)]} = \frac{1.155}{1.0534375} = 1.0964$$

c.



Section 3: Premium Aggregation – Using the One and Two Step Procedures

Solutions to questions from the 2003 exam

11. Determine the written premium trend period.

Step 1: Determine the average written date during the experience period. For the experience period 4/1/01 – 3/31/02, and given that 6 month policies are being written, the average earned date is 10/1/01 and the average written date is **7/1/01**, or ½ the policy term earlier from the average earned date.

Step 2: Determine the average written date during the exposure period. The average written date during the future policy period is a function of the length of time that the rates are expected to remain in effect. In this example, since rates are reviewed every 18 months, this would make the average written date 9 months after the proposed effective date of 4/1/03, which is **1/1/04.** Thus, the written premium trend period is 2.50 years.

Answer: D. ≥ 2.4 years, but < 2.7 years

Solutions to questions from the 2004 exam

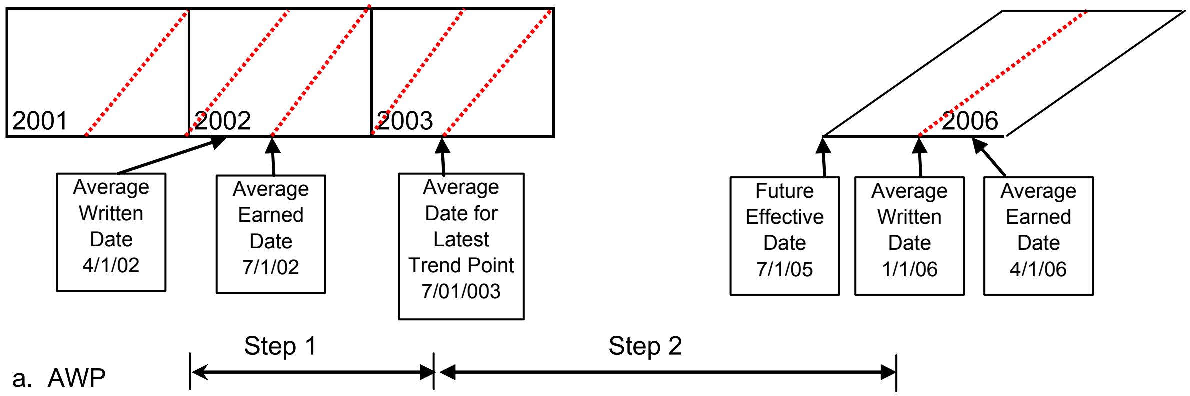
Question 35.

a. (1 point) Calculate the beginning and ending dates for each of the Step 1 and Step 2 trend periods, assuming the selected trend is based on average written premium.

Preliminary information.

The solution below includes a graphic depicting the beginning and ending dates for each of the Step 1 and Step 2 trend periods, assuming the selected trend is based on average written or average earned premium. The graphic is included in our solution for instructional purposes only.

What are the trending periods to apply to CY/AY 2002 earned premium at current rate level using a two-step trending procedure?



Step 1: Determine the trend period from the average written date of the experience period to the average date for the last data point in the average written date series:

To determine the average written date, recognize that the first policies that contribute to calendar year 2002 earned premium would be ones written on 7/2/01, since these policies would be effective until the end of the day on 1/1/02. The last policies that would contribute to CY 2002 earned premium would be ones written on 12/31/02. The total amount of time between the two written dates is 18 months, so the average written date is **4/1/02**.

In establishing the ending point for the first part of the trending period (step 1), it is important to recognize that the average written premium measures in the series are 12-month averages. This means that each figure provides a measure of the average premium at the midpoint of its 12-month period. In other words, since the latest trend point in the series is for the year ending 12/31/03, then the measure of the average premium for that point corresponds to 7/1/03, not 12/31/03.

Thus, the average written date of the experience period is 4/1/02 and the average date for the last data point in the average written date series is 7/1/03.

Step 2: Determine the trend period from the average written date for the last data point in the average written date series to the average written date under the effective period of the rates.

As stated before, the average written date for the last data point in the average written date series under the experience period is 7/1/03. The average written date for polices effective during the planned effective period is January 1, 2006. This is because the average written date in the future policy period does not depend on the length of the policies. Instead, it is the length of time the rates are assumed to be in effect before the next revision.

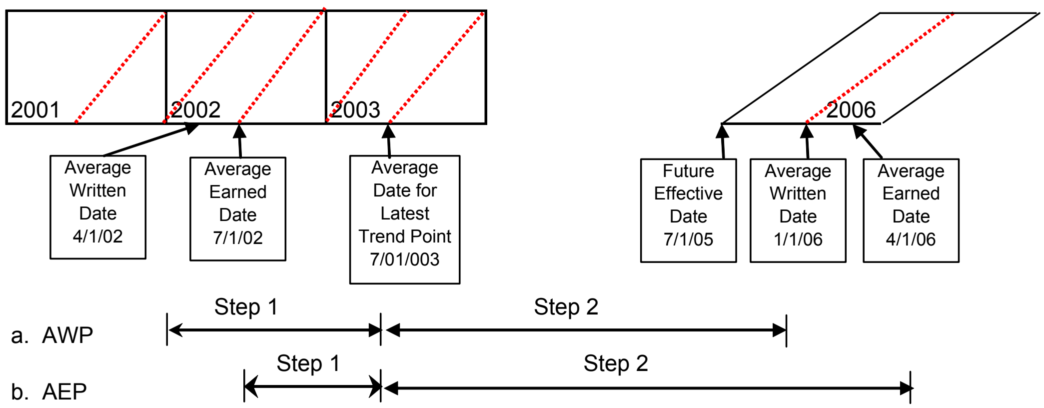
Therefore, the beginning and ending dates for Step 2 trend is 7/1/03 – 1/1/06.

Solutions to questions from the 2004 exam (continued):

b. (1 point) Calculate the beginning and ending dates for each of the Step 1 and Step 2 trend periods, assuming the selected trend is based on average earned premium.

Preliminary information.

It is important to realize that whether the selected trend is based on average written premium or average earned premium, the two alternatives have the same length trending periods. However, these periods are not identical. The trending period for the average earned premium approach is shifted in time so that it is a half a policy period later than the trending period for the average written premium approach.

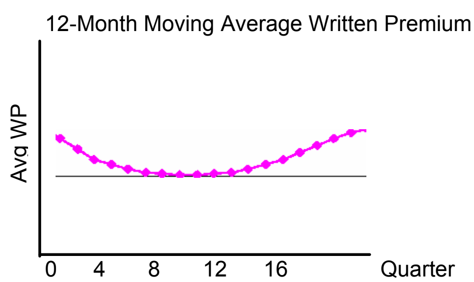


Based on the discussion in part a, and the graphic above, we can determine the following:

The beginning and ending dates for Step 1 trend is 7/1/02 – 7/1/03.

The beginning and ending dates for Step 2 trend is 7/1/03 – 4/1/06.

c. (1 point) Describe a situation when it may be more appropriate to use a two-step trending procedure, rather than a one-step trending procedure. Two step trending is more appropriate when there isn't a clear trend in the series of average written or earned premiums.



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For example, if the 12 month moving average written premiums looked like the series above it would not be appropriate to apply a single trend, since the lower average written premium at the midpoint needs more trend applied to it than the average written premium at the beginning or end.

Solutions to questions from the 2005 exam:

37a. (3.5 points) Using two-step trending, determine the total premium trend factors for each year above.

Initial comments: the two-step trending method simply divides the latest average written premium at current by the average earned premium at current for each year in the experience period. This produces conversion factors for adjusting the total earned premium at current rate level for each year to the latest period's average written premium level.

In establishing the ending point for the first part of the trending period (step 1), it is important to recognize that the average written premium measures in the series are 12-month averages. This means that each figure provides a measure of the average premium at the midpoint of its 12-month period. In other words, if the latest trend point in the series is for the year ending 12/31/01, then the measure of the average premium for that point corresponds to 7/1/01, not 12/31/01. Therefore, the first step of the two-step trending procedure trends the premium to the midpoint of the latest trend data point in the series.

The second step of the two-step trending procedure trends the premium from the midpoint of the latest trend data point to the average written date for the future policy period. If the target effective date were 1/1/03, then the average written date for the future policy year would be half way through, or 7/1/03, with the standard assumption that the proposed rates will be in effect for one year. The trending period in this example would need to extend from the midpoint of the latest average written premium measure (7/1/01) to the average written date for the future policy period (7/1/03). Therefore, the trending period for the second step would be two years.

Problem Specific:

First, one needs to adjust the historical premiums for the 20% rate decrease on 7/1/03.

For CAY 2004 – The average written premium does not need to be adjusted

For CAY 2003 – One half of the written premium needs to be adjusted down by 20%. Thus, the adjusted CAY 2003 average written premium is ½(933.33) + ½(933.33)(0.8) = 840

For CAY 2002 – The entire premium needs to be adjusted downward by 20%: 1,000 × 0.80 = 800

The first step in the two-step trending is to divide the latest year's average written premium by each year's average written premium. The ratios are the trend factors for step 1. They are used to trend the premiums to 7/1/04 and are computed as follows:

CAY	Trend Factor
2002	882/800 = 1.1025
2003	882/840 = 1.05
2004	882/882 = 1.0

This factor already includes the 3% trend due to shifts in limit distributions from 2002-2004.

Solutions to questions from the 2005 exam (continued):

Question 37 (continued):

In step 2, project the average premiums for each year to the anticipated future level.

A prospective trend is not given, so I will use the historical trend of 1.05 reduced for the 3% trend not continuing past 2004. Thus, the prospective trend = 1.05/1.03 = 1.019 = 1.9%

The step 2 trending period extends from 7/1/04 to the average written date of effective period. As rates are reviewed every 18 months, and given that the planned effective date for a rate change is January 1, 2006, the average written date will be 9 months past the effective date, or 10/1/06.

Trend factor for step 2 = $(1.019)^{2.25}$ = 1.043

Thus, the total premium trend factor is calculated as follows:

CAY	Step 1	Step 2	Total
	(1)	(2)	(3)=(1)*(2)
2002	1.1025	1.043	1.15
2003	1.05	1.043	1.095
2004	1.0	1.043	1.043

See page 28.

b. (0.5 point) Why is two-step trending a more suitable procedure for trending premium than for trending loss frequency or severity?

This procedure relies on the assumption that the latest year's average written premium is a time value. For premiums, this assumption holds because premiums are relatively stable. Loss severity and frequency values vary greatly over time and the assumption does not hold.

Alternatively,

"Consider the theoretical implications of two-step trending. This trending method rests on the assumption that the last data point of the trend series is a "true" number. For loss frequency or severity, this can be a dubious assumption because of random fluctuations around the true expected value. For average premium, on the other hand, the individual data points are more believable because there is not as large a random element."

Solutions to questions from the 2006 exam:

Question 26

a. (1.5 points) Assume all policies have a six-month term. Use 2-step trending with average written premium to calculate the trended premium for calendar year 2002. Show all work.

Step 1: Determine the trend period from the average written date of the experience period to the average date for the last data point in the average written date series:

To determine the average written date, recognize that the first policies that contribute to calendar year 2002 earned premium would be ones written on 7/2/01, since these policies would be effective until the end of the day on 1/1/02. The last policies that would contribute to CY 2002 earned premium would be ones written on 12/31/02. The total amount of time between the two written dates is 18 months, so the average written date is **4/1/02**.

In establishing the ending point for the first part of the trending period (step 1), it is important to recognize that the average written premium measures in the series are 12-month averages. This means that each figure provides a measure of the average premium at the midpoint of its 12-month period. In other words, since the latest trend point in the series is for the year ending 12/31/04, then the measure of the average premium for that point corresponds to 7/1/04, not 12/31/04.

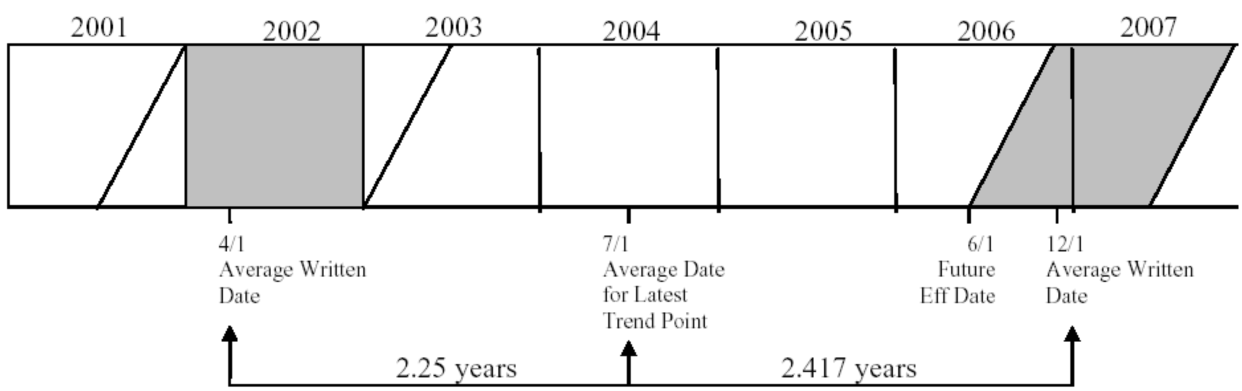
Thus, the average written date of the experience period is 4/1/02 and the average date for the last data point in the average written date series is 7/1/04. This is the period where premium will be trended by the historic premium drift of 5%.

Step 2: Determine the trend period from the average written date for the last data point in the average written date series to the average written date under the effective period of the rates.

As stated before, the average written date for the last data point in the average written date series under the experience period is 7/1/04. The average written date for polices effective during the planned effective period is December 1, 2006. This is because the average written date in the future policy period does not depend on the length of the policies. Instead, it depends on the length of time the rates are assumed to be in effect before the next revision.

Therefore, the beginning and ending dates for Step 2 trend is 7/1/04 – 12/1/06. This is the period where premium will be trended by the expected future premium drift of 3%.

Thus, the trended premium for calendar year 2002 is computed as follows:



Trended Premium = $42,500,000 * $(1.05)^{2.25}$ * $(1.03)^{2.417}$ = $50,943,928

Solutions to questions from the 2006 exam:

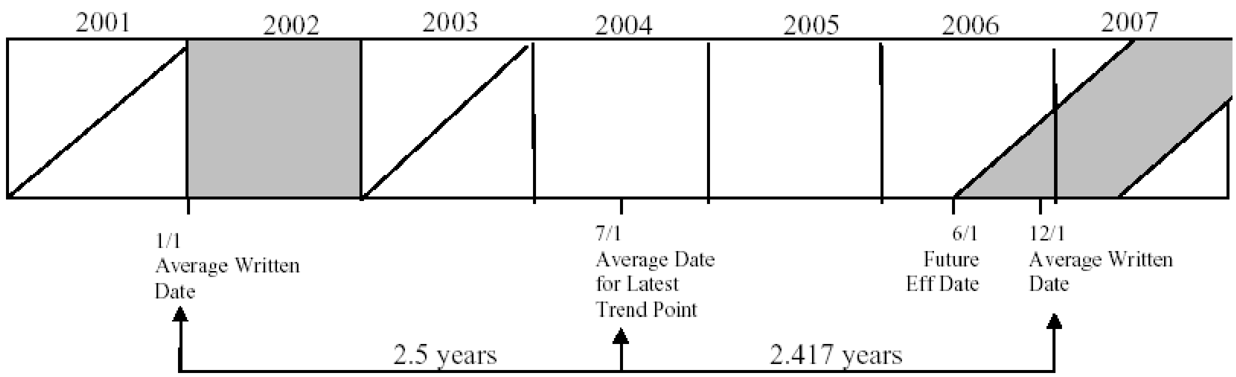
Question 26, part b:

b. (1.5 points) Assume all policies have an annual term. Use 2-step trending with average written premium to calculate the trended premium for calendar year 2002. Show all work.

Note: The only difference in solving this problem, compared with the problem in part a, is the starting date for the trend period. The rationale given for all other points in time in as stated in part a, for both steps, holds.

To determine the average written date, given annual policies, recognize that the first policies that contribute to calendar year 2002 earned premium would be ones written on 1/2/01, since these policies would be effective until the end of the day on 1/1/02. The last policies that would contribute to CY 2002 earned premium would be ones written on 12/31/02. The total amount of time between the two written dates is 24 months, so the average written date is **1/1/02**.

Thus, the trended premium for calendar year 2002 is computed as follows:



Trended Premium = $\$42{,}500{,}000 * (1.05)^{2.5} * (1.03)^{2.417} = \$51{,}571{,}159$

c. (0.5 point) Explain one advantage of using 2-step trending in this example over 1-step trending.

1-step-trending assumes uniform trend from the experience period to the future policy period. This assumption does not apply to certain situations where there are differences in trend between the past and the future. The 2-step trending procedure solves this problem.

Solutions to questions from the 2006 exam (continued):

27. (1 point)

a. (0.5 point) Explain why using average premiums is better than total premiums when analyzing premium trend.
b. (0.5 point) Give one argument for using average earned premiums in the premium trend analysis and one argument for using average written premiums.

CAS Model Solution

Part a.

Total premiums are affected by exposure changes, while average premiums have averaged out the exposure effects. Thus changes in average premium are more related to the actual trend in premium.

Part b.

1 – The premiums being trended are earned premiums, thus it is better to use average earned premiums in the premium trend analysis.

2 – Average written premiums are more responsive to recent changes.

As Jones states

"Since these trends will apply to historical earned premium at current rate level, we should evaluate trends based on shifts in average earned premium."

"Even though the historical premium is earned premium, we can determine the average written date for that block of premium and then observe changes in average written premium to establish the trend. Therefore, basing the trend analysis on average written premium is a valid approach. Furthermore, **average written premium has an important advantage in that it allows us to capture more recent data than average earned premium.** This is because of the simple fact that the premium for a given policy is not earned until well after it is written. In fact, at any given point in time, the latest quarter's average earned premium is based on a group of policies that is a half a policy period older than the group of policies comprising the latest quarter's average written premium. Using average earned premium would unnecessarily postpone the recognition of the effects of the most recent changes in the mix of business."

Solutions to questions from the 2007 exam:

Question 36 - Calculate the trended premium for each year, using the two-step trending method.

Model Solution - Initial comments.

The two-step trending method requires the use of average earned premium at current rate level for each year in the experience period. The components are total earned premium at current rate level and earned exposures. In this problem, we are given the average earned premium at current rate level.

How the two-step trending method is used.

The two-step trending method simply divides the latest average written premium at current level by the average earned premium at current for each year in the experience period. This produces conversion factors for adjusting the total earned premium at current rate level for each year to the latest period's average written premium level.

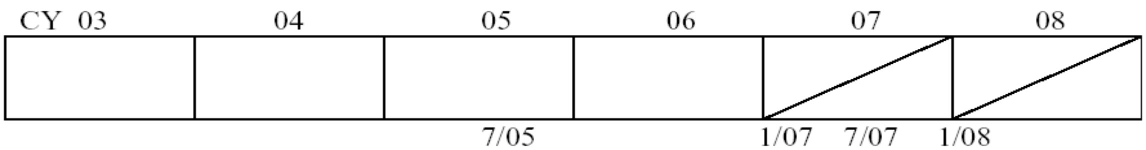
Solutions to questions from the 2007 exam:

Question 36 - Calculate the trended premium for each year, using the two-step trending method.

Model Solution

Step 1: Bring the average earned premium at current rate level to the latest level available in the series of average written premiums at current rate level.

This accounts for shifts in the mix of business and any other factors not already accounted for with a direct adjustment to the historical experience.



For Step 1, we don't need to consider exposures because average written premiums at current level are used.

Step 2: Project the average written premiums at current level for each year to the anticipated future rate level. A three percent annual trend (stated in the problem (see (3)) is applied over a two-year period.

The Step 2 trend period is 2 years (from 7/1/05 to 7/1/07) at 3%.

CY	Avg EP @CRL (1)	Latest Value of Avg WP @CRL (7/05) (2)	Step 1 Trend Factor (3) = (2)/(1)	Step 2 Trend Factor (4)	Total Premium Trend Factor (5) = (3)*(4)
2003	3,605	3,998	1.1090	1.03^2	1.177
2004	3,749	3,998	1.0664	1.03^2	1.131
2005	3,899	3,998	1.0254	1.03^2	1.088

CY	Trended Average Premium **(6) = (1)*(5)**	Earned Exposures (7)	Trended Total Premium (8) = (6)*(7)
2003	4,242	1,000	4,242,000
2004	4,242	1,050	4,454,100
2005	**4,242**	1,100	4,666,200

(4) = The selected annual trend for Step 2 (given in the problem as 3%) is applied from the midpoint of (2) to the average written date in the future policy period (which is 7/1/2007 in this problem).

Note that the total premium trend factors in column (5) are used to compute trended average premium in (6), and are used in place of those developed by the one-step procedure.

Solutions to questions from the 2008 exam:

Model Solution – part a. – question 15

a. Question no longer applicable to the content covered in this chapter.

Model Solution – part b – question 15. - Initial comments.

The two-step trending method requires the use of average earned premium at current rate level for each year in the experience period. This problem is based upon the example in Appendix 2 - the Two-Step Trending Method.

Keep in mind that all policies are semi-annual and thus, Jones' comments on "What about six month policies on pages 17 – 18 apply.

In particular "For a six-month policy term, the first step of the procedure will involve a shorter trending period than the one used for 12-month policies. This is because the average written and average earned dates are closer together for shorter policies. The break point between the first and second step is still the same since we use 12-month moving averages of written premium in both analyses. The second step of the procedure results in the same length trending period as was used for 12-month policies. This is because the average written date in the future policy period does not depend on the length of the policies. Instead, it is the length of time the rates are assumed to be in effect before the next revision."

In step 1, bring the average earned premium at current rate level to the latest level available in the series of average written premiums at current rate level.

In step 2, project the average premiums for each year to the anticipated future level. In this example, a 4 percent annual trend is applied over a two-year period.

NOTE: The following is not needed to solve the problem but is provided to give you a broader understanding of what is happening in this example.

The first policies that contribute to calendar year 2006 earned premium would be ones written on 7/2/05, since these policies would be effective until the end of the day on 1/1/06. The last policies that would contribute to 2006 earned premium would be ones written on 12/31/06. The total amount of time between the two written dates is 18 months, so the average written date is 4/1/06.

In establishing the ending point for the first part of the trending period (step 1), it is important to recognize that the average written premium measures in the series are 12-month averages. This means that each figure provides a measure of the average premium at the midpoint of its 12-month period. In other words, since the latest trend point in the series is for the year ending 12/31/07, then the measure of the average premium for that point corresponds to 7/1/07, not 12/31/07. Therefore, the first step of the two-step trending procedure trends the premium to the midpoint of the latest trend data point in the series.

The second step of the two-step trending procedure trends the premium from the midpoint of the latest trend data point to the average written date for the future policy period. Since the target effective date is 1/1/09, then the average written date for the future policy year would be half way through, or 7/1/09, with the standard assumption that the proposed rates will be in effect for one year. The trending period in this example would need to extend from the midpoint of the latest average written premium measure (7/1/07) to the average written date for the future policy period (7/1/07). Therefore, the trending period for the second step would be two years.

Solutions to questions from the 2008 exam:

Model Solution – part b. – question 15

Thus, the Step 1 trend factor is 112/106 = 1.056 and Step 2 trend factor = 1.04^2 = 1.0816, and
The trend factor to 2006 calendar/accident year = 1.0566 x 1.0816 = 1.1428

This can also be demonstrated as shown below.

Year	(1) Avg EP @CRL	(2) Latest Value of Avg WP @CRL	(3) Step 1 Trend Factor	(4) Step 2 Trend Factor	(5) Total Premium Trend Factor
			(3)=(2)/(1)		(5)=(3)*(4)
2004	$98	$112	1.1429	1.0816	1.2361
2005	$102	$112	1.0980	1.0816	1.1876
2006	$106	$112	**1.0566**	**1.0816**	**1.1428**
2007	$110	$112	1.0182	1.0816	1.1013

Solutions to questions from the 2010 exam:

Question 18

Calculate CY 2008 earned premium at prospective levels using two-step trending.

Step 1: Adjust the historical premium to the current trend level using the following adjustment factor:

$$Current\ Premium\ Trend\ Factor = \frac{Latest\ Average\ WP\ at\ Current\ Rate\ Level}{Historical\ Average\ EP\ at\ Current\ Rate\ Level}$$

Latest Avg WP at Current Rate Level is 682,500/1,300 = 525

Historical Avg EP at Current Rate Level is 487,500/1,000 = 487.50

Thus, the current premium trend factor is **1.0769** (= 525/487.50).

The latest average WP is for CY 2009; thus, the average written date is 7/1/2009 (this will be "trend from" date for the second step in the process).

Step 2: Compute the projected premium trend factor.

Select the amount the average premium is expected to change annually from the "trend from" date to the projected period.

The "trend from" date is 7/01/2009.

The "trend to" date is the average written date during the period the proposed rates are to be in effect, which is 7/01/2011.

Thus, the projected trend period is 2 years long (7/1/2009 to 7/1/2011).

Given a projected annual premium trend of 5%, the projected trend factor is **1.1025** (= $(1.0 + 0.05)^2$).

The total premium trend factor for two-step trending is the product of the current trend factor and the projected trend factor (i.e. 1.18728 (= 1.0769 x 1.1025)).

That number is applied to the average historical EP at current rate level to adjust it to the projected level:

CY08 EP at projected rate level = CY08 EP at current rate level x Current Trend Factor x Projected Trend Factor.

CY 2008 earned premium at prospective levels = (487,500) (1.0769) (1.05^2) = 578,800.10

Solutions to questions from the 2011 exam:

5. (2.25 points) Given the following information:

- Policy term: Six months; Proposed rates in effect from 1/1/2012 to 6/30/2013
- Selected projected premium trend: 5%

Calendar Year	Average Earned Premium at Current Rate Level	Average Written Premium at Current Rate Level
2009	$375	$380
2010	$390	$395

5a. (2 points) Calculate the total premium trend factor for each of CYs 2009 and 2010 using two-step trending.
5b. (0.25 point) Briefly discuss when it is appropriate to use two-step trending.

Question 5 - Model Solution 1

a. Two-step trending = Use Step 1 and Step 2 premium trend factors

- For CY 2009

Step 1 trend = (Avg WP@CRL Latest period) / (Historical Avg EP@CRL) = 395/375 = **1.05333**
AWD for CY 2010 = 7/1/10. Average written date for the period 1/1/2012 to 6/30/2013 is 10/1/2012
Step 2 trend = Starts 7/1/10, Ends 10/1/12.
Step 2 trend period from 7/1/10 - 10/1/12 = 2.25 years
Step 2 trend = $(1.05)^{2.25}$ = 1.116
CY 2009 total premium trend factor = $(1.0533)(1.05^{2.25})$ = 1.1756

- For CY 2010

Step 1 trend = 395/**390** = 1.0128 (see above formula)
Step 2 trend = trend from 7/1/10 – 10/1/12 = 2.25 years
CY 2010 Total premium trend factor = $(1.0128)(1.05^{2.25})$ = 1.1303

b. It is appropriate to use two step trending when the historical trend and the prospective trend are different.

Question 5 - Model Solution 2

a.

	(1)	(2)	(3)	(4)	(5)
CY	Avg EP	2010 Avg. WP	= (2)/(1)	Premium Trend	(5) = (3)x(4)
2009	375	395	1.0533	$1.05^{2.25}$	1.1755
2010	390	395	1.0128	$1.05^{2.25}$	1.1303

2nd step trend period is from 7/1/2010 to 9/30/2012 which is 2.25 years.

b. When the future premium trend is different from the current trend, we cannot use one-step trend, we need to use a 2- step trend instead.

Questions from the 2012 exam:

6a. (1 point) Use the two-step trending method to calculate the projected earned premium for the calendar year ending December 31, 2009.

6b. (1 point) After completing the analysis, the actuary determines that the assumed annual increase in the amount of insurance to account for inflation was materially reduced post-January 1, 2012. Discuss any necessary adjustments to the completed analysis in part a. above

Question 6 – Model Solution 1 (Exam 5A Question 6)

Step 1 factor = latest average written premium @ CRL (current rate level)

Calendar year 2009 average earned premium @ CRL = 560/(5,000,000/10,000) = 560/500 = 1.12

Step 2 => trend from = 11/15/2011 <-midpoint of latest period.

trend to = 7/1/ 2013 <-average written date in projected period

= proposed effective date + ½ the time rates are expected to be in effect.

→trend period = 1.625, and the Step 2 trend factor = (1.05) ^ 1.625

Projected Earned Premium for CY 2009

= EP @ CRL x Step 1 factor x Step 2 factor = 5,000,000 x (1.12) x (1.05) ^ 1.625 = $6,062,066.

b. The assumed annual increase in the amount of insurance to account for inflation is an ongoing and gradual change, and is reflected in the prospective annual premium trend. So it would be necessary to adjust the prospective annual premium trend of +5% downwards to reflect this reduction, which would resultantly adjust the Step 2 factor. Note that since 2-step trending is used in part (a), it will be appropriate to only adjust the Step 2 factor since this change means trend expected in the future will be different from historical trend.

Question 6 – Model Solution 2 (Exam 5A Question 6)

Step 1: 560/ (5,000,000/10,000) =1.12

Step 2: from 11/15/2011 to 7/1/2013

From avg. of latest period (4Q11) to avg. written date of prospective period (7/1/2012 t0 6/30/2014) <-2 years. Thus, the step 2 trend factor is 1.05 ^ (1.625) = 1.0825

Total Projected EP = 5,000,000 x 1.12 .x 1.0825 = 6,062,065.69

b You would need to re-calculate your selected prospective trend in step 2. Step 1 can be left alone, however the step 2 trend would be less than 5%, and would lower the projected premium.

Question 6 – Model Solution 3 (Exam 5A Question 6)

Average written date in 4Q 11 is Nov. 15, 2011

Average written date for 2 year effective period starting July 1, 2012 is July 1, 2013.

Thus, the Prospective Trend period is 1.625 years

Average earned premium for CY2009 is 5,000,000 ÷ 10,000 = 500

Projected Earned Premium for CY2009 is 5,000,000 (560/500) (1.05 ^ 1.625)= 6,062,065.69

b. The 5% prospective premium trend is likely too high and should be reduced in the analysis from a

Examiner's Comments

a. The majority of candidates received full credit. Those that didn't receive full credit typically lost points for calculating the trend period incorrectly.

b. Most candidates either identified both or only one of the other elements needed for full credit. Some candidates identified that the first step in two step trending would not be affected, but this was not necessary for full credit.

1 Loss Definitions 90 - 91

The text uses the term *claim* to mean demand for compensation and *loss* to refer to the amount of compensation.
Losses and LAE usually represent largest portion of premium.
This chapter discusses:

- The different types of insurance losses
- How loss data is aggregated for ratemaking analysis
- Common metrics involving losses
- Adjustments made to historical loss data to make it relevant for estimating future losses in the ratemaking process. This includes adjusting data for:
  - Extraordinary loss events
  - Changes in benefit levels
  - Changes in the loss estimates as immature claims become mature
  - Changes in loss cost levels over time
- Treatment of LAE

Definitions

- **Paid losses**: Payments made to claimants.
- **Case reserve**: An amount expected to be paid on a claim, based on a claims adjuster's estimate or determined by formula.
- **Reported (Case Incurred) losses**: Paid Losses + Case Reserves
- **Incurred but not enough reported (IBNER**): Reported losses adjusted to account for any anticipated shortfall in the case reserves
- **Incurred but not reported (IBNR)**: Reserves for claims incurred but that have not yet been reported.
- **Ultimate Losses**: Reported Losses + IBNER + IBNR

Aggregated losses are based on statistics (e.g. paid or reported losses), a data aggregation method (e.g. calendar, accident, policy, or report month/quarter/year), and a period of time.

The time period for data aggregation is defined by an accounting period and a valuation date.

The ***accounting period*** for losses should be consistent with financial statement dates (e.g. month, quarter, or calendar year).

The ***valuation date*** (which can be different than the end of the accounting period) is the date losses are evaluated for analysis. It is expressed as the number of months after the start of the accounting period (e.g. AY 2010 as of 18 months implies AY 2010 as of 6/30/2011).

Valuation dates can occur prior to the end of the accounting period.

2 Loss Data aggregation Methods 91 -93

Four ways to aggregate data are by calendar year, accident year, policy year, and report year (see Chapter 3 for comments on CY, AY and PY).

Note: Some insurers aggregate losses in twelve-month periods that do not correspond to calendar years. This is called a fiscal accident year and the period is referred to as 12 months ending mm/dd/yy (i.e. the accounting date).

RY Loss aggregation method:

Losses are aggregated according to when the claim is reported (as opposed to when the claim occurs for AY).

- Accident dates are maintained so the lag in reporting can be determined, since report year losses can be subdivided based on the report lag.
- This type of aggregation results in no IBNR claims, but a shortfall in case reserves (i.e. IBNER) can exist.
- RY aggregation is limited to the pricing of claims-made (CM) policies.

Claims Made policies provide coverage based on the date the claim is reported (as opposed to the date the claim occurs).

- It is often written in lines of business for which there is often a significant lag between the date of the occurrence and the reporting of the claim (e.g. medical malpractice).
- CM ratemaking is covered in Chapter 16.

Quantifying Reported Losses under different loss aggregation methods

Assume reserves are $0 prior to CY 2009

Claim Transaction History

Policy Effective Date	Date of Loss	Report Date	Transaction Date	Incremental Payment	Case Reserve
07/01/09	11/01/09	11/19/09	11/19/09	$0	$10,000
			02/01/10	$1,000	$9,000
			09/01/10	$7,000	$2,500
			01/15/11	$3,000	$0
09/10/09	02/14/10	02/14/10	02/14/10	$5,000	$10,000
			11/01/10	$8,000	$4,000
			03/01/11	$1,000	$0

*Case reserve evaluated as of transaction date.

CY 2009 reported losses are $10,000: CY 2009 paid losses (i.e. the sum of the losses paid in 2009 ($0)) plus the ending reserve at 12/312009 ($10,000) minus the beginning reserve in 2009 ($0).

CY 2010 reported losses are $17,500: CY 2010 paid losses ($1,000 + $7,000 + $5,000 + $8,000) plus the ending reserve at 12/31/ 2010 ($2,500 + $4,000) minus the beginning reserve in 2010 ($10,000).

CY 2011 reported losses are -$2,500: CY 2011 paid losses ($3,000+$1,000) plus the ending reserve at 12/31/2011 ($0), minus the beginning reserve in 2011 ($2,500 + $4,000).

AY 2009 reported losses as of 12/31/2011 are $11,000 (considers transactions on the first claim only):

Cumulative losses paid through 12/31/2011 on the first claim ($1,000 + $7,000 + $3,000) plus the case reserve estimate for this claim as of 12/31/2011 ($0). *(When referring to AY paid losses, the adjective cumulative is usually implied rather than explicit.)*

AY 2010 reported losses as of 12/31/2011 are $14,000 (considers transactions on the second claim only):

Losses paid on the second claim through 12/31/2011 ($5,000 + $8,000 + $1,000), plus the case reserve estimate for this claim as of 12/31/2011 ($0).

PY 2009 reported losses as of 12/31/2011 are $25,000 (considers transactions from both policies):

The sum of the losses paid on both policies ($1,000 + $7,000 + $3,000 + $5,000 + $8,000 + $1,000) plus the case reserve estimate as of 12/31/2011 ($0).

PY 2010 reported losses as of 12/31/2011 are $0 since neither of these policies was issued in 2010.

CY 2009, AY 2009, and PY 2009 reported losses at three different valuation dates are shown below

Reported Losses: CY09 v AY09 v PY09

	Valuation Date		
Aggregation Type	12/31/2009	12/31/2010	12/31/2011
Calendar Year 09	$10,000	$10,000	$10,000
Accident Year 09	$10,000	$10,500	$11,000
Policy Year 09	$10,000	$27,500	$25,000

- CY reported losses are finalized at the end of the year, accident year and policy year losses are not.
- PY losses undergo development during the second twelve months of the 24-month policy year period (this longer lag time to get accurate PY data is a shortcoming of the PY aggregation method).

RY 2009 reported losses only include amounts associated with the first claim as it was reported in 2009.

- As of12/31/2009, RY 2009 reported losses are $10,000 (reflects the outstanding case reserve only)
- As of 12/31/2010, RY 2009 reported losses are $10,500: the sum of all payments made ($1,000 + $7,000) and the $2,500 case reserve estimate as of the end of 2010.

The second claim was reported in 2010 and only contributes to RY 2010 losses.

3 Common Ratios Involving Loss Statistics 92 - 93

Four common ratios involving loss statistics are: frequency, severity, pure premium, and loss ratio (see chapter 1 for more information).

Each ratio is defined by:

- a choice of statistics (e.g. paid or reported losses, or earned or written premium)
- a data aggregation method (e.g. calendar, accident, policy, or report month/quarter/year)
- an accounting period, and
- a valuation date.

4 Adjustments To Losses 93 – 121

Prior to projecting losses to the cost level expected when the rates will be in effect, preliminary adjustments may involve:

- removing individual shock losses and catastrophe losses from historical losses and replacing them with a long-term expectations provision.
- developing immature losses to ultimate.
- restating losses to the benefit and cost levels expected during the future policy period.

Extraordinary Losses (Large Individual Losses and Catastrophe Losses)

Large losses (a.k.a. shock losses) are infrequent but are expected in insurance.

Examples: a large multi-claimant liability claim, a total loss on an exceptionally high-valued home, and a total permanent disability of a young worker.

Historical data used to project future losses should exclude a portion of these losses above a threshold, that corresponds to the point at which the losses are extraordinary and their inclusion causes volatility in the rates. The threshold may be:

- based on the minimum amount of insurance offered (i.e. the "basic limit") as it corresponds to the limit associated with the base rate.
- a point significantly higher than the basic limit (e.g. the basic limit for personal auto liability insurance typically equals the amount of insurance required by the financial responsibility laws, but as many insureds select higher limits of insurance, insurers may have a significant number of losses that exceed the basic limit).

When losses are not capped at the basic limit, the actuary must determine the threshold that best balances the goals of: (1) including as many losses as possible and (2) minimizing the volatility in the ratemaking analysis. Set the threshold by:

- examining the size of loss distribution and setting it at a given percentile (e.g. the 99th percentile). Examine individual claim sizes in increasing order and choosing the claim amount for which 99% of the claim inventory is below that amount.
- choosing a certain % losses rather than claim amounts.
  In property insurance the AOI varies based on the value of the insured item, and since the expected size of loss distribution may vary significantly from one policy to the next, it may be more appropriate to use a threshold that is a % of the AOI rather than to use a *fixed* threshold.

Actual shock losses are replaced with an average expected large loss amount calculated over a longer period.

The time period may vary significantly for different lines of business and even from insurer to insurer.

Examples:

- a medium-sized homeowners insurer may derive a good estimate for expected large fire losses using 10 years of data
- a small personal umbrella insurer may need 20 years of data.

Avoid using too many years as older data becomes less relevant over time (e.g. jury awards may be much higher today than previously).

The average should be based on the number of years to produce a reasonable estimate without including so many years as to make the historical data irrelevant.

Excess Loss Factor Calculation

- In this example, individual reported losses are capped at $1,000,000 (a.k.a. non-excess losses)
- The long-term average ratio of excess losses (the portion of each shock loss above the $1,000,000 threshold) to non-excess losses is used to determine an excess loss provision.

Excess Loss Procedure

	(1)	(2)	(3)	(4)	(5)	(6)
Accident Year	Reported Losses	Number of Excess Claims	Ground –Up Excess Losses	Losses Excess of $1,000,000	Non-Excess Losses	Excess Ratio
1996	$118,369,707	5	$ 6,232,939	$1,232,939	$117,136,768	1.1%
1997	$117,938,146	1	$1,300,000	$300,000	$117,638,146	0.3%
1998	$119,887,865	3	$3,923,023	$923,023	$118,964,842	0.8%
1999	$118,488,983	0	$	$	$118,488,983	0.0%
2000	$122,329,298	7	$12,938,382	$5,938,382	$116,390,916	5.1%
2001	$120,157,205	3	$3,824,311	$824,311	$119,332,894	0.7%
2002	$123,633,881	0	$	$	$123,633,881	0.0%
2003	$124,854,827	1	$3,000,000	$2,000,000	$122,854,827	1.6%
2004	$125,492,840	0		$	$125,492,840	0.0%
2005	$127,430,355	6	$13,466,986	$7,466,986	$119,963,369	6.2%
2006	$123,245,269	3	$4,642,4	$1,642,423	$121,602,846	1.4%
2007	$123,466,498	0	$	$	$123,466,498	0.0%
2008	$129,241,078	10	$17,038,332	$7,038332	$122,202,746	5.8%
2009	$123,302,570	0	$	$	$123,302,570	0.0%
2010	$123,408,837	3	$4,351,805	$1,351,805	$122,057,032	1.1%
Total	$1,841,247,359	42	$70,718,201	$28,718,201	$1,812,529,158	1.6%
			(7) Excess Loss Factor			1.016

(4)= (3) - [$1,000,000 x (2)]

(5)= (1) - (4)

(6)= (4) / (5)

(7)= 1.0 + (Tot 6), and is applied to the non-excess losses for each year in the historical experience period.

Notes: The excess loss procedure is ideally performed on reported losses that have been trended to future levels (i.e. excess losses are calculated by censoring trended ground-up losses).

Alternatively, some actuaries may fit statistical distributions to empirical data and simulate claim experience in order to calculate the expected excess losses.

Catastrophe Losses

Ratemaking data excludes losses arising from catastrophic events. Catastrophe losses:

- from hurricanes, tornadoes, hail storms, earthquakes, wildfires, winter storms, explosions, oil spills and certain terrorist attacks are severe and results in a significant number of claims (unlike shock losses from individual high severity claims)
- are defined by the Property Claims Services (PCS) unit of the Insurance Services Office (ISO) as events that cause $25 million or more in direct insured property losses and that affect a significant number of policyholders and insurers.
- may have alternative definitions by insurers for internal procedures.
- are removed from ratemaking data and replaced with an average expected catastrophe loss amount.
- are broken down into non-modeled catastrophe losses and modeled catastrophe losses.

Non-modeled catastrophe analysis is performed on events that occur with some regularity over decades.

Example: Hail storms (which occur with some multi-year on and off regularity) is the most common catastrophic loss related to private passenger auto comprehensive coverage.

- Without a non-modeled cat procedure, indicated rates will increase immediately after a bad storm year and decrease in years having few or no storms.
- The actuary can calculate the ratio of hail storm losses to non-storm losses over a longer experience period (e.g. 10-30 years).
- The number of years used should balance stability and responsiveness.

  Example: If the concentration of exposures in the most hail-prone area of a state has increased drastically over the past 20 years, then a cat procedure based on 20 years of statewide data may understate the expected catastrophe potential.

  Once determined, the ratio can be used to adjust the non-catastrophe losses in consideration of future expected catastrophe loss.

Alternatively, the actuary can develop a pure premium (or loss ratio) for the non-modeled cat exposure.

- Using a pp approach, compute the long-term ratio of cat losses to exposure (or amount of insurance years) and apply that ratio to projected exposures (or projected amount of ins years). See Appendix B.
- The loss ratio indication would be similar except the denominator of the long-term ratio would be EP, which is inflation-sensitive and the premium would need to be brought to current rate level.

Catastrophe models are used for events that are irregular and generate high severity claims (e.g. hurricanes and earthquakes).

- 30 years of data may not capture the expected damage these events can inflict.
- Stochastic models are designed by professionals from a variety of fields (e.g., insurance, meteorologists, engineers) to estimate the likelihood that events of varying magnitudes will occur and the damages that will likely result given the insured property characteristics.
- The modeled cat loss provision is added to the non-catastrophe loss amount to determine the aggregate expected losses to be used for pricing.

Insures writing in cat prone areas:

- may use non-pricing actions (e.g. restrict the writing of any new business, may require higher deductibles for catastrophe-related losses, or may purchase reinsurance) in cat prone areas to control the concentration to minimize the financial impact any one event can have on the profitability.
- may alter the underwriting profit provision in the rates to reflect the higher cost of capital needed to support the risk caused by the higher concentration of policies.

Reinsurance

Historically, ratemaking for primary insurance was done on a direct basis (i.e. without reinsurance consideration).

Some ratemaking analyses are now performed on a net basis (i.e. with consideration of reinsurance) as reinsurance programs have become more extensive and reinsurance costs have increased substantially for some lines of business.

Proportional reinsurance means the same proportion of premium and losses are transferred or “ceded” to the reinsurer (thus, proportional reinsurance may not necessarily need to be included in the pricing consideration).

With non-proportional reinsurance:

- the reinsurer agrees to assume some % of the losses (reinsurance recoverables to the insurer)
- the insurer cedes a portion of the premium (the cost of the reinsurance).

Examples of non-proportional reinsurance include:

- cat excess-of-loss reinsurance (e.g. the reinsurer covers 50% of the losses that exceed $15,000,000 up to $30,000,000 on their entire property book of business in the event of a cat)
- per risk excess of loss reinsurance (e.g. the reinsurer will cover the portion of any large single event that is between $1,000,000 and $5,000,000 for specified risks).

Changes in Coverage or Benefit Levels

An insurer may:

- initiate changes in coverage (e.g. expand or contract coverage with respect to the types of losses covered) or
- opt to increase or decrease the amount of coverage offered.

Benefit levels can be impacted by a law change or court ruling (e.g. caps on punitive damages for auto liability coverage and changes in the WC statutory benefit levels).

Benefit changes can have direct and indirect effects on losses.

- ***direct effects*** are a direct and obvious consequence of the benefit change.
- ***indirect effects*** arise from changes in claimant behavior that as a result of the benefit change (and are more difficult to quantify than direct effects).

Example: Quantification of benefit changes.

Assume an insurer reduces the maximum amount of coverage for jewelry, watches, and furs on a standard homeowners policy from $5,000 to $3,000. The direct effect:

- is that any claimants with jewelry, watches, and furs losses in excess of $3,000 will now only receive $3,000 rather than at most $5,000.
- of this change can be calculated if a distribution of historical jewelry, watches, and furs losses is available. The table below shows the how reported losses on 6 claims would be capped under the two different thresholds.

Direct Effect of a Coverage Limit Change

Claim number	(1) Losses Capped @$5,000	(2) Losses Capped @$3,000	(3) Effect of Change
1	$1,100	$1,100	0.0%
2	$2,350	$2,350	0.0%
3	$3,700	$3,000	-18.9%
4	$4,100	$3,000	-26.8%
5	$5,000	$3,000	-40.0%
6	$5,000	$3,000	-40.0%
Total	$21,250	$15,450	-27.3%

(1) Given
(2) = Min[(1), $3,000]
(3) = (3) / (2) - 1.0

The direct effect is -27.3%.

Example: Indirect effect

Consider an example involving a decrease in coverage.

- Insureds may feel the reduced coverage is inadequate and purchase a personal articles floater (PAF) to cover jewelry, watches, and furs.
- If the HO is secondary to the PAF, the jewelry, watches, and furs losses from the homeowners policy will be further reduced as they are now covered by the PAF.
- Since there is no way to know how many insureds will purchase the PAF and the amount of PAF coverage they will purchase, it is very *difficult to accurately quantify the indirect effect*.

WC benefits are statutory and changes in these statutes can lead to direct and/or indirect effects on losses.

Statutes dictate the maximum/minimum benefits, the maximum duration of benefit, the types of injuries or diseases covered treatments that are allowed, etc.

Consider the case where the WC wage replacement rate increases from 60% to 65% of pre-injury wages.

- the *direct effect* on wage replacement losses is easily quantified as +8.3% (= 65% / 60% - 1.0).
- there may be an *indirect effect* as workers may be more inclined to file claims and claimants may have less incentive to return to work in a timely manner.

Example: Calculation of the direct effect of a benefit level change

Suppose the WC maximum indemnity benefit for a particular state is changing. The assumptions include:

- The compensation rate is 66.7% of the worker's pre-injury wage.
- The state average weekly wage (SAWW) is currently $1,000.
- The minimum indemnity benefit remains at 50% of the SAWW.
- The maximum indemnity benefit is decreasing from 100% of the SAWW to 83.3% of the SAWW.

The distribution of workers (and their wages) according to how their wages compare to the SAWW is as follows:

Benefit Example

Ratio to Average Weekly Wage	# workers	Total Weekly Wages
<50%	7	$3,000
50-75%	24	$16,252
75-100%	27	$23,950
100-125%	19	$23,048
125-150%	12	$16,500
>150%	11	$17,250
Total	100	$100,000

Calculate the direct effect of the benefit level change.

The key is to calculate the benefits provided before and after the change.

The minimum benefit is 50% of the SAWW ($1,000) which equals $500 (= $1,000 x 50%).

The minimum benefit of $500 applies to workers who earn less than 75% of the SAWW (i.e. $500 = *66.7%* x **75%** x $1,000), given the current compensation rate of 66.7%.

The aggregate benefits for 31 (= 7 + 24) employees in this category are $15,500 (= 31 x $500).

The maximum benefit is 100% of the SAWW ($1,000) and thus equals $1,000 (= $1,000 x 100%).

The maximum benefit of $1,000 applies to workers who earn more than 150% of the SAWW (i.e. $1,000 = *66.7%* x **150%** x $1,000), given the current compensation rate of 66.7%.

The aggregate benefits for the 11 employees in this category are $11,000 (= 11 x $1,000).

The remaining 58 (= 27 + 19 + 12) employees fall between the minimum and maximum benefits.

This means their total benefits are 66.7% of their actual wages or $42,354 (= (66.7% x 23,950) + (66.7% x 23,048) + (66.7% x 16,500)).

The sum total of benefits is ***$68,854*** (= $15,500 + $11,000 + $42,354) under the current benefit structure.

Once the maximum benefit is reduced from 100% to 83.3% of the SAWW, more workers will be subjected to the new maximum benefit.

Workers earning approximately ≥125% of the SAWW are subject to the maximum (i.e. $833.75 = (66.7% x 125% x $1,000) > $833). These 23 (= 11 + 12) workers will receive $19,159 (= 23 x $833) in benefits.

Workers subject to the minimum benefit, 31, are not impacted by the change, and their benefits remain $15,500.

There are now only 46 (= 27 + 19) employees that receive a benefit equal to 66.7% of their pre-injury wages or:

$31,348 (= (66.7% x 23,950) + (66.7% x 23,048)) because more workers are now impacted by the maximum.

The new sum total of benefits is $66,007 (= 19,159 + 15,500 + 31,348).

The **direct effect** from revising the maximum benefit is -4.1% (= 66,007 / 68,854 – 1.0).

Benefit Example

(1) Ratio to Average Wage	(2) Workers	(3) Total Weekly Wages	(4) Current Benefits	(5) Proposed Benefits
<50%	7	$3,000	$3,500	$3,500
50-75%	24	$16,252	$12,000	$12,000
75-100%	27	$23,950	$15,975	$15,975
100-125%	19	$23,048	$15,373	$15,373
125-150%	12	$16,500	$11,006	$9,996
>150%	11	$17,250	$11,000	$9,163
Total	100	$100,000	$68,854	$66,007
		(6) Benefit Change		-4.1%

(4)= < Min: (2) x $500,   Other (3) x 0.667   > Max: (2) x 1,000
(5)= < Min: (2) x $500   Other (3) x 0.667   >Max: (2) x $833
(6)= (Tot 5) / (Tot 4) - 1.0

There may also be an *indirect effect* if the max indemnity benefit is decreased.

Assuming there is no data to estimate the indirect effect, it needs to be determined judgmentally (the strength of the indirect effect is a function of the economic environment, the nature of the insured population, etc).

Recall that a benefit change may affect:

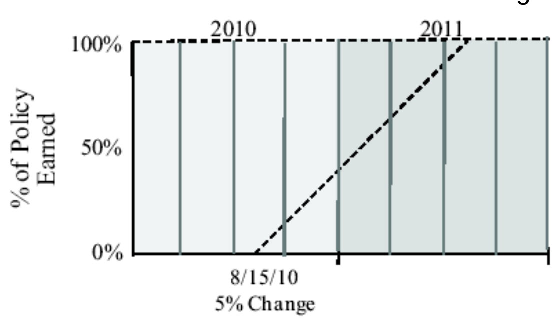
(1) all claims on or after a certain date or

(2) claims arising from all policies written on or after the date.

The needed adjustment is different in each case and the techniques for calculating the adjustment are similar to the parallelogram method for deriving on-level premium.

Example: Benefit Change Loss Adjustment Factor

The figure below shows a law change implemented on 8/15/2010 that only affects *losses on policies written on or after 8/15/2010*. The direct effect of the change for annual policies on an AY basis is estimated at +5%.



- The pre-change loss level is 1.00 and post-change loss level is 1.05.
- Since scenario (1) applies, the line dividing the losses into pre- and post-change is a diagonal line representing a policy effective on the date of the law change.
- Note that the calendar accident years have been divided into accident quarters.

The benefit change loss adjustment factor is $Adjustment = \dfrac{Current\ Loss\ Level}{Average\ Loss\ Level\ of\ Historical\ Period}$

Focusing on the third quarter of 2010, the portion of losses assumed to be pre- and post-change are as follows:

- 3Q 2010 Post-change: 0.0078 = 0.50 x 0.125 x 0.125
- 3Q 2010 Pre-change: 0.2422 = 0.25 - 0.0078

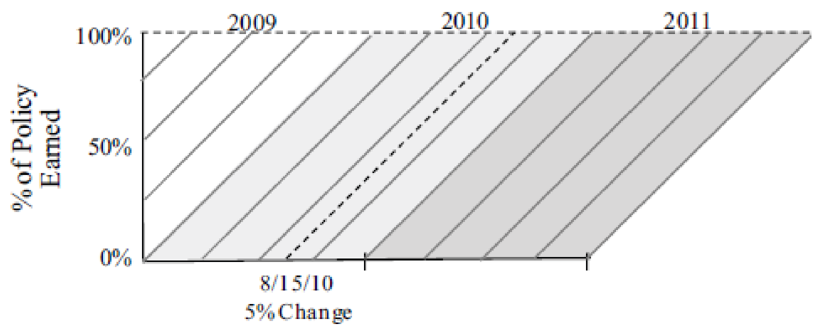
The adjustment factor for 3rd quarter 2010 reported losses is

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.2422}{0.2500}\right)+1.05*\left(\frac{0.0078}{0.2500}\right)} = 1.0484$$

The adjustment factors for the reported losses from all other quarters are calculated similarly.

Example: How to measure the same law change on a policy year basis.

Affect on Losses on New Annual Policies (PY Basis)



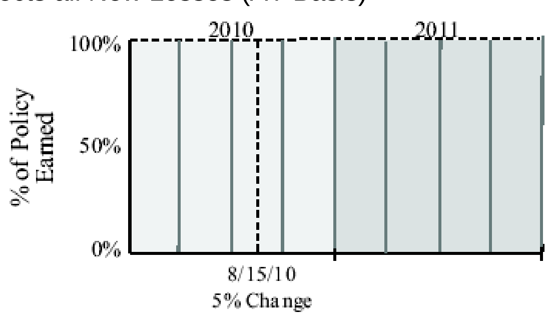
The adjustment factor applicable to the third quarter 2010 policy quarter reported losses is:

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.50*0.25}{0.25}\right)+1.05*\left(\frac{0.50*0.25}{0.25}\right)} = 1.0244$$

- Reported losses from quarters prior to the third quarter need to be adjusted by a factor of 1.05.
- Reported losses from quarters after the third quarter are already being settled in accordance with the new law, and need no adjustment.

Example: A benefit change affecting all losses occurring on or after 8/15/2010 (regardless of the policy effective date).

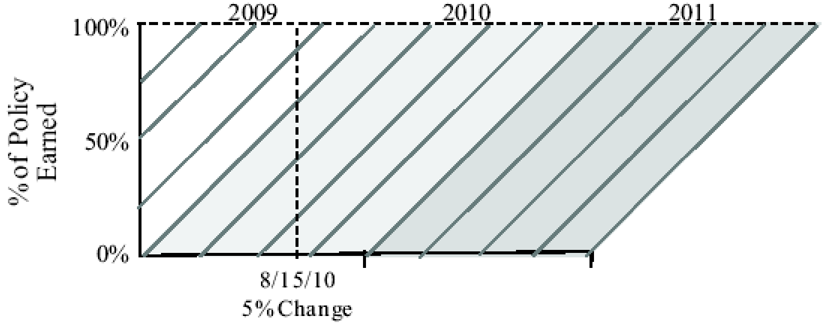
Affects all New Losses (AY Basis)



i. The adjustment factor applicable to the third accident quarter 2010 losses is as follows:

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.50*0.25}{0.25}\right)+1.05*\left(\frac{0.50*0.25}{0.25}\right)} = 1.0244$$

Affects all New Losses (PY Basis)



ii. The adjustment factor applied to third <u>policy quarter</u> 2010 losses is

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.078}{0.2500}\right)+1.05*\left(\frac{0.2422}{0.2500}\right)} = 1.0015$$

Actuaries can access industry sources to determine the effects of benefit level changes also (e.g. NCCI publishes estimated industry effects of benefit level changes at the state level_.

Loss Development

Loss development adjusts immature losses to an estimated ultimate value.

A brief explanation of one commonly used method, the chain ladder method, is given below.

The chain ladder method assumes losses move from unpaid to paid in a consistent pattern over time (hence historical loss development patterns can be used to predict future loss development patterns).

- The method can be performed separately on claim counts and losses to generate ultimate values of each.
- The analysis can be done on various types of claims (e.g. reported, open, closed) and losses (e.g. paid and reported), and to allocated loss adjustment expenses.

For most lines of business, developing reported losses including ALAE is used.

Loss development should be performed on a set of homogeneous claims.

- This can be a line of business or on a more granular level (e.g. coverages or types of losses within that line of business).
- Liability claims and property claims are typically analyzed separately.
- Experience by geography (e.g. state) may also be analyzed separately where there is sufficient volume.

Extraordinary losses should be removed and the losses should be adjusted for any material benefit changes.

Claims data or loss data is organized in a triangle format as shown below:

In this example:

- Each row is a different AY.
- Columns represent each AYs reported losses at successive maturities (starting at 15 months and increasing in annual increments).
- Losses are assumed to be at ultimate levels at 75 months (so no more columns are required), however for other lines of business, ultimate may not be reached for many more years.
- Each diagonal represents a date as of which losses are evaluated (the valuation date) (e.g. the latest diagonal represents a valuation date of 3/31/2008)

Loss Development Triangle

	Reported Losses ($000s) by AY Age (months)					
Accident Year	15	27	39	51	63	75
2002	1,000	1,500	1,925	2,145	2,190	2,188
2003	1,030	1,584	2,020	2,209	2,240	
2004	1,061	**1,560**	2,070	2,276		
2005	1,093	1,651	2,125			
2006	1,126	1,662				
2007	1,159					

The boxed value is the reported losses for accidents occurring in 2004 at 27 months of maturity (i.e. losses paid and case reserves held as of 3/31/2006 for accidents occurring in 2004).

Prior to reviewing development patterns:

Review the magnitude of losses at first development age, 15 months, to see if loss levels at this early stage are consistent from year to year, with consideration for loss trends and any changes in the portfolio.

i. If loss levels are different than expected, examine a similar triangle of claim counts to see if larger or smaller than usual number of claims was reported for a particular AY.

ii. Inconsistent patterns at first development period may be expected for small portfolios or long-tailed lines of business.

The development pattern is analyzed by taking the ratio of losses held at successive maturities (e.g. the link ratio or the age-to-age development factor).

The following data triangle shows the link ratios for each accident year row as well as the:

- arithmetic average
- geometric average
- volume-weighted average (the ratio of total reported losses at successive maturities across all AYs)

	Age-to-Age Development Factors				
Accident Year	15 – 27	27 – 39	39 – 51	51 63	63 -74
2002	1.50	1.28	1.11	1.02	1.00
2003	1.54	1.28	1.09	1.01	
2004	**1.47**	1.33	1.10		
2005	1.51	1.29			
2006	1.48				
2007	--				
Arithmetic average	1.50	1.30	1.10	1.02	1.00
Geometric average	1.50	1.29	1.10	1.01	1.00
Ratio of total losses	1.50	1.29	1.10	1.02	1.00
Selected factor	1.50	1.30	1.10	1.02	1.00

The geometric average is the nth root of the product of n numbers.

The "ratio of total reported losses at successive maturities" compares the sums of an equal number of losses from each maturity (i.e., the most recent losses for the earlier maturity are not considered).

The boxed value shows that AY 2004 losses developed 47% (= 1.47 – 1.0) from age 15 months to age 27 months.

Age-to-Age loss development factor (a-t-a LDF) selection:

The ratemaking actuary selects a suitable link ratio for each maturity (since the link ratios for each development period are fairly consistent across the AYs, the all-year arithmetic average link ratios are selected).

A-t-A LDFs in practice may not be as stable as outlined above:

- If the ratemaking actuary believes patterns may be changing over time, the actuary may prefer to rely on more recent development patterns, and select a two- or three-year average.
- If there is a desire to select based on the most recent data, but the line of business is to too volatile to rely solely on a two- or three-year average, calculate weighted average link ratios giving more weight to the more recent years.
- If A-t-A factors vary widely between AYs or there may be a strong anomaly in one or two AYs, consider adjusted averages that eliminate the highest and lowest development factors from the calculation.

Loss Development:

- Reported losses develop upward as losses approach ultimate (due in part to the emergence of new claims as well as adverse development on known claims).
- In some lines of business, development may be negative:
  i. In auto physical damage coverages, an insurer may declare a vehicle a total loss (i.e. pay the total limit for the car), take the damaged car, and sell it as scrap or for parts. The money received is called “salvage” and is treated as a negative loss.
  ii. When insurers pay losses for which another party is actually liable, it can approach the responsible party for indemnification of those amounts (called subrogation).

  Thus, when subrogation or salvage are common, or when early case reserves are set too high, age-to-age development factors can be less than 1.00.

While this example assumes losses are ultimate at 75 months, for some lines of business, the historical data triangle may not reach ultimate.

Here, actuaries may fit curves to historical development factors to extrapolate the development beyond the patterns in the historical data.

A ‘tail factor’ accounts for additional development beyond that included in the standard chain ladder method.

Adjustments to Historical Data:

- Remove extraordinary losses from the historical data used to measure loss development patterns.
- Benefit or coverage changes may also distort loss development patterns.
  i. Since benefit changes often affect policies prospectively, the effect of the change will first appear in a new AY row.
  ii. If the change impacts all claims occurring on or after a certain date, it is possible there will be a change in the absolute amount of losses even though the development pattern is unaffected.

  If it is not possible to restate the losses, any such distortions should be considered during the a-t-a ldf selection process.

Next Step: Calculate age-to-ultimate development factors (a-t-u ldf) for each maturity.

- The a-t-u ldf is the product of each selected a-t-a ldf and the selected a-t-u ldf for subsequent maturities (and the tail factor, if relevant).
- Example, a-t-u ldf for losses at age 51 months is the product of the selected age-to-age development factors for 51-63 months and 63-75 months (1.02 x 1.00).

Next Step: Apply the a-t-u ldfs to the reported losses at the most recent period of development (the latest diagonal in the reported loss triangle) to yield estimated ultimate losses for each AY as shown below:

Adjusting Reported Losses to Ultimate

Accident Year	(1) Accident Year Age (Months a/o) 3/31/08)	(2) Reported Losses ($000s) a/o 3/31/08	(3) Age-to-Ultimate Development Factor	(4) = (2)*(3) Estimated Ultimate Losses ($000s)
2002	75	$2,188	1.00	$2,188
2003	63	$2,240	1.00	$2,240
2004	51	$2,276	1.02	$2,322
2005	39	$2,125	1.12	$2,380
2006	27	$1,662	1.46	$2,427
2007	15	$1,159	2.19	$2,538
Total		$11,650		$14,095

The chain ladder method is only one method for calculating loss development, and assumes that historical emergence and payment patterns are indicative of patterns expected in the future.

Changes in (claims handling methodology or philosophy) or (dramatic changes in claims staffing) may result in claims being settled faster or slower than historical precedents, and would violate the basic assumption of the chain ladder method.

Other methods to develop losses to ultimate:

- The Bornhuetter-Ferguson (B-F) method incorporates a priori assumptions of the expected loss ratio in order to calculate ultimate losses and consequently the outstanding reserve at a point in time (see Appendix C)
- The Berquist-Sherman (BS) method is used when an insurer has experienced significant changes in claim settlement patterns or adequacy of case reserves that would distort development patterns.

  The method produces adjusted development patterns estimated to be consistent with the reserve levels and settlement rates present as of the last diagonal by restating historical development data.
- Stochastic methods (e.g. the Mack method) study variability around loss development so actuaries can better understand the risk of adverse development.

These methods are covered in more detail in literature regarding loss reserving methodologies.

Loss Trend

It is necessary to adjust the losses for trends expected to occur between the historical experience period and the period for which the rates will be in effect (in addition to projecting historical losses to an ultimate level).

Changes in frequency and severity are referred to as loss trends, and available data to estimate the loss trends should be used to project historical losses.

Loss Trend Selections

1. Monetary inflation, increasing medical costs, and advancements in safety technology are examples of factors that can drive loss trends.
2. Social influences also impact loss costs.

   ASOP 13, Trending Procedures in P&C Insurance Ratemaking defines social influences as “the impact on insurance costs of societal changes such as changes in claim consciousness, court practices, and legal precedents, as well as in other non-economic factors.”
3. Distributional changes in a book of business also affect frequencies and severities (e.g. if the proportion of risky policies is growing, loss costs will be expected to increase).

Loss Trend Measurement

Actuaries measure loss trend by fitting curves to historical data.

Frequency and severity are analyzed separately to better understand the drivers of the trend (in addition to analyzing pure premium data).

If an insurer heavily markets a higher deductible, the resulting shift in distribution will lower frequencies but is likely to increase severities (which is difficult to detect in a pure premium analysis).

The years chosen to review is based on the actuary’s judgment (considering responsiveness and stability).

- Influences (e.g. the cyclical nature of insurance and random noise) may be difficult to eliminate from the trend analysis.
- The actuary should, however, adjust the trend data for more easily quantifiable (e.g. seasonality and the effect of benefit level changes)

Different lines of business call for different or multiple views of the losses for analyzing trend.

i. In stable, short-tailed lines of business (e.g., automobile physical damage), the actuary typically analyzes CY paid losses for the 12 months ending each quarter.

   CY data is readily available, the paid loss definition eliminates any distortion from changes in case reserving practices, and the use of 12-month rolling data attempts to smooth out the effect of seasonality.

ii. In more volatile and long-tailed line of business (e.g. WC medical) analyze the trend in AY reported losses that have already been developed to ultimate and adjusted for benefit changes.

Perform a trend analysis on a set of homogeneous claims:

i. Separate indemnity and medical losses within WC insurance.
ii. Analyze liability claims and property claims separately.
iii. Analyze experience by geography (e.g. state) separately.

Types of trend measurement:

Linear and exponential regression models are the most common methods used to measure the trend.

- Linear models result in a projection that increases by a constant amount for each unit change in the ratio measured (e.g. claim severities).

  A linear model will eventually project negative values when measuring decreasing trends, and since a negative frequency or severity does not occur in insurance, this is a shortcoming of linear trend models.
- Exponential models produce a <u>constant rate of change</u> in the ratio being measured.

The following shows the result of an exponential curve fit to different durations of CY paid frequency, severity, and pure premium data for the 12 months ending each quarter.

Exponential Loss Trend Example

Year Ending Quarter	Earned Exposure	Closed Claim Count	Paid Losses	Frequency	Annual % Change	Severity	Annual % Change	Pure Premium	Annual % Change
Mar-09	131,911	7,745	$8,220,899	0.0587	--	$,061.45	--	$ 62.32	--
Jun-09	132,700	7,785	$8,381,016	0.0587	--	$ 1,076.56	--	$ 63.16	--
Sep-09	133,602	7,917	$8,594,389	0.0593	--	$ 1,085.56	--	$ 64.33	--
Dec-09	135,079	7,928	$8,705,108	0.0587	--	$ 1,098.02	--	$ 64.44	--
Mar-10	137,384	7,997	$8,816,379	0.0582	-0.9%	$ 1,102.46	3.9%	$ 64.17	3.0%
Jun-10	138,983	8,037	$8,901,163	0.0578	-1.5%	$ 1,107.52	2.9%	$ 64.04	1.4%
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
Sep-13	141,800	7,755	$8,702,135	0.0547	-0.7%	$ 1,122.13	2.3%	$61.37	1.5%
Dec-13	142,986	7,778	$8,761,588	0.0544	-0.9%	$ 1,126.46	3.0%	$ 61.28	2.1%

Number of Points	Frequency Exponential Fit	Severity Exponential Fit	Pure Premium Exponential Fit
20 point	-1.7%	0.5%	-1.2%
16 point	-1.3%	-0.1%	-1.4%
12 point	-0.7%	-0.2%	-0.9%
8 point	-1.2%	1.2%	-0.1%
6 point	-0.9%	2.5%	1.6%
4 point	-1.5%	3.3%	1.9%

As shown above, separate exponential models may be fit to the whole of the data and to more recent periods.

If separate frequency and severity trends are selected, these are used to compute a pure premium trend (e.g. a -1% selected frequency trend and a +2% selected severity trend produce a +1% (= (1.0 - 1%) x (1.0 + 2%) - 1.0) pure premium trend.

Exclude catastrophe losses from the loss trend analysis data.

Changes in benefit levels can affect trend analyses. Therefore, if the historical data to which loss trends will be applied is restated to reflect the new benefit level, then either:

- data adjusted for benefit level should be used for the trend analysis, or
- the trend analysis must remove the impact of the benefit level change.

Care must be taken not to “double count” the benefit level change in the projected losses.

Is the historical data is overly volatile or inappropriate for trending purposes? For example:

- the data may be too sparse or reflect non-recurring events that cannot be appropriately adjusted.
- the statistical goodness of fit of the trending procedure may be called into question.

Circumvent the problem by:

- supplementing the loss trend data with multi-state, countrywide, or industry trend data and consider weighting the results.
- consider non-insurance indices (e.g. the medical component of the CPI (Consumer Price Index) may be relevant when selecting severity trends for products related to medical expense coverage.

Also, more sophisticated techniques (e.g. econometric models and generalized linear models) may be employed for quantifying loss trends.

Loss Trend Periods

The loss trend period is the period of time from the average loss occurrence date of each experience period (often a calendar-accident year, CAY) to the average loss occurrence date for the period in which the rates will be in effect (i.e. the forecast period, which is a policy year or years).

The average loss occurrence date depends on the policy term and the duration the new rates will be in effect.

Assume the following:

- The losses to be trended are from AY 2011.
- The company writes annual policies.
- The proposed effective date is January 1, 2015.
- The length of time the rates are expected to be in effect is one year.

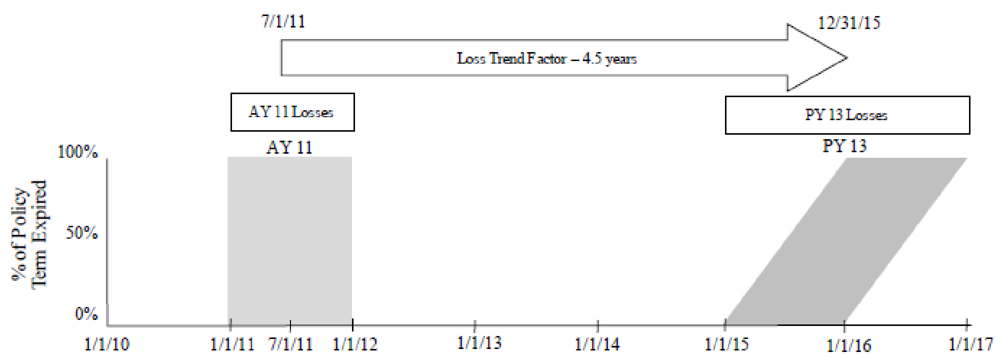
The average loss occurrence date of CAY 2011 (called the "trend from" date) is 6/30/2011.

The average accident date for PY 2011 is 12/31/2011, as polices are in effect over a 24-month period.

The average loss occurrence date during the forecast period (called the "trend to" date) is 12/31/2015.

This is because last policy to be written will be on 12/31/2015, and losses can continue to occur until 12/31/2016, so the midpoint of that two-year time period is 12/31/2015.

Thus, the trend period for CAY 2011 is 4.5 years.

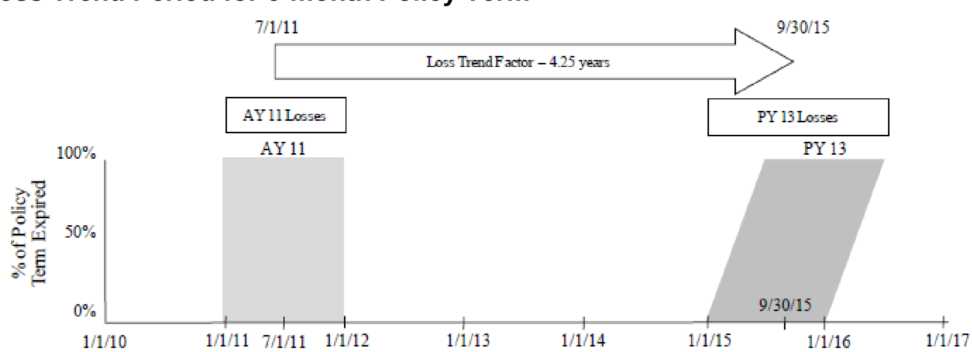


The pure premium trend (+1%) is applied to CAY Year 2011 losses by multiplying the historical losses by $(1.01)^{4.5}$ (which is the trend factor).

If the policy term were semi-annual, the "trend from" date would not change, but the "trend to" date would be different.

Coverage for policies written between 1/1/2015 and 12/31/2015 would extend over an 18-months, of which the midpoint would be 9 months (i.e. 9/302/015). The trend length would be 4.25 years as shown below.

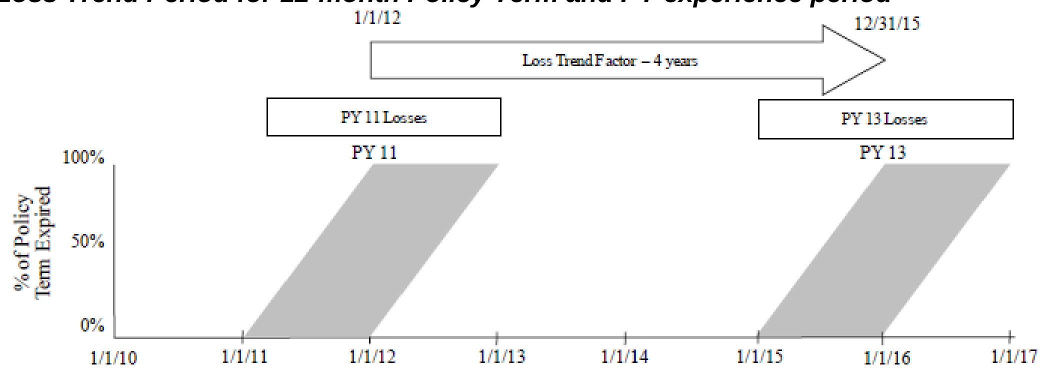
Loss Trend Period for 6-month Policy Term



If data were aggregated by PY:

- the average loss occurrence date for an annual policy term would be one year after the start of the PY, as policies are in effect over 24-months.
- the "trend to" date is the average loss occurrence date for the PY in which rates will be in effect. Therefore, the trend period for PY 2011 annual term policies is 4 years (1/1/2012 to 12/31/2015), as shown below.

Loss Trend Period for 12-month Policy Term and PY experience period

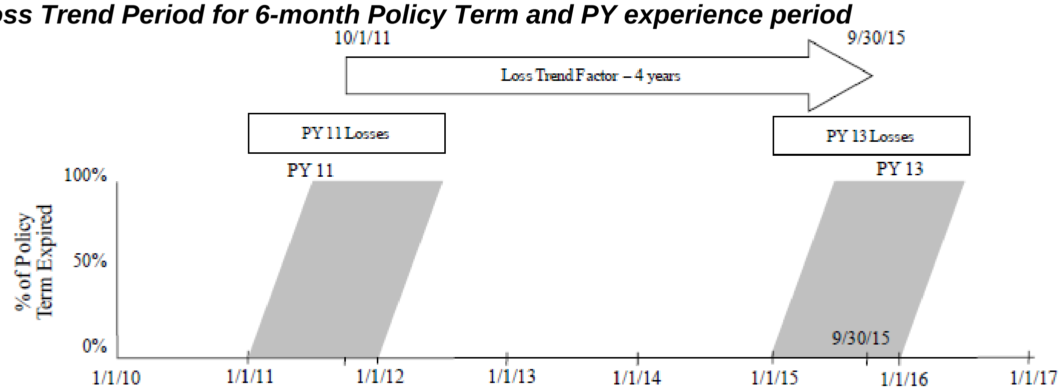


The PY2011 trend factor, applied to PY 2011 losses, is 1.0406 (= $1.01^{4.0}$).

Exhibit 6.18 (below) shows the same PY scenario but with semi-annual policies.

- Both the "trend from" and "trend to" dates are 3 months earlier than the annual policy scenario since the average occurrence date for semi-annual policies is 9 months after the start of the PY.
- Thus, the trend length remains the same as in the annual policy scenario and is still 4 years.

Loss Trend Period for 6-month Policy Term and PY experience period



If the trend selection is based on a linear trend, the selected trend is a constant amount rather than a %.

- The projected dollar change = (the selected annual trend) * (the length of the trend period).
- Assuming the selected annual pure premium linear trend is $1.00 per year, then the dollar increase due to 4 years of trend is $4.00 (= $1.00 x 4.0).

The actuary may choose to undertake a two-step trending process.

- This is beneficial when the trend in the historical experience period and the expected trend for the forecast period are not equal.
- For example, legislative changes in the trend data call for a 2-step trending process if the trend exhibited in the historical period is clearly different from that expected in the future.

In the exponential trend data shown above, historical severity trend exhibits a different pattern in more recent periods than in earlier years.

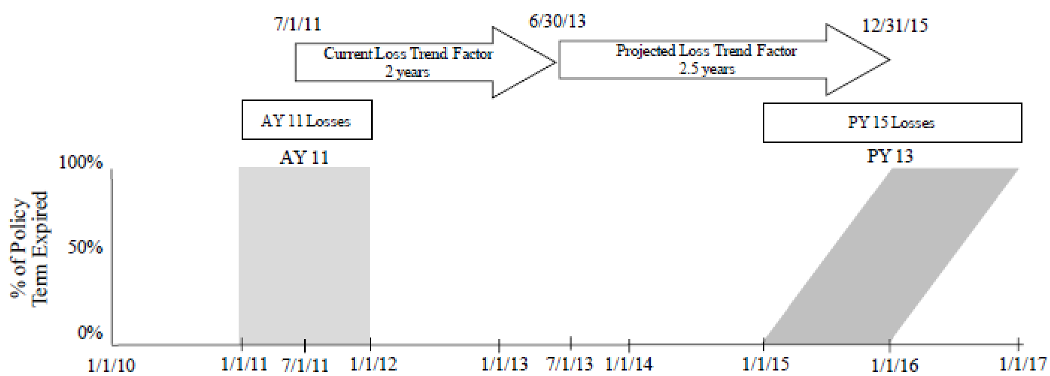
- The losses in the experience period are trended from the average accident date in the experience period to the *average accident date of the last data point in the trend data*. Example:

  The average loss occurrence date of CAY 2011 is 6/30/2011. If the last data point in the loss trend data is the 12 months ending fourth quarter 2013, the average accident date of that period is 6/30/2013.

  If the selected step 1 trend is -1%, the factor to adjust CAY 2011 losses to the end of the experience period is 0.98 (= $(1.0 - 1\%)^2$).
- Next, these trended losses are projected from the average accident date of the last data point in the trend data (the "project from" date of 6/30/2013) to the average loss occurrence date for the forecast period (the "project to" date of 12/31/2015). The length of this projection period is 2.5 years.

  If the trend selection is 2%, step 1 trended losses are adjusted by a factor of 1.05 (= $(1.0 + 2\%)^{2.5}$).

Two-Step Trend Periods for 12-month Policy



When using CY data to measure loss trend, it is assumed that the book of business is not significantly increasing or decreasing in size. Problems with this assumption are:

- claims (or losses) in any CY may have come from older AYs, but are matched to the most recent CY exposures (or claims).
- a change in exposure levels causing changes in the distribution of each CY's claims by accident year.

The solution is to match the risk with the appropriate exposure.

1. Use econometric techniques or generalized linear models to measure trend, which will absorb changes in the size of the portfolio as well as changes in the mix of business.
2. Measure the trend using AY data (in lieu of CY data). The AY losses (or claim counts) need to be developed to ultimate before measuring the trend, which introduces subjectivity into the trend analysis.
3. Analyze the trend in incremental CY frequencies or severities.

   Assume CY 2010 has paid losses on claims from AYs 2010, 2009, and 2008.

   i. CY 2010 frequency is the sum of all [paid claim counts in CY 2010/ CY 2010 exposures].

   ii. Alternatively, CY 2010 frequency is the sum of the following three incremental CY 2010 frequencies:

   - [CY 2010 paid claim counts from AY 2010 / CY 2010 exposures]
   - [CY 2010 paid claim counts from AY 2009 / CY 2009 exposures]
   - [CY 2010 paid claim counts from AY 2008 / CY 2008 exposures]

The alternative method properly matches older claim counts to older exposures and is valid whether the portfolio is changing or not.

Leveraged Effect of Limits on Severity Trend

When loss experience is subject to limits, consider the leveraged effect of those limits on the severity trend.

Basic limits losses are losses that have been censored at a limit referred to as a "basic limit."

Total limits losses are losses that are uncensored

Excess limits losses are the portion of the losses that exceed the basic limit (or the difference between total limits and basic limits losses). It is important to understand that severity trend affects each of these differently.

Consider the following simple example in which every total limits loss is subject to a 10% severity trend.

Effect of Limits on Severity Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						Trended Losses			
	Total	Losses				Capped @ $25,000			
Claim	Limits	Capped @	Excess	Total Limits				Excess Losses	
Number	Loss	$25,000	Losses	Loss	Trend	Loss	Trend	Loss	Trend
1	$10,000	$10,000	$ -	$11,000	10.0%	$11,000	10.0%	$-	N/A
2	$15,000	$15,000	$ -	$16,500	10.0%	$16,500	10.0%	$-	N/A
3	$24,000	$24,000	$ -	$26,400	10.0%	$25,000	4.2%	$1,400	N/A
4	$30,000	$25,000	$ 5,000	$33,000	10.0%	$25,000	0.0%	$8,000	60.0%
5	$50,000	$25,000	$25,000	$55,000	10.0%	$25,000	0.0%	$30,000	20.0%
Total	$129,000	$99,000	$30,000	$141,900	10.0%	$102,500	3.5%	$39,400	31.3%

(2)=min [(1), $25,000] (3) = (1) - (2) (4) = (1) x 1.10 (5) = (4) / (1) - 1.0 (6)=min [(4) , $25,000]
(7)= (6) / (2) - 1.0 (8) = (4) - (6)

The 10% trend in total limits losses affects basic limits losses and excess losses differently.

Basic Limits:

The 10% total limit trend is reduced to 3.5% when considering the basic limits losses.

- The two smallest losses (Claims 1 and 2) are well below the $25,000 limit before and after the 10% increase.
- Claim 3 was below $25,000 before trend was applied, but above the basic limit after applying trend.
- Claims 4 and 5 were already in excess of $25,000, so the amount of loss under the limit is the same before and after trend.

Excess Limits:

The impact of positive trend on excess losses is greater than the total limits trend.

- Claims 1 and 2 are significantly below the limit and do not impact the trend in the excess layer.
- Claim 3 was below $25,000 before trend was applied, but above the basic limit after applying trend.
- Since claims 4 and 5 were already higher than the basic limit, the entire increase in losses associated with these claims is realized in the excess losses trend.

Effect of Limits on Severity Trend

Initial Loss Size	Basic Limits	Total Losses	Excess Losses
$Loss < \frac{Limit}{1.0 + Trend}$	Trend	Trend	Undefined
$\frac{Limit}{1.0+Trend} \le Loss < Limit$	$\frac{Limit}{Loss} - 1.0$	Trend	Undefined
$Limit \le Loss$	0%	Trend	$\frac{[Lossx(1.0+Trend)] - Limit}{Loss - Limit}$

Given positive trend, then Basic Limits Trend $\le$ Total Limits Trend $\le$_ Excess Losses Trend.

Given negative trend, then Excess Losses Trend $\le$ Total Limits Trend $\le$ Basic Limits Trend.

Final notes:

- If severity trends are analyzed on total limits loss data, the indicated trend must be adjusted before it is applied to basic limits losses for ratemaking purposes.
- Alternatively, use basic limits data in analyzing severity trend.
- Deductibles also have a leveraging effect on severity trend. The mathematics is analogous to excess losses except that the censoring is done below the deductible rather than above the limit.

Coordinating Exposure, Premium, and Loss Trends

It is important to make sure that all components of the formula are trended consistently.

When deriving a pure premium rate level indication, three types of trends that are considered are:

- changes in the likelihood of a claim happening,
- changes in the average cost of claims, and
- changes in the level of exposure.

When the insurer's internal frequency and severity trend data is used as the basis of the loss trend, changes in frequency (i.e.# of claims / exposure) account for the net effect of (1) the change in the probability of having a claim and (2) the change in exposure. This also holds when analyzing pure premium data.

When using inflation-sensitive exposure bases, the inflation on the exposure can mask part or all of the change in the likelihood of claims occurring.

To remove the effect of the changing exposure, examine historical frequencies (or pure premiums) that have been adjusted for exposure trend (i.e. the denominator has been adjusted by the exposure trend).

When deriving a loss ratio indication, examine patterns in historical adjusted loss ratios.

- This is the ratio of losses adjusted for development, benefit changes, and extraordinary losses compared to premium adjusted to current rate level. This produced a "net" trend.
- Based on the pattern in adjusted loss ratios, the actuary selects a loss ratio trend to adjust the historical loss ratios to the projected policy period.
- One shortcoming of this approach is that trends in adjusted loss ratios over time may not be stable, and it can be more difficult to understand what may be driving the results.

It may be preferable to examine the individual components of the loss ratio statistic (i.e. frequency, severity, and average premium) and adjust each component to get a better understanding of how each individual statistic is changing and therefore how the entire loss ratio statistic is changing.

Insurers may use external indices to select loss trends (e.g. a WC insurer may use an external study as the basis to estimate the expected increase in utilization and cost of medical procedures)

- However, the loss trend selection does not implicitly account for any expected change in the insurer's premium or exposure due to an inflation-sensitive exposure base.
- Thus, the exposure or premium needs to be adjusted to reflect any expected change in exposure.

Appendices A-F highlight some of the different approaches.

- The auto and homeowners examples do not have inflation-sensitive exposure bases and use internal trend data, however, the homeowners example does include a projection of the amount of insurance years, which is necessary for the projection of the non-modeled catastrophe loading.
- The medical malpractice loss ratio example includes a net trend approach. Trend selections are made using internal data. Since the "frequency" is number of claims divided by premium, the frequency selection accounts for pure frequency trend as well as premium trend.
- The WC example separately applies loss and exposure trend.

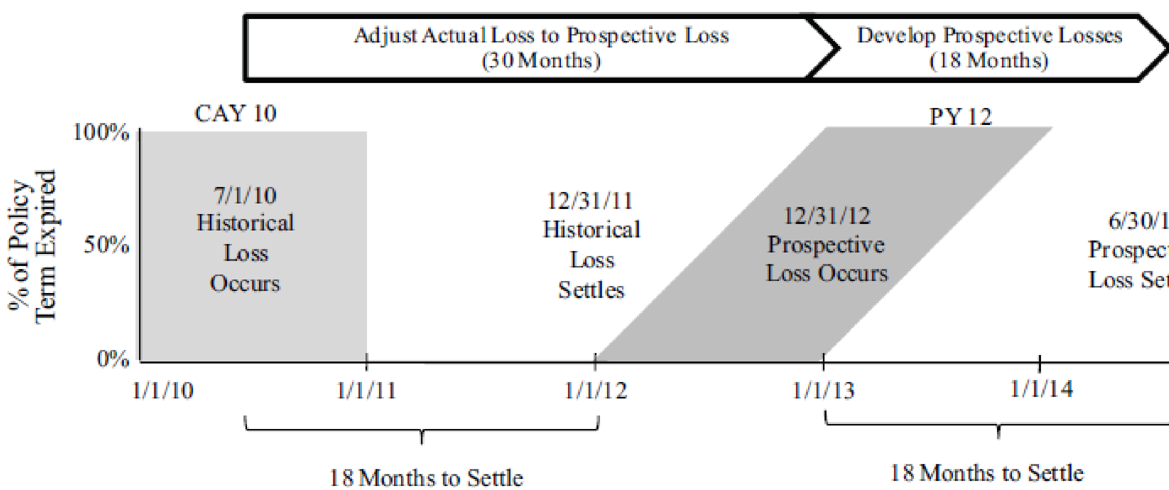
Overlap Fallacy: Loss Development and Loss Trend

Trending restates past losses to the level expected during the future period due to inflation and other factors.

Loss development brings immature losses to their expected ultimate level.

While it is true that loss development incorporates inflationary pressures that cause payments for reported claims to increase over time, this does not prove overlap.

The timeline below shows how losses are trended and developed.



Given the following:

- The historical experience period is CAY 2010.
- The average date of claim occurrence is 7/1/2010.
- Assume it is typical for claims to settle within 18 months, so this "average claim" will settle on 12/31/2011.
- The projection period is the policy year beginning 1/1/ 2012 (i.e. rates are expected to be in effect for annual policies written from 1/1/2012 – 12/31/2012).
- The average hypothetical claim in the projected period will occur on 1/1/2013, and settle 18 months later on 6/30/2014 (i.e. consistent with the settlement lag of 18 months).

Key comments:

Trend adjusts the average historical claim from the loss cost level that exists on 7/1/2010 to the loss cost level expected on 1/1/2013.

Development adjusts the trended, undeveloped claim to the ultimate level, expected to occur by 6/30/2014.

This 48 month period represents ***30 months of trend*** to adjust the cost level to that anticipated during the forecast period and the ***18 months of development*** to project this trended value to its ultimate settlement value.

5 Loss Adjustment Expenses 121 – 122

LAE are all costs incurred by a company during the claim settlement process.

LAE have been divided into two categories:

- Allocated loss adjustment expenses (ALAE) are costs that can be related to individual claims (e.g. legal fees to defend against a specific claim or costs incurred by a claim adjuster assigned to one claim)
- Unallocated loss adjustment expenses (ULAE) are those that are more difficult to assign to particular claims (e.g. claim department salaries).

In 1998, the insurance industry introduced new LAE definitions; costs are now split into defense cost and containment (DCC) expenses and adjusting and other (A&O) expenses.

- DCC expenses include costs incurred in defending claims, including expert witness fees and other legal fees.
- A&O include all other expenses.

Despite the change in U.S. financial reporting definitions, this text will refer to the subdivisions of ALAE and ULAE, which are more commonly used in ratemaking.

In general, ALAE or DCC vary by the dollar amount of each claim, while ULAE or A&O vary by the number of claims reported.

- ALAE are often included with losses for ratemaking purposes (e.g. for loss development and trend).
- In commercial lines, actuaries often study development and trend patterns separately for loss and ALAE, when ALAE are significantly high or in order to detect any changes in ALAE patterns.
- Is ALAE subject to the policy limits or not? This does not affect the treatment of ALAE in a ratemaking context, but it emphasizes the need to understand whether the ALAE data retrieved is the entire ALAE or only the portion included within the policy limits.

ULAE are more difficult to incorporate into the loss projection process.

Assume ULAE expenditures track with loss dollars consistently over time, both in terms of rate of payment and in proportion to the amount of losses paid.

Calculate the ratio of CY paid ULAE to CY paid loss plus ALAE over several years (e.g. three years or longer, depending on the line of business).

- This ratio is applied to each year's reported loss plus ALAE to incorporate ULAE.
- The ratio is calculated on losses that have not been adjusted for trend or development as this data is readily available for other financial reporting.
- The resulting ratio of ULAE to loss plus ALAE is then applied to loss plus ALAE that has been adjusted for extraordinary events, development, and trend.

ULAE Ratio

	(1)	(2)	(3)
Calendar Year	Paid Loss And ALAE	Paid ULAE	ULAE Ratio
2008	$ 913,467	$144,026	15.8%
2009	$1,068,918	$154,170	14.4%
2010	$1,234,240	$185,968	15.1%
Total	$3,216,625	$484,164	15.1%
		(4) ULAE Factor	1.151

(3) = (2) / (1)   (4) = 1.0 + (Tot3)

Catastrophic events can cause extraordinary loss adjustment expenses (e.g. a company setting up temporary offices in the catastrophe area).

- Since these costs are significant and irregular, the historical ratio will be distorted
- Thus cat LAE are generally excluded from the standard ULAE analysis and are determined as part of the catastrophe provision.

The method described above is a ***dollar-based allocation method***. Other allocation methods are:

- ***Count-based allocation methods*** that assume the same kinds of transactions cost the same amount regardless of the dollar amount of the claim, and that there is a cost associated with a claim remaining over time.
- ***Time studies*** showing how claim adjusters spend their time working on what types of claims, what types of claim activities, lines of business, etc.

6 Key Concepts 122 - 123

1. Loss definitions
   a. Paid loss
   b. Case reserves
   c. Reported loss
   d. Ultimate loss

2. Loss aggregation methods
   a. CY
   b. Calendar-accident year
   c. Policy year
   d. Report year

3. Common ratios involving losses
   a. Frequency
   b. Severity
   c. Pure premium
   d. Loss ratio

4. Extraordinary losses

5. Catastrophe losses
   a. Non-modeled catastrophes
   b. Modeled catastrophes

6. Reinsurance recoveries and costs

7. Changes in coverage or benefit levels

8. Loss development

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Loss Trending and Loss Development

Questions from the 1996 Exam:

Question 30. (4 points) You are given:

Wisconsin Personal Automobile Bodily Injury

		20/40 Basic Limits			
Calendar/	Ultimate			Rate Level History	
Accident	Loss &	Written	Earned	Effective	% Rate
Year	ALAE	Premium	Premium	Date	Change
1992	325,000	750,000	375,000	1/1/91	+7.0%
1993	575,000	1,000,000	875,000	10/1/93	+5.0%
1994	800,000	1,250,000	1,125,000	7/1/94	+3.0%
Combined	1,700,000	3,000,000	2,375,000	1/1/95	+5.0%

- Target Loss and ALAE ratio 69.0%
- Countrywide 20/40 Indicated +5.0%
- Proposed effective date 1/1/96
- The filed rate will remain in effect for one year.
- All policies are annual.
- Annual 20/40 severity trend 5.0%
- Annual 20/40 frequency trend -1.0%
- Statewide credibility 50.0%

Using the techniques described by McClenahan, "Ratemaking," Foundations of Casualty Actuarial Science:

(a) (2 points) Calculate the on-level earned premium for the experience period 1992-1994.

(b) (1 point) Calculate the trended on-level loss and ALAE ratio for the experience period 1992-1994.

(c) (1 point) Calculate the indicated rate level change for Wisconsin.

Question 36. (3 points)

Rate Change	Implementation Date	Type of Change
+8%	5/1/94	Experience
+15%	7/1/95	Law Amendment
-10%	7/1/95	Experience
+5%	4/1/96	Experience

- Policies are written uniformly throughout the year.

According to Feldblum, "Workers' Compensation Ratemaking:"

(a) (2 points) Calculate the premium adjustment factor to bring policy year 1995 premium to current rate level.

(b) (1 point) How are experience rate changes and law amendment rate changes different in their purpose and their effect?

Questions from the 1997 Exam:

44. (4 points) You are given:

Calendar/Accident Year	Reported Loss and ALAE	Earned Exposures
1993	1,800,000	2,500
1994	2,275,000	2,900
1995	1,975,000	3,400

Losses are evaluated as of 12/31/96 Loss (incl. ALAE) Development Factors:	LDFs
12 months to ultimate	1.500
24 months to ultimate	1.250
36 months to ultimate	1.050
48 months to ultimate	1.000

- Annual severity trend = +4.3% (trend is exponential)
- Annual frequency trend = -2.0% (trend is exponential)
- Commission = 14.0%
- Taxes = 3.0%
- Variable portion of General and Other Acquisition = 10.0%
- Total fixed expense = $30 per exposure
- Profit load = 3.0%
- All policies are annual
- Filed rates will be in effect for one year
- Proposed effective date for the rate change is 10/1/97

Using the methodology in McClenahan, "Ratemaking," of Foundations of Casualty Actuarial Science,

A. (2 points) Determine the developed and trended Loss and ALAE by accident year (chapter 6)
B. (1 point) Determine the indicated pure premium (chapter 8)
C. (1 point) Determine the indicated gross rate (chapter 8)

Questions from the 1999 exam

39. (2 points) McClenahan in "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, discusses the effects of limits on severity trend. Use the information shown below to determine the one-year severity trend for the loss amounts in the following three layers of loss:

$0-$50 $50-$100 $100-$200

- Losses occur in multiples of $40, with equal probability, up to $200, i.e., if a loss occurs, it has an equal chance of being $40, $80, $120, $160, or $200.
- For the next year, the severity trend will uniformly increase all losses by 10%.

Questions from the 2000 exam

40. (4 points) Using the techniques described by McClenahan in "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below.

You are given the following information for your company's homeowners business in a single state:

Calendar/ Accident Year	Ultimate Loss and ALAE	Written Premium	Earned Premium
1997	635,000	1,000,000	975,000
1998	595,000	1,050,000	1,000,000

Effective Date	Rate Change
July 1, 1996	+4.0%
January 1, 1998	+1.8%
July 1, 1999	+3.0%

Target Loss and ALAE Ratio	0.670
Proposed effective date	July 1, 2000
Effective period for rates	One year
Credibility	0.60
Alternative indication	0.0%
Policy period	Twelve months
Severity trend	+3.0%
Frequency trend	+1.0%

a. (1 1/2 points) Calculate the on-level factors for each of the two calendar years 1997 and 1998. (chapter 5)

b. (1 1/2 points) Calculate the trended projected ultimate on-level loss and ALAE ratio for the combined experience period 1997-1998. (chapter 6)

c. (1 point) Calculate the credibility-weighted indicated rate level change. (chapter 8)

Questions from the 2001 exam

Question 2. Based on McClenahan, "Ratemaking," chapter 2, Foundations of Casualty Actuarial Science, and the following information, answer the question below.

Assume:

- Experience period is accident year 1999.
- Indicated rates will become effective July 1, 2001.
- The next scheduled rate increase is expected to become effective April 1, 2002.
- All policies are expected to have an 18-month period.
- There are no seasonal effects on the frequency of accidents.
- Policies are evenly written throughout the year.

How many months are there between the midpoint of the experience period and the midpoint of the exposure period?

A. < 22 months B. ≥22 months but < 28 months C. ≥ 28 months but < 34 months

D. ≥ 34 months but < 40 months E. ≥ 40 months

Questions from the 2002 exam

17. (4 points) Based on McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below. Show all work.

Projected rates to be effective January 1, 2003 and in effect for 1 year.

Target loss and ALAE ratio is 65%.

Experience is from the accident period January 1, 2000 to June 30, 2001.

Developed accident period loss and ALAE is $21,500.

Annual trend factor is 3%.

All policies have one-year terms and are written uniformly throughout the year.

The rate on January 1, 1999 was $120 per exposure.

Effective Date	Rate Change
January 1, 2000	+10%
January 1, 2001	-15%

Year	Written Exposures
1998	200
1999	200
2000	200
2001	200

a. (1 point) Calculate the experience period trended developed loss and ALAE. (chapter 6)

b. (2 points) Calculate the experience period on-level earned premium. (chapter 5)

c. (1 point) Calculate the indicated statewide rate level change. (chapter 8)

Questions from the 2003 exam:

12. Given the following data and using the loss development method as described by McClenahan in Foundations of Casualty Actuarial Science, calculate the projected ultimate accident year 2001 losses.

	As of December 31, 2002	
Accident Year	Paid Losses	Case Reserves
1999	\$11,000	\$1,000
2000	\$6,000	\$2,000
2001	\$3,500	\$4,000
2002	\$1,000	\$4,000

- Projected ultimate accident year 2000 losses = \$9,240
- 12-24 case-incurred link ratio = 1.71
- 24-36 case-incurred link ratio = 1.20

A. < \$8,700 B. ≥ \$8,700, but < \$9,200 C. ≥ \$9,200, but < \$9,700
D. ≥ \$9,700, but < \$10,200 E. ≥ \$10,200

Questions from the 2004 exam:

7. Given the following data, calculate the trended loss ratio.

Number of Insureds	Earned Premium	Developed Incurred Losses
20	\$50,000	\$35,000

- Years of Trend = 2.5
- Annual Exposure Trend = 2.0%
- Annual Premium Trend = 2.9%
- Annual Frequency Trend = -1 .0%
- Annual Severity Trend = 6.0%

A. < 68% B. ≥ 68% but < 71% C. ≥ 71 % but < 74% D. ≥ 74%, but < 77% E. ≥ 77%

8. Which of the following statements are true regarding loss trends?
   1. When an exponential curve is used to approximate severity, the assumption is a constant multiplicative increase in severity.
   2. *This original statement no longer applies to the content in this chapter*
   3. Linear trends tend to underestimate future costs when inflation is increasing at a multiplicative rate.

A. 1 only B. 3 only C. 1 and 2 only D. 1 and 3 only E. 2 and 3 only

Questions from the 2004 exam (continued):

37. (5 points) Given the information below, answer the following questions. Show all work.

Case-Incurred Losses				
Accident Year	Age 12	Age 24	Age 36	Age 48
2000	$1,412	$1,816	$1,993	$1,993
2001	$1,624	$2,023	$2,137	
2002	$1,841	$2,271		
2003	$2,421			

- Ultimate losses are reached at age 48.
- The annual severity trend is 8%.
- Rates are reviewed annually.
- The annual frequency trend is -2%.
- Planned effective date of rate change is July 1, 2004.
- Policies have a term of 12 months.

a. (1 point) Calculate the age-to-ultimate development factor for accident year 2003 as of December 31, 2003. Explain your assumptions.

b. (0.5 point) Calculate the ultimate loss amount for accident year 2003.

c. (1 point) Calculate the trended ultimate loss amount for accident year 2003.

d. (1.5 points) Briefly describe three causes of loss development.

e. (1 point) Briefly explain why it is appropriate to both trend and develop losses (i.e. why there is no overlap).

Questions from the 2007 exam

22. (1.5 points) The claims department of an insurance company has historically set an initial case reserve of $10,000 for each liability claim at the time the claim is opened. If the claim is not closed within 18 months, the case reserve is adjusted to an appropriate level based on the characteristics of the claim. Starting with accidents occurring January 1, 2006 and later, the initial case reserve was set at $5,000 for each liability claim. The actuarial department was not made aware of this change.

Assume incurred loss data for accident year 2006, valued as of December 31, 2006, is used to derive rates effective July 1, 2007. Explain the impact of this change on incurred loss development and rate adequacy for this liability line of insurance.

Questions from the 2008 exam

17. (2.0 points) Given the following payment and reserve data about 2 different claims on 2 different policies:

Policy Effective Date	Date of Loss	Transaction Date	Payment	Case Reserve
July 1, 2006	December 1, 2006	December 1, 2006	$0	$5,000
		March 1, 2007	$500	$3,500
		October 1, 2007	$3,500	$2,000
		March 1, 2008	$3,000	$0
October 1, 2006	March 1, 2007	March 1, 2007	$5,000	$10,000
		October 1, 2007	$9,000	$1,000
		March 1, 2008	$1,000	$0

a. (0.5 point) Calculate the calendar-year incurred losses for 2006 and 2007.

b. (0.5 point) Calculate the accident-year incurred losses for 2006 and 2007 evaluated as of 12/31/2008.

c. (0.5 point) Calculate the policy-year incurred losses for 2006 and 2007 evaluated as of 12/31/2008.

d. (0.5 point) Identify one advantage and one disadvantage associated with using policy year incurred losses for ratemaking.

Questions from the 2009 exam

22. (2 points) an insurance company started writing annual policies in 2005. Given the following information for claims associated with policies written in 2005:

Accidents Occurring in 2005		
Calendar Year	Payments	Reserve @ End of Year
2005	$ 1,000,000	$500,000
2006	$ 300,000	$300,000
2007	$ 250,000	$100,000
2008	$ 50,000	$

Accidents Occurring in 2006		
Calendar Year	Payments	Reserve @ End of Year
2005	$	$
2006	$ 1,500,000	$ 1,000,000
2007	$ 700,000	$ 200,000
2008	$ 100,000	$ 50,000

a. (0.5 point) Calculate the calendar year losses for 2006.
b. (0.5 point) Calculate the accident year incurred losses for 2006 evaluated as of December 31, 2007.
c. (0.5 point) Calculate the policy year incurred losses for 2005 evaluated as of December 31, 2008.
d. (0.5 point) Provide one advantage and one disadvantage associated with using calendar year incurred losses rather than accident year incurred losses for ratemaking.

24. (1 point) Fully discuss why it may be inappropriate to apply a basic limits loss trend to total limits losses.

27. (1 point Fully discuss the "overlap fallacy" between trend and loss development.

42. (1 point) For homeowners insurance explain two reasons that hurricane rates should be priced separately from non-hurricane rates.

Questions from the 2010 exam

20. (2 points) Given the following claim activity on an annual policy effective on December 29, 2006:

Claim Number	Transaction Date	Incremental Payment	Case Reserve as Of Transaction Date	Transaction Description
1	December 31, 2006			Claim occurred
1	December 31, 2006		$1,000	Claim reported and reserve established
1	October 5, 2007		$ 10,000	Case reserve increased
1	July 5, 2008		$ 25,000	Case reserve increased
1	January 25, 2009	$ 30,000	$-	Settlement made, Payment made, Claim closed
2	April 1, 2007			Claim occurred
2	April 5, 2007		$ 25,000	Claim reported and reserve established
2	July 1, 2008		$-	Claim closed without payment

a. (0.5 point) Calculate 2008 calendar year reported losses.
b. (0.5 point) Calculate 2006 accident year reported losses evaluated as of December 31, 2007.
c. (0.5 point) Calculate 2006 policy year reported losses evaluated as of December 31, 2007.
d. (0.5 point) Briefly describe one advantage and one disadvantage of using calendar year losses as compared to accident year losses in a ratemaking application.

Questions from the 2010 exam

21. (2 points) Identify four adjustments made to historical losses in projecting losses for a future policy period for ratemaking. Briefly describe the purpose of each.

24. (1 point) Given the following countrywide calendar year information:

Calendar Year	Earned Premium	Paid Loss	Paid ALAE	Paid Loss and ALAE	Paid ULAE
2006	$696,667	$475,000	$47,500	$522,500	$26,125
2007	$733,333	$500,000	$50,000	$550,000	$55,000
2008	$805,673	$498,750	$24,938	$523,688	$52,369
2009	$907,725	$518,700	$25,935	$544,635	$54,464

Select a ULAE factor to be applied to the statewide incurred losses and paid ALAE as part of calculating statewide rate indications. Explain your selection.

Questions from the 2011 exam

6. (2.5 points) Given the following information for claims associated with annual homeowners policies written in 2007:

Claim Number	Accident Year	Report Year	Transaction Date	Loss Payment	Case Reserve Balance
1	2007	2007	April 1, 2007	$100	$300
1	2007	2007	July 1, 2008	$200	$600
1	2007	2007	June 1, 2009	$500	$0
2	2007	2008	May 1, 2008	$500	$200
2	2007	2008	July 1, 2009	$200	$0
3	2008	2008	August 1, 2008	$50	$200
3	2008	2008	March 1, 2009	$100	$50
3	2008	2008	July 1, 2010	$200	$0

a. (0.5 point) Calculate the calendar year 2008 incurred losses.

b. (0.5 point) Calculate the accident year 2008 incurred losses, evaluated at December 31, 2009.

c. (0.5 point) Calculate the policy year 2007 incurred losses, evaluated at December 31, 2009.

d. (0.5 point) Calculate the report year 2008 incurred losses, evaluated at December 31, 2009.

e. (0.5 point) Briefly describe one advantage and one disadvantage associated with using policy year losses for ratemaking.

7. (1 point) Fully explain the overlap fallacy between loss development and loss trend.

17. (1 point) Given the following data:

Claim Number	Loss Amount
1	$10,000
2	$15,000
3	$30,000
4	$35,000

- Basic limit = $25,000
- Total limits severity trend = 10%

Calculate the excess loss trend.

Questions from the 2012 exam

7. (5.75 points) An actuary is preparing a rate filing in a state that requires full supporting documentation of the rate level indication. The actuary is given the following information:

- A single trend percentage is used to trend the losses.
- There are no law or benefit changes.
- All policies are annual.
- Rate change effective date is April 1, 2013.
- Rates are reviewed annually.

AY 2010 Reported Losses and ALAE as of 12/31/2010 = $50,000

Reported Loss and ALAE Age-to-Age Development Factors

Accident Year	12-24	24-36	36-48	48-60	60-72	72-ult
2004	1.58	1.35	1.05	1.06	0.98	1.00
2005	1.75	1.31	1.05	1.01	1.01	
2006	2.63	1.20	1.08	1.04		
2007	1.82	1.23	1.02			
2008	1.46	1.18				
2009	1.66					

All year Average	1.82	1.25	1.05	1.04	1.00	1.00
Average ex-hi/lo	1.70	1.26	1.05	1.04		
Average last 3 years	1.65	1.20	1.05			

	Reported Loss and ALAE		
Calendar Year Ending	Frequency	Severity	Pure Premium
March 2008	0.082	$2,410	$197.62
June 2008	0.077	$3,650	$281.05
September 2008	0.073	$3,700	$270.10
December 2008	0.070	$3,710	$259.70
March 2009	0.069	$3,685	$254.27
June 2009	0.068	$2,525	$171.70
September 2009	0.070	$2,580	$180.60
December 2009	0.065	$2,565	$166.73
March 2010	0.065	$2,605	$169.33
June 2010	0.065	$2,675	$173.88
September 2010	0.065	$2,715	$176.48
December 2010	0.065	$2,730	$177.45

Develop the projected ultimate loss and LAE for accident year 2010 losses using the data above. In order to satisfy the state requirements, fully describe the rationale for the selections for loss development, loss trend, and ULAE.

Section 2: Effects of WC Benefit Level Changes

Questions from the 1995 exam

37. (3 points) You are given:

Ratio of Worker's Wage to Average Wage	Cumulative Percentage of Workers	Cumulative Percentage of Wages
0.250	6%	1%
0.500	15%	5%
0.750	35%	17%
1.000	60%	38%
1.250	75%	55%
1.500	90%	76%
1.875	96%	86%
2.250	99%	92%

Current Workers' Compensation Law

- Compensation rate is one-half of worker's pre-injury wage.
- There is no maximum benefit limitation.
- Minimum benefit limit = 50% of average weekly wage.

Revised Workers' Compensation Law

- Compensation rate is two-thirds of worker's pre-injury wage.
- Maximum benefit limit = 125% of average weekly wage.
- Minimum benefit limit = 50% of average weekly wage.

Following the methodology presented by Feldblum, “Workers' Compensation Ratemaking," calculate the direct effect of the law change.

Questions from the 1999 exam

38. (2 points) Based on Feldblum, "Workers' Compensation Ratemaking," and the information shown below, calculate the average benefit as a percentage of the average wage.

Ratio to Average Wage	% Of Workers	% Of Wages
0.00-0.50	15%	6%
0.50-0.75	20%	12%
0.75-1.00	25%	21%
1.00-1.50	20%	24%
1.50-2.00	15%	26%
2.00-2.50	5%	11%

Minimum benefit	0.75 of average wage
Maximum benefit	1.50 of average wage
Compensation rate	0.75 of pre-injury wage

Questions from the 2001 exam:

Question 48. (2 points) Based on Feldblum, "Workers Compensation Ratemaking," and the following information, answer the questions below. Show all work.

Statewide Average Weekly Wage	$900
Maximum Weekly Benefit	900
Minimum Weekly Benefit	360
Compensation Rate	66.7% of pre-injury wage

Wage Distribution Table

Ratio to Average Wage	**Cumulative Percentage of Workers**	**Cumulative Percentage of Wages**
0.40	5%	2%
0.50	15%	7%
0.60	25%	13%
0.70	35%	20%
0.80	45%	28%
1.00	65%	48%
1.25	80%	67%
1.50	90%	82%
1.75	95%	90%

a. (1 point) Calculate the average benefit as a percentage of the statewide average weekly wage.

b. (1 point) Calculate the direct effect of changing the compensation rate from 66.7% to 80.0% of the pre-injury wage.

Questions from the 2007 exam:

40. (2.5 points) Workers compensation law changes can produce both direct and incentive (or indirect) effects.

a. (0.5 point) Explain what is meant by direct effect.

b. (0.5 point) Explain what is meant by incentive effect.

c. (0.75 point) Will implementation of cost of living adjustments have a direct effect, incentive effect, or both? Explain your answer.

d. (0.75 point) Will changes in administrative procedures have a direct effect, incentive effect, or both? Explain your answer.

Questions from the 2008 exam

19. (3.0 points)

a. (2.0 points) You are given the following information related to workers' compensation:

Ratio to Statewide Average Weekly Wage (SAWW)	Cumulative Percent of Workers	Cumulative Percent of Wages
0.50	9%	4%
0.75	35%	20%
1.00	60%	42%
1.25	81%	65%
1.50	91%	81%

- The compensation rate is 2/3 pre-injury wage subject to maximum and minimum limitations.
- Statewide average weekly wage (SAWW) = $100
- Minimum weekly benefit = $50
- Maximum weekly benefit = $67

a. Calculate the direct benefit level effect of increasing the maximum benefit to $100.

b. (0.5 point) Define incentive (or indirect) effect.

c. (0.5 point) Identify and briefly describe an incentive (or indirect) effect that may result from increasing the maximum benefit.

Questions from the 2009 exam

26. (1 point) Given the following information regarding a change to a workers' compensation program's indemnity benefits:

- The replacement rate for benefits is changed from 50% of gross earnings to 85% of net take-home (after-tax) pay.
- The maximum and minimum limitations do not affect the reimbursement, either before or after the change.
- The tax rate for all participants is 30%.

a. (0.5 point) Calculate the direct effect of this benefit change.

b. (0.5 point) Briefly explain two possible indirect effects of this change.

Questions from the 2010 exam

23. (2.5 points) Given the following workers compensation information:

- The compensation rate is 80% of the worker's pre-injury wage.
- The state average weekly wage (SAWW) is $1,500.
- The minimum benefit is 48% of the SAWW.
- The maximum benefit is changing from 128% of the SAWW to 112% of the SAWW.
- The distribution of workers (and their wages) according to how their wages compare to the SAWW is as follows:

Ratio to Average Weekly Wage	Number of Workers	Total Weekly Wages
0 - 60%	64	$37,550
60 - 120%	144	$196,200
120 - 140%	33	$64,350
140 - 160%	21	$47,250
160 +	29	$84,000

a. (2 points) Calculate the direct effect of the change in maximum benefits on losses.

b. (0.5 point) Explain a potential indirect effect of the change in maximum benefits on losses.

Questions from the 2012 exam

7. Develop the projected ultimate loss and LAE for accident year 2010 losses using the data above. To satisfy the state requirements, fully describe the rationale for the selections for loss development, loss trend, and ULAE.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Loss Trending and Loss Development

Solutions to the questions from the 1996 exam

Question 30.

(b) To calculate the trend factor, one must know, the frequency and severity trend indications, the period of time the rates will remain in effect, the proposed effective date of the rates, and the length of the policy issued.

These are given in the problem as (.99)*(1.05) = 1.0395; one year; 1/1/96; and annual policies.

Trend factors are computed based on the time between the average accident date of the experience period to the average accident date of the effective period.

CY	Ultimate Loss and ALAE	Average Accident Date Experience	Effective	Trend Factor	Trended On-Level Loss and ALAE
1992	325,000	7/1/92	1/1/97	$(1.0395)^{4.5}$	386,895
1993	575,000	7/1/93	1/1/97	$(1.0395)^{3.5}$	658,497
1994	800,000	7/1/94	1/1/97	$(1.0395)^{2.5}$	881,356
Total					1,926,748

Thus, the trended, on-level loss and ALAE ratio = 1,926,748/2,646,299 = .728.

Question 36.

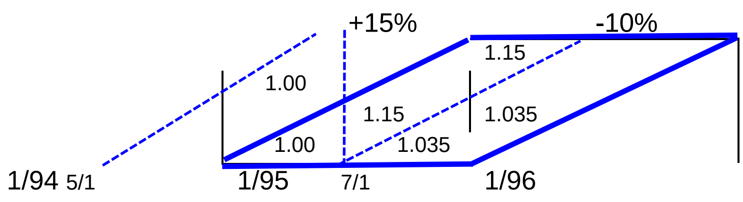
(a). The premium adjustment factor is also known as an on-level factor. The numerator of the on-level factor considers rate changes which impact both PY 1995, represented by the parallelogram below, and rate changes up and through the current level. The denominator of the on-level factor, considers only those rate changes which impact PY 1995.

Calculate the numerator of the on-level factor. This is equal to (1.0)(1.15)(.90)(1.05) = . 1.08675

Calculate the average rate level factor for the **policy year**. This is a weighted average of the rate level factors in the policy year. The weights will be relative proportions of the **parallelogram**. First calculate the area of all triangles (area = .50 * base * height) within the parallelogram and then determine the remaining proportion of the parallelogram by subtracting the sum of the areas of the triangles from 1.0.

Notice the area of the parallelogram at the 1.035 level. Its area is calculated as base * height = .50*1.0 = .50.

The average rate level factor for the policy year = (1/2)(.5)(.5)*1.0 + (1/2)(.5)(.5)*1.15 +.50*1.0*1.035 + (1.0 - .125 - .125 - .50)*1.15 = 1.07375.



The on-level factor = 1.08675 / 1.07375 = 1.012.

Solutions to the questions from the 1996 exam (continued)

Question 36. (continued)

(b) Experience rate changes are represented graphically as diagonal lines, and are computed to adjust current rates for changes anticipated in projected experience level. These affect new and renewal policies only.

Law amendment changes are represented graphically as straight lines, and since they affect **all** policies inforce at a given point in time. These changes adjust premiums for statutory modifications to benefits.

Solutions to questions from the 1997 exam:

Question 44.

(a) Trend Factors:

To calculate trend factors for each year's losses, compute:

1. The annual trend factor.
2. The midpoint of each year's loss exposure (the average accident date for each year of the experience period).
3. The midpoint of loss occurrence during the exposure period (the period the rates are to be in effect).

On page 103, McClenahan states that "While frequency and severity trends are often analyzed separately, it is sometimes preferable to look at trends in the pure premium, thus combining the impact of frequency and severity".

Using this approach, **the annual trend factor is (1+.043)*(1-.020) = 1.022.**

Since we are given accident year 199X losses, **the midpoint of each year loss exposure is 7/1/9x.**

We are told that the revised rates will be in effective for 12 months, from 10/1/97 through 9/30/98 (exposure period), and that all policies written will be annual policies. Therefore, the average policy will run from 4/1/98 to 3/31/99, and **the midpoint of loss occurrence during that policy will be 9/30/98.**

(Note: Another way to remember trend period for annual policies, for which rates will be in effective for 12 months, is midpoint of experience period to one year past the effective date.)

(a) Loss Development Factors (LDFs):

The appropriate LDFs to apply to each year's losses depends upon its age as of the loss evaluation date. Since losses are evaluated at 12/3196, AY 1995 losses are "aged" 24 months, AY 1994 losses are "aged" 36 months, and AY 1993 losses are "aged" 48 months.
To project these losses to ultimate, the respective age to ultimate factors to be used are 1.25, 1.05, and 1.00.

With this information, we can compute developed and trended Loss and ALAE by accident year as follows:

AY	Reported Loss and ALAE	LDF	Annual trend factor	Midpoint of the experience period	Midpoint of the exposure period	Trend Factor	Developed and trended Loss and ALAE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(1)*(2)*(6)
1993	1,800,000	1.00	1.022	7/1/93	9/30/98	1.121	2,017,800
1994	2,275,000	1.05	1.022	7/1/94	9/30/98	1.097	2,620,459
1995	1,975,000	1.25	1.022	7/1/95	9/30/98	1.073	2,648,969

Column (6) = Column (3)^t, where t is the number of years elapsed between column 5 and column 4.

Solutions to questions from the 1999 exam

Question 39.

The severity trend rate = $\frac{E[X']}{E[X]} - 1.0$, where X' represents losses affected by a 10% inflation rate.

Loss Amount Before/After(x)	Probability of loss (f(x))	Distribution of Loss by Layer 0 - 50	50 - 100	100 - 200
40/44	.20	40/**44**	0/0	0/0
80/88	.20	50/50	30/**38**	0/0
120/132	.20	50/50	50/50	20/**32**
160/176	.20	50/50	50/50	60/**76**
200/220	.20	50/50	50/50	100/**100**

Loss amounts before and **after** the impact of uniform 10% increase

Layer	$E[X] = \sum_x x^* f(x)$	$E[X'] = \sum_x x^* f(x)$
0 - 50	$[.2*40+.80*50]=48$	$[.2*40*(1.1)+.80*50]=48.8$
50 - 100	$[.2*30+.60*50]=36$	$[.2*38+.60*50]=37.6$
100 - 200	$[.2*20+.20*60+.20*100]=36$	$[.2*32+.20*76+.20*100]=41.6$

Layer	One year severity Trend
0 – 50	$\frac{48.8}{48} - 1.0 =$ 1.017 or 1.7%
50 – 100	$\frac{37.6}{36} - 1.0 =$ 1.044 or 4.4%
100 – 200	$\frac{41.6}{36} - 1.0 =$ 1.156 or 15.6%

Solutions to questions from the 2000 exam:

Question 40.

b. Calculate the trended projected ultimate on-level loss and ALAE ratio for the combined experience period 1997-1998.

With this information, we can compute developed and trended Loss and ALAE by accident year as follows:

AY	Developed Loss and ALAE (1)	Freq trend factor (2)	Sev trend factor (3)	Midpoint of the experience period (4)	Midpoint of the exposure period (5)	Trend Factor (6)	Developed and trended Loss and ALAE (7)=(1)*(2)*(6)
1997	635,000	1.01	1.03	7/1/97	7/1/2001	$(1.01*1.03)^4$	743,717
1998	595,000	1.01	1.03	7/1/98	7/1/2001	$(1.01*1.03)^3$	669,873
Total							1,413,590

On-level loss and ALAE ratio $= \frac{Developed\ and\ Trended\ losses}{On-Level\ Earned\ Premium} = \frac{1,413,590}{1,027,283+1,039,290} = .684$

Solutions to questions from the 2001 exam

Question 2. Based on McClenahan, "Ratemaking," chapter 2, Foundations of Casualty Actuarial Science, and the following information, answer the question below.

Key dates given:

- Experience period is accident year 1999.
- Indicated rates will become effective July 1, 2001.
- The next scheduled rate increase is expected to become effective April 1, 2002.
- All policies are expected to have an 18-month period.
- Policies are evenly written throughout the year.

How many months are there between the midpoint of the experience period and the midpoint of the exposure period?

Step 1: Determine the midpoint of the experience period:

The midpoint of the experience period is a function of the average accident date during the experience period. The experience period is ACCIDENT year 1999, and since all polices are written evenly throughout the year, the average accident date during the experience period is 7/1/99.

Step 2: Determine the midpoint of the exposure period:

The midpoint of the experience period is a function of the average policy written date and the average accident date (based on the average written date) during the exposure period. The exposure period is from 7/1/2001 – 4/1/2002, and so the average written date during the exposure period is 11/15/2001. Since all policies are expected to have an 18 month period, the average accident date is 9 months later, which is 8/15/2002.

Thus, the number of months between the midpoint of the experience period (7/1/99) and the midpoint of the exposure period (8/15/2002) is 37.5 months. **Answer D.**

Solutions to questions from the 2002 exam

Question 17.

a. (1 point) Calculate the experience period trended developed loss and ALAE.

Since we are given that the developed accident period loss and ALAE is $21,500, and that the annual trend factor is 1.03, what remains to be computed is the trend period.

The trend period is determined by the time between the average accident date of the experience period and the average accident date associated with the effective period of the rates.

The average accident date for the eighteen month (1/1/00 – 6/30/01) accident experience period is 10/1/00.

Since the revised rates will be in effect for a one year period (1/1/2003 – 12/31/2003) and since all polices have one year terms and written uniformly throughout the year, the average policy will run from 7/1/2003 – 6/30/2004, and the midpoint of loss occurrence under that policy will be 1/1/2004).

The trend period is therefore 3.25 years (10/1/2000 – 1/1/2004), and the experience period trended developed loss and ALAE is $21,500 $(1.03)^{3.25}$ = **23,668**

Solutions to questions from the 2003 exam

12. Calculate the projected ultimate accident year 2001 losses.

Step 1: Determine AY 2001 case incurred losses at 12/31/2002 projected to 36 months.

Case incurred losses at 12/31/2002 = $3500 + $4,000 = $7,500. Note that at 12/31/02, AY 2001 case incurred losses are at 24 months of development. The loss development factor from 24-36 months is given as 1.20. Thus, AY 2001 case incurred losses projected to 36 months equals $9,000.

Step 2: Determine AY 2001 case incurred losses at 12/31/2002 projected to ultimate.

AY 2000 36-48 months case incurred loss development factor is $9,420/$8,000 = 1.155. Thus, at 12/31/02, AY 2001 cased incurred losses are at ultimate equals $9,000 * 1.155 = $10,395.

Answer E. $\geq$ **$10,200**

Solutions to questions from the 2004 exam

7. Calculate the trended loss ratio.

Step 1: Based on the givens of the problem, write an equation to determine the trended loss ratio.

$$\text{Trended Loss Ratio} = \left(\frac{\text{Developed Incurred Losses}}{\text{Earned Premium}}\right) * \left(\frac{\text{Freq Trend*Sev Trend}}{\text{Premium Trend}}\right)^{\text{Years of Trend}}$$

Step 2: Using the equation in Step 1, and the data in the problem, solve for the trended loss ratio.

$$\text{Trended Loss Ratio} = \left(\frac{\$35{,}000}{\$50{,}000}\right) * \left(\frac{.99 * 1.06}{1.029}\right)^{2.5} = .7352$$

Answer C: $\geq$ 71 % but < 74%

8. Which of the following statements are true regarding loss trends?

1. When an exponential curve is used to approximate severity, the assumption is a constant multiplicative increase in severity. True. "Since this data contains random fluctuations, the minimization of these fluctuations will provide a better estimate of the underlying trend. This is achieved by fitting the data to a curve. An exponential curve is selected because it assumes a constant percentage trend from year to year."
2. Statement no longer applicable to the content within this article
3. Linear trends tend to underestimate future costs when inflation is increasing at a multiplicative rate. True. Note that the linear model will produce a model in which the projection will increase by a constant amount (a) for each unit change in x. The exponential model will produce a constant rate of change of e^a - 1, with each value being e^a times the prior value.

Answer: D. 1 and 3 only

Solutions to questions from the 2004 exam (continued):

37.(5 points)

a. (1 point) Calculate the age-to-ultimate development factor for accident year 2003 as of December 31, 2003. Explain your assumptions.

Assumptions:

- We are told that ultimate losses are reached at age 48, and therefore our 48-ultimate loss development factor is 1.000.
- Selected age to age development factors are set equal to age to age link ratios computed using the given data. Age to Age link ratios are computed by dividing case-incurred losses at successive intervals (e.g. AY 2000 12-24 link ratio = 1,816/1,412 = 1.2861)

Since accident year 2003 at 12/31/03 is at 12 months of maturity, a 12 to ultimate loss development factor is necessary and is computed as follows:

AY	12-24	24-36	36-48	48-ULT
2000	1.2861	1.0975	1.0000	1.0000
2001	1.2457	1.0564		1.0000
2002	1.2336			1.0000
2003				1.0000
3 yr avg	1.2551	1.0769	1.0000	1.0000
Factor to Ult	**1.3516**	**1.0769**	**1.0000**	**1.0000**

, where

12 to ultimate loss development factor = 1.3516 = 1.2551 * 1.0769 * 1.0000 * 1.0000

b. (0.5 point) Calculate the ultimate loss amount for accident year 2003.

AY 2003 ultimate losses = AY 2003 case incurred $\text{losses}_{12\text{ months}}$ * 12 to ultimate loss development factor

= $2,421 * 1.3516 = $3,272.22

c. (1 point) Calculate the trended ultimate loss amount for accident year 2003.

Since we have computed ultimate losses for AY 2003 as $3,272.22, what remains to be computed is the annual trend factor and the trend period.

The annual trend factor is computed as the product of the given annual frequency and severity trend rates. Thus, the annual trend factor equals .98 * 1.08 = 1.0548

The trend period is determined by the time between the average accident date of the experience period and the average accident date associated with the effective period of the rates.

The average accident date for AY 2003 is 7/1/2003

Since the revised rates will be in effect for a one year period (7/1/2004 – 7/1/2005) and since all polices have one year terms and are written uniformly throughout the year, the average policy will run from 1/1/2005 – 12/31/2005, and the midpoint of loss occurrence under that policy will be 7/1/2005).

The trend period is therefore 2 years (7/1/2003 – 7/1/2005), and the AY 2003 trended developed loss and ALAE is $3,272.22 $(1.0548)^{2.00}$= **$3,640.68**

d. (1.5 points) Briefly describe three causes of loss development.

1. Development on known claims. This occurs when reserves are initially set too low, and then increase as more loss related information becomes known.
2. Newly reported claims. These result from the late reporting of claims.
3. Re-opening of prior closed claims. This happens when additional damages, resulting from the original loss occurrence, arise at point in time after the claim has been closed.

Solutions to questions from the 2004 exam (continued):

Question 37 (continued):

e. (1 point) Briefly explain why it is appropriate to both trend and develop losses (i.e., why there is no overlap).

It is appropriate to both trend and develop losses because there is no double counting of severity trend and loss development factors in the ratemaking process.

The trend factor reflects the severity trend from the midpoint of the experience period to the midpoint of the exposure period.

The loss development factor reflects the underlying severity trend from the midpoint of the exposure period to ultimate.

Solutions to questions from the 2007 exam:

22. Explain the impact of this change on incurred loss development and rate adequacy for this liability line of insurance.

CAS Model Solution

Incurred loss development factors are based on losses prior to accident year 2006. Since the initial case reserves were much higher, the development factors being applied to 2006 losses will be too low.

Ultimate losses for 2006 will be understated therefore indicated projected loss ratios or pure premiums will be too low. This will result in an indication that will be too low. Ultimately, the rates based on accident year 2006 will be inadequate.

Solutions to questions from the 2008 exam:

Model Solution - Question 17

a. (0.5 point) Calculate the calendar-year incurred losses for 2006 and 2007.

CY 2006 incurred losses = CY 2006 Paid losses + CY 2006 Ending Reserves – CY 2006 Beginning Reserves

Note: For CY 2006, we are only concerned with transactions associated with any policies effective during CY 2006 that also have losses during CY 2006. For CY 2006, the only policy meeting this criterion is the policy effective 7/1/2006.

CY 2006 Paid losses (for policy effective 7/1/2006) = $0.

CY 2006 Ending Reserves (for policy effective 7/1/2006) = $5,000 and CY 2006 Beginning Reserves = $0.

Thus, CY 2006 incurred losses = $0 + $5,000 - $0 = $5,000

CY 2007 incurred losses = CY 2007 Paid losses + CY 2007 Ending Reserves – CY 2007 Beginning Reserves associated with policies having CY transactions during CY 2007. Note that both the 7/1/2006 and 10/1/2006 policies have transactions (paid and case reserve activities) during CY 2007.

i. For the policy effective 7/1/2006, total paid losses (based on 2007 transaction dates) = $500 + $3,500 = $4,000. In addition, beginning reserves = $5,000 and ending reserves = $2,000.

Thus, CY 2007 incurred losses (for policy effective 7/1/2006) = $4,000 + $2,000 - $5,000 = **$1,000.**

ii. For the policy effective 10/1/2006, total paid losses (based on 2007 transaction dates) = $5,000 + $9,000 = $14,000. In addition, beginning reserves = $0 and ending reserves = $1,000.

Thus, CY 2007 incurred losses (for policy effective 10/1/2006) = $14,000 + $1,000 - $0 = **$15,000.**

Thus, CY 2007 incurred losses = $1,000 + $15,000 = $16,000.

Solutions to questions from the 2008 exam:

Model Solution - Question 17 (continued)

b. (0.5 point) Calculate the accident-year incurred losses for 2006 and 2007 evaluated as of 12/31/2008.

Note: Here we are concerned with final payments and reserves associated with accidents occurring during AY 2006 and 2007 respectively.

i. For the policy effective 7/1/2006, total paid losses (on accidents occurring during 2006) as of 12/31/2008 = $500 + $3,500 + $3,000 = $7,000. Final reserves as of 12/31/2008 = $0.

Thus, AY 2006 incurred losses (for policy effective 7/1/2006) = $7,000 + $0 = $7,000.

ii. For the policy effective 10/1/2006, total paid losses (on accidents occurring during 2007) = $5,000 + $9,000 + $1,000 = $15,000. Again, final reserves as of 12/31/2008 = $0

Thus, AY 2007 incurred losses (for policy effective 10/1/2006) = $15,000 + $0 = $15,000.

c. (0.5 point) Calculate the policy-year incurred losses for 2006 and 2007 evaluated as of 12/31/2008.

Note: Both policies are effective during 2006. No policies are effective during 2007.

Therefore, there will be no policy year 2007 incurred losses.

i. For the policy effective 7/1/2006, total paid losses (on accidents occurring during 2006) as of 12/31/2008 = $7,000

ii. For the policy effective 10/1/2006, total paid losses (on accidents occurring during 2007) as of 12/31/2008 = $15,000

Thus, PY 2006 incurred losses = $7,000 + $15,000 = $22,000.

Thus, PY 2007 incurred losses = $0

d. (0.5 point) Identify 1 advantage and 1 disadvantage associated with using PY incurred losses for ratemaking.

One advantage is that premiums and losses can be matched using policy year incurred losses.

One disadvantage is that policy year data is the least mature and least responsive compared to CY or AY data.

Solutions to questions from the 2009 exam:

Question 22

a. CY 2006 losses. The question is ambiguous with respect to whether it refers to paid or incurred losses.

Assuming Paid Losses are sought, add paid losses during CY 2006 from accidents occurring in both 2005 and 2006: 300,000 + 1,500,000 = $ 1,800,000

Assuming Incurred Losses (i.e. paid + change in reserves) are sought, use the result from above and compute the change in reserves as the ending reserves – beginning reserves, for accidents occurring in both 2005 and 2006: $1,800,000 + (300,000 - 500,000) + (1,000,000 – 0) = $2,600,000

b. AY 2006 incurred losses @ 12/31/07 =(AY 06 paid through 12/31/07) + (AY 06 reserves @ 12/31/07)

= (1,500,000 + 700,000) + 200,000 = $2,400,000

c. PY 2005 incurred losses @ 12/31/08. Note: Question states that all claims given in the problem arise from policies written in 2005

= (PY 05 Paid until 12/31/08) + (PY 05 reserves @ 12/31/08)

= (1,000,000 + 300,000 +250,000 + 50,000) + (0) [for accidents occurring in 2005] +

(1,500,000 + 700,000 + 100,000) + (50,000) [for accidents occurring in 2006]

= $1,600,000 + $2,350,000 = $ 3,950,000

d. CY incurred losses are more responsive than AY since loss info is known once CY is complete. AY incurred provides a better match to premium and loss then CY basis, although not as well as PY which matches premium and loss.

Solutions to questions from the 2009 exam (continued):

Question 24 Why it may be inappropriate to apply a basic limits loss trend to total limits losses.

If loss costs are increasing, basic limit losses will trend at a lower rate than total losses, and thus a basic limit trend will understate the actual underlying loss trend.

Basic limit losses trend at a lower rate than total losses because for losses near or at basic limits before trending, the full trend will not be realized by limiting losses. A loss that is already at or above basic limits, in fact, will observe no basic limit trends if losses are increasing.

Question 27 Fully discuss the "overlap fallacy" between trend and loss development.

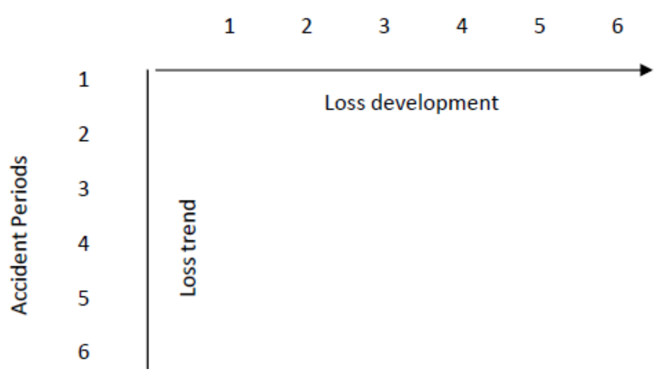
It was believed that loss development and loss trend capture the same change in loss patterns.

Therefore, using both would be “double counting”. This belief was referred to as “overlap fallacy”.

It is incorrect, because loss trend projects losses from the midpoint of experience period to the midpoint of exposure period, while loss development projects losses from midpoint of the exposure period to ultimates.

This can be thought graphically as possible:

Successive Evaluation Periods



Question 42: For homeowners insurance, explain two reasons that hurricane rates should be priced separately from non-hurricane rates.

Ratemaking becomes a much easier process if premiums are split. Traditional techniques can be applied on the non-hurricane portion without having to deduce the non-hurricane portion each time.

Allows appropriate classification. For example, it does not make sense to have a 25 % discount for fire protection in an area where 80 % of losses are hurricane related.

Solutions to questions from the 2010 exam:

Question 20

a. CY 2008 reported losses = CY 2008 Paid losses + CY 2008 Ending Reserves – CY 2008 Beginning Reserves

Note: Since two claims are given, values for each formula component above need to be aggregated. These values are shown below as (claim 1 amount + claim 2 amount)

CY 2008 reported losses = ($0 + $0) + ($25,000 + $0) – (10,000 + $25,000) = -$10,000

b. AY 2006 Reported Loss as of 12/31/2007

Note: Here we are concerned with total payments and reserves as of 12/31/2007 associated with accidents occurring during AY 2006. This limits transactions to claim 1 only.

i. Total paid losses (on accidents occurring during 2006) as of 12/31/2007 = $0. Final reserves as of 12/31/2007 = $10,000.

Thus, AY 2006 incurred losses $0 + $10,000 = $10,000.

c. PY 2006 reported loss as of 12/31/2007

Note: Here we are concerned with total payments and reserves at 12/31/2007 associated with both claims because both claims arose from a single policy issued in 2006.

PY 2006 reported loss as of 12/31/2007 = ($0 + $0) + ($10,000 + $25,000) = 35,000

d. <u>Advantage</u>: CY losses are readily available/immediately known. No need to wait for losses to develop.

<u>Disadvantage</u>: AY aggregation provides a better match of premiums to losses than CY aggregation.

21. (2 points) Identify four adjustments made to historical losses in projecting losses for a future policy period for ratemaking. Briefly describe the purpose of each.

1. Development – taking losses from an early state (e.g. 24 months) to their total ultimate state when all losses are paid and the claims are closed.
2. Trend – taking historical losses from the midpoint of the experience period and projecting to the midpoint of the future period (takes things such as inflation into account)
3. Benefit Level Changes – take into account anything that would change the benefits being charged to get losses to a “current benefit level” (e.g. workers comp. change in the law affecting benefits paid)
4. Catastrophes/Shock Losses/Extraordinary Events – adjust historical losses to take out any cats and load back in an amount to account for them. If cats were always just included, rates would increase years after cats and decrease after years without them to volatile.

Question 24

Select a ULAE factor to be applied to the statewide incurred losses and paid ALAE as part of calculating statewide rate indications. Explain your selection.

Calendar Year	Paid Loss & ALAE (1)	Paid ULAE (2)	Paid ULAE/ Paid Loss & ALAE (3)=(2)/(1)
2006	522,500	26,125	5%
2007	550,000	55,000	10%
200 8	523,688	52,369	10%
2009	544,635	54,464	10%

I would select ULAE factor =10%

Calendar Year 2006 has ULAE factor of 5 % but 2007– 2009 ULAE factors are all at 10% .

I believe there must have been a change in operation in 2007 that caused ULAE to increase to 10%.

Solutions to questions from the 2011 exam:

Question 6

a. (0.5 point) Calculate the calendar year 2008 incurred losses.

b. (0.5 point) Calculate the accident year 2008 incurred losses, evaluated at December 31, 2009.

c. (0.5 point) Calculate the policy year 2007 incurred losses, evaluated at December 31, 2009.

d. (0.5 point) Calculate the report year 2008 incurred losses, evaluated at December 31, 2009.

e. (0.5 point) Briefly describe one advantage and one disadvantage associated with using policy year losses for ratemaking.

Question 6 – Model Solution

a. CY 2008 incurred losses = CY 2008 Paid losses + CY 2008 Ending Reserves – CY 2008 Beginning Reserves

Note: Here we consider transaction date data occurring in 2008. Such data exists for claims 1, 2 and 3.

Claim 1: CY 2008 incurred losses = ($200 + $600 - $300) = $500

Claim 2: CY 2008 incurred losses = ($500 + $200 - $0) = $700

Claim 3: CY 2008 incurred losses = ($5 + $200 - $0) = $250

CY 2008 incurred losses = $500+ $700+$250=$1,450

b. AY 2008 incurred losses = AY 2008 Paid losses + AY 2008 Ending Reserves as of 12/31/2009

Note: Here we consider transaction date data occurring during AY 2008. Such data exists for claim 3 only.

Claim 3: AY 2008 paid losses = ($50 + $100) = $150. AY 2008 case reserve as of 12/31/2009 = $50

CY 2008 incurred losses = $150+ $50 = $200

c. PY 2007 incurred loss as of 12/31/2009

Note: Here we are concerned with total payments and reserves at 12/31/2009 associated with all three claims these claims arose from policies issued in 2007.

PY 2007 paid losses as of 12/31/2009 = 100 + 200 + 500 + 500 + 200 + 50 + 100 = 1650

PY 2007 case reserves of 12/31/2009 = 0 + 0 + 50 = 50

PY 2007 incurred losses as of 12/31/2009 = 1650 + 50 = 1700

d. RY 2008 incurred loss as of 12/31/2009

Here we are concerned with total payments and reserves as of 12/31/2009 associated with accidents reported during 2008. This limits transactions to claim 2 and claim 3.

i. Total paid losses (on accidents reported during 2008) as of 12/31/2009 = $500 + 200 + 50 + 100 = 850.
Case reserves as of 12/31/2009 for claims 2 and 3= $0 + $50 = $50

Thus, RY 2008 incurred losses as of 12/31/2009 $850 + $50 = $900.

a. 200 + 600 - 300 + 500 + 200 + 50 + 200 = 1,450

b. 50 + 100 + 50 = 200

c. 100 + 200 + 500 + 500 + 200 + 50 + 100 + 50 = 1700

d. 500 + 200 + 50 + 100 + 50 = 900

e. Advantage: True match between premiums and losses
Disadvantage: Extended development. It takes longer to develop.

Solutions to questions from the 2011 exam:

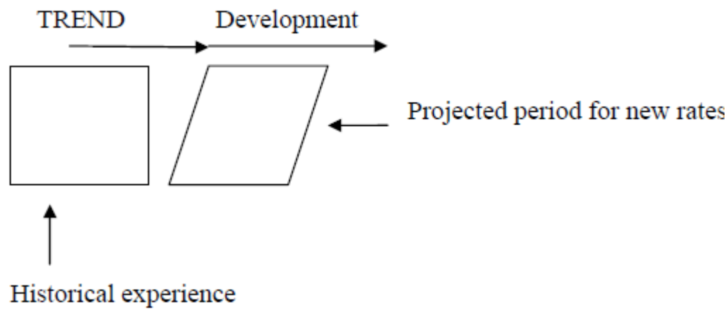
Question 7 – Model Solution 1

There is no overlap when developing loss and trending loss. Trending loss will rend loss from the midpoint of experience period to the midpoint of the exposure period. Developing loss will develop loss from the midpoint of the exposure period to the ultimate.

Question 7 – Model Solution 2

The overlap fallacy between loss development and trend clarifies than there actually is no overlap, or double-counting, between the two adjustments. Trend brings historical losses to the projected cost level/ environment of the future period, whereas development brings these losses to their ultimate settlement value.

The graph below demonstrates this:



Question 17. Given 5 claim amounts; •Basic limit = $25,000; • Total limits severity trend = 10%

Calculate the excess loss trend.

Question 17 – Model Solution

$When\ Limit \leq Loss$, $Excess\ loss\ trend = \frac{[Loss*(1.0+Trend)]-Limit}{Loss-Limit}$

Excess loss trend = Excess trended losses/Excess losses

Claim #	Loss	XS Loss	Trended Loss = loss x (1+10%)	XS Trended Loss
(1)	(2)	(3)	(4)	(5)
1	10,000	0	11,000	0
2	15,000	0	16,500	0
3	30,000	5,000	33,000	8,000
4	35,000	<u>10,000</u>	38,500	<u>13,500</u>
Total		15,000		21,500

(3) = (1) - 25,000, if (1) is greater than 25,000; otherwise (3) = 0
(5) = (4) - 25,000, if (4) is greater than 25,000; otherwise (5) = 0

Excess Loss trend = 21,500/15,000 – 1 = 43.33%

Section 2: Effects of WC Benefit Level Changes
Solutions to questions from the 1995 exam:

Question 37.

Direct effect of a benefit change = $\dfrac{\text{Average benefit (after the change)}}{\text{Average benefit (before the change)}}$.

	Current	Proposed
Replacement (Compensation) rate =% of the pre-injury wage =	.50	.667
Max benefit is set equal to a % state average weekly wage (SAWW)	None	.667*1.875 = 1.25
Min benefit is set equal to .50* (SAWW) =	.50*1.0=.50	.667*.75 = .50
Average Benefit Computed::	(R Rate)*(% SAWW)*(Cum % of workers)	
The % of workers earning ≥ (1.25 * SAWW) receive max benefits	**None**	**.667*1.875*(1-.96) =.05**
The % of workers earning ≤ (.50 * SAWW) receive min benefits	**.50*1.0*.6=.30**	**.667*.75*.35 = .175**
	(R Rate) * (cumulative % of wages)	
Workers earning between the maximum and the minimum receive benefits of equal to a % of their pre-injury wage	**.50*(1-.38) = .31**	**.667*(.86-.17) = .46**
Total	**.30 + .31 = .61**	**.05+.175+.46=.685**

The direct effect of a benefit change = .685/.610 - 1.0 = 12.3.

Solutions to the questions from the 1999 exam

Question 38.

To compute the average benefit, begin by re-stating the %s in the given table as cumulative %s.

Ratio to Average Wage	Cum % Of Workers	Cum % Of Wages
50%	15%	6%
75	35%	18%
1.00	60%	39%
1.50	80%	63%
2.00	95	89%
2.50	100%	100%

Next, determine the % of workers receiving the maximum and minimum benefit. These values are found by looking in the table above for the % of workers earning a certain percentage of the average wage such that the product of (ratio to average wage) * (compensation rate) equals 150% and 75% of the state average wage respectively.

Maximum benefit =	1.50 of average wage Note: At the maximum benefit limit, the compensation rate (.75) times the ratio to the state average wage **(2.0)** equals 1.50 of the state average weekly wage.
Minimum benefit =	0.75 of average wage Note: At the minimum benefit limit, the compensation rate (.75) times the ratio to the state average wage **(1.0)** equals .75 of the state average weekly wage.
Compensation rate =	0.75 of pre-injury wage

Computation of the average benefit:

	Benefits as a % of wages
Workers earning ≥ **2.0** times the state average weekly wage receive max benefits	.75 * 2.0 * .05 = **.075**
Workers earning ≤ **1.0** times the state average weekly wage receive min benefits	.75 * 1.0 * .60 = **.45**
Workers earning between the maximum and the minimum receive benefits of = a % of their pre-injury wage (R Rate) * (cumulative % of wages)	.75 * (.89 - .39) = **.375**
Total	**.075 + .45 + .375 = .90**

Thus, the average benefit is equal to 90% of the state average weekly wage:

Solutions to the questions from the 2001 exam

Question 48.

a. (1 point) Calculate the average benefit as a percentage of the statewide average weekly wage.

Determine the % of workers receiving the maximum and minimum benefit. These values are found by looking in the given table for the % of workers earning a certain percentage of the average wage such that the product of (ratio to average wage) * (compensation rate) equals 100% (900/900) and 40% (360 / 900) of the state average wage respectively.

Maximum benefit =	1.00 of average wage Note: At the maximum benefit limit, the compensation rate (given as .667) times the ratio to the state average wage **(1.50)** equals 1.00 of the state average weekly wage.
Minimum benefit =	0.40 of average wage Note: At the minimum benefit limit, the compensation rate (.667) times the ratio to the state average wage **(.60)** equals .40 of the state average weekly wage.
Compensation rate =	0.667 of pre-injury wage (given)

Computation of the average benefit:

	Benefits as a % of wages
Workers earning ≥ **1.50** times the state average weekly wage receive max benefits	.667 * 1.5 * .10 = **.10**
Workers earning ≤ **0.60** times the state average weekly wage receive min benefits	.667 * .60 * .25 = **.10**
Workers earning between the maximum and the minimum receive benefits of = a % of their pre-injury wage (R Rate) * (cumulative % of wages)	.667 * (.82 - .13) = **.4602**
Total	**.10 + .10 + .4602 = .6602**

Thus, the average benefit is equal to 66.2% of the state average weekly wage (900) = 594.21

b. (1 point) Calculate the direct effect of changing the compensation rate from 66.7% to 80.0% of the pre-injury wage.

$$\text{Direct effect of a benefit change} = \frac{\text{Average benefit (after the change)}}{\text{Average benefit (before the change)}}.$$

	Benefits as a % of wages
Workers earning ≥ **1.25** times the state average weekly wage receive max benefits (.80 * 1.25 = 1.0)	.80 * 1.25 * .20 = **.20**
Workers earning ≤ **0.50** times the state average weekly wage receive min benefits(.80 * 50 = .40)	.80 * .50 * .15 = **.06**
Workers earning between the maximum and the minimum receive benefits of = a % of their pre-injury wage (R Rate) * (cumulative % of wages)	.80 * (.67 - .07) = **.48**
Total	**.10 + .10 + .48 = .74**

Thus, the average benefit is equal to 74% of the state average weekly wage (900) = 666

Direct effect of a benefit change = 666 / 594.21 = 1.121 or 12.1%

Solutions to the questions from the 2007 exam

40. (2.5 points) Workers compensation law changes can produce both direct and incentive (or indirect) effects.
   a. (0.5 point) Explain what is meant by direct effect.
   b. (0.5 point) Explain what is meant by incentive effect.
   c. (0.75 point) Will implementation of cost of living adjustments have a direct effect, incentive effect, or both? Explain your answer.
   d. (0.75 point) Will changes in administrative procedures have a direct effect, incentive effect, or both? Explain your answer.

CAS Model Solution

a. A direct effect is the direct impact on premium or losses solely due to law change not taking into account the human response to a change. For example, if the max benefit is increased, losses will automatically go up because those already at the max will get an increase in benefits.

b. An incentive effect is the impact a change has on premium and losses because of the change in human behavior. For example, if the duration of benefits is lengthened, more people that are ready to go back may malinger to get benefits longer.

c. Both. Direct – Increase in indemnity payments because they will be adjusted upwards with inflation. Indirect – More people may stay out of work longer because their benefits are keeping up with inflation. Previously, they may have returned to work because their benefits were not a sufficient amount.

d. Incentive effect only – Administrative procedures that make it easier to file claims may cause some to file claims they wouldn't have in the past.

Solutions to questions from the 2008:

Model Solution - Question 19

Step 1: Write an equation to determine the direct benefit level effect of increasing the maximum benefit to $100.

Direct effect of a benefit change = [Avg benefit (after the change)/ Avg benefit (before the change]) – 1.0

Step 2: Write an equation to determine the average benefit (effective compensation rate).

The average benefit is computed as the sum of the following:

1. Benefits, as a % of wages, for the % of workers earning the minimum % of the SAWW.
2. Benefits, as a % of wages, for the % of workers earning at least the maximum % of the SAWW.
3. Benefits, as a % of wages, for the % of workers earning between the minimum % of the SAWW and the maximum % of the SAWW.

Step 3: Compute the % of workers earning benefits for each of the three groups of workers identified in Step 2, <u>before</u> increasing the max benefit to $100.

1. The % of workers earning the minimum % of the SAWW. With a compensation rate of .667, the minimum benefit of $50 is received by a worker making $75 ($50/.667), and $75 as a % of the SAWW of $100 equals .75. Using this as the lookup value for table give in the problem, 35% of workers earn the minimum benefit.
2. The % of workers earning the maximum % of the SAWW. With a compensation rate of .667, the maximum benefit of $67 is received by workers making at least $100 ($67/.667), and $100 as a % of the SAWW of $100 equals 1.0. Using this as the lookup value for table give in the problem, 40% (1.0 - .60) of workers earn at least the maximum benefit.
3. The % of wages unaffected by the min and max limits for workers earning between the minimum % and maximum % of the SAWW. Workers between the limits earn 42% - 20% = 22% of state wages.

Solutions to questions from the 2008:

Model Solution - Question 19 (continued)

Step 4: Compute benefits, as a % of wages, for each of the three groups of workers indentified in Step 2.

1. % of workers * min wages as a % of the SAWW * the compensation rate = .35 * .75 * .667 = **.1751**
2. % of workers * max wages as a % of the SAWW * the compensation rate = .40 * 1.0 * .667 = **.2668**
3. % of workers * the compensation rate = .22 * .667 = **.1467**

Current effective compensation rate = .1751 + .2668 * .1467 = .5886

Step 5: Repeat Steps 3 and 4 to determine the % of workers earning benefits for each of the three groups of workers identified in Step 2, after increasing the max benefit to $100.

1. Workers earning no more than 1 half of the SAWW receive the minimum benefit. [Two thirds of 0.75 times the SAWW equals half the SAWW which equals the min benefit.]

   These benefits, as a percentage of wages, are 2/3 x .75 x 35% = **17.51%**
2. Workers earning at least one and a half times the SAWW receive the maximum benefit. [Two thirds of 1.5 times the SAWW equals the revised maximum benefit].

   These benefits, as a percentage of wages, are 2/3 x 1.5 x (100% - 91%) = **9%.**
3. Workers earning between one half of the SAWW and one and a half times the SAWW receive benefits equal to two thirds of their pre-injury wages.

   These benefits, as a percentage of wages, are 2/3 x (81% - 20%) = **40.69%.**

Revised effective compensation rate = 9% + 17.51% + 40.96% = 67.47%

Step 6: Using the equation in Step 1, and the results from Steps 3 and 5, compute the direct benefit level effect.
Direct benefit level affect = .6747/.5886 - 1.0= .1416

b. Incentive effects are the human behavioral responses to changes in the direct effects of increasing or decreasing benefit levels, compensation rates, etc.

c. Because increasing the maximum benefit increased the effective compensation rate, we might expect to see longer duration injuries, since injured workers are receiving more benefit, they have less incentive to return to work. We would also expect an increase in claims, since workers will be paid more for injuries, they will report more injuries.

Solutions to questions from the 2009 exam:

Question 26

a. (0.5 point) Calculate the direct effect of this benefit change.

b. (0.5 point) Briefly explain two possible indirect effects of this change.

a. Before the change: benefits = (.5)(**pre**-tax pay)

After the change: benefits = (.85)(**post**-tax pay)

= (.85)(1 - .30)(pre-tax pay) =(.595)(pr- tax pay)

The direct effect of the benefits change is that benefits have increased by (.595/.5 - 1= .19 = 19%

b1 .We would expect higher frequencies, since the higher benefit will provide employees with more incentive to file claims

b2. We would expect employees to stay on disability longer, rather than returning to work, since they will receive higher benefits.

Solutions to questions from the 2010 exam:

Question 23

a. (2 points) Calculate the direct effect of the change in maximum benefits on losses.

b. (0.5 point) Explain a potential indirect effect of the change in maximum benefits on losses.

Part a.

The key is to calculate the benefits provided <u>before</u> and <u>after</u> the change to determine the direct effect.

The <u>minimum benefit</u> is 48% of the SAWW ($1,500) which equals $720 (= $1,500 x 48%).

The minimum benefit of $720 <u>applies to</u> workers who earn less than 60% of the SAWW (i.e. $720 = 80% x **60%** x $1,500), given the current compensation rate of 80%. Min compensation = $\frac{.48}{.80}$ =60%

The aggregate benefits for 64 employees in this category are $46,080 (= 64 x $720).

The <u>maximum benefit</u> is 128% of the SAWW ($1,500) and thus equals $1,920 (= $1,500 x 128%).

The maximum benefit of $1,920 <u>applies to</u> workers who earn more than 150% of the SAWW (i.e. $1,920 = 80% x **160%** x $1,500), given the current compensation rate of 80%. Max compensation= $\frac{1.28}{.80}$ =160%

The aggregate benefits for the 29 employees in this category are $55,680 (= 29 x $1,920).

The remaining 198 (= 144 + 33 + 21) employees fall between the minimum and maximum benefits.

This means their total benefits are 80% of their actual wages or $246,240 (= (80% x 196,200) + (80% x 64,350) + (80% x 47,250)).

The sum total of benefits is **$348,000** (= $46,080 + $55,680 + $246,240) under the current benefit structure.

Once the maximum benefit is reduced from 128% to 112% of the SAWW, more workers will be subjected to the new maximum benefit.

Workers earning approximately <u>></u>140% of the SAWW are subject to the maximum (i.e. $1,680 = (80% x 140% x $1,500) > $1,680). These 50 (= 21 + 29) workers will receive $84,000 (= 50 x $1,680) in benefits.

New compensation = $\frac{1.12}{.80}$ =140%

Workers subject to the minimum benefit, 64, are not impacted by the change, and their benefits remain $46,080.

There are now only 177 (= 144 + 33) employees that receive a benefit equal to 80% of their pre-injury wages or:

$208,440 (= (80% x 196,200) + (80% x 64,350)) because more workers are now impacted by the maximum.

The new sum total of benefits is $338,520 (= 84,000 + 46,080 + 208,440).

The **direct effect** from revising the maximum benefit is -2.724 (= 338,520/348,000 – 1.0).

Part b.

An indirect effect of lowering the max benefit would be a change in claimant behavior. Higher wage earnings may return to work faster as their benefits would not be as favorable as they had been prior. This might compound the decrease in total compensation.

Solutions to questions from the 2012 exam:

7. Develop the projected ultimate loss and LAE for accident year 2010 losses using the data above. To satisfy the state requirements, fully describe the rationale for the selections for loss development, loss trend, and ULAE.

Question 7 – Model Solution 1 (Exam 5A Question 7)

Loss Development

The ‘06 12-24 factor is a one-off high valve indicating a onetime event. This should be excluded from the selection. Also, the past 3 yrs. 24-36 avg. is stable and has decreased by an absolute 0.1 value from the ‘04 and 05 levels. All other periods are stable and relatively consistent.

Based on this, I select the Avg. last 3 yrs. as my LDF.

Loss Trend:

Frequency: The frequency over the past 12 quarters has been decreasing and leveled off in the final year. I would check w/management about any initiatives they took to decrease the frequency. I would think, based on the data, a process was taken and was effective at bringing freq down to the 0.065 level, but we can expect the stable value going forward.

Freq trend = 0%

Severity : The book went through a shift in Pure premium, freq, and severity after March 2009. The PP is significantly less implying smaller risks were written which brought down severity. After the pure premium stabilized in June ’09 we see an increasing trend in severity. To recognize this trend, but not include the seventy values from prior ’09 June, I would use the 6pt severity trend.

Sev Trend = 5.6%

Trend period: 7/1/2010 -> 4/1/2014 3.75

ULAE: The book went through a shift after ’08 and saw a reduction in freq/sev of claims. I would consult the claims dept about how this is effecting their operations w/the change in the type of claims going forward. Since ’08 is considerably different than ’09 and ’10 I would take an average of the ULAE ratio for these years as they reflect the environment going forward. Selecting only ’10 would be based on the results of my conversations w/claim and could overstate the true ULAE ratio.

ULAE = (15+ 15.6) / 2 = 15.3%

Ult Loss & LAE = 50k x (1.65 x 1.2 x 1.05 x 1.04) Dev x (1 + 0 + .056)^3.75 trend x 1.153 ULAE

Ultimate Loss and LAE = 152.907

Question 7 – Model Solution 2 (Exam 5A Question 7)

Loss Development: Notice that from 36-48 and onward, the link ratio are the same. So focus on 12-24 first. Notice that the all year average is high because of Accident Year 2006 in this maturity. This is likely an anomaly- due to a large loss. The other years in the maturity do not seem substantially different, so select the ex-hi/lo average. Now consider the 24-36 category. There is steady decrease in age-to-age factors here. Given this, I would select the Average $_1$st 3 years average.

So selected link ratios are

12-24	24-36	36-48	48-60	60-72	72-ult
1.7	1.2	1.05	1.04	1.	1

Freq

Loss Trend: Over the last year, frequency is very stable. However, it is declining in all other years. To balance stability of selections (represent the decreasing trend) but also be responsive (recognize that the trend has leveled off some) I would select -2% (between the 4 and 8 point fits).

Sev

Since June 2009, severity trend has been increasing at about +6%. The negative trends appear to be the result of the June 2008 -> March 2009 year, which has much higher severity than all other years. Therefore, adjusting or excluding the year is appropriate. Here, I choose to exclude. Since the 6-point and 4-pt fits are so similar, I feel a 6% is well supported.

Pure prem

Our selections imply a (1.06) * .98 = 1.0388 => 3.88% pure premium trend. Looking at the pure premium and excluding the data points from June 2008 to March 2009, we can see that a 3.88% will balance stability and reasonableness - it falls between the 6 and 4 point fits. Thus, a 3.88% pure premium trend is appropriate.

ULAE No compelling reason is seen in regards to differences in paid.

Loss and ALAE by year. The ULAE ratio does seem to be going, but it could be skewed by the fact that ULAE is more responsive to claim volume growth than Paid loss is (since paid loss is often from accidents occurring in prior years).

So, 15.6% is not appropriate, but 14.5% would not be either without more information on the claims dept. So we select on all-year average of 15% ULAE ratio, which has the added benefit of being explainable to regulators.

	Avg. date of loss		Avg. date of future loss
Our trend paired is from	7/1/2010	->	4/1/2014, 3.75 years

Ultimate projected loss of LAE = 50,000 x 1.7 x 1.2 x 1.05 x 1.04 x 1.0388 ^ (3.75) x 1.15 = 147,745.90

Examiner's Comments

Candidates generally justified the loss development factor selections well. Some candidates did lose credit for not including justification. Occasionally candidates' factors did not match the justification, resulting in the loss of points. Most candidates were able to identify the flat frequency trend and picked a four-point trend. The most common error was selecting a longer projection period without justification of why a decreasing trend was reasonable given the latest points. Many candidates failed to mention either the shock loss or the increasing pattern for severity in recent periods. Some candidates incorrectly calculated the trend period. Some candidates failed to provide justification for the ULAE selection. Most candidates projected ultimate loss and LAE correctly.

Chapter 7 – Expenses and Profit

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Simple Example 125 – 126

How expenses and profit are incorporated within the fundamental insurance equation in the ratemaking process. Assume the following:

- The average expected loss and LAE ($\bar{L}+\bar{E}_L$) for each policy is $180.
- The insurer incurs $20 in expenses ($\bar{E}_F$) for costs associated with printing and data entry, etc. each time it writes a policy.
- 15% of each dollar of premium collected covers expenses that vary with the amount of premium, (V), (e.g. premium taxes).
- Company management has determined that the target profit provision (Q_T) should be 5% of premium.

If the rates are appropriate, the premium collected will be equivalent to the sum of the expected losses, LAE, underwriting (UW) expenses (both fixed and variable), and the target underwriting profit.

Using the notation below, the fundamental insurance equation can be re-written.

$X \quad = Exposures$

$P;\bar{P} \quad = Premium; Average\ premium (P\ divided\ by\ X)$

$V \quad = Variable\ expense\ provision (E_V\ \ divided\ by\ P)$

$Q_T \quad = Target\ profit\ percentage$

$L;\bar{L} \quad = Losses; Pure\ Premium (L\ divided\ by\ X)$

$E_L;\bar{E}_L \quad = Loss\ Adjustment\ Expense (LAE); Average\ LAE\ per\ exposure (E_L\ divided\ by\ X)$

$E_F;\bar{E}_F \quad = Fixed\ underwriting\ expenses; Average\ underwriting\ expense\ per\ exposure \left(E_F\ divided\ by\ X\right)$

$E_V \quad = Variable\ underwriting\ expenses$

Premium = Losses + LAE + UW Expenses + UW Profit

$$P = L + E_L + (E_F + V * P) + Q_T * P$$

$$P - (V + Q_T) * P = L + E_L + E_F$$

$$P = \frac{[L + E_L + E_F]}{[1.0 - V - Q_T]}$$

$$\bar{P} = \frac{[L + E_L + E_F]/X}{[1.0 - V - Q_T]} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]}$$

Substituting the values from the example into the formula produces the following premium:

$$\bar{P} = \frac{\bar{L} + \bar{E}_L + \bar{E}_F}{[1.0 - V - Q_T]} = \frac{[\$180 + \$20]}{[1.0 - 0.15 - 0.05]} = \$250$$

The company should charge $250, composed of $180 of expected losses and LAE, $20 of fixed expenses, $37.50 (= 15% x $250) of variable expenses, and $12.50 (= 5% x $250) for the target UW profit.

This chapter focuses on determining the fixed expense provision (i.e. $20), the variable expense provision (i.e. 15%), and the profit provision (i.e. 5%).

2 Underwriting Expense Categories 126 – 127

Underwriting expenses (or operational and administrative expenses) are usually classified into the following four categories:

- Commissions and brokerage
- Other acquisition
- Taxes, licenses, and fees
- General

1. Commissions and brokerage:

- are paid as a percentage of premium written.
- may vary between new and renewal business.

Contingent commissions vary based on the quality (e.g. a loss ratio) or amount of business written (e.g. predetermined volume goals).

2. Other acquisition costs (e.g. media advertisements, mailings to prospective insureds, and salaries of sales employees who do not work on a commission) are expenses to acquire business other than commissions and brokerage expenses.

3. Taxes, licenses, and fees (e.g. premium taxes and licensing fees) include all taxes and miscellaneous fees due from the insurer excluding federal income taxes.

4. General expenses (e.g. overhead associated with the insurer's home office (e.g. building maintenance) and salaries of certain employees (e.g. actuaries)) include the expenses associated with insurance operations, excluding investment income expenses.

The u/w expense provision is further divided into two groups: fixed and variable.

Fixed expenses (e.g. overhead costs associated with the home office) are assumed to be the same for each risk, regardless of premium size (i.e. the expense is a constant dollar amount for each risk or policy).

Variable expenses (e.g. premium taxes and commissions) vary directly with premium and thus are constant percentage of the premium.

The magnitude and distribution of underwriting expenses vary significantly for different lines of business.

- Commissions tend to be much higher in lines that require a comprehensive inspection at the onset of the policy (e.g. large commercial property) than for lines that do not involve such activity (e.g. personal auto).
- Expenses can even vary significantly by company within a given line of business.
  i. A national direct writer may incur significant other acquisition costs for advertising.
  ii. An agency-based company may rely more heavily on the agents to generate new business; which should lower other acquisition costs, but might be partially offset by higher commission expenses.

Three different procedures used to derive expense provisions for ratemaking:

- All Variable Expense Method
- Premium-based Projection Method
- Exposure/Policy-based Projection Method

3 All Variable Expense Method 127 – 130

The All Variable Expense Method treats all expenses as variable (i.e. all expenses are assumed to be a constant percentage of premium). This method:

- assumes that expense ratios during the projected period will be consistent with the historical expense ratios (i.e. all historical underwriting expenses divided by historical premium).
- is widely used when pricing products for which the total u/w expenses are dominated by variable expenses (i.e. commercial lines products).

The table below shows an example of this method for deriving the other acquisition expense provision of a commercial general liability insurer.

Other Acquisition Provisions Using All Variable Expense Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$72,009	$104,707	$142,072		
b Countrywide Written Premium	$1,532,091	$1,981,109	$2,801,416		
c Variable Expense % [(a)/(b)]	4.7%	5.3%	5.1%	5.0%	5.0%

Historical CY expenses are divided by either CY written or earned premium during the same historical experience period.

The choice to use WP or EP depends on whether the expenses are incurred at the onset of the policy (e.g. commissions) or throughout the policy (e.g. building maintenance).

- WP is used when expenses are incurred at policy inception (as it reflects the premium at the onset of the policy).
- EP is used when expenses are assumed to be incurred throughout the policy (as it reflects the gradual payment of expenses that can be proportional to the earning of premium over the policy term).
- The choice of WP or EP has little impact if an insurer's volume of business is not changing materially (since WP is approximately to EP).
- If the insurer is growing (or shrinking) significantly, WP will be proportionately higher (or lower) than EP. Also, acquisition costs will be higher (or lower) during a period of stable volume.
- Use of an appropriate premium measure provides a better match to the types of expenses incurred during the historical period.

The Annual Statement and Insurance Expense Exhibit (IEE) contain historical expense and premium data.

However, this data may not be available in the level of detail needed for ratemaking purposes (e.g. homeowners data includes renters and mobile homes data, and as a result, may not be appropriate for deriving expense provisions specifically for homeowners policies).

The choice to use countrywide or state data varies by type of expense.

- Other acquisition costs and general expenses are assumed to be uniform across all locations, so C/W data from the IEE are used to calculate these ratios.
- The data used to derive commissions and brokerage expense ratios varies from carrier to carrier (e.g. some insurers use state-specific data and some use C/W data, depending on whether the insurer's commission plans vary by location).
- TL&F vary by state and the expense ratios are based on state data from the Annual Statement.

Data Summarization for All Variable Expense Method

Expense	Data Used	Divided By
General Expense	Countrywide	Earned Premium
Other Acquisition	Countrywide	Written Premium
Commissions and Brokerage	Countrywide/State	Written Premium
Taxes, Licenses, and Fees	State	Written Premium

Historical expense ratios for each category and year are calculated.

The selected ratio is based on either the latest year's ratio or a multi-year average of ratios along with management input, prior expense loads, and judgment.

Since the ratemaking process is a projection of future costs, the actuary should select an expense ratio <u>consistent with what is expected in the future</u> (examples of this are as follows):

- If the commission structure is changing, use the expected commission percentage.
- If productivity gains led to a reduction in staffing levels during the historical experience period, then the selected ratios should be based on the expected expenses after the reduction vs. an all-year average.
- A growing portfolio can cause expense ratios to decrease (since volume will increase faster than expenses); however, if the insurer plans to open a new call center to handle greater planned growth, consider that fixed costs will increase in the short-term until the planned growth is achieved.

If there were non-recurring expenses during the historical period, examine the materiality and nature of the expense to determine how to best incorporate the expense in the rates (if at all).

A few states place restrictions on which expenses can be included when determining rates (e.g. not allowing an insurer to include charitable contributions or lobbying expenses in its rates).

This procedure described is repeated for each of the expense categories, and the sum of the selections is the total expense provision. This provision is used directly in the loss ratio or pure premium rate level indication formulae (see Chapter 8).

Potential Distortions Using this Approach

By treating all expenses as variable, this understates the premium need for risks with a relatively small policy premium and overstates the premium need for risks with relatively large policy premium.

Assume the $20 of fixed expense ($\overline{E}_F$) is included as a percentage with the other 15% of variable expenses (V).

The $20 as a ratio to premium is 8% (= $20 / $250).

Treating all expenses as variable, the premium calculation becomes:

$$\bar{P} = \frac{\bar{L} + \bar{E}_L}{[1.0 - (V + (\bar{E}_F / P) - Q_T]} = \frac{\$180}{[1.0 - (0.15 + 0.08) - .005]} = \$250$$

Since the fixed dollar amount of $20 is exactly equivalent to 8% of $250 (i.e. the provision for the average risk), this approach produces the same result (i.e. $250) as the example that had the fixed expense included in the numerator as a fixed dollar amount.

The table below shows the results of the two methods for risks with a range of average premiums.

Results of All Variable Expense Method

	Correct Premium			All Variable Expense Method			
Loss Cost	Fixed Expense	Variable Expense And Profit	Premium	Fixed Expense	Variable Expense And Profit	Premium	%Diff
$135	$20	20%	$193.75	$ -	28%	$187.50	*-3.2%*
$180	$20	20%	$250.00	$ -	28%	$250.00	0.0%
$225	$20	20%	$306.25	$ -	28%	$312.50	*2.0%*

<u>The All Variable Expense Method *undercharges* risks with premium less than the average and *overcharges* the risks with premium more than the average.</u>

Therefore, insurers that use this approach may implement a premium discount structure that reduces the expense loadings based on the amount of policy premium charged.

- This is common for WC insurers (see Chapter 11).
- Some insurers using the All Variable Expense Method may also implement expense constants to cover policy issuance, auditing, and handling expenses that apply uniformly to all policies.

4 Premium-Based Projection Method 130 – 133

For insurers with a significant amount of both fixed and variable u/w expenses, the premium based projection method is used since it recognizes the two types of expenses separately.

- Like the All Variable Expense Method, it assumes expense ratios during the projected period will be consistent with historical expense ratios
- The enhancement is that this approach calculates fixed and variable expense ratios separately (as opposed to a single variable expense ratio) so that each can be handled more appropriately within the indication formulae.

General Expense Provisions Premium-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$26,531,974	$28,702,771	$31,195,169		
b Countrywide Earned Premium	$450,000,000	$490,950,000	$530,000,000		
c Ratio [(a) / (b)]	5.9%	5.8%	5.9%	5.9%	5.9%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c) x (d)]					4.4%
f Variable Expense % [(c) x (1.0-(d))]					1.5%

Step 1: Determine the % of premium attributable to each expense type by dividing historical underwriting expenses by EP or WP for each year during the historical experience period.

Here, general expenses are assumed to be incurred throughout the policy period, and thus are divided by EP.

Step 2: Choose a selected ratio (e.g. if the ratios are stable over time, a 3-year average may be chosen; if the ratios demonstrated a trend over time, the most recent year's ratio or some other value may be selected).

Step 3: Divide the selected expense ratio into fixed and variable ratios (using detailed expense data so that this division can be made directly, or using activity-based cost studies that help split each expense category appropriately).

The example assumes 75% of the general expenses are fixed, and that percentage is used to split the selected general expense ratio of 5.9% into a fixed expense provision of 4.4% and a variable expense provision of 1.5%.

Step 4: Sum the fixed and variable expense ratios across the different expense categories to determine total fixed and variable expense provisions.

If the average fixed expense per exposure (required for the pure premium approach discussed in Chapter 8) is needed, the fixed expense provision can be multiplied by the projected average premium.

Fixed Expense Per Exposure = Fixed Expense Ratio x Projected Average Premium

Potential Distortions Using this Approach

This approach assumes that historical fixed and variable expense ratios will be the same as in the projected period. . (Note: Recall that an actuary CAN select other than the historical ratios.)

However, the fixed expense ratio will be distorted if the historical and projected premium levels are materially different.

Situations that can cause such a difference to exist:

1. Recent rate increases (or decreases) implemented during or after the historical period will tend to overstate (or understate) the expected fixed expenses.

   Also, using 3-year historical expense ratios increases the chances of rate changes not being fully reflected in the historical premium.

   Solution: Restate historical written or earned premium at current rate level (see Chapter 5).

2. Distributional shifts that have increased the average premium (e.g. shifts to higher amounts of insurance) or decreased the average premium (e.g. shifts to higher deductibles) will tend to overstate or understate the estimated fixed expense ratios, respectively.

   Using 3-year historical expense ratios increases the impact of these premium changes by increasing the amount of time between the historical and projected periods.

   Solution: Trend historical premium to prospective levels (see Chapter 5).

3. Countrywide expense ratios that applied to state projected premium to determine the expected fixed expenses can create inequitable rates for regional or nationwide carriers.
   - This process allocates fixed expenses to each state based on premium.
   - However, the average premium level in states varies due to overall loss cost differences (e.g. coastal states tend to have higher overall homeowners loss costs) as well as distributional differences (e.g. some states have a significantly higher average amount of insurance than other states).
   - If significant variation exists in average rates across the states, estimated fixed expenses will be overstated in higher-than-average premium states and understated in the lower-than-average average premium states.

Assume the historical fixed expense ratio was calculated when the average premium level was $200 rather than $250, then the historical expense ratio is 10% (= $20 / $200).

If the 10% is applied to the premium at current rate level, the projected dollars of fixed expense will be $25 (=$10% x $250), and the overall indicated average premium will be overstated:

$$\bar{P} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]} = \frac{[\$180 + \$25]}{[1.0 - 0.15 - 0.05]} = \$256.25$$

Alternatively, the actuary can use a fixed expense projection method based on exposures or number of policies.

5 Exposure/Policy-based Projection Methods 133 – 135

Variable expenses are treated the same way as the Premium-based Projection Method, but historical fixed expenses are divided by historical exposures or policy count rather than premium.

If fixed expenses are assumed to be constant:

- for each exposure, historical expenses are divided by exposures.
- for each policy, historical expenses are divided by the number of policies.

The table below shows the development of the fixed and variable expenses for the general expenses category. (although the example uses exposures, the procedure is the same if policy counts are used instead.)

General Expense Provisions Using Exposure-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$26,531,974	$28,702,771	$31,195,169		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a) x (b)]	$19,898,981	$21,527,078	$23,396,377		
d Countrywide Earned Exposures	4,378,500	4,665,500	4,872,000		
e Fixed Expense Per Exposure [(c) / (d)]	$4.54	$4.61	$4.80	$4.65	$4.65
f Variable Expense $ [(a) x (1.0-(b))]	$ 6,632,994	$ 7,175,693	$ 7,798,792		
g Countrywide Earned Premium	$450,000,000	$490,950,000	$545,250,000		
h Variable Expense % [(f) / (g)]	1.5%	1.5%	1.4%	1.5%	1.5%

- Expenses are split into variable and fixed components (the assumption that 75% of GE are fixed is used).
- Fixed expenses are then divided by the exposures for that same time period.
- GEs are assumed to be incurred throughout the policy and thus are divided by earned exposures to determine an average expense per exposure for the indicated historical period.

Data Summarization for Exposure/Policy-Based Projection Method

		Divided By	
Expense	Data Used	Fixed	Variable
General	Countrywide	Earned Exposure	Earned Premium
Other Acquisition	Countrywide	Written Exposure	Written Premium
Commissions and Brokerage	Countrywide/State	Written Exposure	Written Premium
Taxes, Licenses, and Fees	State	Written Exposure	Written Premium

- Selected expense ratios are based on either the latest year or a multi-year average.
- Similar values for the projected average expense per exposure imply expenses are increasing or decreasing proportionately to exposures.
- If the insurer is growing and the projected average expense per exposure is declining each year, then expenses may not be increasing as quickly as exposures due to economies of scale.
- Non-recurring expense items, one-time changes in expense levels, or anticipated changes in expenses should be considered in the selection process.
- If the rate level indication approach requires that the fixed expense be expressed as a percentage of premium (i.e. when using the loss ratio approach, see Chapter 8), then the average fixed expense per exposure should be divided by the projected average premium.

$$Projected\ Fixed\ Expense\ Ratio = \frac{Average\ Projected\ Fixed\ Expense\ Per\ Exposure}{Projected\ Average\ Premium}$$

Variable expense ratios (variable expenses divided by historical premium) are treated the same way under both the Premium-based and Exposure/Policy-based Projection Methods.

The three-year average variable expense provision is selected in the example above.

Other Considerations/Enhancements

Shortcomings with the Exposure/Policy-based Projection Method

1. First, the method requires the actuary to split the expenses into fixed and variable portions (like the Premium-based Projection Method and is done judgmentally).

   Activity-based cost studies will more accurately segregate expenses.

   Sensitivity testing shows that the overall indication not materially impacted by moderate swings in % of expenses.

2. The method allocates countrywide fixed expenses to each state based on the exposure or policy distribution by state (as it assumes fixed expenses do not vary by exposure or policy).

   However, average fixed expense levels may vary by location (e.g. advertising costs may be higher in some locations than others).

   Note: If the insurer collects data at a finer level to make more appropriate adjustments, the cost of the data collection should be balanced against the additional accuracy gained.

3. Some expenses considered fixed actually vary by certain characteristics (e.g. fixed expenses may vary between new and renewal business).
   - This only affects the overall statewide rate level indication if the distribution of risks for that characteristic is either changing dramatically or varies significantly by state, or both.
   - Any material fixed expense cost difference not reflected in the rates will impact the equity of the two groups (even if there is no impact on the overall rate level indication).
   - Material differences in new and renewal provisions should be reflected with consideration given to varying persistency levels as described by Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/ Casualty Insurers" (Feldblum 1996). T*his article is part of the 2010 CAS Exam 5 Syllabus.*

4. The existence of economies of scale in a changing book may lead to increasing or decreasing projected average fixed expenses.

   Internal expense trend data and actuarial judgment should suffice for incorporating the impact of economies of scale.

6 Trending Expenses 135 – 137

Expenses are expected to change over time due to inflationary pressures and other factors.
- Since variable expenses automatically change as the premium changes, there is no need to trend the variable expense ratio.
- However, average fixed expense per exposure or policy are expected to increase over time due to inflation.

In the Premium-based Projection Method:
- If the average expenses and average premium are changing at the same rate, then the fixed expense ratio will be consistent and no trending is needed.
- However, if average fixed expenses are changing at a different rate than average premium, then the fixed expense ratio needs to be trended.

In the Exposure/Policy-based Projection Method:

- If an inflation-sensitive exposure base (e.g. payroll per $100) is used, no trending is needed if the expenses and exposure base are changing at the same rate.
- If a non-inflation sensitive base (e.g. car-year or house-year) or policy counts are used, average fixed expenses are expected to change over time and trending is appropriate.

Data used:

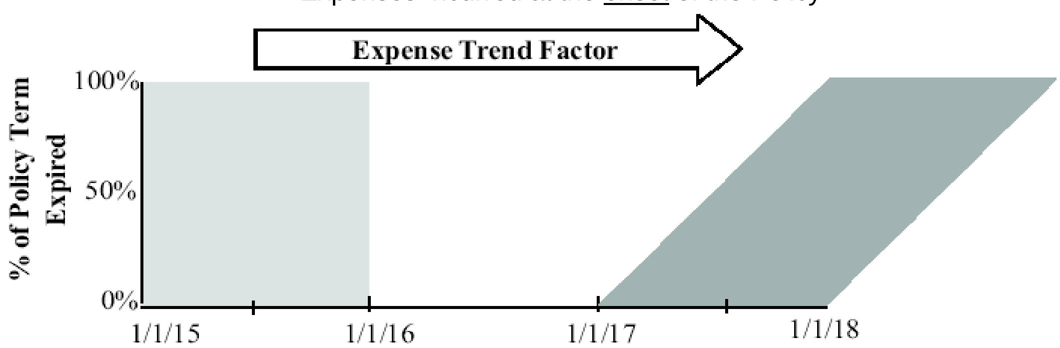
- Some insurers use internal expense data (examining the historical change in average expenses) to select an appropriate trend.
- However, internal data maybe volatile and insurers may use government indices (e.g. Consumer Price Index, Employment Cost Index, etc.) and knowledge of anticipated changes in company practices to estimate an appropriate trend (see the procedure in Appendix B).

Trending:

The selected fixed expense ratio will be trended from the average date that expenses were incurred in the historical expense period to the average date that expenses will be incurred in the forecast period of the rates.

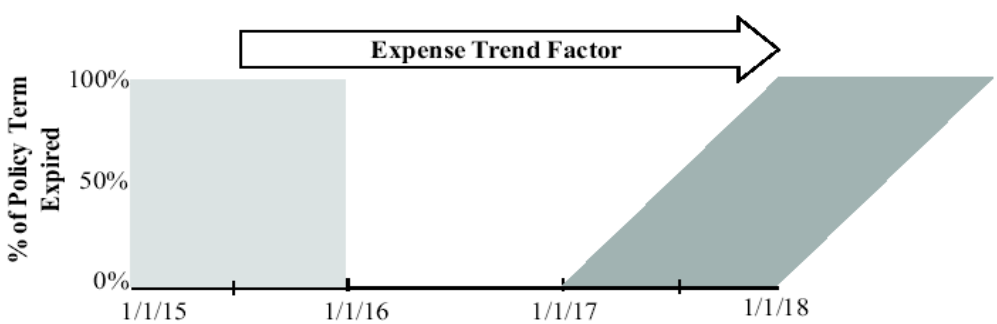
- Expenses incurred at policy inception should be trended from the average date that the policies were written in the historical period to the average written date in the projection period.
- Assume annual policies are sold, a steady book of business is maintained, and projected rates will be in effect for one year:

Expenses Incurred at the onset of the Policy



- Expenses incurred evenly throughout the policy period should be trended from the average date the policies were earned in the historical period to the average earned date in the projection period.

Expenses Incurred Throughout Policy



Points in time:

Since the experience period is a calendar year, the average date the policies are written and earned is the same.

However, expenses incurred throughout the policy are trended 6 months longer than expenses incurred at inception.

To simplify, actuaries make the assumption that all expenses are incurred either a policy inception or evenly throughout the policy period.

After trending, the expense ratio or average dollar amount of expense is called the projected (or trended) fixed expense provision.

7 Reinsurance Costs 137 – 137

Some ratemaking analysis is now performed on a net basis as reinsurance programs have become more extensive and reinsurance costs have increased substantially.

In proportional reinsurance, the same proportion of premium and losses to the reinsurer so this type of reinsurance may not need to be explicitly considered in ratemaking analysis.

With non-proportional reinsurance, projected losses are reduced for any expected non-proportional reinsurance recoveries. However, the cost reinsurance must be included too. This is done by:

- reducing the total premium by the amount ceded to the reinsurer, or
- the net cost of the non-proportional reinsurance (i.e. the cost of the reinsurance minus the expected recoveries) may be included as an expense item in the overall rate level indication.

8 Underwriting Profit Provision 138 – 138

By writing insurance, insurers assume risk and must maintain capital (which includes a reasonable profit provision in their rates) to support that risk.

Total profit is the sum of investment income and underwriting profit: Total Profit = II + UW Profit.

Investment Income (II)
Two sources of II are: II on capital and II on policyholder-supplied funds (PHSF).

Insurer capital funds:

- belonging to insurance company owners is known as equity.
- are also known as policy holder surplus (PHS) although the funds may be from investors rather than policyholders.

Insurers invest these funds and earn II (although disagreement exists as to whether this source of income should be included in ratemaking or not).

Insurers invest money from 2 types of PHS: unearned premium reserves and loss reserves.
Insurers' invest:

- premiums paid at policy inception (i.e. unearned premium) until it is earned.
- funds to pay for claims that have occurred, but have not yet been settled (i.e. loss reserves).

Investment time period:

- For short-tailed lines (e.g. personal auto collision coverage or HO insurance), there is a short time between the payment of premium and the settling of claims, and II will be relatively small.
- For long-tailed lines (e.g. personal auto BI or WC) there may be years between the time the premium is paid and all claims are settled with the opportunity for II to become much larger.

Projection of II is an advanced topic and is outside of the scope of this text.

Underwriting Profit

UW Profit = Premium - Losses - LAE - UW Expenses

The actuary determines the UW profit needed to achieve the target rate of return after consideration of II.

- For some long-tailed lines, II may be large enough that insurers can accept an UW loss and still achieve the target rate of return.
- For short-tailed lines, II is lower and the UW profit is a larger portion of the total return.

9 Permissible Loss Ratios 139 – 139

The expense and profit provisions are used to calculate a variable permissible loss ratio (VPLR) and the total permissible loss ratio (PLR).

The variable PLR is calculated as follows:

$$VPLR = 1.0 - \text{Variable Expense \%} - \text{Target Profit\%} = 1.0 - V - Q_T.$$

- This represents the % of each premium dollar to pay for the projected loss and LAE and projected fixed expenses.
- The remaining portion of each premium dollar is intended to pay for variable expenses and for profit

The total PLR is calculated as follows:

$$PLR = 1.0 - \text{Total Expense \%} - \text{Target Profit\%} = 1.0 - F - V - Q_T$$

- This represents the % of each premium dollar to pay for the projected loss and LAE.
- The remaining portion of each premium dollar is intended to pay for all UW expenses and for profit

If all expenses are treated as variable expenses, the VPLR and PLR are the same.

These ratios are used in the calculation of the overall rate level indications (see Chapter 8).

10 Key Concepts 139 - 139

1. Types of underwriting expenses
   a. Commissions and brokerage
   b. Other acquisition costs
   c. Taxes, licenses, and fees
   d. General expenses

2. Fixed and variable expenses

3. Expense projection methods
   a. All Variable Expense Method
   b. Premium-Based Projection Method
   c. Exposure/Policy-Based Projection Method

4. Expense trending

5. Reinsurance costs

6. Underwriting profit provision

7. Permissible loss ratios
   a. Variable permissible loss ratios
   b. Total permissible loss ratios

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter. By relevant, we mean the concepts tested on past CAS exams relating to expenses and profits are similar to the concepts found in this chapter relation to expenses and profits.

Questions from the 1996 exam

Question 3. You are given:

• Rate per unit exposure	$120
• Pure premium including loss adjustment expense	$75
• General expense ratio	7.0%
• Other acquisition expense ratio	3.0%
• Commission expense ratio	15.0%
• Taxes, licenses and fees ratio	3.0%
• Profit and contingencies ratio	5.0%

• 80% of general and other acquisition expenses are considered to be fixed expense.

Using the pure premium method described by McClenahan, chapter 2, "Ratemaking," Foundations of Casualty Actuarial Science, in what range does the fixed expense per exposure that is incorporated into the rate fall?

A. < $6 B. ≥ $6, but < $9 C. ≥ $9, but < $12 D. ≥ $12, but < $15 E. ≥ $15

Questions from the 2004 exam:

Question 33

b. (1 point) Expenses can be related to written or earned premium. Briefly explain why other acquisition expenses are related to written premium, while general expenses are related to earned premium.

Questions from the 2005 exam

43. (4 points) Use Werner's proposed methodology in "Incorporation of Fixed Expenses" and the information below to answer the following questions for the projected annual policy period beginning July 1, 2005. Show all work.

Statewide Projected Average Premium at Present Rates	$850.00
Statewide Projected Loss and LAE Ratio	68.0%
Profit and Contingencies Provision	5.0%
Annual Fixed Expense Trend	3.0%

	Annual Policy Period	
	2003	2004
Countrywide General Expenses	$25,000	$28,000
Fixed General Expense as percentage of General Expenses	75%	75%
Countrywide Earned Exposures	625	645
Countrywide Written Exposures	640	700
Countrywide Earned Premium	$435,000	$450,000
Countrywide Written Premium	$460,000	$475,000

	Fixed	Variable
Other Acquisition	$60.00	2.5%
Taxes, Licenses, and Fees	$ 2.50	2.0%
Commissions and Brokerage	None	12.0%

- Assume expenses are incurred evenly throughout the policy period.
  a. (2 points) Calculate the fixed expense provision.
  b. (1 point) Calculate the variable expense provision.
  c. (1 point) Calculate the statewide indicated rate change.

Questions from the 2006 exam

33. (3 points) Given the following private passenger automobile ratemaking data for the past three calendar years, answer the following questions.

	Calendar Year		
	2003	2004	2005
Written Premium	$20,000,000	$25,000,000	$30,000,000
Earned Premium	19,000,000	24,000,000	28,000,000
Commissions	3,000,000	3,750,000	3,000,000
General Expenses			
Home Office Salaries	798,000	1,056,000	1,008,000
Home Office Utilities	209,000	216,000	280,000
One-Time Expense associated with Reduction in Staff	0	360,000	0
All Other General Expenses	190,000	240,000	280,000
Total General Expenses	1,197,000	1,872,000	1,568,000
Other Acquisition Expenses	1,780,000	2,175,000	2,640,000
Taxes, Licenses, and Fees	500,000	625,000	750,000

a. (1 point) Beginning on January 1, 2005 all policies written and renewed had commissions changed in order to allow the company to compete more effectively. This new commission rate is expected to continue into the future.

As the actuary for this insurance company, briefly explain the commission provision you would recommend for use in the next rate revision to be effective July 1, 2006. Show all work.

b. (2 points) As shown in the table above, during 2004 the company paid a one-time expense associated with a reduction in staff. This reduction was due to increases in productivity and resulted in fewer employees during 2005. This new level of staffing is expected to continue.

As the actuary for this insurance company, briefly explain the general expense provision you would recommend for use in the next rate revision to be effective July 1, 2006. Show all work.

Questions from the 2008 exam

23. (3.0 points)

a. (0.5 point) Briefly define fixed expense and variable expense.

b. (2.0 points) You are given the following information:

	Historical Expenses	Percent Assumed Fixed
General Expense	$100,000	60%
Other Acquisition	$66,000	50%
Commissions & Brokerage	$110,000	0%
Taxes, Licenses & Fees	$40,000	25%

- Historical written premium = $1,100,000
- Historical earned premium = $1,000,000
- Projected loss & LAE ratio = 75%
- Profit provision = 5%
- General expense and taxes, licenses & fees are throughout the policy.
- Other acquisition and commissions & brokerage to occur at the onset of the policy.

Calculate the indicated rate change.

c. (0.5 point) Identify a situation that could impact the appropriateness of the historical fixed expense ratio for projection purposes and briefly explain the impact on the estimated fixed expenses.

Questions from the 2010 exam

25. (1.5 points) Identify and explain two potential distortions with using the premium-based projection method to determine expense ratios. In the explanation, include discussion of the direction of the distortion.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter. By relevant, we mean the concepts tested on past CAS exams relating to expenses and profits are similar to the concepts found in this chapter relation to expenses and profits.

Solutions to questions from the 1996 exam

Question 3. Calculate the fixed expense per unit of exposure, $\overline{E_F}$:

$\overline{P_I}$ = rate per unit of exposure, and is given as $120

$\overline{L+E_L}$ = pure premium, and is given as $75.

$$\overline{P_I} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}$$

$\overline{E_F}$ = fixed expense per exposure, which is what needs to be solved for.

V = variable expense factor, which requires some computation.

Q_T = profit and contingencies factor, and is given as .05.

The variable expense load is comprised of commissions, taxes, licenses and fees, and as stated in the problem, 20% of the general and other acquisition expense ratio.

V = 0.15 + 0.03 + 20% (0.07) + 20% (0.03) = 0.20 (Fast solving hint: note that 20% of the sum of other acq/gen expenses(10%) is 2%. Added to taxes of 3% is 5%, Added to commission of 15% is 20%.)

Therefore, $\$120 = \dfrac{\$75 \ + \ \overline{E_F}}{1.0 \ - \ [.15+.03+(.07+.03)*.20)+.05]}$. $\overline{E_F}$ = 15. Answer E.

Solutions to questions from the 2004 exam:

Question 33

b. (1 point) Expenses can be related to written or earned premium. Briefly explain why other acquisition expenses are related to written premium, while general expenses are related to earned premium.

   Other acquisition expenses are assumed to be incurred mainly at the beginning of the policy, due to the effort/process of "acquiring" the policy, so it makes more sense to relate it to Written Premium.

   General expenses (e.g. salary/overhead) would continue to be incurred even if policies ceased to be written, so it makes more sense to relate it to Earned Premium.

Solutions to questions from the 2005 exam:

a. (2 points) Calculate the fixed expense provision.

This question can be answered by referencing Exhibit 2-A Sheet i and Exhibit 2B from the Werner article. Create a table similar to the one below to compute the general fixed expense provision per exposure.

		2003	2004	2-Yr Straight Average
	(1) Total CW General Expenses (IEE)	$25,000	$28,000	
	CALCUATION: GEN FIXED EXP PROV PER EXPOSURE:			
	(2) Fixed General Expense as % of Total General Expense	75.0%	75.0%	
(3)=(1)*(2)	(3) Fixed General Expense $	$18,750	$21,000	
	(4) Total CW Earned Exposures	625	645	
(5)=(3)/(4)	(5) Average Fixed General Expense Per Exposure	$30.00	$32.56	
	(6) Expense Trend	1.03	1.03	
	(7) Trend Period from 7/1/XX to 7/1/06)	3	2	
$(8)=(6)^{(7)}$	(8) Expense Trend Factor	1.0927	1.0609	
(9)=(5)*(8)	(9) Projected Average Fixed General Expense Per Exposure	$32.78	$34.54	**$33.66**

Total fixed expense provision = projected average fixed general expense per exposure + other acquisition expenses + Taxes, licenses, and fees = $33.66 + $60.00 + $2.50 = $96.16

b. (1 point) Calculate the variable expense provision.

This question can be answered by referencing Exhibit 2-A Sheet i and Exhibit 2B from the Werner article. Create a table similar to the one below to compute the general variable expense provision

				2-Yr Straight Average
	CALCULATION: GEN VARIABLE EXP PROV			
1.0 - (2)	(10) Variable Gen Expense as % of Total General Expense	25.0%	25.0%	
(11)=(1)*(10)	(11) Variable General Expense $	$6,250	$7,000	
	(12) CW Earned Premium	$435,000	$450,000	
(13)=(11)*(12)	(13) Variable General Expense %	1.44%	1.56%	**1.50%**

Total variable expense provision = variable general expense % + variable other acquisition expenses + variable Taxes, licenses, and fees + variable commission and brokerage = 1.5% + 2.5% + 2.0% + 12.0% = 18.0%

c. (1 point) Calculate the statewide indicated rate change.

This question can be answered by referencing Exhibit 2-C from the Werner article. Create a table similar to the one below to compute the statewide indicated rate change.

	Calculation of Indicated Rate Change	
	(1) Statewide Projected Average Premium at Present Rates	$850.00
	(2) Statewide Projected Loss & LAE Ratio	68.0%
(3)=(1)*(2)	(3) Statewide Projected Average Loss & LAE	$578.00
	(4) Projected Average Fixed Expense Per Exposure	$96.16
	(5) Variable Expense Provision	18.0%
	(6) Profit and Contingencies Provision	5.0%
1.0-(5)-(6)	(7) Variable Permissible Loss Ratio [100%-(5)-(6)]	77.0%
(8)=[(3)+(4))]/(7)	(8) Statewide Projected Average Required Premium	$875.49
(9)=(8)/(1)-1.0	(9) Indicated Rate Change	3.0%

Solutions to questions from the 2006 exam

Question 33.

a. (1 point) Beginning on January 1, 2005 all policies written and renewed had commissions changed in order to allow the company to compete more effectively. This new commission rate is expected to continue into the future.

As the actuary for this insurance company, briefly explain the commission provision you would recommend for use in the next rate revision to be effective July 1, 2006. Show all work.

b. (2 points) As shown in the table above, during 2004 the company paid a one-time expense associated with a reduction in staff. This reduction was due to increases in productivity and resulted in fewer employees during 2005. This new level of staffing is expected to continue.

As the actuary for this insurance company, briefly explain the general expense provision you would recommend for use in the next rate revision to be effective July 1, 2006. Show all work.

CAS Model Solution

a. Use the 2005 commission ratio because it is most indicative of the future. Use written premium because commissions are generally paid at onset of policy.

3,000,000 / 30,000,000 = 10%

b. Use 3-year averages for home office utilities and all other general expense. Use the 2005 ratio for salaries to reflect the new staffing level.

Ignore the one-time expense since it is non-recurring.

Use earned premium since general expenses are usually incurred throughout the policy period.

The general expense provision that I would recommend for use in the next rate revision to be effective July 1, 2006 is computed as follows:

Utilities = [(209,000/19,000,000) + (216,000/24,000,000) + (280,000/28,000,000)]/3 = 1.0%

All other = {(190,000/19,000,000) + (240,000/24,000,000) + (280,000/28,000,000)]/3 = 1.0%

Salaries = 1,008,000/28,000,000 = 3.6%

Total = 1.0% + 1.0% + 3.6% = 5.6%

Solutions to questions from the 2008 exam

Model Solution - Question 23 *Initial comments*: Actuaries generally divide underwriting expenses into two groups: fixed and variable. Fixed expenses are those expenses that are assumed to be the same for each exposure, regardless of the size of the premium (i.e., the expense is a constant dollar amount for each risk). Typically, overhead costs associated with the home office are considered a fixed expense.
Variable expenses are those expenses that vary directly with premium; in other words, the expense is a constant percentage of the premium. Premium taxes and commissions are two good examples of variable expenses.

a. A fixed expense is an expense that is incurred that does not vary with premium. A variable expense is an expense that is incurred that varies with the amount of premium. A better solution is as follows:

Fixed expenses (e.g. overhead costs associated with the home office) are assumed to be the same for each risk, regardless of premium size (i.e. the expense is a constant dollar amount for each risk or policy).

Variable expenses (e.g. premium taxes and commissions) vary directly with premium and thus are constant percentage of the premium.

b. Calculate the indicated rate change.

Step 1: Write an equation to determine the indicated rate change.

$$Indicated\ Rate\ Change = \frac{Projected\ L + LAE\ Ratio + Fixed\ Expense\ ratio}{1.0 - V - Q}$$

Step 2: Using the given expense data in the problem, compute the fixed and variable expense ratio.

Note: Since other acq. and commissions & brokerage are assumed to occur at the onset of the policy, these expenses are related to written premiums, while all other expenses are related to E premium.

$$\text{Fixed expense ratio}=\frac{.6(100k)}{1M}+\frac{.5(66k)}{1.1M}+\frac{.25(40k)}{1M}=.06+.03+.01=.10$$

$$\text{Variable expense ratio}=\frac{.4(100k)}{1M}+\frac{.5(66k)}{1.0M}+\frac{110k}{1.1M}+\frac{.75(40k)}{1M}=.04+.03+.10+.03=.20$$

Step 3: Using the equation in Step 1, and the results from Step 2, compute the indicated rate change.

$$\text{Indicated Rate Change}=\frac{.75+.10}{1.0\text{-}.20\text{-}.05}-1.0=13.3\%\text{ increase}$$

c. Rate changes impact the fixed expenses as a percent of premium because the premium the ratio is applied to is different than contemplated in the ratio itself. If there had been a large rate increase after the fixed ratio was calculated the estimated fixed expenses would be higher than actual

Solutions to questions from the 2010 exam

Question 25 – Model Solution 1

The premium based projection method could produce distorted results if:

1. Premium is not placed at the current rate level. If rates have increased (decreased) since or throughout the historical experience period, premium used in the expense ratios would be understated (overstated), resulting in an overstated (understated) expense ratio.
2. Premium is not trended to reflect shifts in average premium. If average premium is trending upward (downward) after or throughout the historical experience period, premium used in the expense ratios would be understated (overstated), resulting in an overstated (understated) expense ratio.

Question 25 – Model Solution 2 – Acceptable Response

3. If we are using a nationwide expense ratio and apply it to a state that has significantly different average premium but the same fixed expense, there will be a distortion. For states with higher (lower) average premium, fixed expense will be overestimated (underestimated).

1 Introduction and the Pure Premium Method 141 – 143

Introduction:

This chapter explains how to determine whether current rates are appropriate (i.e. whether the profit target is likely to be met at the current rates) in the aggregate.

Chapters 9 - 11 discuss the calculation of indications by subclasses of insureds.

Chapter 14 discusses how to calculate final rates based on the overall indications and indications by subclasses of insureds.

Two basic approaches for determining an overall rate level need:

1. Pure premium method
2. Loss ratio method

This chapter will discuss each of these in detail, demonstrate the mathematical equivalency of the approaches, and discuss rationale for selecting one over the other.

The Pure Premium Method:

The pure premium method:

- is the simpler and more direct of the two ratemaking formulae
- determines an <u>indicated average rate</u> (not an indicated change to the current average rate).
- involves projecting the average loss and loss adjustment expenses per exposure and the average fixed expenses per exposure to the period that the rates will be in effect.

The indicated average rate per exposure is computed as follows:

$$Indicated\ Average\ Rate = \frac{Pure\ Premium\,(including\ LAE) + Fixed\ UW\ Expense\ Per\ Exposure}{1.0 - Variable\ Expense\ Ratio - Target\ Profit\ Percentage}$$

Recall the following notation:

X = Exposures

$P;\overline{P}$ = Premium; Average premium (P divided by X)

$P_I;\overline{P_I}$ = Indicated premium; Average indicated premium (P_I divided by X)

V = Variable expense provision (E_V divided by P)

Q_T = Target profit percentage

$L;\overline{L}$ = Losses; Pure Premium (L divided by X)

$E_L;\overline{E_L}$ = Loss Adjustment Expense (LAE); Average LAE per exposure (E_L divided by X)

$E_F;\overline{E_F}$ = Fixed underwriting expenses; Average underwriting expense per exposure (E_F divided by X)

E_V = Variable underwriting expenses

Using the above notation, the formula can be rewritten as:

$$\bar{P_I} = \frac{\left[\overline{L+E_L}+\overline{E_F}\right]}{\left[1.0-V-Q_T\right]} = \frac{\left[{(L+E_L)}/{X} + {E_F}/{X}\right]}{\left[1.0-V-Q_T\right]}$$

Derivation of Pure Premium Indicated Rate Formula

Begin with the fundamental insurance equation:

Premium = Losses + LAE + UW Expenses + UW Profit.

$$P_I = L + E_L + (E_F + V * P_I) + (Q_T * P_I).$$

$$P_I - V * P_I - Q_T * P_I = (L+E_L) + E_F.$$

$$P_I \times [1.0-V-Q_T] = (L+E_L)+E_F; \quad P_I = \frac{(L+E_L+E_F)}{[1.0-V-Q_T]}$$

Dividing by the number of exposures converts each of the component terms into averages per exposure, and the formula becomes the pure premium indication formula:

$$P_I/X = \frac{\left[{(L+E_L)}/{X} + {E_F}/{X}\right]}{\left[1.0-V-Q_T\right]} = \frac{\left[\overline{L+E_L}+\overline{E_F}\right]}{\left[1.0-V-Q_T\right]} = \overline{P_I}$$

Given the following information:

- Projected pure premium including LAE = \$300
- Projected fixed UW expense per exposure = \$25
- Variable expense ratio = 25%
- Target profit percentage = 10%

The indicated average rate per exposure is:

$$Indicated\ Average\ Rate = \frac{\left[\overline{L+E_L}+\overline{E_F}\right]}{\left[1.0-V-Q_T\right]} = \frac{[\$300 + \$25]}{[1.0 - 0.25 - 0.10]} = \$500$$

New Company

When determining rates for an insurer writing new business, no internal historical data exists. However, the actuary can still determine the indicated rate by estimating the expected pure premium and expense provisions and selecting a target profit provision (based on external data or determined judgmentally).

2 Loss Ratio Method 143 – 145

The loss ratio method:

- is the more widely used of the two rate level indication approaches.
- calculates an indicated change factor
- compares the sum of the projected loss and LAE ratio and the projected fixed expense ratio to the variable permissible loss ratio.

$$Indicated\ Change\ Factor = \frac{[Loss\ \&\ LAE\ Ratio + Fixed\ Expense\ Ratio]}{[1.0 - Variable\ Expense\ Ratio - Target\ UW\ Profit\%]}$$

When the numerator and denominator are not in-balance, the indicated change factor will be something other than 1.0. The factor can be applied to the current premium to bring the formula back in balance.

The loss ratio indication formula can be rewritten as follows: $Indicated\ \ Change\ \ Factor = \frac{\left[(L+E_L)/P_C + F\right]}{\left[1.0 - V - Q_T\right]}$

The indicated change is computed by subtracting 1.0: $Indicated\ \ Change = \frac{\left[(L+E_L)/P_C + F\right]}{\left[1.0 - V - Q_T\right]} - 1.0$

Derivation of Loss Ratio Indicated Rate Change Formula

Start with the fundamental insurance equation: Premium = Losses + LAE + UW Expenses + UW Profit.

Using the following notation, $P_C = Premium\ at\ current\ rates;\ Q_C = Profit\ percentage\ at\ current\ rates$, the fundamental insurance equation can be rewritten as follows:

$$P_C = L + E_L + (E_F + V * P_C) + Q_C * P_C$$

Rearranging the terms leads to:

$$Q_C * P_C = P_C - (L + E_L) - (E_F + V * P_C)$$

Dividing each side by the projected premium at current rate level (P_C) yields:

$$Q_C = 1.0 - \frac{(L+E_L)+(E_F+V*P_C)}{P_C} = 1.0 - \frac{L}{P_C} - \left(\frac{E_L+E_F}{P_C} + V\right)$$

Thus, Profit % at Current Rates = 1.0 – Loss Ratio – OER = 1.0 - Combined Ratio.

The goal of the ratemaking: Determine whether current rates can cover the estimated losses and expenses and produce the target profit.

- If the expected profit % at current rates (Q_C) is equivalent to the target profit % (Q_T), then the current rates are appropriate.
- It is more likely case is that (Q_C) is not equivalent to (Q_T) and rates need to be adjusted.

$$Q_C = 1.0 - \frac{(L + E_L) + E_F}{P_C} - V$$

The objective: How much does the premium at current rates need to be increased or decreased to achieve the target profit percentage?

Determine this by substituting:

- (Q_T) for (Q_C) and
- the indicated premium (P_I) for the projected premium at current rates (P_C) (indicated premium is the projected premium at current rates times the indicated change factor):

$$Q_T = 1.0 - \frac{(L + E_L) + E_F}{P_C * \text{Indicated Change Factor}} - V$$

Rearranging terms leads to: $1.0 - V - Q_T = \frac{(L + E_L) + E_F}{P_C * \text{Indicated Change Factor}}$

Rearranging terms and dividing through by P_C yields:

$$\text{Indicated Change Factor} = \frac{L + E_L + E_F}{P_C * (1.0 - V - Q_T)} = \frac{(L + E_L)/P_C + E_F/P_C}{(1.0 - V - Q_T)}$$, which

<u>is equivalent to the loss ratio indication formula</u>: $\text{Indicated Change Factor} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]}$

A result greater than 1.0 means the current rates are inadequate and need to be adjusted upward (and vice versa).

Subtract 1.0 from both sides to produce an indicated change: $\text{Indicated Change} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0$

Example of Loss Ratio Indicated Rate Change Formula

- Projected ultimate loss and LAE ratio = 65%
- Projected fixed expense ratio = 6.5%
- Variable expense ratio = 25%
- Target profit percentage =10%

$$\text{Indicated Change} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0 = \frac{[65\% + 6.5\%]}{[1.00 - 0.25 - 0.10]} - 1.0 = 10\%$$

Thus, the overall average rate level is inadequate and should be increased by 10%.

New Company

It is not used to price rates for a new insurer since the loss ratio approach is dependent on current premium.

The LR method is only used for making rates for a company with existing rates (since the loss ratio approach is dependent on current premium).

3 Loss Ratio Versus Pure Premium Methods 145 – 147

Comparison of Approaches

Two major differences between the two approaches.

1. The loss measure used in each approach: **the loss ratio** (i.e. projected ultimate losses and LAE divided by projected premium at current rate level) versus the **pure premium statistic** (i.e. projected ultimate losses and LAE divided by projected exposures).
   - The loss ratio indication formula requires premium at current rate level and the pure premium indication formula does not.
   - The pure premium formula requires exposures whereas the loss ratio indication formula does not.

   Preference:
   - The pure premium approach is preferable if premium is not available or if it is difficult to calculate premium at current rate level (e.g. the rating algorithm for personal auto includes a large number of rating variables, and if significant changes were made to those variables during the historical period, it may be difficult to calculate the premium at current rate level).
   - The loss ratio method is preferable if exposure data is not available or if the product being priced does not have clearly defined exposures (e.g. CGL policies have multiple sub-lines, each with different exposure bases). Thus, it's easier to obtain and use premium at current rate level rather than trying to define a consistent exposure.

2. The output of the two formulae.
   - The loss ratio formula produces an ***indicated change to rates*** currently charged.
   - The pure premium formula produces an **indicated rate** (thus, the pure premium method must be used with a new line of business for which there are no current rates to adjust).

Equivalency of Methods

Both formulae can be derived from the fundamental insurance equation (thus two approaches are mathematically equivalent).

1. Start with the loss ratio indication formula: $Indicated\ Change\ Factor = \dfrac{\left[(L+E_L)/P_C + F \right]}{[1.0 - V - Q_T]}$

   Restate the formula as: $Indicated\ Change\ Factor = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

2. The indicated adjustment factor, the ratio of the indicated premium (P_I) to the projected premium at current rates (P_C), yields the following: $P_I/P_C = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

3. Multiplying both sides by the projected average premium at current rates (P_C / X) results in the pure premium indication formula (proving the two methods are equivalent):

$$P_I/X = \frac{\left[(L+E_L)/X + E_F/X \right]}{[1.0 - V - Q_T]} = \frac{[\overline{L+E_L} + \overline{E_F}]}{[1.0 - V - Q_T]}$$

Note: The equivalency depends on consistent data and assumptions used for both approaches.

Example: If the premium at current rate level is estimated using the parallelogram method rather than the more accurate extension of exposures method, any inaccuracy introduced by the approximation may result in inconsistency between the loss ratio and pure premium methods.

4 Indication Examples 147 – 147

Chapters 1 – 8 have provided different techniques that can be used to determine an overall rate level indication.

The exact techniques used by actuaries to determine the overall rate level indication depend on various factors (e.g. unique characteristics of the product being priced, data limitations, historical precedence, and regulatory constraints).

Appendices A – D:

- provide overall rate level indication examples for 4 different lines of business (insurance products).
- example indications are based on several years of subject experience.

Calculating the total loss ratio (or pure premium) can be done as follows:

i. Insurers may sum projected ultimate loss and LAE across all years and divide by projected EP at present rates (or projected exposures) across all years (i.e. equivalent to weighting each year's loss and LAE ratio (pure premium) by the relevant premium (or exposure).

ii. Alternatively, some insurers select weights for each AY's experience, giving more weight to the more recent years.

5 Key Concepts 147 – 148

1. Pure premium indication formula

$$Indicated\ Average\ Rate = \frac{Pure\ Premium\,(including\ LAE) + Fixed\ UW\ Expense\ Per\ Exposure}{1.0 - Variable\ Expense\ Ratio - Target\ Profit\ Percentage}$$

$$Indicated\ Average\ Rate = \frac{\left[(L+E_L)/X + E_F/X\right]}{[1.0 - V - Q_T]} = \frac{[\,\overline{L+E_L} + \overline{E_F}\,]}{[1.0 - V - Q_T]}$$

2. Loss ratio indication formula

$$Indicated\ Change = \frac{[Loss\ \&\ LAE\ Ratio + Fixed\ Expense\ Ratio]}{[1.0 - Variable\ Expense\ Ratio - Target\ Profit\ \%]} - 1.0$$

$$Indicated\ Change = \frac{\left[(L+E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0$$

3. Loss ratio versus pure premium method
   a. Strengths and weaknesses of each method
   b. Mathematical equivalency of methods

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 2002 exam

17. (4 points) Based on McClenahan, "Ratemaking," chapter 2 of Foundations of Casualty Actuarial Science, and the following data, answer the questions below. Show all work.

Projected rates to be effective January 1, 2003 and in effect for 1 year.

Permissible loss and ALAE ratio (modified) is 65%.

Experience is from the accident period January 1, 2000 to June 30, 2001.

Developed accident period loss and ALAE is $21,500.

Annual trend factor is 3%.

All policies have one-year terms and are written uniformly throughout the year.

The rate on January 1, 1999 was $120 per exposure.

Effective Date	Rate Change
January 1, 2000	+10%
January 1, 2001	-15%

Year	Written Exposures
1998	200
1999	200
2000	200
2001	200

a. (1 point) Calculate the experience period trended developed loss and ALAE. (chapter 6)
b. (2 points) Calculate the experience period on-level earned premium. (chapter 5)
c. (1 point) Calculate the indicated statewide rate level change. (chapter 8)

Questions from the 2003 exam:

36. (5 points) Using the following information, answer the questions below. Show all work.

- On-level earned premium = $500,000
- Experience period losses = $400,000
- Experience period earned exposure = 5,000
- Premium-related expense factor = 22%
- Fixed underwriting expenses (modified) = $20,000
- Profit and Contingencies factor = 3%

a. (1 point) Calculate the variable permissible loss ratio using the loss ratio method (modified).
b. (1 point) Calculate the indicated rate level change using the loss ratio method.
c. (1 point) Calculate the indicated rate level change using the pure premium method.
d. (1 point) Describe a situation where the pure premium method cannot be used.
e. (1 point) Describe a situation where the loss ratio cannot be used.

Questions from the 2004 exam:

10. Which of the following statements is false regarding the loss ratio and pure premium methods for ratemaking?
    - A. The loss ratio and pure premium methods are identical when using consistent assumptions.
    - B. The pure premium method is preferable when on-level premium is difficult to calculate.
    - C. The loss ratio method produces indicated rate changes.
    - D. The pure premium method requires well-defined, responsive exposures.
    - E. The loss ratio method is preferable for a new line of business.

13. Given the information below, determine the indicated rate per exposure unit.
    - Frequency per exposure unit = 0.25
    - Severity = $100
    - Fixed expense per exposure unit = $10
    - Variable expense factor = 20%
    - Profit and contingencies factor = 5%

    A. < $35 B. $\geq$ $35 but < $40 C. $\geq$ $40 but < $45 D. $\geq$ $45 but < $50 E. $\geq$ $50

33. (3 points) Given the following information, answer the questions below.

Accident Year	On-Level Earned Premium	Trended Ultimate Loss & ALAE
2000	$800	$512
2001	$900	$540
2002	$1,000	$550

- Ratio of commissions to written premium = 14%
- Ratio of taxes, licenses and fees to written premium = 3
- Ratio of other acquisition expenses to written premium = 2%
- Ratio of general expense to earned premium = 6.25%
- Profit and contingency provision = 5%
- Fixed U/W expense ratio (modified) = 5%
- Assume each year of historical experience receives equal weighting.

a. (2 points) Determine the indicated rate change for policies to be written from January 1, 2004 to December 31, 2004. Show all work.

b. (1 point) Expenses can be related to written premium or earned premium. Briefly explain why other acquisition expenses are related to written premium, while general expenses are related to earned premium. (chapter 7)

Questions from the 2005 exam:

46. (5 points) Given the following data for private passenger auto bodily injury basic limits, answer the questions below. Show all work.
    - Policies are annual.
    - Proposed Effective Date = July 1, 2005
    - Rates are in effect for one year.
    - Current Rate = 225

    Experience Period Exposures and Losses

Calendar Accident Year	Earned Exposures	Loss & ALAE as of December 31, 2004
2002	450	$52,000
2003	500	$54,000
2004	530	$40,000

    - Age-to-age loss development factors

      12-24 months =1.50; 24-36 months =1.15; 36-48 months= 1.05; 48 - ultimate =1.06
    - Frequency trend = 2%
    - Severity trend = 5%
    - Permissible Loss Ratio (modified) = 65%

    a. (4 points) Calculate the indicated statewide rate level change using the loss ratio method.

    b. (1 point) Using your results from part a. above, illustrate the equivalency of the loss ratio method and the pure premium method.

Questions from the 2006 exam:

36. (4 points) Using the methods described by McClenahan, and the following information, answer the questions below. Show all work.
    - Experience period on-level earned premium = $500,000
    - Experience period trended and developed losses = $300,000
    - Experience period earned exposure = 10,000
    - Premium-related expenses factor = 23%
    - Fixed underwriting expenses (modified) = $21,000
    - Profit and Contingency factor = 5%

    a. (1.5 points) Calculate the indicated rate level change using the loss ratio method.

    b. (1.5 points) Calculate the indicated rate level change using the pure premium method.

    c. (1.0 point) Describe one situation in which it is preferable to use the loss ratio method, and one situation in which it is preferable to use the pure premium method.

Questions from the 2007 exam:

7. You are given the following information:
   - Indicated base rate is $300 per unit of exposure.
   - Profit and contingencies provision is 3%.
   - Other variable expenses represent 15% of premium.

   What would the revised base rate be if the company changes the profit and contingencies provision to -6%?

   A. < $272.00 B. ≥ $272.00 but < $285.00 C. ≥ $285.00 but < $298.00
   D. ≥ $298.00 but < $311.00 E. ≥ $311.00

8. You are given the following information:

On-level Earned Premium:	$100,000
Projected Loss & ALAE:	$75,000
Projected Fixed Expense Ratio (modified):	10%
Variable Expense Ratio (modified):	25%
Profit and Contingencies Ratio:	0%

   What is the indicated rate level change?

   A. < 6.5% B. ≥ 6.5% but < 8.0% C. ≥ 8.0% but < 9.5% D. ≥ 9.5% but < 11.0% E. ≥ 11.0%

Questions from the 2007 exam (continued):

42. (6.0 points) You are given the following information:

Calendar Accident Year	Incurred Losses & LAE	Earned Premium	Weights for Accident Year
2004	$5,000,000	$10,000,000	35%
2005	3,750,000	11,000,000	65%

Historical Rate Level Changes

July 1, 2003	5.0%
July 1, 2004	-1.0%
July 1, 2005	10.0%
July 1, 2006	0.0%

- Losses are valued as of June 30, 2006.
- Selected annual frequency trend is 4%.
- Selected annual severity trend is 1%.
- There is no premium or exposure trend.
- All policies are annual.
- Fixed expense ratio is 7%.
- Profit and contingencies provision is 5%.
- Other variable expenses are 20% of premium.
- The indication is considered to be 60% credible.
- The complement of credibility is no change.

Loss Development Factors

Age	Age to Ult.
6	3.500
12	2.500
18	2.000
24	1.700
30	1.500
36	1.400
42	1.350

Calculate the indicated rate change for rates to be effective from July 1, 2007 through June 30, 2008. Show all work.

Note: This is a chapter 5, chapter 6 and chapter 8 question.

Questions from the 2007 exam (continued):

43. (3.0 points) Using Werner and Modlin's notation:

a. (2.0 points) Demonstrate the equivalence of the pure premium and loss ratio approaches, assuming identical data and consistent assumptions.

b. (0.5 point) Which approach is more appropriate when pricing a new line of business? Explain.

c. (0.5 point) Which approach is more appropriate when pricing a line of business for which the historical rate change history is not available? Explain.

Questions from the 2008 exam:

24. (1.0 point) The indicated average rate was determined to be $300 based on the following information:

- Average fixed expense per exposure = $16
- Variable expense provision = 15%
- Profit and contingencies provision = 3%

Calculate the revised indicated average rate assuming the expected loss costs will be 10% higher than those assumed in the original analysis.

Questions from the 2008 exam continued:

26. (5.75 points) You are given the following information:

	Calendar/Accident Year	
	2006	2007
Earned Premium	$345,704	$396,714
Base Rate Underlying Premiums	$100	$100

Case Incurred Loss and ALAE					
Accident	Evaluation Age in Months				
Year	15	27	39	51	63
2002	$164,000	$213,200	$245,180	$262,343	$262,343
2003	$172,000	$223,600	$257,140	$269,997	$269,997
2004	$181,000	$235,300	$258,830	$271,772	
2005	$190,000	$228,000	$250,800		
2006	$200,000	$240,000			
2007	$210,000				

- Current base rate = $110
- Current rating structure is purely multiplicative.
- Proposed rates will be effective January 1, 2009, and will be in effect for one year.
- All policies are annual policies.
- On January 1, 2005 the claims department changed case reserving practices applicable to all outstanding claims.
- Premium trend = 3%
- Frequency trend = -1% and severity trend = 2%
- Unallocated loss adjustment provision = 10% of ultimate incurred loss & ALAE
- Fixed expense ratio = 8% and variable expense ratio = 20%
- Profit and contingencies provision = 5%
- Accident year projections should be weighted 60% to accident year 2007 and 40% to accident year 2006.
- Overall indication is assumed to be 75% credible.
- Complement of credibility should be assigned to no change.

a. (1.25 points) Calculate calendar/accident year 2006 and calendar/accident year 2007 projected premium at present rates. (Chapter 5, but shown here)

b. (3.0 points) Calculate accident year 2006 and accident year 2007 ultimate incurred losses and loss adjustment expenses, projected to future loss cost levels. (Chapter 6, but shown here)

c. (1.5 points) Calculate the indicated rate change. (Chapter 8)

27. (1.0 point)

a. (0.5 point) Provide an example of where a pure premium method is more appropriate than a loss ratio method.

b. (0.5 point) Provide an example of where a loss ratio method is more appropriate than a pure premium method.

Questions from the 2009 exam:

31. (1.5 points) For each of the following identify whether the loss ratio or pure premium ratemaking method is preferable. Briefly explain your answer.
    a. (0.5 point) Setting prices for a new line of business.
    b. (0.5 point Setting prices for a product that is not written uniformly throughout the year; current systems do not support re-rating policies.
    c. (0.5 point) Setting prices for a commercial lines product that has multiple complex exposures underlying each risk.

Questions from the 2010 exam:

26. (2 points)
    a. (1.5 points) Derive the indicated pure premium rate formula starting from the fundamental insurance equation.
    b. (0.5 point) Briefly describe two instances where it is more appropriate to use the pure premium method than the loss ratio method.

Questions from the 2011 exam:

9. (6.75 points) Given the following information for a book of business:
- Policies have a six month term
- Rate change history:
  - -3% effective October 1, 2008
  - +6% effective January 1, 2010
- Annual premium trend = 1.5%
- Annual loss trend = 2.2%
- Proposed rates will be in effect for one year beginning on October 1, 2011
- Unallocated loss adjustment expense provision = 3.2% (of loss and ALAE)
- Fixed expense ratio = 5.6%
- Variable expense ratio = 24.0%
- Underwriting profit and contingencies provision = 3.5%
- Rates developed based on calendar/accident year 2009 and 2010

Calendar Year Ending:	Earned Premium (000s)
December 31, 2009	$110,865
December 31, 2010	$128,973

	Incurred Losses and ALAE (000s)				
Accident Year	12 months	24 months	36 months	48 months	60 months
2006	$44,860	$51,589	$56,748	$57,315	$57,315
2007	$47,985	$54,703	$60,720	$61,327	
2008	$51,384	$59,606	$64,970		
2009	$60,735	$69,845			
2010	$76,094				

a. (2 points) Calculate the projected calendar year earned premium at current rate level for calendar years 2009 and 2010.
b. (4.25 points) Calculate the indicated rate change.
c. (0.5 point) Assume the 2009 incurred loss and ALAE amount includes an additional $25,000,000 in losses attributable to a single weather event. Discuss an appropriate strategy for including this information in the indicated rate change calculation.

Questions from the 2011 exam continued:

10. (1.5 points) Identify whether the loss ratio or pure premium ratemaking method is preferable in each of the following scenarios. Briefly explain each answer.
    a. (0.5 point) A company introduced two new rating variables within the past year.
    b. (0.5 point) A company is entering a new line of business.
    c. (0.5 point) A company writes a commercial product with multiple exposure bases.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Solutions to questions from the 2002 exam:

Question 17.

c. (1 point) Calculate the indicated statewide rate level change

$$Indicated\ Rate\ Change = \overline{P_I} = \frac{\left[(L+E_L) \big/ P_C \right]}{[PLR]} - 1.0$$

$$\frac{(L+E_L)}{P_C} = \frac{Developed\ and\ Trended\ losses}{On\text{-}Level\ Earned\ Premium} = \frac{23{,}668}{33{,}660} = .70315$$

PLR = $\left[1.0 - V - Q_T\right]$ = .65 (given in the problem)

$$Indicated\ Rate\ Change = \frac{.70315}{.65} - 1 = 0.0818$$

Solutions to questions from the 2003 exam:

Question 36.

a. (1 point) Calculate the variable permissible loss ratio (VPLR) using the loss ratio method.

$VPLR = [1.0 - V - Q_T\ ]$, where V and Q_T are given as 0.22 and 0.03

VPLR = (1.0 - 0.22 - 0.03) = 0.75 = 75.0%

b. (1 point) Calculate the indicated rate level change using the loss ratio method (LRM).

$$Indicated\ Change = \frac{\left[(L+E_L\ ) / P_C + F \right]}{[1.0 - V - Q_T\ ]} - 1.0 = \frac{\left[(L+E_L\ ) / P_C + F \right]}{VPLR} - 1.0\ ,$$

$\dfrac{(L+E_L\ )}{P_C} = \dfrac{400K}{500K} = 0.80$, $F = \dfrac{E_F}{P_c} = \dfrac{20K}{500K} = 0.04$; VPLR = (1.0 - 0.22 - 0.03) = 0.75 = 75.0%

Thus, the indicated rate level change using the LRM = [0.80+0.04]/0.75 – 1.0 = .12 = 12%

c. (1 point) Calculate the indicated rate level change using the pure premium method.

Under the pure premium method, the indicated rate (R) is computed as follows: $\overline{P_I} = \dfrac{\left[\overline{L+E_L} + \overline{E_F} \right]}{\left[1.0 - V - Q_T\right]}$.

$\overline{L+E_L}$ = Indicated pure premium = $\dfrac{Experience\ Period\ Losses}{Experience\ Period\ Exposures} = \dfrac{\$400{,}000}{5{,}000} = \$80$

$\overline{E_F}$ = Fixed expense $\dfrac{Non-premium\ Related\ Expensess}{Experience\ Period\ Exposures} = \dfrac{\$20{,}000}{5{,}000} = \$4$

V = Variable expense = .22; Q_T = Profit load = .03; Thus, $\overline{P_I} = \dfrac{\$80+4}{1 - .22 - .03} = \$112$

The current rate can be computed on-level earned premium/experience period earned exposures. Thus, the current rate is computed as $500,000/5,000 = $100.

Therefore, indicated rate level change using the pure premium method = $112/$100 – 1.0 = .12 = 12%

d. (1 point) Describe a situation where the pure premium method cannot be used.

The pure premium method cannot be used if exposure information is not available.

e. (1 point) Describe a situation where the loss ratio cannot be used.

The loss ratio method cannot be used for a new line of business because the method requires existing rate.

Solutions to questions from the 2004 exam:

10. Which statements is <u>false</u> regarding the loss ratio and pure premium methods for ratemaking?

A. The loss ratio and pure premium methods are identical when using consistent assumptions. True.
B. The pure premium method is preferable when on-level premium is difficult to calculate. True.
C. The loss ratio method produces indicated rate changes. True.
D. The pure premium method requires well-defined, responsive exposures. True.
E. The loss ratio method is preferable for a new line of business. **False**. The loss ratio method cannot be used for a new line.

Solutions to questions from the 2004 exam (continued):

13. Determine the indicated rate per exposure unit.

Step 1: Write an equation to determine the indicated rate per exposure unit, based on the given data

The given data lends itself to computing the rate per exposure unit using the pure premium method. Under the pure premium method, the indicated rate is computed as follows:

$$\overline{P_I} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}. \textit{ Based on the given data, } \overline{P_I} = \frac{Freq * Sev + \overline{E_F}}{PLR}$$

Step 2: Using the equation from Step 1, and the data given in the problem, solve for the indicated rate per exposure unit.

$$\overline{P_I} = \frac{.25 * \$100 + 10}{1 - .20 - .05} = \frac{\$35}{.75} = \$46.67$$

Answer: D. $\geq$ \$45 but < \$50

33. (3 points)

a. (2 points) Determine the indicated rate change for policies to be written from 1/1/2004 to 12/312004. Show all work.

Step 1: Write an equation to determine the indicated rate change (IRC).

$$\textit{Indicated Change} = \frac{\left[(L+E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0 \text{ ,}$$

Step 2: Using the equation from Step 1, and the data given in the problem, solve for the experience loss ratios and the variable expense factor.

$$\frac{(L+E_L)}{P_C} = \left(\frac{512}{800} + \frac{540}{900} + \frac{550}{1{,}000}\right)/3 = .5967$$, since it is assumed that each year of historical experience receives equal weighting.

$$V = .14 + .03 + .02 + .0625 = .2525; \quad Q_T = .05; \quad \mathrm{F} = .05$$

Step 3: Using the equation from Step 1, the results from Step 2, and the data given in the problem, solve for the indicated rate change for policies to be written from 1/1/2004 to 12/31/2004.

$$\textit{Indicated Change} = \frac{\left[(L+E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0 = \frac{(0.5967 + .05)}{(1.0 - 0.2525 - .05)} - 1.0 = \frac{0.6467}{0.6975} = -0.0728$$

Solutions to questions from the 2005 exam:

46. (5 points)

a. (4 points) Calculate the indicated statewide rate level change using the loss ratio method.

Step 1: Write an equation to determine the indicated rate change (IRC).

$$Indicated\ Rate\ Change = \overline{P_I} = \frac{\left[(L+E_L) / P_C \right]}{[1.0 - F - V - Q_T]} - 1.0 = \frac{\left[(L+E_L) / P_C \right]}{[PLR]} - 1.0 .$$

Note: The problem does not mention fixed expenses, so we assume there are no fixed expenses. So the PLR is used (which, in this case, is equal to the VPLR)

Step 2: Calculate the trended projected ultimate on-level loss and ALAE ratio for the combined experience period 2002 - 2004. With the given information in the problem, compute the developed and trended Loss and ALAE by accident year as follows:

AY	Loss and ALAE at 12/31/2004	Age to Ult LDFS	Midpoint of the experience period	Midpoint of the exposure period	Trend Factor	Developed and Trended Loss and ALAE
	(1)	(2)	(3)	(4)	(5)	(6)=(1)*(2)*(5)
2002	52,000	1.113	7/1/2002	7/1/2006	$(1.071)^4$	76,147.63
2003	54,000	1.280	7/1/2003	7/1/2006	$(1.071)^3$	84,912.60
2004	40,000	1.920	7/1/2004	7/1/2006	$(1.071)^2$	88,092.75
Total						249,152.98

Notes:

(2) Age to ultimate LDF computations:
36 – ult = (1.05)(1.06) = 1.113
24 – ult = (1.15)(1.113) = 1.280
12 – ult = (1.50)(1.280) = 1.920

(4) Avg Accident date of the exposure period is one year beyond the proposed effective date of the rates.

(5) A combined frequency and severity trend is computed as (1.02)(1.05) = 1.071. Thus, (5) = 1.071^t, where t is the number of years elapsed between column 3 and column 4.

Step 3: Compute the Experience Loss and ALAE ratio as

$$\frac{Developed\ and\ Trended\ losses}{On\text{-}Level\ Earned\ Premium} = \frac{\$249{,}152.98}{\$225[450+500+530]} = \frac{\$249{,}152.98}{\$333{,}000} = 0.748$$

Step 4: Using the equation from Step 1, the results from Step 2, and the data given in the problem, solve for the indicated rate change for policies to be written from July 1, 2005 to July 1, 2006.

$$Indicated\ Rate\ Change = \overline{P_I} = \frac{\left[(L+E_L) / P_C \right]}{[PLR]} - 1.0 = \frac{.748}{.65} - 1 = 0.151$$

Solutions to questions from the 2005 exam (continued):

b. (1 point) Using your results from part a. above, illustrate the equivalency of the loss ratio method and the pure premium method.

Under the pure premium method, the indicated rate (R) is computed as follows: $\overline{P_I} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}$.

In this problem,

$\overline{L+E_L}$ = Indicated pure premium = $\frac{\textit{Experience Period Developed and Trended Losses}}{\textit{Experience Period Exposures}} = \frac{\$249{,}152}{(450+500+530)} = \$168.35$

$\overline{E_F}$ = Fixed expenses per exposure, V = Variable expense, and Q_T = Profit load.

Since F, V and Q_T are not given, and since (1.0 – V – Q_T) = PLR, $\overline{P_I} = \frac{\$168.35}{.65} = \$259$. Therefore, the indicated rate change using the pure premium method is $IRC = \frac{\textit{Indicated Rate} - \textit{Current Rate}}{\textit{Current Rate}} = \frac{\$259 - \$225}{\$225} = 0.151$

Solutions to questions from the 2006 exam:

Question 36

a. (1.5 points) Calculate the indicated rate level change using the loss ratio method.

Step 1: Write an equation to determine the indicated rate change (IRC).

$$\textit{Indicated Change} = \frac{\left[\frac{(L+E_L)}{P_C} + F\right]}{[1.0 - V - Q_T]} - 1.0$$

Step2: Using the equation from Step 1, and the data given in the problem, solve for the indicated rate change using the loss ratio method.

$$IRC = [\left(\frac{300{,}000}{500{,}000}\right) + 21{,}000/500{,}000]/(1 - .23 - .05) - 1.0 = \frac{.642}{.72} - 1 = -.108333 = -10.83\%$$

Solutions to questions from the 2006 exam (continued):

b. (1.5 points) Calculate the indicated rate level change using the pure premium method.

Under the pure premium method, the indicated rate (R) is computed as follows: $\overline{P_I} = \dfrac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}$.

$\overline{L+E_L}$ = Indicated pure premium = $\dfrac{Experience\ Period\ Developed\ and\ Trended\ Losses}{Experience\ Period\ Exposures} = \dfrac{\$300{,}000}{10{,}000} = \$30.0$

$\overline{E_F}$ = Fixed expenses per exposure unit = $\dfrac{Fixed\ U/W\ Expenses}{Experience\ Period\ Exposures} = \dfrac{\$21{,}000}{10{,}000} = \$2.10$

V and Q_C are the premium related expense ratio and P&C load respectively, as given in the problem.

Thus, $\overline{P_I} = \dfrac{\$30.0 + \$2.10}{1.0 - 0.23 - 0.05} = \$44.60$.

The current rate = $\dfrac{Experience\ Period\ On\text{-}level\ Earned\ premiums}{Experience\ Period\ Exposures} = \dfrac{\$500{,}000}{10{,}000} = \$50.0$

Thus, the indicated rate change using the pure premium method is

$$IRC = \frac{Indicated\ Rate - Current\ Rate}{Current\ Rate} = \frac{\$44.60 - \$50}{\$50} = -0.108 = -10.8\%$$

c. (1.0 point) Describe one situation in which it is preferable to use the loss ratio method, and one situation in which it is preferable to use the pure premium method.

- The loss ratio method is preferable when the exposure unit is not available.
- The loss ratio method is preferable when the exposure unit is not reasonably consistent between risks.
- The pure premium method is preferable for a new line of business.
- The pure premium method is preferable where on-level premium is difficult to calculate.

Solutions to questions from the 2007 exam:

7. What would the revised base rate be if the company changes the profit and contingencies provision to -6%?

Step 1: Write an equation to determine the pure premium and fixed expenses associated with the current rate, based on the given data. This will help determine what this provision is when computing the revised based rate. The given data lends itself to computing pure premium and fixed expenses using the pure premium method. Under the pure premium method, the base rate is computed as follows:

$$\overline{P_I} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}.$$

Step 2: Using the equation from Step 1, and the data given in the problem, solve for the pure premium and fixed expenses $300 = \dfrac{\overline{L+E_L} + \overline{E_F}}{1 - .15 - .03}$; $\overline{L+E_L} + \overline{E_F} = 246$

Step 3: Using the results from Step 2, and the equation in Step 1, solve for the revised base rate.

$$\overline{P_I} = \frac{246}{1 - .15 - (-.06)} = 270.32$$

Answer: A

Solutions to questions from the 2007 exam (continued):

8. What is the indicated rate level change?

Step 1: Write an equation to determine the indicated rate change (IRC).

$$Indicated\ Change = \frac{\left[{(L+E_L)}/{P_C} + F \right]}{[1.0 - V - Q_T]} - 1.0\ ,$$

$L;\bar{L}$ = Losses; Pure Premium (L divided by X)

$E_L;\bar{E}_L$ = Loss Adjustment Expense (LAE); Average LAE per exposure (E_L divided by X)

$E_F;F$ = Fixed underwriting expenses; Proj Fixed Exp Ratio = (E_F divided by P)

E_V = Variable underwriting expenses;

X = Exposures

P_c = Premium at current rates

V = Variable expense provision (E_V divided by P)

Q_T = Target profit percentage

Step 2: Using the equation from Step 1, the results from Step 2, and the data given in the problem, solve for the indicated rate change. $Indicated\ Change = \frac{[75{,}000/100{,}000 + 10.0\%]}{[1.00 - 0.25 - 0.0]} - 1.0 = 1.133\%$

Answer: E

Solutions to questions from the 2007 exam (continued):

42. Calculate the indicated rate change for rates to be effective from July 1, 2007 through June 30, 2008.

Step 1: Write an equation to determine the indicated rate change.

$$Indicated\ Change = \frac{\left[(L+E_L) / P_C + F \right]}{[1.0 - V - Q_T]} - 1.0$$

Note that losses will need to be adjusted by the selected annual frequency and severity trend rates, and developed to ultimate. Premiums need to be adjusted by rate level changes only, since there is no premium or exposure trend. Since we are given two years of premiums and losses, a weighted loss ratio will need to be calculated. And after computing the indicated rate change, a credibility weighted indicated rate change must be determined since the indication is considered to be 60% credible.

Step 2: Determine on-level earned premium. To do so, compute on-level factors for CYs 2004 and 2005. This is the current rate level divided by the weighted average of the rate level factors in the experience period. The weights will be relative proportions of each square or triangle. First calculate the area of all triangles (area = .5 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

Rate Level Factors:

Date	Rate Change	Rate Level Factor
7/1/03	5%	1.05000 = 1.05 * 1.000
7/1/04	-1%	1.03950 = 1.05 * (1-.01)
7/1/05	10%	1.14345 = 1.0395 * 1.10
7/1/06	0%	1.14345 = 1.14345 * 1.00

Current Rate Level = 1.05 * (1.0 -0.01) * 1.1 * 1.0 = 1.14345

On level Earned Premium:

2004 on level EP: 1.14345/(0.125*1.00+0.75*1.05+0.125*1.0395) * 10M = 1.097 * 10M = 10,970,000

2005 on level EP: 1.14345/(0.125*1.05+1.0395*0.75+1.14345*0.125) * 11M = 1.085 * 11M = 11,935,000

Step 3: Determine ultimate losses. As of 6/30/2006, AY 2004 losses are 30 months old while AY 2005 losses are 18 months old.

2004 ultimate losses: 5,000,000 * (30-Ult Factor) = 5,000,000 * 1.5 = 7,500,000

2005 ultimate losses: 3,750,000 * (18-Ult Factor) = 3,750,000 * 2.0 = 7,500,000

Note: Losses also need to be trended to one year beyond the effective date of the rates (i.e. 7/1/2008). For AY 2004, the average accident date is 7/1/2004. Thus, four years of frequency/severity trend is applied.

Step 4: Determine the projected weighted loss ratio.

	Ultimate Loss	CL Earned Premium	Loss Trend	Trended Loss	Loss Ratio
2004	7,500,000	10,970,000	$[(1.04)(1\ .01)]^4$	9,130,196	0.8323
2005	7,500,000	11,935,000	$[(1.04)(1\ .01)]^3$	8,692,114	0.7283

Thus, the project weighted loss ratio = 0.35(0.8323) + 0.65(0.7283) = 0.7647

Indicated change = $[(L+E_L)/P_c + F]/[1.0 – V – Q_T]$ – 1.0 =(0.7647+0.07)/(1 - 0.2 - 0.05) – 1.0 = .1129

Credibility weighted indicated rate change: [0.60* 1.1129 +0.4 (1.00)] - 1.0 = .0677 = +6.77%

Solutions to questions from the 2007 exam (continued):

Question 43

a. (2.0 points). Demonstrate the equivalence of the pure premium and loss ratio approaches, assuming identical data and consistent assumptions.
b. (0.5 point) Which approach is more appropriate when pricing a new line of business? Explain.
c. (0.5 point) Which approach is more appropriate when pricing a line of business for which the historical rate change history is not available? Explain.

Model Solution

1. Start with the loss ratio indication formula: $\text{Indicated Change Factor} = \dfrac{\left[(L+E_L)/P_C + F \right]}{[1.0 - V - Q_T]}$

   Restate the formula as: $\text{Indicated Change Factor} = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

2. The indicated adjustment factor, the ratio of the indicated premium (P_I) to the projected premium at current rates (P_C), yields the following: $P_I/P_C = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

3. Multiplying both sides by the projected average premium at current rates (P_C / X) results in the pure premium indication formula (proving the two methods are equivalent):

$$P_I/X = \frac{\left[(L+E_L)/X + E_F/X \right]}{[1.0 - V - Q_T]} = \frac{[\,\overline{L+E_L} + \overline{E_F}\,]}{[1.0 - V - Q_T]}$$

b. The pure premium method produces an indicated rate, so no existing rate is required. The loss ratio method produces an indicated rate change, so an existing rate is required. The pure premium method is more appropriate for new line of business.

c. The pure premium method does not require premium at current level. The loss ratio method requires premium at current level to calculate the indicated change. The pure premium method is more appropriate when no historical rate changes are available.

Solutions to questions from the 2008 exam:

Model Solution - Question 24

24. (1.0 point) The indicated average rate was determined to be $300 based on the following information:

- Average fixed expense per exposure = $16
- Variable expense provision = 15%
- Profit and contingencies provision = 3%

Calculate the revised indicated average rate assuming the expected loss costs will be 10% higher than those assumed in the original analysis.

Step 1: Write an equation to determine the revised indicated average rate.

$$Indicated\ Average\ Rate\ =\ \overline{P_I} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}$$ and thus the revised indicated average rate equals

$$\frac{\left[1.10 * \overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]}$$

Step 2: Using the equations in Step 1, solve for the revised indicated average rate.

W are given that $\overline{P_I}$ = $300, $\overline{E_F}$ = $16, V = .15 and Q_T = .03, Thus, $\overline{L+E_L}$ = $300(1.0-0.18)-16 = $230

Thus, revised $\overline{P_I} = \frac{230(1.1)+16}{1-.15-.03} = 328.05$

Solutions to questions from the 2008 exam:

Model Solution - Question 26

a. (1.25 points) Calculate calendar/accident year 2006 and calendar/accident year 2007 projected premium at present rates.

Step 1: Write an equation to determine CAY 2006 and CAY 2007 projected premium at present rates (PPPR).

PPPR = Earned Exposures * Current Base Rate * $(1.0 + \text{Premium Trend})^{(\text{midpt exper period to 1 yr after proj eff date})}$

Step 2: Determine Earned Exposures * Current Base Rate for CAY 2006 and CAY 2007

CAY 2006 Earned Exposures * Current Base Rate = $345,704/100 * $110 = $380,274.4

CAY 2007 Earned Exposures * Current Base Rate = $396,714/100 * $110 = $436,385.4

Step 3: Compute the trend period for CAY 2006 and CAY 2007

The Trend period should extend from the midpoint of the experience period to 1 year after the projected effective date of the rates.

For CAY 2006, the trend period is from 7/1/06 to 1/1/2010 = 3.5 years

For CAY 2007, the trend period is from 7/1/07 to 1/1/2010 = 2.5 years

Step 4: Using the equation in Step 1, and the results from Steps 2 and 3, compute PPPR

CAY 2006 PPPR = $380,274.4 * $(1.03)^{3.5}$ = $421,723

CAY 2007 PPPR = $436,385.4 * $(1.03)^{2.5}$ = $469,854

b. (3.0 points) Calculate accident year 2006 and accident year 2007 ultimate incurred losses and loss adjustment expenses, projected to future loss cost levels.

Step 1: Write an equation to determine AY 2006 and AY 2007 Trended and Ultimate Incurred L+ALAE

Projected Ultimate Incurred L+ALAE+ULAE

= Case Incurred Losses * LDF_{ULT} * $(1+ \text{loss Trend})^{(\text{midpt exper period to 1 yr after proj eff date})}$ * (1+ULAE factor)

Step 2: Using the case incurred loss triangle, compute age to age factors, select age to ultimate factors, and compute AY 2006 and AY 2007 ultimate losses.

Case Incurred Link Ratios

AY	15-27	27-39	39-51	51-63
2002	1.30	1.15	1.07	1.00
2003	1.30	1.15	1.05	1.00
2004	1.30	1.10	1.05	
2005	1.20	1.10		
2006	1.20			

We can see the change in case reserving practices from the link ratios. We will use the link ratios below the solid line.

Sel A-t-A	1.200	1.100	1.050	1.000
Age to Ult	1.386	1.155	1.050	1.000

AY 2006 ultimate losses = $240,000 * 1.155 = 277,200

AY 2007 ultimate losses = $210,000 * 1.386 = 291,060

Solutions to questions from the 2008 exam continued:

Model Solution - Question 26

Part b.

Step 3: Using the given frequency and severity trends, compute the loss trend and using the previously determined trend periods, compute the loss trend factors for AY 2006 and AY 2007. Apply this facto to compute trended and ultimate incurred losses.

Loss trend = Frequency trend * Severity trend = (1.0 - .01)*(1+.02) = 1.0098

The Trend period should extend from the midpoint of the experience period to 1 year after the projected effective date of the rates.

- For CAY 2006, the trend period is from 7/1/06 to 1/1/2010 = 3.5 years
- For CAY 2007, the trend period is from 7/1/07 to 1/1/2010 = 2.5 years

Thus, AY 2006 trended and ultimate incurred L+ALAE = 277,200 * $(1.0098)^{3.5}$ = 286,825

Thus, AY 2007 trended and ultimate incurred L+ALAE = 291,060 * $(1.0098)^{2.5}$ = 298,243

Step 4: Multiply trended and ultimate incurred L+ALAE by the ULAE factor.

AY 2006 Projected Ultimate Incurred L+ALAE+ULAE = 286,825 (1.10) = 315,508

AY 2007 Projected Ultimate Incurred L+ALAE+ULAE = 298,243 (1.10) = 328,067

c. (1.5 points) Calculate the indicated rate change.

Step 1: Write an equation to determine the credibility weighted Indicated Rate change:

Credibility Weighted Indicated Rate change factor = Indicated Rate change factor * Z + (1.0 – Z)*1.0 (note that the problem states that the complement of credibility should be assigned to no change).

Step 2: Write an equation to determine the Indicated Rate change factor and solve for it:

Indicated Rate change factor = $\dfrac{Weighted\ Loss\ Ratio+F}{1-V-Q_T}=\dfrac{[.40*AY\ 06\ Loss\ Ratio+.60*AY\ 07\ Loss\ Ratio]+F}{1-V-Q_T}$,

since AY projections should be weighted 60% to AY 2007 and 40% to AY 2006.

AY 2006 loss ratio = 315,508/421,723 = .748. AY 2007 loss ratio = 328,067/469,854 = .698.

Thus, $=\dfrac{[.40*.748+.60*.698]+.08}{1-.20-.05}=1.064$

Step 3: Using the equation in Step 1, the results from Step 2, and the credibility factor to be applied to the overall indication, compute the credibility weighted Indicated Rate change.

Credibility Weighted Indicated Rate change factor = 1.064 * Z + (1.0 – Z)*1.0 = (1.064*0.75+.25)-1=.048

Model Solution - Question 27

27. (1.0 point)

a. (0.5 point) Provide an example of where a pure premium method is more appropriate than a loss ratio method.

b. (0.5 point) Provide an example of where a loss ratio method is more appropriate than a pure premium method.

a. Pure premium method is more appropriate than loss ratio method when current rate level premiums are difficult to calculate.

b. Loss ratio method is more appropriate than pure premium method when a well defined and responsive exposure base is not present.

Solutions to questions from the 2009 exam:

31. (1.5 points) For each of the following identify whether the loss ratio or pure premium ratemaking method is preferable. Briefly explain your answer.
    a. (0.5 point) Setting prices for a new line of business.
    b. (0.5 point Setting prices for a product that is not written uniformly throughout the year; current systems do not support re-rating policies.
    c. (0.5 point) Setting prices for a commercial lines product that has multiple complex exposures underlying each risk.

a. Pure premium - because it produces an indicated rate, which does not require historical rates

b. Pure premium - loss ratio method requires on-level premiums which would be challenging/ not possible here

c. Loss ratio - in this situation it would be easier to use premiums and not have to deal with difficult exposures in the pure premium method.

Solutions to questions from the 2010 exam:

Question 26

a. (1.5 points) Derive the indicated pure premium rate formula starting from the fundamental insurance equation.

b. (0.5 point) Briefly describe two instances where it is more appropriate to use the pure premium method than the loss ratio method.

a. Begin with the fundamental insurance equation:

Premium = Losses + LAE + UW Expenses + UW Profit.

$$P_I = L + E_L + (E_F + V * P_I) + (Q_T * P_I).$$

$$P_I - V * P_I - Q_T * P_I = (L + E_L) + E_F.$$

$$P_I \times [1.0 - V - Q_T] = (L + E_L) + E_F\,; \quad P_I = \frac{(L + E_L + E_F)}{[1.0 - V - Q_T]}$$

Dividing by the number of exposures converts each of the component terms into averages per exposure, and the formula becomes the pure premium indication formula:

$$P_I/X = \frac{\left[(L+E_L)/X + E_F/X\right]}{\left[1.0 - V - Q_T\right]} = \frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]} = \overline{P_I}$$

b1. Use it for anew line of business for which you do not have a current premium level.

b2. If you are unable to get a rate change history to put historical premium on-level (which the LR method requires).

Solutions to questions from the 2011 exam:

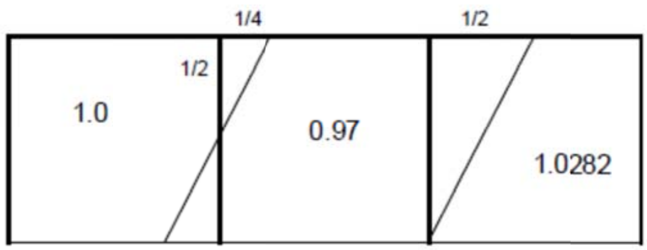
9a. (2 points) Calculate the projected CY EP current rate level for calendar years 2009 and 2010.

9b. (4.25 points) Calculate the indicated rate change.

9c. (0.5 point) Assume the 2009 incurred loss and ALAE amount includes an additional $25M in losses attributable to a single weather event. Discuss an appropriate strategy for including this information in the IRC calculation.

Question 9 – Model Solution 1

a. Projected calendar year earned premium at current rate level = EP * OLF * Premium trend factor
Current rate level is 1.0 * (1.0 - 0.03) * (1.0 + .06) = 1.0282



CY 09 at 1.0 level: Area = 1/2 *b*h. b = 3mos/12mos. h is a function of when a rate change occurs and the length of the policies being written. h = 1/2 as it intersects CY 09 three months after the 10/1/08 rate change impacting the six month policies being written.

2009 on level factor = 1.0282 / [1/16*(1) + (15/16)*.97] = 1.058; 1/16 = 1/2*(1/4)*(1/2)

2010 on level factor = 1.0282 / [1/4*(.97) + 3/4*(1.0282)] = 1.014; 1/4 = 1/2*(1/2)*(1)

2009 premium = 110865 * 1.058 * 1.015^3 = 122,653 = EP * OLF * Premium trend factor

2010 premium = 128973 * 1.014 * 1.015^2 = 134,731

2009 premium trend period from avg written date of 4/1/09 to average written date 4/1/12 or 3 years

2010 premium trend period from avg written date of 4/1/10 to average written date 4/1/12 or 2 years

b. $$Indicated\ Change\ Factor = \frac{[Loss\ \&\ LAE\ Ratio + Fixed\ Expense\ Ratio]}{[1.0 - Variable\ Expense\ Ratio - Target\ UW\ Profit\%]}$$

	12-24	24-36	36-48	48-60
	1.15	1.1	1.01	1
	1.14	1.1	1.01	
	1.16	1.09		
	1.15			
Selected	1.15	1.1	1.01	1
ATU	1.278	1.111	1.01	1

2009 losses: 69845 x 1.111 x 1.022^3 (1.032) = 85483 = Latest Losses * LDF to Ult * Loss trend factor * ULAE

2009 losses: 69845 x 1.111 x 1.022^3 (1.032) = 85483 Loss ratio = 85,483/122,653 = .697

2010 losses: 76094 x 1.278 x 1.022^2 (1.032) = 104824.5 Loss ratio = 104,824.5/134,731 = .778

2010 Trend: from 7/1/2010 to 7/1/2010 or 2 years; ULAE factor = 1.032

Overall Trended and Ultimate Loss and LAE Ratio = 190,279/257,426 = .739

Indicate rate change = [LR + F / (1 - V - Q)] - 1.0 = [.739 + .056] / (1 - .24 - .035) = 1.09655 - 1 = 9.66%

c. Given that 25m is a large proportion of the incurred to date losses of $69,845,000, I would exclude this loss and include a CAT load based on a cat model or longer term historical average of cat losses instead.

Solutions to questions from the 2011 exam continued:

Question 9 – Model Solution 2

a.

OLF_{09} = 1.0282 / [1000 * (½ * ½ * ¼) + 0.97 * (1 - 0.0625)] = 1.05795; 1/2*1/2*1/4 = 0.0625

OLF_{10} = 1.0282 / [0.97 * (½ * 1 * ½) + 1.0282 * (1 - .25)] = 1.01435

	(1)	(2)	(3)	(4)	(5)	(6) = (1)*(2)*(5)
CY	EP	OLF	Trend From	Trend To	Trend Factor	Trended on-level EP
2009	110,865	1.05795	4/1/09	4/1/12	1.015^3	122,648
2010	128,973	1.01435	4/1/10	4/1/12	1.015^2	134,778
						257,426

(3) = avg. written date of policies earned in calendar year

(4) = avg. written date of projection period

b.

Weighted avg	**12-24**	**24-36**	**36-48**	**48-60**
LDF	1.150	1.100	1.010	1.000
To Ultimate	1.27765	1.111	1.010	1.000

	(1)	(2)	(3)	(4)	(5)	(6)	(7) = (1)*(2)*(3)*(6)	
CY	Loss & ALAE	LDF	ULAE Load	Trend From	Trend To	Trend Factor	Trended Ultimate Loss & LAE	LR
2009	69,845	1.111	1.032	7/1/09	7/1/12	1.0223	85,483	0.69699
2010	76,094	1.27765	1.032	7/1/10	7/1/12	1.0222	104,796	0.7775
							18,279	0.7392

Indicated change = [LR + F / (1 - V - Q)] - 1 = [0.7352 + 0.056 / (1 - 0.24 - 0.035)] - 1 = +9.677%

c. This amount is a catastrophic loss and will distort indications. It should be excluded from the analysis and an appropriate catastrophe load should be incorporated based on separate analysis.

Question 10

10. (1.5 points) Identify whether the loss ratio or pure premium ratemaking method is preferable in each of the following scenarios. Briefly explain each answer.
   a. (0.5 point) A company introduced two new rating variables within the past year.
   b. (0.5 point) A company is entering a new line of business.
   c. (0.5 point) A company writes a commercial product with multiple exposure bases.

Question 10 – Model Solution

a. Pure premium because bringing historical premium to CRL with the new variables may be difficult.

b. Pure premium because there is no existing rate to which an indicated change can be applied.

c. Loss ratio because an accurate and consistent exposure measure will be difficult to calculate.

Section 1 Background

A. Background regarding the Principles:

1. The principles are limited to the portion of the ratemaking process involving the estimation of costs associated with the transfer of risk.
2. Provides the foundation for the development of actuarial procedures and standards of practice.
3. Applies to other risk transfer mechanisms.

The ratemaking process considers marketing goals, competition, legal restrictions, etc., to the extent they affect the estimation of future costs associated with the transfer of risk

B. The costs associated with transfer of risk include:

1. Claims 2. Settlement expenses 3. Operational and administrative 4. Cost of Capital.

Section 2 Definitions

Select Definitions:

Other acquisition expense	All costs, *__except__* commission and brokerage, associated with the acquisition of business.
U/W P&C provision	Amounts that, when considered with net investment income and other income, provide an appropriate total after-tax return.
TL&F	Taxes, licenses and fees *__except__* federal income taxes.

Section 3 The Statement of Principles

Principle 1	A rate is an estimate of the expected value of future costs.
Principle 2	A rate provides for all costs associated with the transfer of risk.
Principle 3	A rate provides for the costs associated with an individual risk transfer. (When an individual risk's experience does not provide a credible basis for estimating costs, it is appropriate to consider the aggregate experience of similar risks).
Principle 4	A rate is reasonable and NOT excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

Notes:

- Ratemaking produces cost estimates that are actuarially sound if it is based on principles 1, 2 and 3.The actuary need not be completely bound by these precedents. Material assumptions should be documented and available for disclosure.

Section 4 Considerations

Data	Consider historical premium, exposure, and loss data (external and internal).
Exposure Unit	Should vary with the hazard, and be practical and verifiable.
Mix of Business	Changes in deductibles, coverage limits affecting frequency and severity.
Credibility	Homogeneity. A group should be large enough to be statistically reliable.
Actuarial Judgment	Can be used effectively. It should be documented and available.
Policy Provisions	Review subrogation and salvage, coinsurance, deductibles, 2nd injury fund recoveries.
Reinsurance	Examine the effects of various arrangements.
Individual Risk Rating	Examine the impact of individual risk rating plans on overall experience.
Trends	Consider past and prospective changes in frequency, severity, exposure, expenses.
Organization of Data	CY, AY, RY, PY. Availability, clarity, and simplicity dictate the choice.
Catastrophe	Consider including an allowance for the catastrophe exposure in the rate.
Operational changes	Review U/W, Claims, Reserving, Marketing.
Other Influences	Regulatory, Residual Markets, Economic Variables need to be considered.
Loss Development	Expected development is subject to CAS Statement of Reserving Principles.
Risk	*Risk of random variation from expected costs*; It should be consistent with the cost of capital, and therefore influences the U/W profit provision. *Risk of systematic variation of estimated costs from expected costs.* This charge should be reflected when determining the Contingency provision.
Investment and other income	
Class Plans	Properly defined, it enables the development of actuarially sound rates.
Homogeneity	Subdivide or combine to minimize effects of procedural changes.

Question from the 1989 exam

4. According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following are true?

    1. A rate is an estimate of the expected value of future costs.
    2. Informed actuarial judgment should not be used in ratemaking, unless there is a lack of credible data.
    3. Consideration should be given in ratemaking to the effects of subrogation and salvage.

    A. 1 B. 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question from the 1990 exam

1. (1 point) According to the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," which of the following are true?

    1. Marketing, underwriting, legal and other business considerations should NOT be a factor when applying the principles set forth in the above statement.
    2. Historical premium, exposure, loss and expense experience is usually the starting point of ratemaking.
    3. Accident year is the best acceptable method of organizing data to be used in ratemaking.

    A. 1 B. 2 C. 3 D. 1, 2 E. None of the above.

Question from the 1991 exam

18. (1 point) According to the CAS Committee on Ratemaking Principles, "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," which of the following are stated principles?

    1. A rate provides for all costs associated with the transfer of risk.
    2. A rate is an estimate of the expected value of future costs.
    3. A rate provides for the costs associated with an individual risk transfer.

    A. 1 B. 1, 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question from the 1992 exam

There were no questions from this article tested on the above referenced exam.

Question from the 1993 exam

23. According to *Statement of Principles Regarding Property and Casualty Insurance Ratemaking,* which of the following are true?

    1. The charge for any systematic variation of the estimated costs from the expected cost should be reflected in the determination of the contingency provision.
    2. Experience should be organized on an accident year basis whenever possible.
    3. A rate provides for the costs associated with an individual risk transfer.

    A. 2 only B. 3 only C. 1, 3 only D. 2, 3 only E. 1, 2, 3.

Question from the 1994 exam

39. (3 points) You are an actuary analyzing recommended rates for a line of business for which you only write two classes. The company has a monopoly, and all insureds must buy insurance. There are no legal restrictions on the rates charged. Below is a summary of the current rate situation.

Class	Current	Indicated	Recommended
A	\$100	\$ 75	\$100
B	\$200	\$225	\$200
Average	\$150	\$150	\$150

Are the recommended rates consistent with the Principles set forth in the "'Statement of Principles Regarding Property and Casualty Insurance Ratemaking"? Be specific and explain why or why not.

Questions from the 1995 exam

1. (1 point) According to the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking", which of the following are true?
   1. Affordability is specifically stated as an important factor that should be considered in the ratemaking process.
   2. The cost of reinsurance should be considered in the ratemaking process
   3. Changes in the underwriting process should be considered in the ratemaking process.

   A. 1 only B. 2 only C. 3 only D. 2, 3 only E. 1, 2, 3.

28. (2 points) Your company wants to start writing Automobile Insurance in State X. You have developed rates and have filed them with the insurance department. The insurance department accuses your company of filing excessive rates because they are significantly higher than your rates for identical insureds in neighboring State Y.

    Using the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," list and briefly describe four external influences that you could cite that justify higher rates in State X.

Question from the 1996 exam

1. According to the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," which of the following are true of ratemaking?
   1. Consideration should be given to the effect of reinsurance arrangements.
   2. Consideration should be given to the quality of company management.
   3. Consideration should be given to changes in claims handling practices.

   A. 1 only B. 2 only C. 3 only D. 1, 3 only E. 1, 2, 3

Question from the 1997 exam

25.
   A. (1 point) According to the "Statement of Principles Regarding Property and Casualty Ratemaking," what are three desirable features for exposure units to have?

Question from the 1998 exam

46. Assume that a state has a monopoly on a line of insurance, and it mandates that each insured pays the same fixed rate, based upon what it believes the average insured can afford. Any deficit is made up from the state's general revenues, and any surplus goes into other state funds.

Based on the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," answer the following questions.

a. (1.5 points) Identify principles 1, 2, and 3 and state whether the system described above satisfies each principle. Briefly explain why or why not.

b. (.50 point) If the state changes the system so that if there is a deficit, there is an equal surcharge on all policyholders, and if there is a surplus there is an equal rebate, how would your answer to part (a) change?

Question from the 1999 exam

Question 41. As the ratemaking actuary for your company, you have proposed to change the exposure base for automobile coverage to "actual miles the vehicle is driven."

Based on the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," state three criteria for a desirable exposure base and briefly discuss whether your proposal satisfies (or does not satisfy) each criteria.

Question from the 2000 exam

22. According to the <u>Statement of Principles Regarding Property and Casualty Insurance Ratemaking</u>, which of the following statements is true?

A. Subdividing the data to minimize the effects of operational or procedural changes may increase credibility.

B. Creating homogeneous groupings of data will tend to decrease the credibility of the data.

C. Data should not be organized by calendar year for purposes of producing rates.

D. When considering the trade-off between partitioning of data into homogeneous groups versus increasing the volume of ratemaking data in each grouping, preference should be given to creating the most homogeneous groupings.

E. None of A, B, C, or D is true.

Question from the 2000 exam

42. (2 points)

According to the <u>Statement of Principles Regarding Property and Casualty Insurance Ratemaking</u>, ratemaking produces actuarially sound cost estimates if rates are based on three principles.

a. (1 point) State these three principles.

b. (1 point) If a rate is actuarially sound, it complies with four criteria commonly used by actuaries. Name these four criteria.

Questions from the 2001 exam

Question 3. According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following statements is true?

A. Unallocated loss adjustment expenses are the claim settlement costs directly assignable to specific claims.

B. Taxes, licenses, and fees exclude federal income taxes.

C . Policyholder dividends are a return of premium not assigned as an expense.

D. Allocated loss adjustment expenses include all costs associated with the settlement of claims.

E. General administrative expenses are all costs, except commission and brokerage costs, associated with the acquisition of business.

Question 4. According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following statements is true?

A. Consideration should be given to changes in case reserving that affect the continuity of the experience.

B. Consideration should be given to the determination of an appropriate exposure unit or premium basis, although it is not essential.

C. Ratemaking is retrospective because the property and casualty insurance rate must be developed after the transfer of risk.

D. Credibility is generally increased by making groupings more heterogeneous due to the diversification benefit from combining uncorrelated items.

E. Changes in policy provisions, such as coordination of benefits and second injury fund recoveries, are outside the scope of ratemaking data and thus need not be considered in ratemaking methodologies.

Questions from the 2002 exam

1. Based on the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following statements is false?

   A. A rate is an estimate of the expected value of current costs.

   B. A rate provides for all costs associated with the transfer of risk.

   C. A rate provides for the costs associated with an individual risk transfer.

   D. Rates that are actuarially sound comply with the following criteria: reasonable, not excessive, not inadequate, and not unfairly discriminatory.

   E. Ratemaking is prospective because the property and casualty insurance rate must be developed prior to the transfer of risk.

Questions from the 2003 exam

30. (3 points) The Statement of Principles Regarding Property and Casualty Insurance Ratemaking lists numerous considerations involved in the ratemaking process. State and briefly discuss three of these considerations that have been impacted by the recent rise in worldwide terrorist activity.

Questions from the 2004 exam

9. Which of the following is true regarding ratemaking expense provisions?

   1. Taxes, licenses and fees do not include federal income tax.
   2. Other acquisition expenses include commission and brokerage expenses.
   3. General administrative expenses represent all costs associated with the claim settlement process not directly assignable to specific claims.

   A. 1 only B. 2 only C. 3 only D. 1 and 2 only E. 1 and 3 only

Questions from the 2004 exam (continued):

38. (1.5 points) Credibility is an important consideration in ratemaking methodology.
   a. (0.5 point) Define credibility.
   b. (0.5 point) One method of increasing credibility is by increasing the size of the groupings analyzed. Briefly describe another method to increase credibility.
   c. (0.5 point) Explain a potential weakness in increasing credibility by the method you provided in part b. above.

Questions from the 2005 exam

35. (2 points) State the four ratemaking principles of the Casualty Actuarial Society.

Questions from the 2006 exam

25. (1.5 points) The ratemaking actuary for ABC Insurance Company is proposing to change the exposure base for Homeowners Insurance from number of homes to amount of Coverage A.
   a. (0.5 point) According to the *Statement of Principles regarding P&C Insurance Ratemaking,* state two desirable characteristics of an exposure base.
   b. (1.0 point) Determine which exposure base better satisfies each of the characteristics stated in part a. above. Explain.

Questions from the 2007 exam

11. Which of the following is true based on the Statement of Principles Regarding Property and Casualty Insurance Ratemaking?
   A. Unallocated loss adjustment expenses are the claim settlement costs directly assignable to specific claims.
   B. Taxes, licenses, and fees exclude federal income taxes.
   C. Policyholder dividends are a return of premium not assigned as an expense.
   D. Allocated loss adjustment expenses include all costs associated with the settlement of claims.
   E. General administrative expenses are all costs, except commission and brokerage costs, associated with the acquisition of business.

Questions from the 2009 exam

39. (1.75 points)
   a. (1 point) Identify two considerations from the "Statement of Principles Regarding Property & Casualty Ratemaking" that could apply to the concept of insurance to value. Briefly explain the relevance of each to insurance to value.
   b. (0.75 point) An insurance company increases the insurance to value of its book of business. Briefly describe the impact on each of the following:
      - Premium
      - Losses
      - Expenses

Solution to the question from the 1989 exam

Question 4.

1. T.
2. F.
3. T. **Answer C.**

Solution to the question from the 1990 exam

Question 1.

1. F.
2. T.
3. F. **Answer B.**

Solution to the question from the 1991 exam

Question 18.

1. T.
2. T.
3. T. **Answer E.**

Solution to the question from the 1993 exam

Question 23.

1. T. Risk
2. F. Organization of Data.
3. T. **Answer C.**

Solution to the question from the 1994 exam

Question 39.

Principle 1: A rate is an estimate of the expected value of future costs. The recommended average rate of $150 is consistent with the indicated estimate of the expected value of future costs.

Principle 2: A rate provides for all costs associated with the transfer of risk. By recommending an average rate, which provides for the costs associated with the transfer of risk, equal to the indicated average rate, equity among insureds is maintained.

Principle 3: A rate provides for the costs associated with an individual risk transfer. The recommended rate of $200 for class B does not provide for the costs associated with an individual risk transfer, as it is $25 below that which is indicated.

Solutions to questions from the 1995 exam

Question 1.

1. F. Affordability is not one of the considerations.
2. T. Reinsurance.
3. T. Operation Changes **Answer D.**

Solutions to questions from the 1995 exam

Question 28.

1. Other Influences: The judicial environment, residual markets, guaranty fund assessment all vary by state.
2. Trends: Consideration of past and prospective changes in frequency, severity, exposure, expenses, which can vary by state.
3. Economic variables: Costs associated with repair and replacement all vary by state.
4. Catastrophe: The types of natural catastrophe's vary by state, and degree of frequency and severity.

Solution to the question from the 1996 exam

Question 1.
The "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," identifies 18 considerations.

1. Reinsurance is specifically listed.
2. Quality of company management is not listed.
3. Changes in claims handling practices is just one of the items mentioned under the category "Operational Changes". **Answer D.**

Solution to the question from the 1997 exam

Question 25.
A. Exposure units should **vary with the hazard**, and **be practical** and **be verifiable**.

Solution to the question from the 1998 exam

Question 46.
a.
Principle 1: A rate is an estimate of the expected value of future costs. The recommended rate, based on affordability, and not on expected future costs, is not consistent with this principle.

Principle 2: A rate provides for all costs associated with the transfer of risk. Since any deficit is made up by the state's general fund, this principle is not satisfied.

Principle 3: A rate provides for the costs associated with an individual risk transfer. Since the recommended rate is fixed, this principle is not satisfied, as the costs associated with individual risk transfer are not recognized.

b. Principle 2 is now satisfied since offering a rebate or imposing a surcharge provides a mechanism to target all costs associated with the transfer of risk.

Solutions to questions from the 1999 exam

Question 41.

The statement of principles state that "it is desirable that exposure unit:

1. be Practical
2. be Verifiable
3. vary with the level of risk

The proposed exposure base is "actual miles the vehicle is driven."

1. The proposed exposure base is <u>not</u> practical from a number of aspects, including:

   Accuracy - asking insureds to provide exposure base information makes the exposure base easy to manipulate, and thus, gives rise to a moral hazard.
   Expense - the expense of having the odometer read by company personnel may outweigh the benefits gained from using this exposure base.

2. The proposed exposure base is verifiable (odometers can be read), but is subject to the following types of manipulation:

   a. odometers can malfunction
   b. odometers can be adjusted by individuals and automobile shops.

3. For auto liability and collision, actual miles driven (as an exposure unit) clearly varies with the level of risk.

Solutions to questions from the 2000 exam

Question 22. Which of the following statements is true?

A. T. Subdividing the data to minimize the effects of operational or procedural changes may increase credibility. Credibility is <u>increased</u> by making groupings more homogeneous or by increasing the size of the group analyzed. Homogenous groups require refinement and portioning of the data. See page 3.

B. F. Creating homogeneous groupings of data will tend to decrease the credibility of the data. Credibility is <u>increased</u> by making groupings more homogeneous or by increasing the size of the group analyzed. See page 3.

C. F. Data should not be organized by calendar year for purposes of producing rates. Acceptable methods of organizing data include calendar year, accident year, report year and policy year. See page 3.

D. F. When considering the trade-off between partitioning of data into homogeneous groups versus increasing the volume of ratemaking data in each grouping, preference should be given to creating the most homogeneous groupings. Each situation requires balancing homogeneity and the volume of data. See page 3.

Answer A.

Solutions to questions from the 2000 exam

Question 42.
a. State the three principles in which ratemaking produces actuarially sound cost estimates

Principle 1	A rate is an estimate of the expected value of future costs.
Principle 2	A rate provides for all costs associated with the transfer of risk.
Principle 3	A rate provides for the costs associated with an individual risk transfer.
	(When an individual risk's experience does not provide a credible basis for estimating costs, it is appropriate to consider the aggregate experience of similar risks).

b. If a rate is actuarially sound, name the four criteria commonly used by actuaries.

Principle 4: A rate is actuarially sound if it is:

1. Reasonable
2. NOT excessive
3. NOT inadequate
4. NOT or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

Solutions to questions from the 2001 exam

Question 3. Which of the following statements is true?

A. Unallocated loss adjustment expenses are the claim settlement costs directly assignable to specific claims. False. Allocated loss adjustment expenses are claim settlement costs directly assignable to specific claims.

B. Taxes, licenses, and fees exclude federal income taxes. True. **Answer B.**

C . Policyholder dividends are a return of premium not assigned as an expense. False. Policyholder dividends are a non-guaranteed return of premium charged to operations as an expenses.

D. Allocated loss adjustment expenses include all costs associated with the settlement of claims. False. Allocated loss adjustment expenses are the claim settlement costs directly assignable to specific claims.

E. General administrative expenses are all costs, except commission and brokerage costs, associated with the acquisition of business. False. General administrative expenses are all other operational and administrative costs.

Solutions to questions from the 2001 exam

Question 4. According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following statements is true?

A. Consideration should be given to changes in case reserving that affect the continuity of the experience. True. **Answer A.**

B. Consideration should be given to the determination of an appropriate exposure unit or premium basis, although it is not essential. False. The determination of an appropriate exposure unit or premium basis it is essential.

C. Ratemaking is retrospective because the property and casualty insurance rate must be developed after the transfer of risk. False. Ratemaking is prospective because the property and casualty insurance rate must be developed prior to the transfer of risk.

D. Credibility is generally increased by making groupings more heterogeneous due to the diversification benefit from combining uncorrelated items. False. Credibility is generally increased by making groupings more homogeneous or by increasing the size of the group analyzed.

E. Changes in policy provisions, such as coordination of benefits and second injury fund recoveries, are outside the scope of ratemaking data and thus need not be considered in ratemaking methodology. False. Changes in policy provisions, such as coordination of benefits and second injury fund recoveries, need to be considered in ratemaking methodology

Solutions to questions from the 2002 exam

1. Based on the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following statements is false?

A. A rate is an estimate of the expected value of current costs.

False. A rate is an estimate of the expected value of **future** costs.

B. A rate provides for all costs associated with the transfer of risk. True.

C. A rate provides for the costs associated with an individual risk transfer. True.

D. Rates that are actuarially sound comply with the following criteria: reasonable, not excessive, not inadequate, and not unfairly discriminatory. True.

E. Ratemaking is prospective because the property and casualty insurance rate must be developed prior to the transfer of risk. True.

Solutions to questions from the 2003 exam

30. (3 points) The Statement of Principles Regarding Property and Casualty Insurance Ratemaking lists numerous considerations involved in the ratemaking process. State and briefly discuss three of these considerations that have been impacted by the recent rise in worldwide terrorist activity.

1. Reinsurance. Reinsurance has become more expensive because of the major losses on Sept 11. In addition, many reinsurers have become insolvent, making recoveries uncertain. Both the cost of reinsurance and the solvency of the reinsurer must be considered.

2. Catastrophe losses. Terrorist attacks were considered a catastrophe. The potential for future catastrophic losses from terrorist attacks needs to be considered in any allowance for the catastrophe exposure in the rates.

3. Legislation. There is a bill that has or is about to be passed about government involvement in losses sustained in terrorist attacks. When this bill is passed, the effect on net losses for insurers will need to be considered in ratemaking process.

Solutions to questions from the 2004 exam

9. Which of the following is true regarding ratemaking expense provisions?
   1. Taxes, licenses and fees do not include federal income tax. True. See Section 1: Definitions.
   2. Other acquisition expenses include commission and brokerage expenses. False. Other acquisition expenses are all costs, except commission and brokerage, associated with the acquisition of business.
   3. General administrative expenses represent all costs associated with the claim settlement process not directly assignable to specific claims. False. General administrative expenses are all other operational and administrative costs.

Answer A. 1 only

38. (1.5 points) Credibility is an important consideration in ratemaking methodology.
   a. (0.5 point) Define credibility.

   According to the CAS Statement of Principles regarding P&C ratemaking, "credibility is a measure of the predictive value that the actuary attaches to a particular body of data."

   Note: The CAS model solution from the 2004 exam reads as follows: "Credibility is determined by how much experience is expected to be a good predictor of future experience."

   b. (0.5 point) One method of increasing credibility is by increasing the size of the groupings analyzed. Briefly describe another method to increase credibility.

   Another method would be to increase the homogeneity of groupings analyzed. The more stable and homogeneous a group, the larger the credibility. Obtaining homogeneous groupings requires refinement and partitioning of the data. See the CAS Statement of Principles regarding P&C ratemaking.

   c. (0.5 point) Explain a potential weakness in increasing credibility by the method you provided in part b. above.

   There needs to be a balance between the size of the groupings and how homogeneous you make the groupings. If groups are segregated too much in an attempt to increase homogeneity, the groups will be too small to be credible. According to the CAS statement of principles, there is a point at which partitioning divides data into groups too small to provide credible patterns. Each situation requires balancing homogeneity and the volume of data."

Solutions to questions from the 2005 exam

35. (2 points) State the four ratemaking principles of the Casualty Actuarial Society.

   1. A rate is an estimate of the expected value of future costs.
   2. A rate provides for all costs associated with the transfer of risk.
   3. A rate provides for the cost associated with an individual risk transfer.
   4. A rate is reasonable, not inadequate, excessive, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of future costs associated with an individual transfer of risk.

Solutions to questions from the 2006 exam

25. (1.5 points) The ratemaking actuary for ABC Insurance Company is proposing to change the exposure base for Homeowners Insurance from number of homes to amount of Coverage A.

   a. (0.5 point) According to the Statement of Principles regarding P&C Insurance Ratemaking, state two desirable characteristics of an exposure base.

   b. (1.0 point) Determine which exposure base better satisfies each of the characteristics stated in part a. above. Explain.

Initial comments:

Exposure Unit—The determination of an appropriate exposure unit or premium basis is essential. It is desirable that the exposure unit vary with the hazard and be practical and verifiable.

CAS Model Solution:

Part a.

1 – Verifiable.

2 – Vary with hazard.

- OR -

3 – Be practical

Part b.

1 – It is easier to verify that there is a home (# homes) rather than the value of home. Thus number of homes is better for verifiability.

2 – Coverage A amount is a better exposure base for varying with hazard. The amount of damage and loss depends on the value of the home.

- OR -

3 – The number of homes is more practical since Coverage A amount is subject to some judgment.

Solutions to questions from the 2007 exam

11. Which of the following is true based on the Statement of Principles Regarding Property and Casualty Insurance Ratemaking?

A. Unallocated loss adjustment expenses are the claim settlement costs directly assignable to specific claims False. Unallocated loss adjustment expenses are all costs associated with the claim settlement function not directly assignable to specific claims. See Definitions.
B. Taxes, licenses, and fees exclude federal income taxes. **True**. See Definitions.
C. Policyholder dividends are a return of premium not assigned as an expense. False. Policyholder dividends are a non-guaranteed return of premium charged to operations as an expense. See Definitions.
D. Allocated loss adjustment expenses include all costs associated with the settlement of claims. False. Allocated loss adjustment expenses are claims settlement costs directly assignable to specific claims. See Definitions.
E. General administrative expenses are all costs, except commission and brokerage costs, associated with the acquisition of business. False. Statement E. is the definition of other acquisition expenses. General administrative expenses are all other operational and administrative costs. See Definitions.

Solutions to questions from the 2009 exam

Question 39 – Model Solution

a. Mix of business - changing mix of ITV in the book will influence premium and loss trends.

Economic/Social

Social trends = if there is a movement towards lower insurance to value because people are purchasing lower amounts of coverage to save money on premium due to hard economic times, the actuary may want to evaluate the insurance to value contemplated on the current rates.

b. Premium - could see higher prem. as a result of larger exposure amounts written
could see lower premium if there are higher cancel/non-renews

Losses – expect to see larger total and near total claim amts. from larger exposures

Losses may decrease from higher cancel/non-renew

Losses may decrease if reinspection also leads to loss control measures implemented by homeowners.

Expenses – increased inspection/reinspection may create additional expenses, however increase relative to premium change is unclear.

1 Purpose, Scope, Cross References, and Effective Date 1 - 1

1.1 Purpose—To provide guidance to actuaries when performing trending procedures to estimate future values.

1.2 Scope—This standard applies to actuaries when performing work for insurance or reinsurance companies, as well as self insurers.

A trending procedure does not encompass "development," which estimates changes over time in losses (or other items) within a given exposure period (e.g. accident year or underwriting year).

If the actuary departs from the guidance in this standard to comply with applicable law (statutes, regulations, and other legally binding authority) or for any other reason the actuary deems appropriate, refer to section 4.3.

1.3 Cross References—When referring to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called.

If any amended or restated document differs materially from the originally referenced document, consider the guidance in this standard to the extent it is applicable and appropriate.

2 Section 2. Definitions 1 - 2

2.1 Coverage—The terms and conditions of a plan or contract, or the requirements of applicable law, that create an obligation for claim payment associated with contingent events.

2.2 Experience Period—The period of time to which historical data used for actuarial analysis pertain.

2.3 Forecast Period—The future time period to which the historical data are projected.

2.4 Social Influences—The impact on insurance costs of societal changes (e.g. changes in claim consciousness, court practices, and legal precedents, as well as in other noneconomic factors).

2.5 Trending Period—The time over which trend is applied in projecting from the experience period to the forecast period.

2.6 Trending Procedure—A process by which the actuary evaluates how changes over time affect items such as claim costs, claim frequencies, expenses, exposures, premiums, retention rates, marketing/solicitation response rates, and economic indices. Trending procedures estimate future values by analyzing changes between exposure periods (e.g. accident years or underwriting years).

3 Section 3. Analysis of Issues and Recommended Practices 2 - 3

3.1 Purpose or Use of Trending Procedures—Trending is an important component in ratemaking, reserving, valuations, underwriting, and marketing.

Where multiple purposes or uses are intended, the actuary should consider the potential conflicts arising from those multiple purposes or uses and should consider adjustments to accommodate the multiple purposes or uses to the extent that, in the actuary's professional judgment, it is appropriate and practical to make such adjustments.

The actuary may present the trend estimate resulting from the trending procedure in a variety of ways (e.g. a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the trend estimate).

3.2 Historical Insurance and Non-Insurance Data

The actuary should select data (historical insurance or non-insurance information) appropriate for the trends being analyzed.

When selecting data, the actuary should consider the following:

1. the credibility assigned to the data by the actuary;
2. the time period for which the data is available;
3. the relationship to the items being trended; and
4. the effect of known biases or distortions on the data relied upon (e.g. the impact of catastrophic influences, seasonality, coverage changes, nonrecurring events, claim practices, and distributional changes in deductibles, types of risks, and policy limits).

3.3 Economic and Social Influences

Consider economic and social influences that can have a significant impact on trends in selecting the appropriate data to review, the trending calculation, and the trending procedure.

Consider the timing of the various influences.

3.4 Selection of Trending Procedures

In selecting trending procedures, the actuary may consider relevant information as follows:

a. procedures established by precedent or common usage in the actuarial profession;
b. procedures used in previous analyses;
c. procedures that predict insurance trends based on insurance, econometric, and other non-insurance data; and
d. the context in which the trend estimate is used in the overall analysis.

3.5 Criteria for Determining Trending Period

The actuary should consider the following when determining the trending period:

- the lengths of the experience and forecast periods
- changes in the mix of data between the experience and forecast periods when determining the trending period.

When incorporating non-insurance data in the trending procedure, the actuary should consider the timing relationships among the non-insurance data, historical insurance data, and the future values being estimated.

3.6 Evaluation of Trending Procedures—The actuary should evaluate the results produced by each selected trending procedure for reasonableness and revise the procedure where appropriate.

3.7 Reliance on Data or Other Information Supplied by Others—When relying on data or other information supplied by others, the actuary should refer to ASOP No. 23, Data Quality, for guidance.

3.8 Documentation —The actuary should prepare and retain appropriate documentation regarding the methods, assumptions, procedures, and the sources of the data used.

The documentation should be in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work, and should be sufficient to comply with the disclosure requirements in section 4.

4 Section 4. Communications and Disclosures 3 - 4

4.1 Actuarial Communication—When issuing an actuarial communication subject to this standard, the actuary should refer to ASOP Nos. 23 and 41, Actuarial Communications.

In addition, the actuary should disclose the following, as applicable, in an actuarial communication:

a. the intended purpose(s) or use(s) of the trending procedure, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses, if any, as described in section 3.1; and
b. significant adjustments to the data or assumptions in the trend procedure, that may have a material impact on the result or conclusions of the actuary's overall analysis.

4.2 Additional Disclosures—The actuary may need to make the following disclosures in addition to those in 4.1:

a. When the actuary specifies a range of trend estimates, disclose the basis of the range provided.
b. Disclose changes to assumptions, procedures, methods or models that the actuary believes might materially affect the actuary's results or conclusions *as compared to those used in a prior analysis, if any, performed for the same purpose.*

4.3 Deviation—If the actuary departs from the guidance set forth in this standard, the actuary should include the following where applicable:

4.3.1 the disclosure in ASOP No. 41, section 4.2, *if any material assumption or method was prescribed by applicable law* (statutes, regulations, and other legally binding authority)

4.3.2 the disclosure in ASOP No. 41, section 4.3.1, *if any material assumption or method was selected under applicable law by a party other than the actuary, and the actuary disclaims responsibility for the assumption or method;*

4.3.3 the disclosure in ASOP No. 41, section 4.3.2, *if the actuary disclaims responsibility for any material assumption or method in any situation not covered under section 4.3.1 or 4.3.2; and*

4.3.4 the disclosure in ASOP No. 41, section 4.4, *if the actuary deviated from the guidance of this ASOP*.

Question from the 1993 exam

21. Based on the "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following are examples of biases or distortions which should be considered when examining historical insurance data for trending purposes?

1. Hurricane Andrew which struck Florida in 1992.
2. The increase in the Massachusetts automobile Personal Injury Protection coverage from $2,000 to $8,000.
3. The impact of school vacations on automobile miles driven.

A. 1 only B. 2 only C. 1, 3 only D. 2, 3 only E. 1, 2, 3

Question from the 1994 exam

19. Based on "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following items should be considered in the trending procedure used in ratemaking for Workers Compensation insurance?

1. An enacted reform that restricts the use of lump sum settlements.
2. Annual revisions in the hourly rate of compensation for union employees.
3. A decrease in attorney representation as Workers Compensation returns to a true "first party" coverage.

A. 1 only B. 2 only C. 1, 2 only D. 2, 3 only E. 1, 2, 3

Question from the 1995 exam

There were no questions associated with this article appearing on the 1995 exam.

Question from the 1997 exam

2. Based on the "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following are biases or distortions that could affect the selection of trending procedures?

1. Revising Homeowners policy coverage from actual cash value to replacement cost value.
2. A new underwriting requirement for percentage hurricane deductibles.
3. An automatic insurance to value program at policy renewal.

A. 1 B. 2 C. 3 D. 1, 2 E. 1, 2, 3

Questions from the 2001 exam

Question 14**.** According to "Actuarial Standard of Practice No. 13: Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following items should be considered in the trending procedure used in ratemaking for private passenger automobile insurance?

A. A decrease in automobile usage due to rising gas prices

B. The introduction of higher policy limits

C. A recently enacted tort reform that strengthens the verbal threshold for lawsuits

D. Changes in price levels in the economy as measured by external indices such as the Consumer Price Index

E. All of the above should be considered.

Questions from the 2007 exam

6. According to ASOP No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking, which of the following should be considered when selecting trending procedures?

   1. Known biases (e.g., seasonality)
   2. The impact on the overall indication
   3. The credibility of the data

A. 1 only B. 1 and 2 only C. 1 and 3 only D. 2 and 3 only E. 1, 2, and 3

Solutions to questions from the 1993 exam
Question 21.
Analysis of Historical Insurance Data

Select trending procedures with considerations to: The effect of known biases or distortions (Cats, Seasonality, Deductible changes, Coverage changes , Type of Risks, and Policy Limits).

1. T. CATS
2. T. Coverage changes
3. T. Seasonality **Answer E.**

Solutions to questions from the 1994 exam
Question 19.

1. T. Non-recurring changes (tort reform
2. T. Economic Influences
3. T. Coverages changes **Answer E.**

Solutions to questions from the 1997 exam
Question 2.
Select trending procedures with considerations to:

a. Those established by precedent or common usage in the actuarial profession.
b. Those used in previous analyses.
c. The choice of the data base and methodology, with emphasis given to the credibility of the data.
d. The effect of known biases or distortions (e.g. Cats, Nonrecurring events, Seasonality, **Deductible changes**, **Coverage changes**, Type of Risks, and **Policy Limits**).

Thus, 1, 2, and 3 are true. **Answer E.**

Solutions to questions from the 2001 exam
Question 14. Which of the following items should be considered in the trending procedure used in ratemaking for private passenger automobile insurance?

A. A decrease in automobile usage due to rising gas prices. True. Economic influences (such as rising gas prices) impact trend.
B. The introduction of higher policy limits. True. Trending procedures should consider the effect of known biases or distortions when using historical data (Cats, Seasonality, Deductible changes, Coverage changes, Type of Risks, and <u>Policy Limits</u>).
C. A recently enacted tort reform that strengthens the verbal threshold for lawsuits. True. Social inflation (the impact on insurance costs from changes in claim consciousness, court practices, judicial attitudes) impacts trend.
D. Changes in price levels in the economy as measured by external indices such as the Consumer Price Index. True. Consideration should be given to non-insurance data that supplements insurance data.
E. All of the above should be considered. True. **Answer E.**

Solutions to questions from the 2007 exam

6. According to ASOP No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking, which of the following should be considered when selecting trending procedures?

   1. Known biases (e.g., seasonality). True.
   2. The impact on the overall indication. False.
   3. The credibility of the data. True **Answer: C. 1 and 3 only**

1 Summary

3 elements associated with the economic uncertainty of losses:

1. Occurrence.
2. Timing.
3. Financial impact.

Risk classification:

a. is necessary to maintain a financially sound and equitable system.
b. enables the development of equitable insurance prices, which in turn assures the availability of needed coverage to the public.
c. is achieved through the grouping of risks to determine averages and the application of these averages to individuals.

Risk classification is:	Risk classification is not:
the grouping of risks with similar risk characteristics for the purpose of setting prices.	a. the prediction of experience for individual risks (it is both impossible and unnecessary to do so). b. to identify good or bad risks OR to reward or penalize certain groups of risks at the expense of others.

3 primary purposes of risk classification:

1. Protect the insurance system's financial soundness.
2. Be fair.
3. Encourage availability of coverage through economic incentives.

Note: Achieving an appropriate balance among these purposes is not easy. However, they are in the public interest and are not incompatible.

5 basic principles to achieve the primary purposes:

A risk classification system should:

1. Reflect expected cost differences.
2. Distinguish among risks based on relevant cost-related factors.
3. Be applied objectively.
4. Be practical and cost-effective.
5 Be acceptable to the public.

Marketing, underwriting and administration combine with risk classification to provide an entire system of insurance.

2 Economic Security and Insurance

3 mechanisms for coping with the financial impact of chance occurrences (both natural and societal):

1. Hazard avoidance and reduction.
   a. Some hazards may be avoided or exposure to them reduced. Choose not to engage in a hazardous activity or implement safety precautions to reduce the incidence and severity of other hazards.
      However, the practical application of hazard avoidance and hazard reduction is limited.
   b. While some financially insignificant hazards may be retained and funded through savings or reserves, retention of major financial uncertainties may be undesirable and unwise.

2. Transfer of financial uncertainty (governmental assistance, self-insured group pension, private ins, etc).
   Programs for transferring financial uncertainty include charitable activities by individuals and organizations; governmental assistance and insurance programs; self-insured group pension and welfare plans; and private insurance programs.

3. Public vs. Private insurance programs:

Similarities	Differences
1. The transfer of financial uncertainty and the subsequent pooling of risks. 2. The exposure to loss is (should be) broad enough to assure reasonable predictability of total losses.	1. Gov't plans are usually **compulsory** while Private programs are usually *voluntary*. 2. Gov't plans are **provided by law** while Private plans are *subject to contractual agreement*. 3. *Competition plays an important role* in Private but not public plans. 4. Gov't plans often **provide coverage for risks which are "uninsurable" privately**. 5. In Gov't programs, the **benefits received** by, or **paid on behalf of a class**, are **not necessarily related to the amount paid into the plan by that class**. 6. Private insurance programs *are highly diverse*.

3 The Need for Risk Classification

Although the exchange of uncertainty for a fixed price does not alter the uncertainty, the firm should find a way of establishing a fair price for assuming the uncertainty.

3 Means of Establishing a Fair Price:

1. Reliance on wisdom, insight, and good judgment.
2. Observation of the risk's actual losses over an extended period of time.
   (Not appropriate for life insurance applications. Also, a gradual change in the hazard may render past information useless).
3. **Observation of losses from groups of individual risks with similar characteristics.**
   This is the most frequently used method.
   Its major problem: **identification of similar risk characteristics** (determined by fact and informed judgment) **and related classes <u>before</u> the observation period**.

3 The Need for Risk Classification

3 Primary Purposes of Risk Classification

1. *Protect the insurance program's financial soundness*.

   This is threatened by adverse selection (in markets where buyers are free to select, with a motivation to minimize the price for the coverage sought, adverse selection is possible).

   Risk classification minimizes the effects of adverse selection.

   Regulation can control adverse selection by restricting the buyer's freedom (e.g. participation can be made mandatory).

2. *Enhanced fairness*
   - Produce prices that are not unfairly discriminatory.
   - Price differentiation should reflect differences in expected costs with no redistribution or subsidy among classes.
   - Prices and expected costs should also match within each class.

3. *Economic incentive*
   - Risk classification will help ensure adequate prices for the assumed uncertainty.
   - Selling to higher cost risks will increase market penetration which provides economies of scale.
   - Competition will motivate an insurer **to refine its risk classification system** so that it can better serve both lower and higher cost risks.
   - A risk classification system should be efficient. It should not cost more to refine than the reduction in expected costs.

Finally, while there is a close, and reinforcing, relationship among the 3 distinct primary purposes of risk classifications, a system which serves any one tends to serve the other two as well.

4 Considerations in Designing a Risk Classification System

1. **Underwriting** is the process of determining the acceptability of a risk based on its own merits.
   - is in contrast to the assignment of a risk to a classed based on general criteria.
   - controls the practical impact of the classification system.
2. **Marketing** influences the insurer's mix of business and restrictions on / adjustments to a risk classification system may produce unintended changes in the mix of business.
3. **Program Design** elements related directly to risk classification include:
   - *degree of choice available to the buyer* (compulsory programs use broad classes while voluntary programs are more refined).
   - *experience based pricing* (when purchased by or through an organization, the price adjustment is referred to as an experience rating adjustment; when purchased by an individual, it is recognized by a dividend or in the premium paid).
   - *classes used for experience rating* (may be different than those used for the original pricing). The *need for less refined classes* exists when experience rating is used.
   - *premium payer. Use a broad class system* to reduce the chance of adverse selection if the premium payer is not the individual insured (i.e. group insurance).

4 Considerations in Designing a Risk Classification System

4. **Statistical Considerations** may be conflicting. An increase in the number of classes may improve homogeneity at expense of credibility.
   - Homogeneity. The overlap phenomenon (actual claim experience of some risks in one class being the same as those in another class) is both anticipated and a statistically inevitable ramification.
   - Credibility. Each class in the risk classification should be large enough to permit credible predictions.
   - Predictive stability requires the risk classification system to be:

     (a) responsive to changes in the nature of insurance losses, yet

     (b) stable in avoiding unwarranted abrupt changes in prices.

5. **Operational Considerations**
   - *expense* - costs to obtain and maintain data, assigning risks to a class, and determining fair prices by class.
   - *constancy* - the lack of constancy in the characteristics used increases expense and reduces its utility.
   - *maximize coverage availability*. Properly matching expected costs and price will enhance availability.
   - *extreme discontinuity avoidance*. Attention is needed in defining classes at the extreme ends of a range. There should be enough classes to establish a reasonable continuum of expected losses but few enough to allow significant differences between classes
   - *absence of ambiguity* - classes should be collectively exhaustive and mutually exclusive.
   - *minimize abilities to manipulate the system*.
   - *measurability* - class variables (age, sex, occupation, location) should be reliably measurable.

6. **Hazard Reduction Incentives** (e.g. recognizing sprinklers for risk classification) are desirable but not necessary features of a risk classification system.

7. **Public Acceptability Considerations:**

   Are difficult to apply in practice because social values:
   - are difficult to ascertain.
   - vary among segments of society.
   - change over time.

   Public acceptability considerations should:
   - not differentiate unfairly among risks.
   - be based on clearly relevant data.
   - respect personal privacy.
   - be structured so that risks tend to identify naturally with their classification.

   Regulatory and legislative restrictions on the risk classification system must balance the desire of public acceptability with the potential economic side effects of adverse selection or market dislocation.

4 Considerations in Designing a Risk Classification System

8. Causality:

- Class characteristics may be more publicly acceptable if there is a demonstrable cause and effect relationship between the risk characteristic and expected costs, since such relationships tend to boost confidence that such information is useful in predicting the future.
- It is often impossible to prove statistically any postulated cause and effect relationship.

Thus, causality cannot be made a requirement of a risk classification system.

Causality may be used in a general sense, implying the existence of plausible relationships between characteristics of a class and the insured hazard.

9. Controllability:

Refers to the ability of an insured to control its own characteristics as used in the classification system.

Controllability as a	
Desirable risk characteristic:	Undesirable risk characteristic:
1. Its close association with an effort to reduce hazards.	1. Susceptibility to manipulation.
2. Its general acceptability by the public.	2. Its irrelevance to predictability of future costs.

5 Conclusion

- Classification of risks is fundamental to any true insurance system.
- Risk classification is done to determine average claim costs and to apply those averages to individual risks.
- Any risk classification is only part of an entire insurance structure and does not operate in a vacuum.

Questions from the 1991 Exam:

2. According to the ”Risk Classification Statement of Principles," by the American Academy of Actuaries, which of the following statistical considerations are involved in designing a sound risk classification system?
   1. Creation of classes large enough to allow credible statistical predictions regarding the class.
   2. Creation of classes small enough to be homogenous.
   3. Creation of classes that are publicly acceptable.

   A. 1 only B. 3 only C. 1 and 2 D. 2 and 3 E. 1, 2 and 3.

3. According to the ”Risk Classification Statement of Principles, " by the American Academy of Actuaries, which of the following statements is true?
   A) In insurance programs that are largely or entirely compulsory, with broad classifications and no voluntary choice among competing institutions, adverse selection will likely occur.
   B) Risk classification reduces adverse selection by balancing the economic forces governing buyers and sellers.
   C) Causality is a necessary requirement for risk classification systems.
   D) Controllability is always a desired characteristic in a risk classification system.
   E) None of the above statements is true.

20. (2 points) According to the "Risk Classification Statement of Principles" by the American Academy of Actuaries, briefly discuss how and why individual risk rating affects the needed level of refinement in a classification system.

Questions from the 1992 Exam:

1. Based on the American Academy of Actuaries' paper Risk Classification Statement of Principles, which of the following are true:
   1. The application of experience based pricing, based on the risk's actual losses, increases the need for a refined classification system.
   2. The presence of strong competition decreases the need for an insurer to have a refined classification system.
   3. Homogeneity and credibility are somewhat conflicting considerations for a risk classification system.

   A. 1 only B. 3 only C. 1 and 3 D. 2 and 3 E. All of the Above

Questions from the 1994 Exam:

5. According to the American Academy of Actuaries' "Risk Classification Statement of Principles", which of the following are considered primary purposes of risk classification?
   1. To protect the insurance program's financial soundness.
   2. To enhance fairness.
   3. To permit economic incentives to operate.

   A. 2 only B. 1 and 2 C. 1 and 3 D. 2 and 3 E. 1, 2 and 3

Questions from the 1994 Exam (continued):

26. (2 points) In the American Academy of Actuaries' monograph "Risk Classification Statement of Principles", several operational considerations in designing a successful classification system are cited. List four of these considerations, and briefly explain how each contributes to the success of a classification system. (Only the first four considerations listed will be graded.)

Questions from the 1995 Exam:

4. According to the American Academy of Actuaries' "Risk Classification Statement of Principles," which of the following are true?
   1. In contrast to the assignment of a risk to a class based on individual and possibly unique characteristics of each risk, the underwriting process involves the evaluation of the risk based on general criteria.
   2. To the extent that prices are adjusted based on a risk's emerging actual experience after the insurance and its initial price have been established, less refined initial risk classification systems are needed.
   3. As the proportion of the total premium paid by the insured increases, the use of a broader classification system becomes more appropriate.

   A. 1 only B. 2 only C. 3 only D. 2 and 3 E. 1, 2 and 3

5. According to the American Academy of Actuaries' "Risk Classification Statement of Principles," which of the following are true?
   1. Operational expenses for a risk classification system include those expenses associated with determining a price for each class.
   2. Particular attention often is required in defining classes at the extreme ends of the expected claim cost range, in order to reduce large differences in anticipated average claim costs between the extreme class and the adjacent class.
   3. Hazard reduction incentives are desirable and necessary features of a risk classification system.

   A. 1 only B. 3 only C. 1 and 2 D. 2 and 3 E. 1, 2, and 3

Questions from the 1996 Exam:

17. According to "Risk Classification Statement of Principles" by the American Academy of Actuaries, which of the following are the primary purposes of risk classification?
    1. To protect the financial soundness of the insurance program.
    2. To permit economic incentives to operate and thus encourage widespread coverage availability.
    3. To identify unusually high and low quality risks.

    A. 2 B. 3 C. 1, 2 D. 1, 3 E. 1,2,3

47. a. (1.25 points) According to the American Academy of Actuaries' "Risk Classification Statement of Principles" promulgated in 1980, what are the five basic principles that should be present in any sound risk classification system?
    b. (0.5 point) The Actuarial Standards Board's "Actuarial Standard of Practice No. 12 Concerning Risk Classification" was promulgated in 1989. Which of the five principles from part (a) did this Standard explicitly omit?
    c. (0.75 point) List three reasons given by the American Academy of Actuaries in "Risk Classification Statement of Principles" on why the principle identified in part (b) is difficult to apply in practice.

Questions from the 1996 Exam (continued):

48. A property insurance company is considering adding a new classification rating variable to its homeowners insurance program based on individual risk's actual loss experience over the past five year period as follows:

    Class A - No claims

    Class B - One or two claims

    Class C - Three or more claims

    a. (1.5 points) Evaluate this new classification rating variable based on the following considerations as described in the American Academy of Actuaries' "Risk Classification Statement of Principles":
        1. Controllability
        2. Operational Expense
        3. Hazard Reduction Incentives

    b. (1.5 points) Considering the basic principles that should be present in any sound risk classification system, would you recommend the addition of this new classification? Why or why not?

Questions from the 1997 Exam:

48. (3 points) As the personal lines actuary for the department of insurance in the state of Crazyfornia, you have been asked by the state's insurance commissioner to comment on Proposition 99.

    Proposition 99- The ratemaking for personal automobile insurance should be based on a new classification system using the following 6 criteria:
    1. Insureds are to be classified based on nationality.
    2. Insureds are to be classified based on the ability to pass an annual random drug test
    3. Insureds are to be classified based on whether they can pass a comprehensive, individually administered 8 hour driving test every year.
    4. Insureds are to be classified based on their weights.
    5. Insureds are to be classified as either 'good eyesight' or 'bad eyesight'. Each eye doctor can have his/her own definition of good/bad eyesight.
    6. Insureds are to be classified as 'right handed' or 'left handed'.

    For each criterion, identify which one of the five basic principles of a sound risk classification system (as mentioned in "Risk Classification Statement of Principles" by the American Academy of Actuaries Committee on Risk Classification) is violated. You may not use the same principle for more than 2 criteria.

Questions from the 1999 Exam:

43. You are the actuary for Aggressive Mutual Insurance Company. The marketing department has approached you with a plan to increase business by liberalizing protection class definitions. The new definition would allow you to classify any risk within eight miles of the nearest fire department using the protection class of that town, without any verification of its ability to respond to the location of that risk.

    a. (0.75 point) According to the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles," what are the three primary purposes of risk classification?

    b. (1.5 points) Based on these principles, what would you tell the marketing director about the appropriateness of the proposed class definitions? Include a discussion of all three principles from part a.

Questions from the 1999 Exam (continued):

46. Based upon the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles," answer the following questions.

    In an insurance program, an individual buying insurance exchanges the uncertainty of occurrence, timing, and magnitude of a particular event for the certainty of a fixed price.

    a. (1 point) List three methods for determining this price.

    b. (1 point) List one deficiency for each method described in part a.

Questions from the 2000 Exam:

16. According to the American Academy of Actuaries Committee on Risk Classification's 'Risk Classification Statement of Principles," which of the following are not operational considerations relating to classification plans?

    A. Availability of Coverage

    B. Avoidance of Extreme Discontinuities

    C. Absence of Ambiguity

    D. Measurability

    E. All of the above are operational considerations.

35. Adverse selection is a financial threat to an insurance program's solvency. Based on the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles," answer the following.

    a. (0.5 point) Briefly describe adverse selection.

    b. (1.5 points) Briefly explain the two methods described for controlling adverse selection.

Questions from the 2001 Exam:

3. According to the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles," in which of the following situations would a refined risk classification program be most appropriate?

   A. Insurance premiums are determined prior to the policy period and are not adjusted on the basis of actual experience.

   B. Participation in the insurance program is entirely compulsory.

   C. Dividends are paid after the initial insurance premium has been established and are based on the risk's actual experience.

   D. The insurance premium is paid by someone other than the individual insured.

   E. None of A, B, C, or D are appropriate situations for a refined risk classification program.

23. (1.5 points) List and briefly describe the three primary purposes of risk classification according to the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles."

Questions from the 2002 Exam:

20. Which of the following best describes a basic principle of a sound risk classification system?

A. The system should be applied subjectively.
B. The system should produce prices based on the observed actual losses of each risk.
C. The system should reflect expected cost differences.
D. The system should be based solely on public acceptability.
E. The system should be the same for all competitors.

46. (2 points) Your company is planning to implement a new classification system. List and describe two statistical and two operational considerations in designing this new classification system.

48. (4 points) Your company is planning to purchase a block of boat owner's insurance business from Zeron. Zeron has raised overall rates on this block of business for three consecutive years, but does not classify risks by age or size. Despite the rate increases, loss ratios continue to worsen and growth remains high.

a. (1 point) Explain how adverse selection could be impacting the seller's poor results.

b. (3 points) Using the information below, calculate rates to address the adverse selection problem. Briefly justify your methods in light of risk classification principles.

Age Group	Boat Size	Ethnicity Group	Exposures	Premium	Losses
1	Large	A	75	15,000	4,600
1	Medium	A	35	7,000	3,200
1	Small	A	5	1,000	350
1	Large	B	15	3,000	1,100
1	Medium	B	20	4,000	1,800
1	Small	B	45	9,000	6,500
2	Large	A	100	20,000	11,100
2	Medium	A	60	12,000	8,500
2	Small	A	20	4,000	2,500
2	Large	B	25	5,000	2,600
2	Medium	B	25	5,000	2,800
2	Small	B	50	10,000	7,200

Questions from the 2003 Exam:

1. According to the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles," which of the following statements are intentions of risk classification?
   1. to identify good and bad risks
   2. to predict the experience for an individual risk
   3. to group individual risks having reasonably similar expectations of loss

A. 1 only B. 2 only C. 3 only D. 1 and 3 only E. 2 and 3 only

Questions from the 2004 Exam:

23. (3 points)

a. (1.5 points) Given the following information:

Type of Vehicle	Earned Exposures	Number of Claims per year	Pure Premium
Cars	100,000	5,000	$200
Trucks	75,000	4,000	$300

Would a classification plan that assigns cars and trucks to different classes be statistically sound? Explain why or why not.

b. (1.5 points) Given the following information:

Type of Vehicle	Earned Exposures	Number of Claims per year	Pure Premium
Type A	99,950	4,950	$199
Type B	50	5	$2,199

Would a classification plan that assigns Type A and Type B cars to different classes be statistically sound? Explain why or why not.

24. (4 points)

a. (2 points) List and describe four operational considerations in designing a risk classification plan.

b. (2 points) Compare the use of miles driven and the use of accident and violation history for auto insurance based on the following risk classification considerations:

i. Hazard Reduction Incentives

ii. Availability of Coverage

Questions from the 2005 Exam:

1. (3 points)

a. (1.5 points) Describe three statistical considerations in designing a risk classification system.

b. (1.5 points) Discuss one advantage and two disadvantages of using controllability as a consideration for identifying rating variables.

Questions from the 2006 Exam:

1. (1.5 points) Describe three primary purposes of risk classification.

Questions from the 2007 Exam:

1. (2 points) The American Academy of Actuaries, "Risk Classification Statement of Principles", discusses three statistical considerations that an actuary must contemplate when designing a risk classification system.

a..(1.5 points) Identify and briefly explain these three statistical considerations.

b..(0.5 point) Explain how two of these considerations may be in conflict with one another.

Questions from the 2008 Exam:

1. (1.5 points) According to "Risk Classification Statement of Principles" the process of risk classification should serve three primary purposes.
   a. (0.75 point) State these three primary purposes of risk classification.
   b. (0.75 point) Briefly describe how each of these purposes helps to establish and maintain a viable insurance system.

2. (3 points) A company is considering changing its "Age of Home" rating system, which has been in use for five years, and has compiled the following data:

Age Of Home	Current Age Discount	2005 — 2007 Combined Earned Exposures	Earned Premium ($)*	Loss Ratio	2007 Loss Ratio
0	5%	40,000	28,000,000	54%	27%
1	5%	35,000	23,625,000	65%	62%
2	5%	35,000	23,100,000	65%	50%
3	3%	25,000	16,125,000	60%	48%
4	3%	20,000	12,600,000	45%	40%
5	3%	25,000	15,375,000	60%	53%
6+	0%	30,000	18,000,000	60%	59%
Total		210,000	136,825,000	63%	50%

*At current discounts

Provide a recommendation whether the company should adopt each of the three changes below. Defend the recommendation on the basis of at least one of the Statistical and one of the Operational considerations presented in the AAA publication "Risk Classification Statement of Principles".

a. (1 point) Set the discount for Age 0 (new homes) to 15%, leaving other discounts unchanged.
b. (1 point) Set the discount for Age 4 to 25%, leaving other discounts unchanged.
c. (1 point) Disaggregate the Age 6+ group and implement discounts of 2% for Age 6 and Age 7 and 1% for Age 8 and Age 9, leaving discounts for Age 10+ at 0%.

Questions from the 2009 Exam:

1. (2 points) With respect to a private, voluntary insurance program, discuss the extent to which each of the following assumptions is or is not important for defining a risk classification system.
   a. (0.5 point) The system should contemplate the level of competition in the market place.
   b. (0.5 point) The characteristics of the system should be based on causality.
   c. (0.5 point) The system should provide incentives for risks to reduce their expected losses.
   d. (0.5 point) The system should balance between providing a reasonable continuum of expected claim costs and maintaining significant differences in prices between classes.

Questions from the 2011 Exam:

12. (1 point) Describe two primary purposes of risk classification.

Solutions to questions from the 1991 Exam:

Question 2. Which statistical considerations are involved in designing a sound risk classification system?

1. **T.** This is one of 3 statistical considerations (homogeneity, credibility, and predictive stability). See page 14.
2. **T.** "There should be no clearly identifiable subclasses with significantly different potential for losses". See page 14.
3. **F.** This is a consideration, Public Acceptability, (see page 19), but not a statistical one.

Answer C.

Question 3. Which statements listed in the problem are true?

1. **F.** Adverse selection occurs when prices are not reflective of expected costs. Broad classifications and having no voluntary choice among competing institutions leads to pricing on an expected cost basis.

   Adverse selection is controlled by restricting the buyers' freedom, and risk classification is the primary means to control the instability caused by adverse selection. See page 8.
2. **T.** Based on the above.
3. **F.** It is often impossible to prove statistically any postulated cause and effect relationship. Thus, causality cannot be made a requirement of a risk classification system. See page 21.
4. **F**. Controllability has two undesirable risk characteristics:
   (a) its susceptibility to manipulation.
   (b) its irrelevance to predictability of future costs. See page 21.

Answer B.

Question 20. Briefly discuss how and why individual risk rating affects the needed level of refinement in a classification system.

To the extent that prices are adjusted based on a risk's actual experience, after the insurance and its initial price have been established, **less refined initial risk classification systems are needed**. Experience rating refunds, premium adjustments, or dividends, ultimately produce a refined risk classification system. See page 13.

Solutions to questions from the 1992 Exam:

Question 1. Which statements listed in the problem are true?

1. **F**. Experience rating refunds, premium adjustments, or dividends, ultimately produce a refined risk classification system. See page 13.
2. **F**. Competition will motivate an insurer to refine its risk classification system so that it can better serve both lower and higher cost risks. See page 10.
3. **T**. The statistical considerations of Homogeneity, Credibility, and Predictive stability are somewhat conflicting. Increasing the number of classes may improve homogeneity but at the expense of credibility. See page 16.

Answer B.

Solutions to questions from the 1994 Exam:

Question 5. Which statements are considered primary purposes of risk classification?

These are the 3 Primary Purposes of Risk Classification. See page 2. **Answer E.**

Question 26. List four considerations and briefly explain how each contributes to the success of a classification system.

Four of the seven operational considerations are as follows (See pages 16 - 18):

1. Expense - The costs to obtain and maintain data, assigning risks to a class, & determining fair prices by class.
2. Absence of ambiguity - classes should be collectively exhaustive and mutually exclusive.
3. Minimize abilities to manipulate the system.
4. Measurability - class variables (age, sex, occupation, location) should be reliably measurable**.**

Solutions to questions from the 1995 Exam:

Question 4. Which statements listed in the problem are true?

1. **F**. underwriting is the process of determining the acceptability of a risk based on its own merits. See page 11.
2. **T**. the need for less refined classes when experience rating is used. See page 13.
3. **F**. As the more of the price is paid by other than the individual insured, the individual becomes more indifferent to the classification structure. It is possible that broad classification systems may be appropriate, since the distinction between payer and insured can operate to reduce the likelihood of adverse selection. See page 13.

Answer B.

Question 5. Which statements listed in the problem are true?

1. **T**. expense includes costs to obtain and maintain data, assigning risks to a class, & determining fair prices by class. See page 16.
2. **T**. extreme discontinuity avoidance. Attention is needed in defining classes at the extreme ends of a range.
   - There should be enough classes to establish a reasonable continuum of expected losses but few enough to allow significant differences between classes
   - Particular attention often is required in defining classes at the extreme ends of the expected claim cost range, in order to reduce large differences in anticipated average claim costs between the extreme class and the adjacent class. See page 18.
3. **F**. Hazard Reduction Incentives (i.e recognizing sprinklers for risk classification) are desirable but not necessary features of a risk classification system. See page 19.

Answer C.

Solutions to questions from the 1996 Exam:

Question 17. Which statements are considered primary purposes of risk classification?

The <u>3 primary purposes of risk classification:</u>

1. Protect the insurance system's financial soundness.
2. Be fair.
3. Encourage availability of coverage through economic incentives.

Thus, 1 is true, 2 is true and 3 is False. **Answer C.**

Solutions to questions from the 1996 Exam: (continued)

Question 47. Answer the statements listed in the question.

A. 5 basic principles to achieve the primary purposes:

A risk classification system should:

1. Reflect expected cost differences.
2. Distinguish among risks based on relevant cost-related factors.
3. Be applied objectively.
4. Be practical and cost-effective.
5 Be acceptable to the public.

B. ASB 12 omitted the principle of being acceptable to the public.

C. Public Acceptability Considerations:

Are difficult to apply in practice because social values

- are difficult to ascertain.
- vary among segments of society.
- change over time.

Question 48. Answer the statements listed in the question.

A. Controllability:

Refers to the ability of an insured to control its own characteristics as used in the classification system.

Controllability as a	
Desirable risk characteristic:	Undesirable risk characteristic:
1. Its close association with an effort to reduce hazards.	1. Susceptibility to manipulation.
2. Its general acceptability by the public.	2. Its irrelevance to predictability of future costs.

The use of a individual risk's actual loss experience over the past five year period as a rating variable certainly has both desirable risk characteristics as noted above.

The **operational cost** of utilizing this rating variable should be less than the benefits received by using it.

Hazard Reduction Incentives (e.g. reduced prices for better experience) are desirable but not necessary features of a risk classification system.

B. The 5 basic principles to achieve the primary purposes:

A risk classification system should:

1. Reflect expected cost differences.
2. Distinguish among risks based on relevant cost-related factors.
3. Be applied objectively.
4. Be practical and cost-effective.
5. Be acceptable to the public.

I would recommend implementation of the new rating variable, since its use will comply with most of the basic principles, especially principles 1, 2, and 5.

Solutions to questions from the 1997 Exam:

Question 48. For each criterion, identify which one of the five basic principles of a sound risk classification system is violated.

The 5 basic principles of a sound risk classification system are to:

1. Reflect expected cost differences.
2. Distinguish among risks based on relevant cost-related factors.
3. Be applied objectively.
4. Be practical and cost-effective.
5 Be acceptable to the public.

Proposition 99 Criteria	Statement of principle violated
1. Insureds are to be classified based on nationality.	Principle 1: Reflect expected cost differences.
2. Insureds are to be classified based on the ability to pass an annual random drug test	Principle 5: Be acceptable to the public.
3. Insureds are to be classified based on whether they can pass a comprehensive, individually administered 8 hour driving test every year.	Principle 4: Be practical and cost-effective.
4. Insureds are to be classified based on their weights.	Principle 5: Be acceptable to the public.
5. Insureds are to be classified as either 'good eyesight' or 'bad eyesight'. Each eye doctor can have his/her own definition of good/bad eyesight.	Principle 3: Be applied objectively.
6. Insureds are to be classified as 'right handed' or 'left handed'.	Principle 2: Distinguish among risks based on relevant cost-related factors.

Solutions to questions from the 1999 Exam:

Question 43.

a. (0.75 point) what are the three primary purposes of risk classification?
b. (1.5 points) Based on these principles, what would you tell the marketing director about the appropriateness of the proposed class definitions? Include a discussion of all three principles from part a.

a 3 primary purposes of risk classification:

1. Protect the insurance system's financial soundness.
2. Be fair.
3. Encourage availability of coverage through economic incentives.

b. 1. The financial soundness of Aggressive Mutual's new plan is threatened by adverse selection, since equitable rates are not being charged. A deterioration in its overall profitability is likely to materialize over time. Risk classification minimizes the effects of adverse selection.

2. A plan is fair if its prices are not unfairly discriminatory, and reflect differences in expected costs with no redistribution or subsidy among classes. By liberalizing the protection class definitions, there are fewer opportunities for justifiable price discrimination.

3. Economic incentives (profitability through justifiable price discrimination) motivate insurers to refine their risk classification, to better serve low and high cost risk. Liberalizing the protection class definitions works against these incentives.

Solutions to questions from the 1999 Exam (continued):

Question 46.

a. (1 point) List three methods for determining this price.

b. (1 point) List one deficiency for each method described in part a.

a. 1. Reliance on wisdom, insight, and good judgment.
   2. Observation of the risk's actual losses over an extended period of time.
   3. Observation of losses from groups of individual risks with similar characteristics. This is the most frequently used method.

b. 1. Valuable information about expected future loss experience is lost when a risk's actual loss experience is not reviewed.
   2. Gradual changes in the hazard may render past information useless.
   3. Identification of similar risk characteristics (commonly determined by fact and informed judgment) and related classes <u>before</u> the observation period is problematic.

Solutions to questions from the 2000 Exam:

Question 16. Which are not operational considerations relating to classification plans?

All of the operational considerations listed relate to classification plans. See pages 11 – 13. **Answer E.**

Question 35

a. (0.5 point) Briefly describe adverse selection.

   Adverse selection arises when buyers (looking to secure the minimum price) are free to select among different sellers, and when sellers react by offering a similar product in order to incite the movement of buyers in an attempt to gain an economic advantage, often at a price where the seller has not matched price to cost. See page 7.

b. (1.5 points) Briefly explain the two methods described for controlling adverse selection.

   1. Risk classification in a voluntary market - charges each risk the appropriate rate through proper risk identification and balances the economic forces governing buyer and seller actions. This is the primary means to control instability caused by adverse selection.
   2. Compulsory insurance with limited choices (e.g. group insurance) reduces the voluntary choice among competing institutions. Restriction of buyer freedom prevents movement or reduces the price incentive. See pages 8 and 12-13.

Solutions to questions from the 2001 Exam:

3. In which of the following situations would a refined risk classification program be most appropriate?

A. Insurance premiums are determined prior to the policy period and are not adjusted on the basis of actual experience. True. To the extent that prices are NOT adjusted based on a risk's actual experience, MORE refined risk classifications systems are needed.

B. Participation in the insurance program is entirely compulsory. In government programs, participation is usually compulsory and the benefits received by, or paid on behalf of a class, are not necessarily related to the amount paid into the plan by that class.

C. Dividends are paid after the initial insurance premium has been established and are based on the risk's actual experience. To the extent that prices are adjusted based on a risk's actual experience, less refined risk classifications systems are needed.

D. The insurance premium is paid by someone other than the individual insured. Here, the individual insured is indifferent to the classification system, and thus, broad classification systems may be appropriate.

E. None of A, B, C, or D are appropriate situations for a refined risk classification program. False. A is true.

Solutions to questions from the 2001 Exam (continued):

23. (1.5 points) List and briefly describe the three primary purposes of risk classification according to the American Academy of Actuaries Committee on Risk Classification's "Risk Classification Statement of Principles."

    1. Protect the insurance system's financial soundness. Risk classification is the primary means to control instability caused by adverse selection.
    2. Be fair. A proper risk classification system produces prices which are reflective of expected costs.
    3. Encourage availability of coverage through economic incentives. A proper risk classification system will allow an insurer to write and better serve both higher and lower cost risks.

See pages 2 – 9.

Solutions to questions from the 2002 Exam

20. Which of the following best describes a basic principle of a sound risk classification system?

    A. The system should be applied subjectively. False. The system should be applied <u>objectively</u>. See page 2.

    B. The system should produce prices based on the observed actual losses of each risk. False. A system that produces prices based on observed actual losses of each risk is an example of experience based pricing. Further, to the extent that prices are adjusted based on a risk's emerging actual experience after the insurance and its initial price have been established, less refined initial risk classification systems are needed. See pages 12 and 13.

    C. The system should reflect expected cost differences. **True**. See page 2.

    D. The system should be based solely on public acceptability. False. Although the system should be acceptable to the public, it should not be based <u>solely</u> on public acceptability. See page 2.

    E. The system should be the same for all competitors. False. Insurers should refine their risk classification systems and thus their pricing structures to be more successful than their competitors, so that it could serve both lower cost and higher cost risks in the marketplace. See pages 9 and 10.

46. (2 points) Your company is planning to implement a new classification system. List and describe two statistical and two operational considerations in designing this new classification system.

Statistical:
1. **Homogeneity**. Individual risks within a class should have reasonably similar expected costs. Within a class there should be no clearly identifiable subgroups with significantly different loss potential.
2. **Credibility**. The larger the numbers of observations, the more accurate are the statistical predictions that can be made. Each class does not have to be large enough to stand on its own, since accurate predictions can be made based on statistical analysis of the experience of broader grouping of correlative classes.

Note: Candidates would also receive credit for listing and defining Predictive Stability.

Operational:
1. **Manipulation**. The ability to manipulate or misrepresent a risk's characteristics to affect its class assignment should be minimized.
2. **Measurability** – Risk characteristics should lend themselves to reliable and convenient measurement, such as age, sex, occupation or location.

Note: Candidates would also receive credit for listing and defining Expense, Constancy, Availability of Coverage, Avoidance of Extreme Discontinuities, Absence of Ambiguity, and Hazardous Reduction Incentives.

Solutions to questions from the 2002 Exam (continued):

48. (4 points) Your company is planning to purchase a block of boatowner's insurance business from Zeron. Zeron has raised overall rates on this block of business for three consecutive years, but does not classify risks by age or size. Despite the rate increases, loss ratios continue to worsen and growth remains high.

General information. Based on the given information, we know that Zeron does not classify risks by age or size, that their loss ratios are worsening and that their growth remains high (presumably due to writing a large proportion of poor risks). This implies that that Zeron's competitors do classify by age and size, which impacts the types of risks they underwrite, and the rates they charge.

a. (1 point) Explain how adverse selection could be impacting the seller's poor results.

Apparently, Zeron's worsening loss ratios and high growth rate are the result of writing a large proportion of poor risks at inadequate rates. A review of the given premium and exposure data indicates that Zeron charges an average rate for all risks. Assuming that Zeron's competitors classify risks by age and size, better risks will purchase from Zeron's competitors at an actuarially fair rate while poorer risks will purchase from Zeron. Zeron's pricing is causing a significant shift in the types of risks it underwrites.

b. (3 points) Using the information below, calculate rates to address the adverse selection problem. Briefly justify your methods in light of risk classification principles.

Rates should be based on measurable risk characteristics (e.g. age and size) and not on ethnicity group (since this is not a publicly acceptable classification criteria). Therefore, the data should be configured as follows:

Age Group	Boat Size	Premium	Exposures	Current Rates	Losses	Loss Ratio
		(1)	(2)	(3)=(1)/(2)	(4)	(5)=(4)/(1)
1	L	18,000	90	200	5,700	0.3167
1	M	11,000	55	200	5,000	0.4545
1	S	10,000	50	200	6,850	0.6850
2	L	25,000	125	200	13,700	0.5480
2	M	17,000	85	200	11,300	0.6647
2	S	14,000	70	200	9,700	0.6929
Total		95,000			52,250	0.5500

Given the significant variability in the loss ratios, rates should be based on differences in expected costs. This can be reflected by adjusting current rates by loss ratio relativities.

Age Group	Proposed Rates
	(6)
1	115.15
1	165.29
1	249.09
2	199.27
2	241.71
2	251.95

(6) = (3) * [(5) ÷ (5)total]

Solutions to questions from the 2003 Exam:

1. Which of the following statements are intentions of risk classification?
   1. to identify good and bad risks. False. This is not mentioned.
   2. to predict the experience for an individual risk. False. This is not mentioned.
   3. to group individual risks having reasonably similar expectations of loss. True. See page 121.

Answer C. 3 Only.

Solutions to questions from the 2004 Exam:

Question 23- Model Solution 1

a. (1.5 points) Given the following information:

Type of Vehicle	Earned Exposures	Number of Claims per year	Pure Premium
Cars	100,000	5,000	$200
Trucks	75,000	4,000	$300

Would a classification plan that assigns cars and trucks to different classes be statistically sound? Explain why or why not.

Yes, assigning cars and trucks to different classes would be statistically sound. Both cars and trucks have large volumes of data (100,000 earned exposures for cars; 75,000 for trucks). Also, the pure premiums of cars and trucks are significantly different ($200 for cars versus $300 for trucks).

b. (1.5 points) Given the following information:

Type of Vehicle	Earned Exposures	Number of Claims per year	Pure Premium
Type A	99,950	4,950	$199
Type B	50	5	$2,199

Would a classification plan that assigns Type A and Type B cars to different classes be statistically sound? Explain why or why not.

No, assigning Type A and Type B to different classes would not be statistically sound. Even though Type B has much higher pure premium than Type A, there are only 50 exposures for Type B, which is too small to derive statistical conclusions. The high cost of Type B may only be random loss fluctuation.

Question 23 – Model Solution 2

a. There would be homogeneity within the class. There are enough exposures in each to have statistical credibility. These are mutually exclusive classes that could not be manipulated by the insureds. There are differences in severity. Yes, assigning cars and trucks to different classes would be o.k.

b. No, there are not enough exposures in Type B to have statistical credibility.

Question 23, part b only- Model Solution 3

b. I would say yes. While Type B has very small volume, by examining the credibility-weighted differences between the types would still bring value. Type B is significantly worse in the three types of characteristics identified in A above (frequency, severity and pure premium).

Solutions to questions from the 2004 Exam (continued):

Question 24 - Model Solution 1

a. (2 points) List and describe four operational considerations in designing a risk classification plan.

b. (2 points) Compare the use of miles driven and the use of accident and violation history for auto insurance based on the following risk classification considerations:

i. Hazard Reduction Incentives

ii. Availability of Coverage

a. 1. Measurability – the variables should be easy to defined & measure.
2. Manipulation – the plan should not allow for insureds to manipulate their classifications.
3. Expense – the expenses of the classification plan should be as low as possible while maximizing company value.
4. Absence of ambiguity – the classifications should be all encompassing and mutually exclusive; each insured should fit into one and only one class.

b. i. It would be difficult to significantly alter the number of miles driven since most are of necessity (work, etc.). It doesn't provide much hazard reduction incentive. Some drivers may avoid long trips.

Hazard reduction incentives would work for accident and violation history because drivers would be more cautious in order to avoid higher rates.

ii. Miles driven would allow for more availability of coverage because miles driven have an impact on loss exposure. Using this as a classification would improve rate accuracy and thus encourage widespread availability.

Use of accident and violation history may have the same impact as described for miles driven.

However, insurers may use this information to deny coverage to drivers with more than a certain number of accidents. This would reduce availability.

Question 24 - Model Solution 2

a. 1. Measurability – it should be easy to measure or quantify the value of the classification (e.g., age or sex).
2. Expense – the value added by having the classification should be greater than the expense of having it in the plan.
3. Avoidance of extreme discontinuity – we should avoid a large jump in rates between a class and the one next to it.
4. Maximize coverage availability – the plan should accurate price risks so that the availability of coverage is maximized.

b. i. Hazard reduction incentive

a. Use of miles driven – to the extent that an insured will avoid unnecessary road trips, this may reduce the hazard. But this does not seem like an effective way to reduce hazard because people still need to drive.

b. Accident / violation – this will create an incentive for insureds to drive safely and avoid accidents.

ii. Availability of coverage

a. Use of miles driven – to the extent that costs are correlated with miles drive, this may more accurately price risks and thus result in more availability of coverage.

b. Accident / violation – since accident / violation history is correlated with costs, having this variable will promote more accurate rates, leading to better availability.

Solutions to questions from the 2005 Exam:

1. (3 points)
   a. (1.5 points) Describe three statistical considerations in designing a risk classification system.
   b. (1.5 points) Discuss one advantage and two disadvantages of using controllability as a consideration for identifying rating variables.

Question 1 – Model Solution 1

a. Statistical Considerations
   1. Homogeneity: risks in the same class should have reasonably similar loss potential.
   2. Credibility: the number of claims should be voluminous to warrant credibility.
   3. Predictive Stability: responsive to changes in the nature of insurance yet stable in avoiding unwarranted abrupt changes.

b. Advantage: If the rating variable is closely associated with the efforts to reduce hazard, then the classification will help reduce the potential loss.

   Disadvantages:
   1. If the variable is susceptible to manipulation then the insured may misuse it.
   2. If the variable is irrelevant to the predictability of the losses, then the variable may not be useful in predicting future losses and this may not be acceptable to the public.

Question 1 – Model Solution 2

a. Statistical Considerations
   1. Homogeneity: Risks are grouped according to their traits as homogeneously as allowed (but not forgoing credibility).
   2. Credibility: Risks are grouped in volumes that are adequate for the group to be credible.
   3. Predictive Stability: Risks are grouped according to traits that are responsive enough to changes; but stable enough to not allow abrupt changes.

b. Advantage: It is a good way to encourage reduction in hazard; insureds will want to control how much they pay in premium.

   Disadvantages:
   1. Manipulation: Risks may tend to manipulate their exposure to reduce premiums.
   2. Impractical: Some traits may not be practical to implement in a classification system.

Solutions to questions from the 2006 Exam:

1. (1.5 points) Describe three primary purposes of risk classification.

Question 1 – Model Solution 1

1. Protect the insurance system's financial soundness. This is threatened by adverse selection which can occur if insurance companies are not allowed to classify.
2. Enhance fairness. Charge insureds appropriately for their potential for loss, do not punish or reward insureds at the expense of others.
3. Provide economic incentive to make coverage available. With classification, companies will be able to charge appropriately and will be able to serve higher and lower risk insureds and will be incented to provide coverage.

Solutions to questions from the 2006 Exam:

Question 1 – Model Solution 2

1. To protect insurance system's financial soundness. Minimize potential for adverse selection by matching expected costs with price.
2. To enhance fairness. By ensuring prices valid and equitable with no subsidization between classes. Each risk is charged appropriate rate through proper risk identification.
3. To permit economic incentives to operate and thus encourage widespread availability of coverage
   - By charging higher premiums for higher risks and lower premiums for lower risks
   - Economies of scale by offering coverage to all at appropriate rates
   - Financial incentive to be a better risk and thus reduce one's premium

See pages 2 – 3.

Solutions to questions from the 2007 Exam:

Question 1 – Model Solution 1

Credibility -> enough risks in the class to allow reasonable and credible inferences to be drawn

Homogeneity -> risks in the class should be similar (i.e. no subgroups identifiable)

Predictive stability -> use of the classes should be responsive to changing conditions, but avoid large swings in rates from year to year

Credibility and homogeneity may be in conflict. We want the risks to be very similar, but we also want enough experience so that they are credible.

Question 1 – Model Solution 2

Homogeneity ->the risks within the class should be similar (i.e. there should be little variation within the class)

Credibility ->there must be enough data in the class to be able [to] rely on

Predictive Stability-> should be responsive to the nature of insurance losses yet stable enough to avoid abrupt price changes

Homogeneity and credibility are in conflict since making a class more homogeneous by eliminating risks comes at the expense of credibility, since there may not end up being enough risks in the class to make it credible.

Solutions to questions from the 2008 Exam:

Question 1 – Model Solution 1

a. State these three primary purposes of risk classification.
   1. Enhance insurance system financial soundness
   2. Enhance fairness
   3. Permit economic incentives to operate and increase availability of insurance

b. Briefly describe how each of these purposes helps to establish and maintain a viable insurance system.
   1. Risk classification minimizes adverse selection which will exist when buyers are free to select who they purchase insurance from
   2. Rate should be in line with their expected loss costs and there shouldn't be any subsidy between risk classes
   3. Each risk class should be priced to their expected losses so that insurers have same profit potential on all risks and are willing to write high risks and low risks, rather than just going after low risks. This increases availability.

Solutions to questions from the 2008 Exam:

Question 1 – Model Solution 2

a.

1. To protect the financial soundness of the insurance system
2. Enhance fairness
3. Economic incentives to make coverage available

b.

1. Risk classification protects insurers from adverse selection which could impair an insurance company
2. It would provide rates that are reflective of insured's expected cost making them fair and not unfairly discriminatory
3. Encourages insurer to refine system to better serve both high and low risk insureds because of competition.

Solutions to questions from the 2008 Exam:

a. (1 point) Set the discount for Age 0 (new homes) to 15%, leaving other discounts unchanged.

b. (1 point) Set the discount for Age 4 to 25%, leaving other discounts unchanged.

c. (1 point) Disaggregate the Age 6+ group and implement discounts of 2% for Age 6 and Age 7 and 1% for Age 8 and Age 9, leaving discounts for Age 10+ at 0%.

Question 2 – Model Solution 1

a.	Yes		
	Stat	Credibility	There seems to be enough data to provide a reasonable prediction.
	Oper	Manipulation	The age of the home would not be subject to manipulation since it should be well documented.
b.	No		
	Stat	Predictive Stability	This is probably random loss fluctuation and should not be too responsive.
	Oper	Discontinuity	There would be a discontinuity of coverage changing discount from 3% to 25% back to 3%.
c.	No		
	Stat	Homogeneity	These risks should be similar and therefore can be grouped
	Oper	Expense	Expensive to implement and change system when there is not an apparent need.

Question 2 – Model Solution 2

a. Agree with making the change

- i. From the statistical consideration, this age group has the most exposures and thus the most credibility and their loss ratios would support this change in discount.
- ii. From an operational consideration, this is one that could not be manipulated by the insured.

b. Disagree with making the change

- i. Statistical – although the discount may be supported by loss ratios, this is smallest age group category so has the least credibility.
- ii. Operational – This would result in Age group 3 with a 3% discount, age group 4 with a 25% discount, and then age group 5 with a 3% discount again. This is an extreme discontinuity which we want to avoid.

c. Disagree

- i. Statistical – The credibility for making this change might be in question.
- ii. Operational – The expense of making this change would likely outweigh the benefits.

Solutions to questions from the 2009 Exam:

1. (2 points) With respect to a private, voluntary insurance program, discuss the extent to which each of the following assumptions is or is not important for defining a risk classification system.
   a. (0.5 point) The system should contemplate the level of competition in the market place.
   b. (0.5 point) The characteristics of the system should be based on causality.
   c. (0.5 point) The system should provide incentives for risks to reduce their expected losses.
   d. (0.5 point) The system should balance between providing a reasonable continuum of expected claim costs and maintaining significant differences in prices between classes.

Question 1 – Model Solution 1

a. This is important, the less competition the less refined classification system is required.
b. Causality is not necessary and is impossible to prove so it is not important, nice though.
c. Incentives to reduce loss are good, but not a requirement for a risk classification system.
d. This is an important operational consideration. They should aim to avoid extreme discontinuities in the price, but differences should still be significant.

Question 1 – Model Solution 2

a. Important – in a competitive market risk classification is important to avoid adverse selection.
b. Not important – may help with public acceptance, but difficult to prove; can use plausibility instead.
c. Not important – thought hazard reduction incentives are beneficial to society, the utility is limited.
d. Important – system should avoid extreme discontinuities, but should have significant enough differences to justify different class.

Solutions to questions from the 2011 Exam:

Question 12 – Model Solution 1

1. To ensure the insurance system's financial soundness by protecting it against adverse selection, which happens in a competitive environment when others are using risk classification.
2. To be fair. Risk classification allows the insurer to better match expected costs and premiums for the policy holders based on how they classify with respect to exposure to risk.

[These purposes come from AAA Risk Classification Principles]

Question 12 – Model Solution 2

1. Protect financial soundness of the insurance system. If buyers are free to purchase insurance in a competitive market, adverse selection could result if appropriate risk classification is not used. This could put the solvency of insurers at risk.
2. Encourage availability of coverage through economic incentives. Equitable pricing ensures that prices reflect expected differences in cost. In the long run, this allows insurers to better serve both low and high cost insureds.

[These purposes come from AAA Risk Classification Principles]

Section	Description
1	**Select Definitions**
2	**Personal Auto Policy – Eligibility**
3	**Premium Determination**
4	**Classifications**
5	**Safe Driver Insurance Plan (SDIP)**
6	**Model Year/Age Groups for Comprehensive and Collision**

SELECT information from each of the 6 sections will be provided in this review. For additional information, consult the syllabus reading.

1 Select Definitions

A. Private Passenger Auto:
1. is a four wheel motor vehicle, owned or leased under contract for a continuous period of at least 6 months, and
2. can also be considered a pickup or van, and
3. can also be considered a farm family owned or a farm family co-partnership, or farm family corporation motor vehicle.

B. AUTO refers to a private passenger auto or a vehicle considered as a private passenger auto.

C. LIABILITY refers only to Bodily Injury and Property Damage Coverages.

D. OWNED includes an auto leased under contract for a continuous period of at least 6 months.

2 Personal Auto Policy – Eligibility

A Personal Auto Policy shall be used to afford coverage to:

A. private passenger autos and motor vehicles considered as private passenger autos in Rule 1., if:
   1. They are written on a specified auto basis, and
   2. They are owned by an individual or by a husband and wife who are residents in the same household.

B. private passenger autos, and pickups and vans as defined in Rule 1., that are owned jointly by two or more:
   1. Resident relatives other than husband and wife;
   2. Resident individuals; or
   3. Non-resident relatives, including a non-resident husband and wife; If:
      - They are written on a specified auto basis, and
      - The Joint Ownership Coverage endorsement is attached.

C. motorcycles, motor homes, golf carts or other similar type vehicles and snowmobiles if:
   1. They are written on a specified vehicle basis,
   2. They are owned by:
      a. An individual;
      b. A husband and wife;
      c. Two or more relatives other than husband and wife; or
      d. Two or more resident individuals; and
   3. Coverage is limited in accordance with the miscellaneous type vehicle or snowmobile endorsement.

D. a named individual who does not own an auto. The named non-owner coverage endorsement must be attached.

Note: Exposures in A. B. or C. above may be written under a commercial auto policy when combined with a commercial risk.

3 Premium Determination

Single Limit Liability, or BI and PD Liability; Medical Payments; Comprehensive and Collision premiums are determined as follows:

A. Refer to <u>the Classification Rule</u> to determine the applicable *classification, rating factors and statistical Code.*

B. Refer to the <u>Model Year/Age Group Rule and the Symbol and Identification section</u> to determine the *model year/age* of the auto and the appropriate *symbol* of the auto.

   NOTES:

   - When a model year is used in rating and the rates for a model year are not displayed in the Rate Pages, use the rates shown for the latest model year.
   - If no Rating Symbol is shown in the Symbol and Identification (S&I) Section, use the following procedure to determine an interim rating symbol.
     a. If the S&I section displays a rating symbol for the PRIOR MODEL YEAR version of the same vehicle, use the prior model year's Rating Symbol for the new model year vehicle.
     b. If the S&I Section does NOT display a rating symbol for the PRIOR MODEL YEAR version of the same vehicle, assign a symbol based on the cost new of the auto, using the Price/Symbol Chart located in the reference pages of the S&I Section.

C. Refer to Territory Definitions to determine the *territory code for the location where the auto is principally garaged.*

D. Refer to the Rate pages to determine *base rates for the desired coverage for the appropriate territory.*

E. Expense Fees

   The premium for each coverage is determined by <u>multiplying</u> the base rate by the appropriate rating factor and <u>adding</u> the appropriate Expense Fees (see page 2 for more details).

   Notes:

   - Expense Fees are added separately to the premium for the Single Limit Liability or BI and PD Liability, Comprehensive, Collision and No-Fault Coverages applying to each auto.
   - Expense Fees are not subject to modification by the provisions of any rating plans or other rating rules (e.g. Classifications, Safe Driver Insurance Plan
   - Expense Fees are subject to the Cancellation and Suspension provisions of this manual.

4 Classifications

A. Classifications:

Autos owned by an individual, or owned jointly by two or more relatives or resident individuals are classified as follows:

1. Primary Classification

   Classify the auto according to the sex and marital status of the operators, the use of the auto and the eligibility of youthful operators for the Driver Training and/or Good Student classes.

2. Secondary Classification

   Refer to the Symbol and Identification section to determine if the auto is:

   a. 1. Standard performance.
      2. Intermediate performance
      3. High performance.
      4. Sports, or
      5. Sports premium.

   b. 1. A single car, or
      2. Part of a multi-car risk.

3. Classification Changes

   Premium adjustments are made on a pro-rata basis when changes in Primary and Secondary Rating Classifications are made.

   Exceptions.

   A policy may not be changed mid-term:

   a. because of the attained age of an operator of the auto.
   b. to effect a change in the Driving Record Sub Classification.
   c. due to a change in symbol assignment based on a review of loss experience.

B. Definitions.

1. Use Classifications:

   a. BUSINESS USE (other than going to or from the principal place of occupation, profession or business)
   b. FARM USE
   c. PLEASURE USE means:
      1. No Business use.
      2. includes driving to and from work or school
         a. less than 3 road miles one way
         b. 3 or more, but less than 15, road miles one way for not more than 2 days per week, or more than 2 weeks per 5 week period.

d. WORK LESS THAN 15 MILES means:	e. WORK MORE THAN 15 MILES means:
1) No Business use.	1. No Business use.
2) includes driving to and from work or school:	2. includes driving to and from work or school:
a. 3 or more, but less than 15, road miles one way for not more than 2 days per week, or more than 2 weeks per 5 week period.	
b. 15 or more road miles one way for not more than 2 days per week, or more than 2 weeks per 5 week period.	15 or more road miles one way more than 2 days per week, or more than 2 weeks per 5 week period.

Note: An auto driven part way to or from work or school (e.g. to a railroad or bus depot) shall be considered as driving to or from work a school.

2. Age, Sex and Marital Status Classifications

YOUTHFUL OPERATOR means any operator resident in the same household who customarily operates the auto, and is one of the following:

a. YOUTHFUL UNMARRIED FEMALE OPERATOR - unmarried female under 25 years of age.
b. YOUTHFUL MARRIED MALE OPERATOR - married male under 25 years of age.
c. YOUTHFUL UNMARRIED MALE OPERATOR - unmarried male under 25 years of age who is not an owner or principal operator.
d. YOUTHFUL UNMARRIED MALE OWNER OR PRINCIPAL OPERATOR unmarried male under 30 years of age who is an owner or principal operator.

3. Driver Training

Driver Training Classification applies to each Youthful Operator under 21 years of age where “Satisfactory Evidence” is presented that such operator has successfully completed a driver education course meeting the following standards:

a. The course included a minimum of 30 clock hours of classroom instruction plus a minimum of 6 clock hours of actual driving experience per student.
b. The course was conducted by instructors certified by the State Department of Education or other responsible educational agency.

"Satisfactory Evidence" is a certificate signed by a school official certifying to the fulfillment of the requirements.

4. Good Student

The Good Student Classification applies provided the owner or operator is -

1) At least 16 years of age, and
2) A full time high school, college or university student.

A certified statement from a school official is presented to the Company on each anniversary date of the policy indicating that the student has met <u>one</u> of the following requirements during the immediately preceding school semester.

1) Is in the upper 20% of his/her class scholastically, or
2) Maintains a "B" average, or its equivalent.
3) When in a school maintaining a numerical grade, must have at last a 3 in a 4, 3. 2. 1 point system
4) Student is included in a "Dean's List " 'Honor Roll" or comparable list indicating scholastic achievement.

Note: A classification change resulting from a change in the scholastic standing of the student cannot be effected between anniversary dates of the policy.

5. a. Youthful Operators

1) Single Car Risks

The youthful operator with the highest Primary Rating Factor shall apply.

2) Multi-Car Risks

(a) Assign any youthful principal operators to the autos they principally operate.

(b) Assign other youthful operators to remaining autos (see page 5 for details)

b. Operators Age 50 and Over

1) The Principal Operator Age 50-64 Class shall apply if the principal operator of the auto is age 50 to 64.

2) The Principal Operator Age 65-74 or 75 or Over Classes shall apply if the principal operator of the auto is age 65 or over.

c. Multi-Car Discount

The Multi-Car Rating Factor applies if:

1) more than one private passenger auto is owned by an individual or owned jointly by two or more relatives or resident individuals, and

2) two or more autos are insured in the same company for any of the following coverages: single limit liability (or BI and PD liability,) medical payments, no-fault, comprehensive or collision.

d. TOTAL BASE PREMIUM is the <u>sum of the base premium</u> for single limit liability or BI and PD liability, medical payments, no-fault, comprehensive and collision coverages that apply to the auto.

6. Vehicles Equipped With Anti-Theft Devices

These discounts apply to comprehensive coverage <u>only</u>.

7. Safety Equipment Discounts

a. Passive Restraint Discount

The following discounts apply *to Medical Payments and/or any No-Fault Coverage <u>only</u>.*

1) 20% discount shall be afforded when the restraint is installed in the driver-side only position.

2) 30% discount shall be afforded when the restraints are true in both front outboard seat positions.

b. Anti-Lock Braking System Discount

A 5% *for BI and PD Liability (or Single Limit Liability) coverages* shall be afforded for those private passenger autos equipped with a factory installed four wheel Anti-Lock Braking System (ABS).

5 Safe Driver Insurance Plan (SDIP)

SECTION I.

The SDIP applies to policies written in Companies authorizing its use. For companies electing not to use the Plan see Section II of this Rule. When SDIP is used it is to be applied to all eligible autos.

A. Eligibility:

An auto is eligible for rating under this Plan if it is:

1. Owned by an individual, or owned jointly by two or more relatives or resident individuals.
2. Owned by a family partnership or family corporation, provided the vehicle is:
   a. Garaged on a farm a ranch; and
   b. Not rated as part of a fleet; and
   c. Not used in any occupation other than farming or a ranching.

B. Definitions:

1. Driving Record Points

a. Convictions

Points shall be assigned for convictions during the experience period for motor vehicle violations of the applicant or any other currently resident operator as follows:

(1) 3 points are assigned for conviction of:

(a) Driving while intoxicated or under the influence of drugs; or

(b) Failure to stop and report when involved in an accident; or

(c) Homicide or assault arising out of the operation of a motor vehicle; or

(d) Driving while license is suspended or moving traffic violation in connection with revoked.

(2) 2 points are assigned for the accumulation of points under a State Point System or a series of convictions requiring the filing of evidence of Financial Responsibility under any Financial Responsibility Law as of the effective date of the policy.

(3) 1 point is assigned for conviction of any other moving traffic violation resulting in:

(a) Suspension a revocation of an operators license, or

(b) The filing of evidence of financial responsibility under any Financial Responsibility Law as of the effective date of the policy.

b. Accidents

Points shall be assigned for each accident

1 point is assigned for each auto accident that results in:

(a) Bodily injury, or death; or

(b) Total damage to all property, including his or her own, in excess of $500.

c. Inexperienced Operator

(1) If the principal operator of the auto has no point assigned for an accident or conviction but has been licensed less than 2 years, 1 point is assigned. Sub-Classification 1B applies.

(2) Sub-Classification 1A applies only when the policy has total of 1 point assigned based on any operator's accident or conviction record.

d. Refund of Surcharged Premium

If a point has been assigned for an accident and it is later determined that the accident falls under one of the exceptions in this rule, the company shall refund to the Insured the increased portion of the premium generated by the accident.

C. Driving Record Sub-Classification

The driving record sub-classification shall be determined from the number of Driving Record Points accumulated during the experience period as follows:

Number of Driving Record Points	Driving Record Sub-classification
0	0
1	1
2	2
3	3
4 or more	4

SECTION II

For companies electing not to use SDIP, rate eligible private passenger autos by adding 0.20 to the Rating Factor otherwise applicable.

Use the following Secondary Rating Factors and Codes:

1971 and Later Model Autos

Single Car	Code	Factor
Standard Performance	19	+0.00
Intermediate Performance	39	+0.15
High Performance	59	+0.30
Sports	79	+.015
Sports Premium	99	+0.15

Note: Factors also apply to Multi-Car and to 1970 and Prior Model Autos

6 Model Year/Age Groups for Comprehensive and Collision

A. Where Model Year Is Used in Rating:

1. The model year of the auto is the year assigned by the auto manufacturer.
2. Rebuilt or Structurally Altered Autos - the model year of the chassis determines the model year of the auto.
3. If the rates for a model year are not displayed in the Rate Pages, use the rates shown for the latest model year.

B. Where Age Is Used in Rating:

1. Age is determined as follows:

Age Group	Definition
1	Autos of “current model year”
2	Autos of first preceding year
3	Autos of 2nd preceding year
“”	“”

Note: The “current model year" changes effective October 1 of each calendar year regardless of the actual introduction of the makes and models.

2. Rebuilt or Structurally Altered Autos - the age of the chassis determines the age of the autos.

C. Coding applicable whether Model Year or Age is used in rating:

1. Policies effective July 1, 1980 and subsequent:

   Code the last two digits of the model year, e.g. code 1980 vehicles as 80, 1981 as 81, etc.

2. Policies effective prior to July 1, 1980:

Description	Code
Current Model Year	1
First Preceding Model Year	2
Second Preceding Model Year	3
Third Preceding Model Year	4
Fourth Preceding Model Year	5

Questions from the 2002 exam

8. Based on Insurance Services Office, Inc., Personal Automobile Manual (Effective 6-98), which of the following is <u>false</u>?

   A. The Manual describes the types of vehicles eligible for coverage.

   B. The Manual specifies that all Liability and Physical Damage policies must have a policy period of no longer than 12 months.

   C. The Manual specifies which drivers must be categorized as "Youthful Operators".

   D. The Manual sets forth rating factor adjustments for companies electing not to use the Safe Driver Insurance Plan.

   E. The Manual describes the primary and secondary classifications applicable.

Questions from the 2004 exam

21. (2 points) Using Rule 4 of the Insurance Services Office, Inc. Personal Auto Manual and the following information, determine the appropriate primary classification factor. Explain how you arrived at your selection.

    The insured:

    - Is a 28 year-old unmarried male.
    - Owns the insured vehicle.
    - Drives 25 miles one way to work twice a week.

Primary Classification Description	Pleasure	Work Less Than 15 Miles	Work 15 or More Miles	Business
Youthful Unmarried Male - Operator	2.0	2.1	2.3	2.4
Youthful Unmarried Male - Owner or Principal Operator	2.5	2.6	2.8	3.0
All Other	1.5	1.6	1.7	1.8

Questions from the 2005 exam

6. A driver's insurance premium, before discounts and without expense fees, is as follows:

   - Bodily Injury and Property Damage Liability= $210
   - Comprehensive (Other than Collision) = $100
   - Collision = $320
   - Medical Payments = $20

   The driver's vehicle has a qualifying alarm, dual-side passive restraints and anti-lock brakes. If the premium is calculated using the ISO Personal Automobile Manual, how much does the driver save by having these safety features?

   A. < $21.60　　B. ≥ $21.60, but < $24.60　　C. ≥ $24.60, but < $27.60

   D. ≥ $27.60, but < $30.60　　E. ≥ $30.60

Questions from the 2006 exam:

3. According to the ISO Personal Automobile Manual, which of the following mid-term changes to an annual policy can result in a mid-term premium adjustment?

   A. The use of a vehicle on the policy is changed from "Business Use" to "Pleasure Use."

   B. An operator on the policy attains a certain age that results in a Classification change.

   C. An operator is involved in an accident that results in a change in the Driving Record Sub-Classification.

   D. A review of loss experience results in a change in symbol assignment of a vehicle that is on the current policy.

   E. An operator on the policy now qualifies for the Good Student Classification.

Questions from the 2007 exam

5. A driver's insurance premium, before discounts and without expense fees, is as follows:
   - Single Limit Liability = $250
   - Comprehensive (other than Collision) = $125
   - Collision = $325
   - Medical Payments = $30

The driver's vehicle has an alarm and a fuel system disabling device which is manually activated using a switch under the dashboard. It also has driver-side passive restraints and anti-lock brakes. If the premium is calculated using the ISO Personal Automobile Manual, how much does the driver save by having these safety features?

A. < $22.50 B. ≥ $22.50 but < $25.00 C. ≥ $25.00 but < $27.50 D. ≥ $27.50 but < $30.00
E. ≥ $30

Questions from the 2011 exam

1. (2 points) Given the following information for a semi-annual ISO Personal Automobile Policy:
   - Principal operator is a 16-year-old single male
   - Auto is driven to school every day, 10 miles from operator's residence
   - Operator is full-time student
     - o 3.2 grade point average on a 4-point scale
     - o Not in the top 20% of students at his school
   - Good student discount is 20%
   - Bodily injury and property damage base rate is $200

Age/Sex/Marriage Status Classification	Multiplicative Rate Factor
Youthful Unmarried Female Operator	1.4
Youthful Married Male Operator	1.2
Youthful Unmarried Male Operator	1.85
Youthful Unmarried Male Owner or Principal Operator	2.1
Use Classification	Multiplicative Rate Factor
Business Use	1.4
Pleasure Use	0.9
Work Less Than 15 Miles Use	1.1
Work 15 or More Miles Use	1.3

   - No other rating factors apply

   a. (1 point) Calculate the premium for bodily injury and property damage liability coverage.

   b. (0.5 point) Exactly three months after the policy is sold, the driver moves to a new home that is two miles from school. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining three months.

   c. (0.5 point) Exactly four months after the policy is sold, the driver has an accident that results in a change to the driving record sub-classification. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining two months.

Questions from the 2012

1. (2.5 points) Given the following information for personal automobile policy:
   - Principal operator is a 35-year-old male.
   - Operator just obtained his driver's license, and has no prior driving experience or accidents.
   - The only vehicle is a 2011 Honda Accord sedan.
     - Vehicle is equipped with anti-theft passive disabling device and anti-lock braking system.
     - The physical damage rating symbol for this car is 13.
   - The current model year is 2012.
   - Operator drives 10 miles to work every weekday.
   - The policy expense fee is $60.
   - Selected coverage:
     - The bodily Injury limits are $100,000/300,000.
     - The property damage limit is $100,000.
     - $1,000 deductible for both Collision and Comprehensive.

Primary Classification	Factor
Pleasure Use	1.00
Less Than 15 Miles	1.05
15 or More Miles	1.15
Business Use	1.20
Farm Use	0.85

Secondary Classification	Factor
0	0.00
1A	0.40
1B	0.50
2	0.90
3	1.50
4	2.20

	Collision Relativities		Comprehensive Relativities	
Symbol	2012	2011	2012	2011
13	1.11	1.05	1.06	1.00

Bodily Injury Limit	Factor
$25,000/$50,000	1.00
$50,000/$100,000	1.25
$100,000/$300,000	1.54

Property Damage Limit	Factor
$25,000	1.00
$50,000	1.06
$100,000	1.12

Coverage	Base Rate
Bodily Injury	$88
Property Damage	$109
Collision	$231

Collision Deductible	Factor
$100	118%
$500	100%
$1,000	83%

Comprehensive Deductible	Factor
Full Coverage	157%
$500	100%
$1,000	73%

Calculate the premium for this policy using the ISO Personal Automobile Manual.

Solutions to Questions from the 2002 Exam.

8. Based on Insurance Services Office, Inc., Personal Automobile Manual (Effective 6-98), which of the following is false?

   A. True. See page G-1.

   B. **False. "No policy may be written for a period longer than 12 months for Liability Coverage or 36 months for Physical Damage."**

   C. True. See section 4: Classifications, page G-5.

   D. True. See section 5: Safe Driver Insurance Plan, section 2 page G-8.

   E. True. See section 4: Classifications, page G-2.

Solutions to questions from the 2004 Exam:

21. (2 points) Using Rule 4 of the Insurance Services Office, Inc. Personal Auto Manual and the following information, determine the appropriate primary classification factor. Explain how you arrived at your selection.

To determine the appropriate primary classification factor, candidates must use the information found within the ISO Personal Auto Manual excerpt that accompanied the exam (which can also be obtained from the CAS exam 5 Study Kit).

Based on the given data, find the information within Rule 4 which answers the following questions:

1. What Driving Category (Pleasure, Work, Business) does the insured fall into?

   Under Rule 4: 4.C. Definitions

   1.d. (2) (b) states - 15 or more road miles one way, for not more than 2 days per week or not more than 2 weeks in any 5-week period, shall be classified as **WORK LESS THAN 15 MILES.**

2. What Primary Classification Description does the insured belong to?

   Under Rule 4: 4.C. Definitions

   Under 2.a. (4) states - unmarried male under 30 years of age who is an owner or principal operator, shall be classified as **Youthful Unmarried Male -Owner or Principal Operator.**

Therefore, the primary class factor = 2.6

Solutions to questions from the 2005 exam

6. If the premium is calculated using the ISO Personal Automobile Manual, how much does the driver save by having these safety features?

Initial comments: On page G-6 of the ISO Personal Automobile Manual, it states that a 5% discount on comprehensive coverage (premium) shall be afforded on vehicles equipped with alarm only devices which sound an audible alarm that can be heard at a distance of at least 300 feet for a minimum of three minutes; a 30% discount applicable to medical payments (premium) shall be afforded with restraints are installed in both front outboard seats; a 5% for BI and PD (premium) shall be afforded for those autos equipped with a factory installed four wheel anti-lock braking system.

In light of the above, the amount saved resulting from these safety features is .05 ($100) + .30 ($0.20) +.05 ($210) = $5 + $6 + $10.50 = $21.50

Answer: A < $21.60

Solutions to questions from the 2006 exam

3. According to the ISO Personal Automobile Manual, which of the following mid-term changes to an annual policy can result in a mid-term premium adjustment?

   A. The use of a vehicle on the policy is changed from "Business Use" to "Pleasure Use."

   B. An operator on the policy attains a certain age that results in a Classification change.

   C. An operator is involved in an accident that results in a change in the Driving Record Sub-Classification.

   D. A review of loss experience results in a change in symbol assignment of a vehicle that is on the current policy.

   E. An operator on the policy now qualifies for the Good Student Classification.

Answer: A – See page G-3 – Section 4: Classifications

Solutions to questions from the 2007 exam

5. If the premium is calculated using the ISO Personal Automobile Manual, how much does the driver save by having these safety features?

Initial comments: On page G-6 of the ISO Personal Automobile Manual, it states that a 5% discount on comprehensive coverage (premium) shall be afforded on vehicles equipped with alarm only devices which sound an audible alarm that can be heard at a distance of at least 300 feet for a minimum of three minutes; a 20% discount applicable to medical payments (premium) shall be afforded with restraints are installed in the driver side only position ;and a 5% for BI and PD / Single Limit (premium) shall be afforded for those autos equipped with a factory installed four wheel anti-lock braking system.

In light of the above, the amount saved resulting from these safety features is
.05 ($125) + .20 ($30) +.05 ($250) = $6.25 + $6.00 + $12.50 = $24.75

Answer B. $\geq$ $22.50 but < $25.00

Solutions to questions from the 2011 exam

Question 1

a. (1 point) Calculate the premium for bodily injury and property damage liability coverage.

b. (0.5 point) Exactly three months after the policy is sold, the driver moves to a new home that is two miles from school. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining three months.

c. (0.5 point) Exactly four months after the policy is sold, the driver has an accident that results in a change to the driving record sub-classification. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining two months.

Note: Access to ISO PAM (effective 6-98) is needed to answer the question. Section 4. Classifications

a. Base rate = $200

   Youth, unnamed, male, principal op: multiplier = 2.1

   10 mi/day: work <15 mi: multiplier = 1.1

   Full-time, 16y/o, 3.2 GPA: disc = 20%

   Premium = $200 * 2.1 * 1.1 * (1-.2) = $369.6

b. per ISO PAM part 4.Cc. (page G-3) use class = pleasure use, thus the multiplier = 0.9

   Prem = $200 * 2.1 * 0.9 * (1-.2) = $302.4. Policy is semi-annual so Total prem = ½ (369.6 + 302.4) = $336

   Thus, the impact of the mid-term adjustment is a decrease is premium of $369.6 - $336 = $33.6

c. According to ISO PAM part 4.A3 (page G-3), a policy shall not be changed mid-term to effect a change in driving record sub-class, so there is no impact from part a.

Questions from the 2012 exam

12a. (1 point) Calculate the premium for bodily injury and property damage liability coverage.

12b. (0.5 point) Exactly three months after the policy is sold, the driver moves to a new home that is two miles from school. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining three months.

12c. (0.5 point) Exactly four months after the policy is sold, the driver has an accident that results in a change to the driving record sub-classification. Assuming all other policy characteristics remain consistent with part a above, determine the impact of the mid-term adjustment for the remaining two months.

Question 1 – Model Solution

Based on the given data in the problem, key rating manual classifications to identify prior to solving this problem are as follows:

- Inexperienced operator = subclass 1B
- 10mi commute everyday = work less than 15mi
- Passive disabling device = 15% discount on comp
- Anti lock braking = 5% discount on BI PD
- Vehicle is a 2011 model => use 2011 relativities

<u>BI</u>

88 x 1.54 x (1.05 + 0.5) x 0.95 = 199.55

<u>Property</u>

109 x 1.12 x (1.05 + 0.5) x 0.95 = 179.76

<u>Collision</u>

231 x 0.83 x 1.05 x (1.05 + 0.5) = 312.04

<u>Comprehensive</u>

60 x 0.73 x 1.00 x (1.05 + 0.5) x (0.85) = 57.71

<u>Total Prem</u>

(57.71 +312.04 + 179.76 +199.55) + 60 expense fee = $809

Examiner's Comments

A very small number of candidates received full credit.

Most candidates did sum the 4 components and add the expense fee correctly.

Most candidates made mistakes in calculating and applying the primary and secondary classification factor. Many multiplied the primary and secondary classification factors, instead of adding them together.

Some candidates did not correctly calculate other components (beyond the primary and secondary classification factor) of the premium (base rate, ILF and other factors and discounts).

Actuarial Notes for Spring 2014 CAS Exam5

Syllabus Section A

Ratemaking, Classification Analysis, Miscellaneous Ratemaking Topics

Volume 1b

Table of Contents

Exam 5 – Volume 1b: Ratemaking, Classification Analysis and Miscellaneous Ratemaking Topics – Part 2

Notes:

The predecessor papers to the CAS 2011 syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous.

Past CAS questions and our solutions to those questions associated with those readings that are within this volume, remain relevant to understanding the content covered in these chapters.

Chapter 9 – Traditional Risk Classification

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Introduction and Importance of Equitable Rates 150 – 154

INTRODUCTION

The fundamental insurance equation is in ***balance in the aggregate*** when total premium covers the total costs and allows for the target underwriting profit.

- It is also important to develop a ***balanced indication for individual risks*** or risk segments as well.
- Other considerations (e.g. marketing, operational, and regulatory) may require implementing a rating algorithm other than what is indicated by the actuary's analysis.

Very large risks (e.g. a multi-billion dollar manufacturing corporation with property, commercial liability, and WC exposures) may have enough historical experience to estimate the amount of premium required for a future policy term (see rating techniques covered in Chapter 15).

For smaller risks with not enough individual historical experience, **classification ratemaking** (i.e. grouping risks with similar loss potential and charging different manual rates to reflect differences in loss potential among the groups) is used.

First, class ratemaking requires risk criteria to segment risks into groups with similar expected loss experience (e.g. a homeowners insurer may recognize that the expected loss for a homeowners policy varies based on the age of the home).

- The characteristic examined is a <u>rating variable</u> (which refers to any variable used to vary rates, even if it is based on a characteristic considered as an UW characteristic).
- The different values of the rating variable are known as <u>levels</u> (e.g. age of the home is the rating variable, and the different ages or age ranges are the levels).

The insured population is then subdivided into appropriate levels for each rating variable.

Next, the actuary calculates *indicated rate differentials* relative to the base level for each level priced.

- A rate differential applied multiplicatively is known as a ***rate relativity***.
- A rate differential applied additively is known as an ***additive***.
- The term class refers to a group of insureds belonging to the same level for each of several rating variables (e.g. in personal lines auto, class refers to a group of insureds with the same age, gender, and marital status).

This chapter discusses:

- The importance of charging equitable rates
- Criteria for evaluating potential rating variables
- Traditional univariate (one-way) techniques used to estimate rate differentials for various levels of a given rating variable.

  To eliminate distortions inherent in univariate techniques, multivariate classification ratemaking techniques (discussed in Chapter 10) are used.

  Chapter 11 outlines special classification ratemaking techniques used for certain rating variables.

IMPORTANCE OF EQUITABLE RATES

An insurer that fails to charge the right rate for individual risks (when others are doing so) is subject to adverse selection (and thus, deteriorating financial results).

An insurer that differentiates risks using a valid risk characteristic (when others are not) may achieve favorable selection, and gain a competitive advantage.

Adverse Selection - Example

The goal of class ratemaking: Determine a rate commensurate with the individual risk.

Assume Simple Insurer charges an average rate for all risks (and others have implemented a rating variable that varies rates to recognize the differences in expected costs).

- Simple will attract and retain higher-risk insureds and lose lower-risk insureds to those offering lower rates).
- A distributional shift toward higher-risk insureds makes Simple's previously "average" rate inadequate and causes the insurer to be unprofitable.
- Thus, Simple must raise the average rate.
- The increase in the average rate will encourage more lower-risk insureds to switch to competing insurers, causing the revised average rate to be unprofitable.
- This downward spiral will continue until Simple:
  - i. improves their rate segmentation, or
  - ii. becomes insolvent, or
  - iii. decides to focus solely to higher-risk insureds and raises rates.

When Simple receives a disproportionate number of higher cost insureds, relative to its classification plan, it is being ***adversely selected against***.

As stated above, if adverse selection continues, Simple must either lose money, change its underwriting criteria, or increase its premiums.

Example - The Adverse Selection Cycle

- The average loss ($\bar{L}$) and LAE ($\overline{E_L}$) is \$180. Therefore, assuming no UW expenses or profit, average total cost is \$180.
- The insured population consists of 50,000 high-risk insureds (Level H) and 50,000 low-risk insureds (Level L).
- The market consists of two insurers (Simple and Refined) each insuring 25,000 of each class of risk.
- H risks have a cost of \$230, and L risks have a cost of \$130.
- Simple charges H and L risks the same rate, \$180. Refined implements a rating variable to vary the rates according to the cost and charges H and L risks \$230 and \$130, respectively.
- 1 out of every 10 insureds shops at renewal and bases the purchasing decision on price.

The risks are distributed evenly amongst the two companies and the rates are set as follows:

Original Distribution, Loss Cost, and Rates

	(1)	(2)	(3)	(4)	(5)
	True	Refined Insurer		Simple Insurer	
	Expected	Insured	Charged	Insured	Charged
Risk	Cost	Risks	Rate	Risks	Rate
H	$230.00	25,000	$230.00	25,000	$180.00
L	$130.00	25,000	$130.00	25,000	$180.00
Total	$180.00	50,000	$180.00	50,000	$180.00

As shown below, if there is no movement of risks between the insurers, aggregate premium collected by both insurers is the same.

- For Refined, the premium charged varies by level of the rating variable and is equitable.
- For Simple, H risks are not charged enough premium (the $1,250,000, shortfall is completely offset by the excess premium collected from L risks).

  Thus, L risks are subsidizing the H risks at Simple Insurer.

Static Distribution With Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Refined			Simple	
	True			Total			Total
	Expected	Insured	Charged	$Excess/	Insured	Charged	$Excess/
Risk	Cost	Risks	Rate	($Shortfall)	Risks	Rate	($Shortfall)
H	$230.00	25,000	$230.00	$-	25,000	$180.00	$(1,250,000)
L	$130.00	25,000	$130.00	$-	25,000	$180.00	$1,250,000
Total	$180.00	50,000	$180.00	$-	50,000	$180.00	$-

(4)= [(3)-(1)] x (2) (7)= [(6)-(1)] x (5)

Since 1 out of 10 insureds shops at renewal and makes their purchase based on price, the distribution of insureds will not remain static.

- 2,500 =[.10 * (25,000)] Refined H risks will buy from Simple and 2,500 Simple L risks buy from Refined.
- This movement results in the following distribution of risks for policy year one:

Policy Year One Distribution With Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Refined Company			Simple Company	
	True			Total			Total
	Expected	Insured	Charged	$Excess/	Insured	Charged	$Excess/
Risk	Cost	Risks	Rate	($Shortfall)	Risks	Rate	($Shortfall)
H	$230.00	**22,500**	$230.00	$-	***27,500***	$180.00	$(1,375,000)
L	$130.00	**27,500**	$130.00	$-	***22,500***	$180.00	$1,125,000
Total	$180.00	50,000	$175.00	$-	50,000	$180.00	$(250,000)

[(22,500 * $230) + (27,500 * $130)]/50,000 = 175.00

(4)= [(3)-(1)] x (2) (7)= [(6)-(3)] x (5)

Because Simple's distribution has shifted toward more H risks, the excess premium from the L risks fails to make up for the shortfall from the H risks. It is forced to increase the rate from $180 to $185, the new average cost based on the new distribution to make up for the $250,000 = [($185.00 - $180.00) * 50,000] shortfall.

Until Simple changes its price by risk level, this cycle will continue each year.

Policy Year Five Distribution With Results

Risk	(1) True Expected Cost	(2) Refined Company Insured Risks	(3) Refined Company Charged Rate	(4) Refined Company Total $Excess/ ($Shortfall)	(5) Simple Company Insured Risks	(6) Simple Company Charged Rate	(7) Simple Company Total $Excess/ ($Shortfall)
H	$230.00	14,762	$230.00	$-	35,238	$197.20	$(1,155,798)
L	$130.00	35,238	$130.00	$-	14,762	$197.20	$992,023
Total	$180.00	50,000	$159.52	$-	50,000	$197.20	$(163,775)

(4)= [(3)-(1)] x (2) (7)= [(6)-(1)] x (5); (7tot)=(7H)+(7L)

This trend will continue until such time that Simple:

- segments its portfolio in a more refined manner
- loses too much money to continue
- only insures H risks at the rate of $230.

There are many factors that affect the adverse selection cycle (e.g. raising rates to the new true average cost each year may not be feasible, and many jurisdictions require a company to obtain approval to change rates).

Favorable Selection

When an insurer identifies a characteristic that differentiates risk that other companies are not using, the insurer has two options for making use of this information:

1. Implement a new rating variable.
2. Use the characteristic for purposes outside of ratemaking (e.g. for risk selection, marketing, agency management).

If the insurer implements a new rating variable and prices it appropriately:

- its' new rates will be more equitable.
- it may write a segment of risks that were previously considered uninsurable.
- it will attract more lower-risk insureds at a profit.
- some of the higher-risk insureds will remain and will be written at a profit

Over the long run, the insurer will be better positioned to profitably write a broader range of risks.

The motorcycle insurance market is a good example of favorable selection.

- Initially, motorcycle insurers rating algorithms did not include variation based on age of operator.
- Insurers recognizing that age of operator is an important predictor of risk charged higher rates for youthful operators.

To keep overall premium revenue neutral, they lowered rates for non-youthful operators and were able to attract a large portion of the profitable adult risks from their competitors.

Also, youthful operators who chose to insure with them were written profitably.

At times, insurers may not be able to (or may choose not to) implement a new or refined rating variable.

- If allowed by law, the insurer may continue to charge the average rate but use the characteristic to identify, attract, and select the lower-risk insureds (a.k.a. "skimming the cream)."
- This will allow the insurer to lower the average rate to reflect the better overall quality of the risks insured.

2 Criteria For Evaluating Rating Variables 154 – 159

The first step in class ratemaking is to identify rating variables to segment insureds into different groups of similar risks for rating purposes (e.g. the number, type, and skill level of employees are risk characteristics that may be used as rating variables for WC insurance).

Criteria to evaluate the appropriateness of rating variables can be grouped into the following categories:

- Statistical
- Operational
- Social
- Legal

Statistical Criteria

The following statistical criterion helps to ensure the accuracy and reliability of a potential rating variable:

- Statistical significance
- Homogeneity
- Credibility

The rating variable should be a ***statistically significant*** risk differentiator:

- Expected cost estimates should vary for the different levels of the rating variable
- Estimated differences should be within an acceptable level of statistical confidence
- Estimated differences should be relatively stable from one year to the next.

Risk potential should be ***homogeneous within groups and heterogeneous between groups***.

Identify and group risks for which the magnitude and variability of expected costs are similar (since by doing so more accurate and equitable rates will be developed).

The number of risks in each group should either be ***large enough or stable enough or both to accurately estimate costs*** (a.k.a. having sufficient credibility as discussed in Chapter 12).

Thus, group risks into a sufficient number of levels to ensure the risks within each group are homogeneous while being careful not to create too many defined groups that may lead to instability in the estimated costs.

Operational Criteria

For a rating variable to be practical, it should be

- Objective
- Inexpensive to administer
- Verifiable

Examples:

1. Levels within ***a rating variable should have objective definitions***.
    - Estimated costs for medical malpractice insurance vary by the skill level of a surgeon. Example: However, the skill level of a surgeon is difficult to determine and subjective (thus, it is not a practical choice for a rating variable).
    - More objective rating variables like board certification, years of experience, and prior medical malpractice claims can serve as proxies for skill level.

2. ***The cost to obtain information to properly classify a risk should not be high***. Example:
    - Building techniques and features that improve the ability of a home to withstand high winds can significantly reduce expected losses, and should be implemented as a rating variable to recognize differences, but cannot be easily identified without a very thorough inspection of the home performed by a trained professional.
    - Thus, if the cost of the inspection outweighs the benefit, do not use that risk characteristic as a rating variable.

3. ***The levels of a rating variable*** should not be easily manipulated by the insured and ***should be easy for the insurer to verify***. Example:
    - Number of miles driven is a risk differentiator for personal auto insurance. However:
    - Many car owners cannot accurately estimate how many miles their car will be driven in the upcoming policy period, and
    - Insurers may not have a cost-effective way to verify the accuracy of the amount estimated by the insured.

Since insureds may not report accurate data, insurers may not use annual miles driven as a rating variable.

Note: As technology (e.g. on-board diagnostic devices) become standard equipment in cars, this rating variable may become more verifiable and how it is used in rating may make it miles driven a viable rating variable.

Social Criteria

The following affect social acceptability of using a risk characteristic as a rating variable:

- Affordability
- Causality
- Controllability
- Privacy concerns

1. ***Affordability***: It is desirable for insurance to be affordable for all risks. This is true when:
    - it is required by law (e.g. states require "proof of financial responsibility" from owners of vehicles)
    - it is required by a third party (e.g. lenders require homeowners insurance)
    - it facilitates ongoing operation (e.g. stores purchase commercial general liability insurance).

Social Criteria (continued)

2. ***Causality***: It is preferable if rating variables are based on characteristics that are causal in nature. Examples:
   - A sump pump in a house has a direct effect on water damage losses to the house, and a corresponding reduction in premium for the presence of a sump pump is socially acceptable.
   - While insurance credit scores (a measure of the insured's financial responsibility) have been incorporated into rating algorithms (given its strong statistical power in predicting losses), use of this variable has resulted in a consumer backlash from a belief of a lack of obvious causality to losses.

3. ***Controllability***: It is preferable for an insured to have some control as to the class they belong to (affecting the premium charged). For example:
   - The type and quality of a company's loss control programs affects WC expected losses, since approved loss control programs can reduce expected losses and thus the charged premium.
   - In contrast, insureds cannot control their age or gender. Although age and gender have been shown to impact personal lines loss costs, some jurisdictions do not allow them as rating variables.

4. ***Privacy***: There are privacy concerns associated with the use of particular rating variables. Examples:
   - When technology to determine how safely a car is being driven is standard in all vehicles, this can greatly improve an insurer's ability to accurately price a given risk. To address the privacy concern, the data is deemed to be protected and the insurer is only able to use it with the consent of the insured.
   - Some insurers have implemented usage-based insurance programs on a voluntary basis.

     However, any such usage-based programs will be most effective if they can be used on all risks rather than just the ones who volunteer.

Legal Criteria

Most jurisdictions worldwide have laws and regulations related to P&C insurance products.

In the U.S. P&C insurance products are regulated by the states.

- Most states have statutes that require insurance rates to be "not excessive, not inadequate, and not unfairly discriminatory."
- Some states' statutes may require certain rates to be "actuarially sound."
- Some states have regulations about what is allowed and not allowed in risk classification rating for various P&C insurance products.
- Some states statutes prohibit the use of gender in rating while others permit it as a rating variable.
- Some states may allow the use of a rating variable, but may place restrictions on its use (e.g. allosing a credit score to be used for rating personal insurance for new business, but not allowing insurers to raise rates for renewal risks should the insured's credit worsen (although they may allow companies to reduce rates if the insured's credit score improves).
- Some states prohibit variables from use in the rating algorithm but allow their use in U/W (which may be used to guide risk selection decisions and or guide risk placement decisions).

To be familiar with the laws and regulations of each jurisdiction the insurer writes in, the actuary should work with lawyers or regulatory compliance experts in determining what is acceptable and what is not.

3 Typical Rating (or Underwriting) Variables 159 – 159

Examples of rating variables by line of business are as follows:

Type of Insurance	Rating Variables
Personal Automobile	Driver Age and Gender, Model Year, Accident History
Homeowners	Amount of Insurance, Age of Home, Construction Type
Workers Compensation	Occupation Class Code
Commercial General Liability	Classification, Territory, Limit of Liability
Medical Malpractice	Specialty, Territory, Limit of Liability
Commercial Automobile	Driver Class, Territory, Limit of Liability

Note: Some risk characteristics may be used as both rating variables and underwriting variables.

4 Determination of Indicated Rate Differentials 159 - 168

The actuary must identify the amount of rate variation among the levels of each rating variable. The rate for all non-base levels is expressed relative to the base level (see chapter 2) as prescribed in the rating algorithm.

This chapter discusses traditional univariate methods that use the historical experience for each level of a rating variable to determine the differentials.

Each of the approaches described below assume that the rating algorithm is multiplicative, so differentials are called ***relativities***.

Differentials could be derived in an additive/subtractive manner (but this is not addressed in the examples).

The following approaches are discussed:

1. Pure Premium
2. Loss Ratio
3. Adjusted Pure Premium

The output of these approaches is a set of indicated rate relativities.

- If relativities are changed for some or all of the levels of the rating variables, more or less premium being collected overall can result, and the base rate can be altered to compensate for the expected increase or decrease in premium.
- This topic (base rate offsetting) is discussed in Chapter 14.

Assumptions for Simple Example

The assumptions:

- All UW expenses are variable. The variable expense provision (V) is 30% of premium, the target profit percentage (Q_T) is 5% of premium, so the PLR is 65% (= 1 – 30% - 5%).
- There are only 2 rating variables: amount of insurance (AOI) and territory. Exposures are distributed across the two rating variables as follows:

Exposure Distribution (in number and in percentage)

	Territory					Territory			
AOI	1	2	3	Total		1	2	3	Total
Low	7	130	143	280		1%	13%	14%	28%
Medium	108	126	126	360		11%	13%	13%	37%
High	179	129	40	348		18%	13%	4%	35%
Total	294	385	309	988		30%	39%	31%	100%

- The "true" underlying loss cost relativities (which the actuary is attempting to estimate) as well as the relativities currently used in the insurer's rating structure are as follows:

True and Charged Relativities for AOI and for Territory

AOI	True Relativity	Charged Relativity
Low	0.7300	0.8000
Medium	**1.0000**	**1.0000**
High	1.4300	1.3500

Terr	True Relativity	Charged Relativity
1	0.6312	0.6000
2	**1.0000**	**1.0000**
3	1.2365	1.3000

Note: The base levels are Medium AOI and Territory 2:

- The exposure, premium, and loss information needed for the analysis is summarized as follows:

Simple Example Data

AOI	Terr	Exposure	Loss & LAE	Premium @ Current Rate Level
Low	1	7	$210.93	$335.99
Medium	1	108	$4,458.05	$6,479.87
High	1	179	$10,565.98	$14,498.71
Low	2	130	$6,206.12	$10,399.79
Medium	2	126	$8,239.95	$12,599.75
High	2	129	$12,063.68	$17,414.65
Low	3	143	$8,441.25	$14,871.70
Medium	3	126	$10,188.70	$16,379.68
High	3	40	$4,625.34	$7,019.86
TOTAL		988	$65,000.00	$100,000.00

Pure Premium Approach

Given a rating variable R1 with a rate differential for each level i given by $R1_i$, then the rate for each level of rating variable R1 ($Rate_i$) is the product of the base rate (B) and the rate differential ($R1_i$): $Rate_i = R1_i \times B$.

The indicated differential is calculated as follows: $R1_{I,i} = \frac{Rate_{I,i}}{B_I}$, where subscript I denotes indicated.

The formula for the indicated rate using the pure premium method is $Indicated\ Rate = \frac{[\overline{L+E_L} + \overline{E_F}]}{[1.0 - V - Q_T]}$.

- If all UW are considered to be variable <u>or</u> if fixed expenses are handled through a separate fee, then the fixed expense component (F) is set equal to zero and the formula simplifies to the following:

  $$Indicated\ Rate = \frac{[\overline{L+E_L}]}{[1.0 - V - Q_T]}$$

- If fixed expenses are material and a separate expense fee is not used (i.e. the base rate includes a provision for fixed expenses), include the fixed expense loading in the formula.

  This will "flatten" the otherwise indicated relativities to account for the fact that the fixed expenses represent a smaller portion of the risks with higher average premium.

Assuming the fixed component is not necessary and substituting the formula for the indicated rate and base rate, the indicated differential for level i is calculated as follows: $R1_{I,i} = \dfrac{\frac{[\overline{L+E_L}]_i}{[1.0 - V - Q_T]_i}}{\frac{[\overline{L+E_L}]_B}{[1.0 - V - Q_T]_B}}$

Assuming all policies have the same UW expenses and profit provisions, then $R1_{I,i} = \frac{[\overline{L+E_L}]_i}{[\overline{L+E_L}]_B}$

Pure Premium Approach in Practice

- It is not always feasible to allocate ULAE to different classes of business, so the pure premiums used in class analysis generally only include L + ALAE.
- If the actuary chooses to incorporate U/W expense provisions and target profit provisions that vary by type of risk, the indicated PP for each level can be adjusted by the applicable provisions prior to calculating the indicated relativities.

Depending on the portfolio, it may not always be necessary to trend and develop the loss and (A)LAE.

- In stable portfolios for short-tailed lines of business (e.g. HO), it is acceptable to ignore these adjustments for class analysis.
- If the portfolio is growing or shrinking, or the distribution of loss and (A)LAE by class is changing over time, a multi-year PP analysis would be improved by applying aggregate trend and development factors to the individual year's loss and (A)LAE before summing.
- In long-tailed lines (e.g. WC), it is possible that classes of risk undergo trend and development at materially different rates. For example:

  i. WC risks with return-to-work programs may experience less development over time than risks without such a program.

  ii. If trend and development are materially different by level or claim type (e.g. WC indemnity and medical), consider developing and/or trending individual risks or levels prior to classification analysis.

It is common to adjust losses for extraordinary and catastrophic events in classification data as they can have a disproportionate impact on a level or levels for the rating variable being analyzed. For example:

- a catastrophic event may only affect one territory.
- one extraordinary loss only impacts one level.

Thus, the actuary should consider replacing these actual losses with an average expected figure for each level (if such data is available).

The following shows the Pure Premium Method calculations for the simple example:

(1) Terr	(2) Exposures	(3) Loss & LAE	(4) Indicated Pure Premium	(5) Indicated Relativity	(6) Indicated Relativity to Base
1	294	$15,234.96	$51.82	0.7877	0.7526
2	385	$26,509.75	$68.86	1.0467	1.0000
3	309	$23,255.29	$75.26	1.1439	1.0929
Total	988	$65,000.00	$65.79	1.0000	0.9554

(4)= (3)/(2); (5)= (4)/(Tot4); (6)= (5)/(Base5)

In this example, loss and LAE in (3) is **not** developed or trended, and implicitly assumes that all levels of the rating variable experience development and trend at the same rate.

- In many short-tailed lines of business (e.g. HO), the assumption may be reasonable.
- In long-tailed lines (e.g. WC), risks may undergo trend and development at different rates (e.g. WC risks with return-to-work programs may experience less development than risks without such a program).
- If trend and development are materially different by level, consider developing and/or trending individual risks or levels prior to class analysis.

- Adjust class data for extraordinary and catastrophe losses as they can have a disproportionate impact on a level or levels for the rating variable being analyzed (e.g. a cat event may only affect one territory).
- While column (6) can be calculated directly from column (4), column (5) was included as insurers typically compare current, indicated, and competitors' relativities all normalized so that the total average exposure-weighted relativity is 1.00 for each (thus relativities can be compared on a consistent basis).

Distortion (in the true vs. indicated relativities)

Compare the true underlying pure premium relativities and the relativities indicated by the pure premium analysis:

Terr	True Relativity	Pure Premium Indication
1	0.6312	0.7526
2	1.0000	1.0000
3	1.2365	1.0929

Key! The indicated and true territorial relativities do not match due to a shortcoming of the univariate pure premium approach.

The pure premium for each level is based on the experience of each level and assumes a uniform distribution of exposures across all other rating variables.

- ***If one territory has a disproportionate number of exposures of high or low AOI homes, this assumption is invalid.***
- ***By ignoring the exposure correlation between territory and AOI, the loss experience of high or low AOI homes can distort the indicated territorial relativities resulting in a "double counting" effect.***

i. Territory 1 indicated PP relativity is higher than the true relativity due to a disproportionate share of high-value homes in Territory 1.

ii. Territory 3 indicated PP relativity is lower than the true relativity due to a disproportionate share of low-value homes in Territory 3.

If AOI were distributed in the same way within each territory, the indicated relativities would not have been affected. This does not mean that each of the three AOI levels needs to be 1/3rd of the exposures within each territory, but that the distribution of AOI must be the same within every territory.

Note: Since in reality there are many characteristics that affect an insured's risk potential, to the extent there is a distributional bias in some or all of the other characteristics, the resulting pure premiums can be biased.

The Adjusted Pure Premium, discussed later, minimizes the impact of the distributional bias resulting from the AOI relativities.

Loss Ratio Approach

The major difference between the PP and LR approaches is that the LR approach uses premium (vs. exposure).

The LR approach compares LRs for each of the levels to the total LR to determine the appropriate adjustment to the current relativities.

Loss Ratio Approach Calculations:

Step 1: Start with the PP indicated differential formula (assumes all policies have the same UW expenses and profit provisions):

$$R1_{I,i} = \frac{[\overline{L+E_L}]_i}{[\overline{L+E_L}]_B} = \frac{\frac{(L+E_L)_i}{X_i}}{\frac{(L+E_L)_B}{X_B}}$$

Step 2: Multiply both sides of the equation by the ratio of the avg. premium at current rates for the base level $(\overline{P_{C,B}})$ to the avg. premium at current rates for level i of the rating variable being reviewed $\overline{P_{C,i}}$

$$R1_{I,i} \times \frac{\overline{P_{C,B}}}{\overline{P_{C,i}}} = \left| \frac{[\overline{L+E_L}]_i}{[L+E_L]_B} \right| \times \frac{\overline{P_{C,B}}}{\overline{P_{C,i}}}$$

Step 3: Average premium equals total premium divided by total exposures and average PP equals total losses and LAE divided by total exposures: $\overline{P} = \frac{P}{X}$ *and* $\overline{L+E_L} = \frac{L+E_L}{X}$

Step 4: The current differential for level i ($R1_{C,i}$) equals the ratio of the current average premium for level i divided by the current average premium at the base level: $R1_{C,i} = \frac{\overline{P_{C,i}}}{\overline{P_{C,B}}}$

Step 5: Transform the Step 4 formula as follows:

$$Indicated\ \ Differential\ Change = \frac{R1_{I,i}}{R1_{C,i}} = \frac{\frac{(L+E_L)_i}{P_{C,i}}}{\frac{(L+E_L)_B}{P_{C,B}}} = \frac{Loss\ \ \&\ LAE\ Ratio\ for\ i}{Loss\ \ \&\ LAE\ Ratio\ for\ B}$$

Loss Ratio Approach in Practice

Similar to the PP premium approach, many of the same data limitations and assumptions regarding losses apply (e.g. ULAE cannot be allocated by class).

- In the LR approach, however, it is important to bring earned premium to the current rate level of each class.
- This is most accurately done via extension of exposures, though the parallelogram method can be performed at the class level if data limitations preclude use of extension of exposures.

Calculations for the Loss Ratio Method:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Terr	Premium @ Current Rate Level	Loss & LAE	Loss & LAE Ratio	Indicated Relativity Change Factor	Current Relativity	Indicated Relativity	Indicated Relativity Base
1	$21,314.57	$ 15,234.96	71.5%	1.1000	0.6000	0.6600	0.6540
2	$40,414.19	$ 26,509.75	65.6%	1.0092	1.0000	1.0092	1.0000
3	$38,271.24	$ 23,255.29	60.8%	0.9354	1.3000	1.2160	1.2049
	$100,000.00	$ 65,000.00	65.0%	1.0000			

(4)= (3)/(2); (5)= (4)/(Tot4) ; (7)= (5)x(6); (8)= (7)/(Base7)

Noteworthy comments:

- Column 4 should be adjusted for any extraordinary or catastrophic losses.
- The validity of the assumption that trend and development apply uniformly to all risks applies should be challenged.
- Column 5 represents the amount the territory relativities should be changed to make the loss and LAE ratios for every territory equivalent.
- Column 7 relativities have the same overall weighted average as the current relativities.

  Since it is useful to compare the current, indicated, and competitors' relativities for a variable, each set of relativities should be adjusted so that the overall weighted-average relativity is the same.

  The proper way to make such an adjustment is shown in column 8, which adjusts the relativities to the base level by dividing the indicated relativity for each level by the indicated relativity at the base level.

Distortion (in the true vs. indicated relativities)

Compare the true underlying pure premium relativities and the relativities indicated by the pure premium analysis:

Terr	True Relativity	Pure Premium Indication	Loss Ratio Indication
1	0.6312	0.7526	0.6540
2	1.0000	1.0000	1.0000
3	1.2365	1.0929	1.2049

The indicated LR territorial relativities are closer to the true relativities than those computed using the PP approach.

- Since the PP approach relies on exposures (i.e. one exposure for each house year), the risks in each territory are treated the same regardless of the AOI.
- In contrast, LR approach relies on premium (in the denominator of the loss ratio) which reflects the fact that the insurer collects more premium for homes with higher AOI.

  Using the current premium helps adjust for the distributional bias.
- Regardless, the LR method did not produce the correct relativities (the distortion coming from the variation in AOI relativities being charged rather than the true variation).

  If the current AOI relativities equaled the true AOI relativities, then the LR method will produce the true territorial relativities.

Indicated relativities (using the LR method) "adjust" for the inequity present in the other rating variables.

- The rate relativity for Territory 1 is higher than the true relativity because the process by which it takes into account the high proportion of high-valued homes relies on the current AOI relativities that are under-priced.
- The downside to this adjustment is that all homes in Territory 1, not just the high-value homes, are being charged an extra amount to correct for the inequity in AOI relativities.

Adjusted Pure Premium Approach

It is possible to make an adjustment to the PP approach to minimize the impact of any distributional bias.

The PP approach can be performed using exposures adjusted by the exposure-weighted average relativity of all other variables.

Calculation of the current exposure-weighted average AOI relativities by territory is shown below:

AOI	Charged AOI Factor	Exposures by Territory 1	2	3
Low	0.8000	7	130	143
Medium	1.0000	108	126	126
High	1.3500	179	129	40
Total		294	385	309
Wtd Avg AOI Relativity by Terr		***1.2083***	***1.0497***	***0.9528***

- If there are more than two rating variables, the above table needs to be expanded so that the exposure-weighted average relativity is based on all rating variables.
- If this is not practical, the actuary may focus only on rating variables suspected to have a distributional bias across the levels of the rating variable being analyzed.

Adjusted Pure Premium Method

(1) Terr	(2) Earned Exposures	(3) Wtd Avg AOI Relativity	(4) Adjusted Exposures	(5) Loss & LAE	(6) Indicated Pure Premium	(7) Indicated Relativity	(8) Indicated Relativity @Base
1	294	***1.2083***	355.24	$15,234.96	$42.89	0.6954	0.6538
2	385	***1.0497***	404.13	$26,509.75	$65.60	1.0636	1.0000
3	309	***0.9528***	294.42	$23,255.29	$78.99	1.2806	1.2040
Total	988		1,053.79	$65,000.00	$61.68	1.0000	0.9402

(4)= (2)*(3) (6)= (5)/(4); (7)= (6)/(Tot6); (8)= (7)/(Base7)

Distortion

- Since the current AOI relativities were used for the adjustment, the resulting indicated relativities are equivalent to those calculated using the LR approach (except for rounding).
- The same comments made about the distortion associated with the LR approach apply.

Since univariate techniques cause distortion, many insurers have moved to multivariate techniques, which are possible to perform with today's technology, and are covered in the next chapter.

5 Appendix E - Univariate Classification Examples 168 -168

The following show examples of classification analysis using a pure premium and loss ratio analysis.

Pure Premium Approach

Wicked Good Auto Insurance Company
Classification Relativities Using the Pure Premium Approach

Class	(1) Earned Exposures	(2) Reported Loss & ALAE	(3) Pure Premium	(4) Indicated Relativity	(5) Current Relativity	(6) Normalized Current Relativity	(7) Credibility	(8) Credibility-Weighted Indicated Relativity	(9) Credibility-Weighted Indicated Relativity @ Base Class	(10) Selected Relativity	(11) Relativity Change	(12) Relativity Change with Off-Balance
J	16,520	$878,200	$53.16	0.7831	1.00	0.7811	1.00	0.7831	1.0000	1.00	0.0%	0.2%
K	11,328	$740,940	$65.41	0.9636	1.15	0.8983	1.00	0.9636	1.2304	1.23	7.0%	7.2%
L	1,266	$136,830	$108.08	1.5922	1.95	1.5232	0.34	1.5466	1.9748	1.98	1.5%	1.7%
M	12,836	$888,582	$69.23	1.0198	1.35	1.0545	1.00	1.0198	1.3022	1.30	-3.7%	-3.5%
N	4,200	$753,156	$179.32	2.6418	3.50	2.7340	0.62	2.6771	3.4184	3.42	-2.3%	-2.1%
P	11,538	$518,146	$44.91	0.6616	0.85	0.6640	1.00	0.6616	0.8448	0.84	-1.2%	-1.0%
TOTAL	57,688	$3,915,854	$67.88	1.0000	1.2802	1.0000		1.0016		1.2776	-0.2%	0.0%

(3) = (2) / (1)
(4) = (3) / (Tot3)
(Tot5) = (5) Weighted by (1)
(6) = (5) / (Tot5)
(7) = [(1) / 11,050] ^ 0.5 limited to 1.0
(8) = (4) * (7) + [1.0 - (7)] * (6)
(Tot8) = (8) Weighted by (1)
(9) = (8) / (Base8)
(Tot10) = (10) Weighted by (1)
(11) = (10) / (5) - 1.0
(12) = [1.0 + (11)] / [1.0 + (Tot11)] - 1.0

Column 1: Earned exposures are the best match to reported losses to produce pure premiums

Column 2: Calendar accident year reported loss and ALAE. These amounts have been adjusted to convert historical losses and ALAE to projected loss and LAE (e.g. development, trend, ULAE adjustment) at the aggregate level.

Column 4: Note that the total exposure-weighted average relativity is 1.00, which is important for comparing indicated pure premium relativities to those currently used by the insurer or competitors (assuming those are normalized to 1.00 also).

Column 5: The current class relativities found in the rating manual having base class J (with a relativity of 1.0)

Column 6: Current class relativities normalized so that the total exposure-weighted average relativity is 1.00.

- Weight the relativities using premium adjusted to the base class, but exposures are used as a proxy.
- By normalizing these relativities, they can be compared to the indicated relativities in Column 4.

Column 7: Full credibility standard is 11,050 exposures, and partial credibility is computed using the square root rule (11,050 is based on a 663 claim standard and an expected frequency of 6%).

As discussed in Chapter 12, the 663 standard assumes no variation in the size of loss and that there is a 99% chance that the observed value will be within 10% of the true value.

Column 8: Credibility-weights the indicated relativities with the current normalized relativities.

The all class pure premium is another common complement of credibility, but it was ruled out due to the significant variation between the classes.

Column 11: Shows the expected change in premium for each class due to the change between the current and selected manual relativities.

- A total exposure-weighted average relativity of -0.2% change (= 1.2776 / 1.2802 -1.0) means that if the selected class relativities are implemented without any other changes, the overall premium will change by -0.2%.
- This is the amount the base rate needs to be offset by if no overall premium change is desired (i.e. to make the rate change revenue neutral).

Column 12: Displays the relativity change assuming the base rate will be offset so that there is no overall increase or decrease due solely to the implementation of the selected relativities.

Loss Ratio Approach – Part 1

Wicked Good Auto Insurance Company

Classification Relativities - Using the Loss Ratio Approach

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Class	Premium at Current Rate Level	Reported Loss & ALAE	Loss Ratio	Indicated Change	Number of Claims	Credibility	Credibility-Weighted Indicated Change	Current Relativity	Credibility-Weighted Indicated Relativity
J	$1,114,932	$878,200	78.8%	2.3%	826	1.00	2.3%	1.00	1.0227
K	$917,284	$740,940	80.8%	4.9%	652	0.99	4.8%	1.15	1.2056
L	$166,314	$136,830	82.3%	6.8%	124	0.43	2.9%	1.95	2.0075
M	$1,162,236	$888,582	76.5%	-0.7%	866	1.00	-0.7%	1.35	1.3401
N	$1,056,318	$753,156	71.3%	-7.4%	736	1.00	-7.4%	3.50	3.2400
P	$666,978	$518,146	77.7%	0.9%	490	0.86	0.7%	0.85	0.8563
TOTAL	$5,084,062	$3,915,854	77.0%	0.0%	3,694				

(3) = (2) / (1)
(4) = (3) / (Tot3) - 1.0
(Tot5) = (5) Weighted by (1)
(6) = [(1) / 663] ^ 0.5 limited to 1.0
(7) = (4) * (6) + 0.0% * [1.0 - (6)]
(9) = [1.0 + (7)] * (8)

Column 1: It is critical that the premium is adjusted at the granular level rather than at the aggregate level (i.e. it is not sufficient to use the parallelogram method at the aggregate level if the rate changes varied by the classes being examined).

Column 2: The same comments about aggregate adjustments made in the pure premium approach apply.

Column 3: Indicated change is the % the current class relativities (column 8) need to be increased or decreased so that the expected loss ratio will be the same for every class.

Columns 5 through 7: The full credibility standard is 663 claims, partial credibility is calculated using the square root rule, and the complement of credibility is no change.

Column 9: Credibility-weighted indicated relativities are adjusted to the base class level in Column 10.

Loss Ratio Approach – Part 2

(9) Credibility-Weighted Indicated Relativity	(10) Credibility-Weighted Indicated Relativity @ Base Class	(11) Selected Relativity	(12) Relativity Change	(13) Relativity Change with Off-Balance
1.0227	1.0000	1.00	0.0%	2.4%
1.2056	1.1789	1.18	2.6%	5.0%
2.0075	1.9630	1.96	0.5%	2.9%
1.3401	1.3104	1.31	-3.0%	-0.7%
3.2400	3.1682	3.17	-9.4%	-7.3%
0.8563	0.8373	0.84	-1.2%	1.2%
			-2.3%	0.0%

(10) = (9) / (Base9)
(12) = (11) / (8) - 1.0
(Tot12) = (12) Weighted by (1)
(13) = [1.0 + (12)] / [1.0 + (Tot12)] - 1.0

Column 10: Uses column (9) credibility-weighted indicated relativities to adjust to the base class level

Column 11: Selected relativities, and
Column 12: The total change (-2.3%):

- is the weighted average of the class changes using premium at current rate level as the weight.
- represents the expected change in premium due to the selected class relativity changes, and is the amount the base rate needs to be offset if these relativity changes are to be implemented on a revenue-neutral basis.

Column 13: The relativity change for each class if the base rates are offset.

6 Key Concepts 169 - 169

1. Definitions used in classification ratemaking
    a. Rating variable
    b. Level of a rating variable
    c. Rate differentials

2. Importance of equitable rates
    a. Adverse selection
    b. Favorable selection

3. Considerations for evaluating rating variables
    a. Statistical criteria
    b. Operational criteria
    c. Social criteria
    d. Legal criteria

4. Calculating indicated rate differentials
    a. Pure premium approach
    b. Loss ratio approach
    c. Adjusted pure premium approach

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

By relevant, we mean <u>concepts</u> tested on past CAS exams relate to similar to the <u>concepts</u> found in this chapter.

Section 1: Criteria Used In Traditional Risk Classification

Questions from the 1991 exam

3. According to Werner and Modlin, "Basic Ratemaking", statistical criteria are used to achieve which of the following goals when establishing a classification system?

   1. Homogeneity 2. Credibility 3. Causality

   A. 1 B. 2 C. 3 D. 1, 2 E. 1, 3.

Questions from the 1993 exam

31. a. (1 point) Identify the three statistical criteria for selecting rating variables mentioned in Werner and Modlin, "Basic Ratemaking".

Questions from the 1997 exam

31. (3 points) According to Werner and Modlin, "Basic Ratemaking",

a. (2 points) Identify and explain three statistical criteria that should be considered when selecting rating variables for a classification plan.

b. (1 point) Question no longer applicable to the content covered in this chapter.

Questions from the 1998 exam

43. Werner and Modlin, "Basic Ratemaking" list a number of social criteria that any rating plan should satisfy.

a. (1 point) List and briefly describe four of these social criteria.

Questions from the 2004 exam

29. (4 points) ABC Insurance Company writes standard auto business in State X and uses driver classification to rate policies. Based on the most recent analysis, a 5% rate level increase is needed in order to maintain rate adequacy. This rate level need varies by driver classification, as detailed in the table below.

Driver Classification	Indicated Rate Change
A	-40%
B	-20%
C	+20%
D	+40%
State Total	+5%

a. (1 point) Other than an overall rate level increase, describe an action the insurance company could undertake to restore overall rate adequacy. Assume that the indicated rate need by driver classification does not change when the proposed action is taken.
b. (1 point) Suppose that ABC Insurance Company's chief competitor in State X has the same underwriting rules and writes a similar distribution of business as ABC Insurance Company. The competitor is rate adequate by driver classification as well as on a statewide basis. Describe the situation that could result if ABC Insurance Company fails to reflect the indicated changes by driver classification.
c. (1 point) Suppose regulation was enacted abolishing the use of the driver classification rating variable for State X. Briefly describe the impact on ABC Insurance Company's profitability.
d. (1 point) Briefly describe the social consequences of the abolishment of the driver classification rating variable.

40. (2 points) Finger, in "Classification Ratemaking," discusses several criteria for rating variables. Some companies use information from credit reports as a rating variable. State four criteria for rating variables and explain whether or not they are fulfilled by information from credit reports.

Questions from the 2005 exam:

45. (2 points) Finger, in "Risk Classification," discusses the effect of market forces on the refinement of insurance classification plans.
    a. (1 point) Describe how the behavior of policyholders creates pressure on insurers to refine classification plans.
    b. (1 point) Explain why classification plans may also become more refined as insurance coverage becomes more expensive. Discuss the perspective of both the insurer and the policyholder.

Questions from the 2006 exam

8. Which of the following changes might cause an insurer to develop a more refined classification plan?
    1. The market becomes more competitive.
    2. Coverage becomes more expensive.
    3. The market becomes larger.

A. 1 only B. 2 only C. 1 and 3 only
D. 2 and 3 only E. 1, 2, and 3

Questions from the 2006 exam

38. (3 points) Werner and Modlin, "Basic Ratemaking" discuss various criteria for selecting rating variables. As the actuary for an insurance company, you are developing an auto class plan in which one of the proposed rating variables is estimated miles driven during the coverage period.
    a. (1.5 points) Identify and briefly describe two statistical criteria, and explain whether mileage defined this way satisfies these criteria.
    b. (1.5 points) Identify and briefly describe two operational criteria, and explain whether mileage defined this way satisfies these criteria.

Questions from the 2008 exam:

28. (2.0 points) An insurance company wants to use color of car as a rating variable within its risk classification system.
    a. (1.0 point) Identify two operational risk classification criteria and evaluate the variable "color of car" with respect to each criterion.
    b. (1.0 point) Identify two social risk classification criteria and evaluate the variable "color of car" with respect to each criterion.

Questions from the 2009 exam:

33. (1 point) Fully discuss how an insurance company can "skim the cream" to gain a competitive advantage.

34. (1.5 points) An insurance company is considering using a rating factor based on a detailed psychological profile.
    a. (1 point) Identify and briefly explain two of the criteria for desirable classification rating factors.
    b. (0.5 point) Evaluate if the rating factor based on the new psychological profile meets each of the criteria identified in part a. above.

Section 2: Traditional classification analysis using PP and LR analyses.

Questions from the 1991 exam

41. (2 points) This question should be answered using Chapter 5, "Risk Classification" from the CAS textbook Foundations of Casualty Actuarial Science.

Using the loss ratio method and the data that follows, calculate the revised territorial relativities. Territory A is the base class. Show all work.

Territory	EP @ Present Rates	Incurred Losses	Credibility	Existing Relativity
A	2,000,000	1,400,000	.85	1.000
B	1,500,000	900,000	.50	.900
C	500,000	400,000	.40	1.200
Total	4,000,000	2,700,000		

Questions from the 1994 exam

42. (4 points) Use the methodologies described by Finger in chapter 5, "Risk Classification," Foundations of Casualty Actuarial Science, and the information below:

Territory	Earned Exposures	Base Exposure	Earned Premium	Incurred Losses	Claim Count	Current Relativity
A	800	1,000	$200,000	$108,000	530	1.000
B	1,800	1,500	300,000	180,000	1,200	0.900
C	400	500	100,000	72,000	271	0.800

The full credibility standard is 1,082 claims.

(a) (2 points) What are the territory relativities using the loss ratio approach?
(b) (2 points) What are the first iteration territory relativities using the pure premium approach?

Questions from the 1996 exam

Question 32. (4 points) You are given:

Class	Incurred Losses	Current Class Relativity	Historical Earned Exposure Territory A	B	Total
1	500,000	1.000	2,000	3,000	5,000
2	400,000	1.100	1,500	1,500	3,000
3	360,000	0.900	2,000	2,000	4,000
Total	1,260,000		5,500	6,500	12,000
Current Territory Relativity:			1.000	0.600	

Using the pure premium method described by Finger, chapter 5, "Risk Classification," Foundations of Casualty Actuarial Science:

(a) (2 points) Determine the first iteration classification relativities.
(b) (1 point) Determine the first iteration territory base exposures.
(c) (1 point) Explain your selection of exposures for weighting classification relativities in (a) above.

Questions from the 1997 exam

43. (3 points) You are given:

Territory	Prior Year Base Rates	Prior Year Earned Premium	Current Year Base Rates	Current Year Earned Premium	Combined Years Earned Premium @ Current Rates	Combined Years Incurred Losses	Combined Years Claim Counts
A	100	250,000	110	300,000	575,000	330,000	435
B	60	400,000	55	350,000	716,667	525,000	800
C	120	200,000	100	250,000	416,667	290,000	390
D	150	100,000	160	150,000	256,667	135,000	275

- Full credibility is 1,082 claims
- Territory A is the base territory
- Incurred losses and claim counts are developed and trended
- No weighting is used to combine the two years of data

Based on Finger, "Risk Classification," chapter 5 of Foundations of Casualty Actuarial Science, calculate the indicated territorial relativities using the loss ratio approach.

Questions from the 1999 exam

13. Based on Finger, "Risk Classification" chapter 5 of Foundations of Casualty Actuarial Science, use the loss ratio approach for setting classification relativities and the data below to determine the adjustment to class B's relativity after balancing to no overall rate change.

Class	Earned Premium	Incurred Loss	Credibility
A	$100	$60	0.50
B	$200	$90	1.00
Total	$300	$150	

A. < -10%
B. ≥ -10% but < -8%
C. ≥ -8% but < -6%
D. ≥ -6% but < -4%
E. ≥ -4%

Questions from the 2000 exam

21. Using the loss ratio approach described by Finger in "Risk Classification," chapter 5 of Foundations of Casualty Actuarial Science, and the following data, calculate the indicated balanced adjustment to territory 3's relativity.

Territory	Earned Premium	Incurred Losses	Credibility
1	$1,200,000	$600,000	1.00
2	800,000	500,000	0.80
3	500,000	300,000	0.60

A. < 1.010 B. ≥ 1.010 but < 1.030 C. ≥ 1.030 but < 1.050 D. ≥ 1.050 but < 1.070 E. ≥ 1.070

Questions from the 2005 exam

49. (3 points) Using a loss ratio approach, calculate the territorial relativities indicated by the following information. Show all work.

- Territory A is the base class.
- 2005 earned premium is an accurate estimate of next year's writings.
- Incurred losses are for the experience period 2003-2004 and are fully trended and developed.
- The full credibility standard is 1,082 claims. Partial credibility is determined using the square root rule.

		Earned Premium			Base Rates				
Territory	Current Relativity	2003	2004	2005	2003	2004	2005	Incurred Losses	Claim Count
A	1.00	$500,000	$600,000	$600,000	$50	$55	$55	$500,000	1,500
B	0.40	$100,000	$200,000	$200,000	$40	$40	$60	$300,000	300

Questions from the 2008 exam

30. (3.0 points) You are given the following information:

Territory	Premium	Incurred Loss & ALAE	Claim Count	Current Relativity
1	$520,000	$420,000	600	0.60
2	$1,680,000	$1,250,000	1,320	1.00
3	$450,000	$360,000	390	0.52
	$2,650,000	$2,030,000	2,310	

- Full credibility standard is 1,082 claims and partial credibility is calculated using the square root rule.
- The complement of credibility is no change.

Calculate indicated territorial relativities using this most recent experience. Assume that Territory 2 remains the base territory.

Questions from the 2009 exam:

37. (3 points) Given the following information:

Territory	Historical Earned Exposures	Current Territorial Relativity	Average Relativity for Other Factors*	Reported Losses	Reported Claim Count
1	4,000	0.60	1.30	$ 420,000	600
2	16,000	1.00	1.05	$1,250,000	1,320
3	3,750	0.52	1.20	$ 360,000	390

*Weighted-average rate relativity for all factors except territory.

- Territory 2 will remain the base territory.
- Full credibility standard is 1,082 claims.
- Complement of credibility is no change.

Calculate the indicated territorial relativities.

Questions from the 2010 exam:

29. (3 points) A private passenger auto insurance company uses only two rating variables: territory and marital status.

The distribution of exposures is:

Marital Status	Territory 1	Territory 2	Territory 3
Married	123	79	87
Single	74	123	33

The rating factors for each variable are:

Marital Status	Current Relativity
Married	1.00
Single	1.15

Territory Territory	Current Relativity
1	0.60
2	1.00
3	0.90

Losses/LAE for each category during the experience period are:

Territory	Marital Status	Loss & LAE
1	Married	$7,760
1	Single	$5,789
2	Married	$8,307
2	Single	$16,038
3	Married	$8,233
3	Single	$3,873

- No fixed expense adjustment is necessary.
- All policies have the same underwriting expense and target profit.

a. (2.5 points) Using the adjusted pure premium approach and maintaining the same base classes, develop the indicated relativity for policyholders who are single.

b. (0.5 point) Explain why the adjusted pure premium approach is preferable to the pure premium method.

Questions from the 2011 exam:

11. (2.75 points) Given the following information for State X:

- Only two insurance companies write automobile policies
- Total expected costs (including expenses) per policy are the same for 2010 and 2011
- All policies are annual policies effective January 1
- 10% of class 1 risks shop for new insurance every year
- 20% of class 2 risks shop for new insurance every year
- All insureds who shop always select the carrier with the lowest rate

2010 Policy Year		Company A				Company B			
Class	Total Insureds	# Insureds	Expected Costs	2010 Rates	2011 Rates	# Insureds	Expected Costs	2010 Rates	2011 Rates
1	10,000	5,000	100	150	100	5,000	100	150	150
2	10,000	5,000	200	150	200	5,000	200	150	150
Total	20,000	10,000	150	150		10,000	150	150	

Company A will introduce a new rating variable effective January 1, 2011, that segments the market into two 2 classes.

The 2011 rate levels will be consistent with the expected costs associated with each class of business.

Company B will not be changing rates on January 1, 2011. Company B uses one rate level for all insureds.

a. (1.5 points) Calculate the total profit for Company A and Company B for Policy Year 2011.

b. (0.5 point) Company A's goals were to improve profitability and increase market share. Briefly explain whether the goals were achieved.

c. (0.25 point) Provide one recommendation to Company A to help achieve its goals of improved profitability and increased market share.

d. (0.5 point) Describe the impact of Company A's action on Company B.

Questions from the 2011 exam:

15. (3 points) Given the following information:

Territory	Earned Exposures	Developed Incurred Loss and ALAE Total for Accident Years 2009 and 2010	Current Relativity
A	20,000	$500,000	1.00
B	5,000	$125,000	0.95
C	15,000	$250,000	1.25
Total	40,000	$875,000	

- The effective date for the proposed rate change is January 1, 2012 and rates will be in effect for one year.
- Average date of loss is January 1, 2010.
- All policies are annual.
- Full credibility standard 11,050 exposures

On a statewide basis, annual pure premium trends have been holding steady at 0%.

However, due to fraudulent claim behavior, pure premiums are expected to trend at different rates throughout the state as follows:

Territory	Annual Pure Premium Trend
A	-5%
B	0%
C	10%
Total	0%

This fraudulent behavior is expected to continue into the foreseeable future.

a. (2.75 points) Assuming Territory A is the base territory, calculate the credibility-weighted indicated relativities to the base territory.

b. (0.25 point) Briefly describe a reason multivariate classification techniques are preferred over univariate classification techniques when performing territorial relativity analyses.

Questions from the 2012 exam:

13. (1.75 points) Given the following information:

	As of January 1, 2011	As of July 1, 2011
Base Rate	$200	$250
Good Driver Discount Factor	0.85	0.75
Territory 1 Factor	1.00	1.00
Territory 2 Factor	1.10	1.10

	Good Driver Discount	
Exposures	Yes	No
Territory 1	750	250
Territory 2	600	150

	Good Driver Discount	
Loss and ALAE	Yes	No
Territory 1	$90,000	$40,000
Territory 2	$80,000	$20,000

- The rating algorithm is base rate x good driver discount factor x territory factor.
- Territory 1 and No Good Driver Discount remain the base classification.

Use the loss ratio method to calculate indicated territorial relativities.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

By relevant, we mean concepts tested on past CAS exams relate to similar to the concepts found in this chapter.

Section 1: Criteria Used In Traditional Risk Classification

Solutions to questions from the 1991 exam

Question 3.

1. T.
2. T.
3. F. This is one of the social criteria. **Answer D.**

Solutions to questions from the 1993 exam

Question 31. The three statistical criteria are: Credibility, Homogeneity, and Statistical Significance.

Solution to questions from the 1997 exam

Question 31.

a Credibility: A rating group should be large enough so that costs can be measured with sufficient accuracy.
Homogeneity: If all are charged the same rate, then all members should have the same expected costs.
Statistical Significance: The rating variable should be a **statistically significant** risk differentiator, meaning:

- Expected cost estimates should vary for the different levels of the rating variable
- Estimated differences should be within an acceptable level of statistical confidence
- Estimated differences should be relatively stable from one year to the next.

b. Question no longer applicable to the content covered in this chapter.

Solution to questions from the 1998 exam

Question 43.

1. Privacy. People in general are reluctant to provide any information than what is normally justifiable for securing insurance. Although some insureds may choose to pay more in order to avoid disclosing personal information, others might secure insurance from carriers that do not require this information for rating purposes. Therefore, introducing this rating element into the plan does not satisfy one of the social criteria that should be a part of any sound rating plan.

2. Affordability. High rates, and higher rates for lower income groups cause affordability problems. If there was a tendency for lower income households to have a greater than average number of children, then the proposal would not satisfy this social criterion.

3. Causality. Causality implies that an intuitive relationship exits between the rating variable and the cost of insurance. The proposal satisfies this criteria, since the greater the number of children in a household, the more likely it is that liability losses may ensue from careless or reckless behavior. However, additional studies should be conducted to determine whether this is truly a causal relationship and not a highly correlated one.

4. Controllability. When insureds have some control over a rating variable, they can implement accident prevention measures. Therefore, the proposal fails this criterion since the insured realistically cannot control this exposure.

Solutions to questions from the 2004 exam:

29. a. (1 point) Other than an overall rate level increase, describe an action the insurance company could undertake to restore overall rate adequacy. Assume that the indicated rate need by driver classification does not change when the proposed action is taken.

The insurer should try to retain its lower cost insureds within a classification by adjusting its underwriting practices. In this case, it should try to retain more insureds in driver classifications A and B.

b. (1 point) Suppose that ABC Insurance Company's chief competitor in State X has the same underwriting rules and writes a similar distribution of business as ABC Insurance Company. The competitor is rate adequate by driver classification as well as on a statewide basis. Describe the situation that could result if ABC Insurance Company fails to reflect the indicated changes by driver classification.

If ABC fails to reflect indicated changes by driver classification, ABC will receive a disproportionate number of higher cost insureds, relative to its classification plan. ABC will be adversely selected against. “If the adverse selection continues, ABC must either lose money, change its underwriting criteria, or increase its premiums. Premium increases may induce ABC’s lower-cost insureds to move to another insurer, creating more adverse selection and producing a need for further premium increases.”

c. (1 point) Suppose regulation was enacted abolishing the use of the driver classification rating variable for State X. Briefly describe the impact on ABC Insurance Company's profitability.

If drivers were equally distributed among A, B, C and D, then there would be no impact. However, the state total indicated rate change is positive (+5) which implies that there are more C and D drivers who need an increased rate for ABC to be profitable. Thus, if the driver classification rating variable was abolished, ABC would be less profitable.

d. (1 point) Briefly describe the social consequences of the abolishment of the driver classification rating variable. “Abolition will create subsidies. Insurers may voluntarily insure underpriced groups. Otherwise, residual markets will expand; since most residual markets are subsidized by the voluntary market, subsidies will be created.”

Solutions to questions from the 2004 exam:

40. (2 points) State four criteria for rating variables and explain whether or not they are fulfilled by information from credit reports.

1. Privacy: not fulfilled, since people are reluctant to have personal information disclosed to others, and consider credit report data a very private issue.
2. Causality: not fulfilled, since a bad credit report has no causal connection to an individual's propensity to have more claims, or more severe claims.
3. Controllability: is fulfilled. Since insureds have control over managing their finances and paying off their debts, the use of credit reports as a rating variable allows insureds to reduce their premiums through fiscal responsibility.
4. Availability: fulfilled, since companies have access to and can run credit reports easily to determine an insured's fiscal responsibility.

Solutions to questions from the 2005 exam

45. (2 points) Finger, in "Risk Classification," discusses the effect of market forces on the refinement of insurance classification plans.

a. (1 point) Describe how the behavior of policyholders creates pressure on insurers to refine classification plans.

Policyholders shop around for the most affordable coverage. Therefore, insurers who can identify lower cost risks can make greater profits by offering discounts to lower cost insureds. This process is known as "skimming the cream".

Conversely, insurers who don't recognize high-cost characteristics will be adversely selected against.

In either case, this puts pressure on insurers to refine their classification plans.

b. (1 point) Explain why classification plans may also become more refined as insurance coverage becomes more expensive. Discuss the perspective of both the insurer and the policyholder.

Insurer:

- has more "expense" dollars on more expensive coverages with which to refine the classification system.
- has incentive to keep large premium accounts that are profitable.

Insured:

- has more incentive to shop around as coverage becomes more expensive since he/she is paying the premium. Thus, the more insureds shop, the more incentive an insurer has to refine its class plan.

Solutions to questions from the 2006 exam:

8. Which of the following changes might cause an insurer to develop a more refined classification plan?

1. The market becomes more competitive. True. A competitive market tends to produce more refined classifications and accurate premiums.
2. Coverage becomes more expensive. True. Classification systems may also become more refined as coverage becomes more expensive. From the buyer's side, shopping for favorable prices is encouraged when coverage is more expensive. From the insurer's side, more expense dollars may be available to classify and underwrite; in addition, the cost of making mistakes, or of not having as refined a system, is higher when premiums are higher.
3. The market becomes larger. True. Classification systems usually are more refined for larger markets.

A. 1 only B. 2 only C. 1 and 3 only D. 2 and 3 only E. 1, 2, and 3

Answer: E.

Solutions to questions from the 2006 exam:

38. (3 points) Werner and Modlin, "Basic Ratemaking" discuss various criteria for selecting rating variables.

As the actuary for an insurance company, you are developing an auto class plan in which one of the proposed rating variables is estimated miles driven during the coverage period.

a. (1.5 points) Identify and briefly describe two statistical criteria, and explain whether mileage defined this way satisfies these criteria.

b. (1.5 points) Identify and briefly describe two operational criteria, and explain whether mileage defined this way satisfies these criteria.

CAS Model Solutions

Part a.

1 – Homogeneity (relates to similar insureds being grouped together) – If you group insured by miles driven, you are in fact putting similar exposures to loss together, so their average loss cost should be similar.

2 – Credibility (having enough data to estimate future costs) – If you segment miles driven into large enough discrete ranges, you should have enough data to accurately estimate future loss costs.

Part b.

1 - Verifiable/Available (the rating variable is easily available for rating purposes) – “Estimated” miles would need to be audited at end of year and therefore not easily available/verifiable.

2 – Cost Effective (the increase in accuracy should be balanced by the cost of getting data) – Since audits would be required, this variable may not be cost effective.

- OR -

3 – Objective (should have little ambiguity, mutually exclusive and exhaustive classes) – Classes which are mutually exclusive and exhaustive should be easy to derive, and mileage is an objective measure, so mileage is objective.

Solutions to questions from the 2008 exam:

Question 28.

a. 1. Verifiable - color would be easy to verify
   2. Objective Definition - color would also satisfy this criteria

b. 1. Privacy - color would satisfy this criteria since color is not a very private issue
   2. Controllability -the insured can choose the color of their car, so it is controllable

Solutions to questions from the 2009 exam:

Question 33

If an insurer notices a positive characteristic that is not used in their rating structures (or competitors), the insurer can market to those with the positive characteristic and try to write more of them (skimming the cream). The insurer will then benefit from lower loss ratios and better profitability.

Solutions to questions from the 2009 exam:

Question: 34

a. Cost effective - the cost of obtaining the information should not exceed the benefit of additional accuracy.

Privacy – insured may rather pay more to avoid disclosing certain information

b. For cost effectiveness, detailed psychological profile may cost a lot to obtain. This is most likely not cost effective.

For privacy, many people will not want to take the psychological test for the profile or may not wish to disclose their profile to insurance company.

Alternate Solution:

a. 1. Social criteria: privacy, affordability, causality and controllability

2. Operational: Low administrative expense, objective definition, verification intuitively related, underlying losses

b. 1. Social: privacy not met, insured may not want to disclose that information and it's not something that's easily controllable, although it may be good from causality standpoint.

2. Operational: increased administrative expense, but it is objectively defined, verifiable, and likely intuitively related.

Section 2: Traditional classification analysis using PP and LR analyses.

Solutions to questions from the 1991 exam

Question 41.

Territory	Loss Ratio	LR relativity	Cred	Credibility wtd LR relativity	Premium Extension	Balanced LR relativity	Existing Relativity	Territory Relativity
	(1)	2= 1/1 tot	(3)	4 = (2-1.0)*3 + 1.0	5 = EP * 4	6 = 4/4tot	(7)	8=6*7/6base
A	.700	1.037	.85	1.0315	2,063,000	1.027	1	1.00
B	.600	0.888	.50	.944	1,417,000	.940	.90	.824
C	.800	1.185	.40	1.074	537,000	1.070	1.20	1.25
Total	.675	1.000		1.004	4,017,000			
				4017K/4000K				

Solution to questions from the 1994 exam

Question 42. Note: The values shown above are identical to those asked in question 38, on the 1992 exam.

a. Territory relativities using the loss ratio approach.

Terr	Loss Ratio IL / EP	relativity	Cred	Credibility wtd LR relativity	Premium Extension	Balanced LR relativity	Existing Relativity	Territory Relativity
	(1)	2= 1/1 tot	(3)	4 = (2-1.0)*3 + 1.0	5=EP*4	6=4/4tot	(7)	8=6*7/6base
A	.54	.90	.70	.93	186,000	.937	1.000	1.000
B	.60	1.0	1.0	1.0	300,000	1.007	.900	.967
C	.72	1.2	.50	1.1	110,000	1.108	.800	.945
Total	.60			.9933	596,000			
				596K/600K				

Note: Credibility = Min ($\sqrt{\text{claim count / 1082}}$, 1.0)

b. Territory relativities using the pure premium approach.

Terr	Pure Premium IL/B.Exp	relativity	Cred	Credibility wtd PP relativity	Premium Extension	Balanced PP relativity	Existing Relativity	Territory Relativity
	(1)	2= 1/1 tot	(3)	4 = (2-1.0)*3 + 1.0	5=EP*4	6=4/4tot	(7)	8=6*7/6base
A	108	.90	.70	.93	186,000	.937	1.000	1.000
B	120	1.0	1.0	1.0	300,000	1.007	.900	.967
C	144	1.2	.50	1.1	110,000	1.108	.800	.945
Total	120			.9933	596,000			
				596K/600K				

Note: 1. Credibility = Min ($\sqrt{\text{claim count / 1082}}$, 1.0)

2. The suggested solution accompanying the 1994 CAS exam does not follow the procedure in the 1995 errata to this syllabus reading.

Solution to questions from the 1996 exam

(a) (2 points) Determine the first iteration classification relativities.

Question 32: An approach to calculating class relativities using the pure premium method:

New class relativity = Current class relativity * Indicated adjustment.

The indicated adjustment, for class (i) = $\text{Class}_i \text{ pure premium} / \sum_{i=1}^{3} \text{Class}_i \text{ pure premium}$.

The class (i) pure premium is computed using "base exposures"

Base exposures in this example are earned exposures adjusted for current territorial relativities.

Class	Current Class & Territory A Relativity	Current Class & Territory B Relativity	Historical Earned Exposures A	Historical Earned Exposures B	Base Exposures A	Base Exposures B
1	**1.000**	.600	2,000	3,000	2,000	1,800
2	1.100	.660 = .6*1.10	1,500	1,500	1,650	990
3	0.900	.540 = .6*.900	2,000	2,000	1,800	1,080
Total			5,500	6,500	5,450	3,870

Class	Incurred Losses	Total Base Exposures	Pure Premium	Indicated Adj. (Pure premium relativity	Current Class Relativity	First Iteration Class Relativity
1	500,000	3,800	131.58	0.973	1.000	1.000
2	400,000	2,640	151.52	1.121	1.100	1.267 = 1.121/.973*1.10
3	360,000	2,880	125.00	0.925	0.900	.855
Total	1,260,000	9,320	135.19			

(b) Using the first iteration class relativities, compute the first iteration territory base exposures.

Class	Indicated Class & Territory A Relativity	Terr B Relativity	Indicated Class & Territory B Relativity	Historical Earned Exposures A	Historical Earned Exposures B	Base Exposures A	Base Exposures B
1	**1.000**		.600	2,000	3,000	2,000	1,800
2	1.267		.760 = 1.267*.600	1,500	1,500	1,900	1,140
3	0.855		.513	2,000	2,000	1,710	1,026
Total		.600		5,500	6,500	5,610	3,966

(c) "the reason for using base exposures instead of actual exposures is to correct for varying exposure levels in the non-reviewed relativities. For example, Territory A and B may differ in the distribution of insureds by class".

Solution to questions from the 1997 exam

Question 43: Based on Finger, "Risk Classification," chapter 5 of Foundations of Casualty Actuarial Science, calculate the indicated territorial relativities using the loss ratio approach.

1. Replace unclear column headings with more meaningful ones.
   Column 12 in exhibit II is labeled “Preliminary adjustment”. Its counterpart in the exhibit below is labeled “Combined years loss ratio relativity”.
2. Compute only those values necessary to calculate the territorial relativities.

Territory	Combined years Experience Loss Ratio (1)	Combined years Experience Relativity (2)	Credibility (3)	Credibility wtd LR relativity (4)	Current EP * (4) (5)	Balanced Crd LR rel (6)	Current Relativity (7)	Territory Relativity (8)
	(1)	2= 1/(1 tot)		4 = (2-1.0)*3 + 1.0	5=EP*4	6=4/4tot		8=6*7/6base
A	0.574	0.881	0.634	0.925	277,500	0.915	1.000	1.000
B	0.733	1.125	0.860	1.108	387,800	1.097	0.500	0.599
C	0.696	1.068	0.600	1.041	260,250	1.030	0.909	1.023
D	0.526	0.807	0.504	0.903	135,450	0.894	1.455	1.420
Total	0.651			1.010	1,061,000			

Note: Column (3) Credibility = Min $(\sqrt{\text{claim count} / 1082},\ 1.0)$.

Column (4) total, 1.010 = Column (5) total ÷ Current year earned premium total (1,050,000), which is given.

Column (7) relativities are based on the Current year base rates in each territory relative to the base territory (a).

Solutions to questions from the 1999 exam

Question 13.

1. Replace unclear column headings with more meaningful ones.
   Column 12 in exhibit 2 is labeled “Preliminary adjustment”. Its counterpart in the exhibit below is labeled “Combined years loss ratio relativity”.
2. Compute only those values necessary to calculate the territorial relativities.

Class	Combined years Loss Ratio IL / EP	Combined years Loss Ratio relativity	Credibility	Credibility wtd LR relativity	Premium Extension	Balanced LR relativity
	(1)	2= 1/1 tot	(3)	4 = (2-1.0)*3 + 1.0	5=EP*4	6=4/4tot - 1
A	.60	1.20	.50	1.10	110	
B	.45	.90	1.00	.90	180	-.069
Total	.50			.966 290/300	290	

Note: Column (3) credibility is given

Column (4) total, .966 = Column (5) total ÷ Current year earned premium total, which is given.

Thus, the adjustment to class B's relativity after balancing to no overall rate change is -.069. Answer C.

Solutions to questions from the 2000 exam

Question 21.

Terr	Earned Premium	Incurred Losses	Loss Ratio	Loss ratio relativity	Cred	Credibility wtd LR relativity	Premium Extension	Balanced Adjustment
			(1)	2= 1/1 tot	(3)	4 = (2-1.0)*3 + 1.0	5 = EP * 4	6 = 4/4tot
1	1.2M	600K	.500	.893	1.00	.893	1.072M	
2	800K	500K	.625	1.116	.80	1.093	874.4K	
3	500K	300K	.600	1.071	.60	1.043	521.5K	1.0567
Total	2.5M	1.4M	.560			.987	2.468M	
						2.468M/2.5M		

Answer D.

Solutions to questions from the 2005 exam

49. (3 points)

Using a loss ratio approach, calculate the territorial relativities indicated by the given information.

Step 1: Compute on-level earned premium for 2003 and 2004. Create a table similar to the one below to compute on-level earned premium to be used in Step 2 below.

Territory	2003 Premium	2004 Premium	2003 Base Rate	2004 Base Rate	Onlevel 2003-2004 Earned Premium	2005 Premium	Trend&Dev 2003-2004 Incurred Losses	Claim Count
	(1)	(2)	(3)	(4)	(5)		(6)	
A	500,000	600,000	50	55	1,150,000	$600,000	500,000	1,500
B	100,000	200,000	40	40	450,000	$200,000	300,000	300
Total	600,000	800,000			1,600,000	**800,000**	800,000	1,800

(5) = [(1)/(3)+(2)/(4)]*2005 base rates

Step 2: Compute the indicated territorial relativities ((8) below) by creating a table similar to the one below and performing the notated computations.

Territory relativities using the Loss Ratio Approach.

Territory	Experience Loss Ratio	(2003-2004) Relativity	Credibility	Credibility wtd LR relativity	Curr EP * (4)	Balanced Crd LR rel	Current Relativity	Territory Relativity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A	0.435	0.870	1.000	0.870	521,739	0.919	1.000	**1.000**
B	0.667	1.333	0.527	1.176	235,104	1.243	0.400	**0.541**
Total	0.500			0.946	756,843			

Notes See page 321
(2)= 1/1 tot. (3) = Sqrt[Claim Count / 1082] Full Cred = 1.0 if CC > 1,082
(4) = [(2)-1.0]*3 + 1.0. (4) Total = 756,843/**800,000**
(6) = (4) / (4,Total)
(8) = [(7)*(6)] / (6,A)

Solutions to questions from the 2008 exam:

Model Solution 1 - Question 30

Territory	Premium	Incurred Loss & ALAE	Loss Ratio	Preliminary Adjustment	Credibility	Credibile Adjustment	Current Relativities	Indicated Relativities
	(1)	(2)	(3)=(2)/(1)	4=(3)/(3)total	(5)	6=[(4)-1]*(5)+1	(7)	(8)=(6)/(6)2*(7)
1	$520,000	$420,000	0.8077	1.054	0.745	1.040	0.600	0.643
2	$1,680,000	$1,250,000	0.7440	0.971	1.000	0.971	1.000	1.000
3	$450,000	$360,000	0.8000	1.044	0.600	1.027	0.520	0.550
	$2,650,000	$2,030,000	0.7660					

(1), (2) and (7) are given
(4) 1.054=.8077/.7666
Column (5) Credibility = $\text{Min}\left(\sqrt{\text{claim count}/1082},\ 1.0\right)$
(8) = [(6)/.971] * (7), since territory 2 remains the base territory.

Model Solution 2 - Question 30

Initial comments.

In this model solution, premiums are adjusted to the territory 2 level, as shown in (2) below, prior to computing loss ratios in (4) below. By doing so, this allows us to compute indicate relativities to territory 2, since the latter will remain as the base territory. Indicated relativities are generally credibility weighted with existing relativities hence the need to compute (6) and (7).

Territory	Prem	Prem at Ter 2 Level	Loss & ALAE	Loss Ratio	Indicated Relativities	Credibility	Credibility Weighted Relativities
	(1)	(2)	(3)	(4)=(3)/(2)	$(5)=(4)/(4)_2$	(6)	(7)
1	520,000	866,667	420,000	0.4846	0.6513	0.745	0.638
2	1,680,000	1,680,000	1,250,000	0.7440	1.0000	1.000	1.000
3	450,000	865,385	360,000	0.4160	0.5591	0.600	0.543

(1) and (3) are given
(2) = (1)*[Territory 2 Current Relativity/Territory Relativity]
(6) Credibility = $\text{Min}\left(\sqrt{\text{claim count}/1082},\ 1.0\right)$
(7) = (5)(6) + [1.0-(6)](CurRel)

Solutions to questions from the 2009 exam:

Question: 37

Terr.	(1) (Historical x all relativities) Base Exposures	(2) Rep. Losses	(3)= (2)/(1) Base Premium	(4)= (3)/91.1 Prelim. Adjustment	(5) Credibility	(6)= (5)x((4)-1) +1 Cred. Adjustment	(7) =(6)/.816xCur. Rel. New Relativity
1	3,120	420,000	134.615	1.4761	0.74467	1.355	0.996
2	16,800	1,250,000	74.405	0.8159	1	0.816	1.000
3	2,340	360,000	153.846	1.6870	0.6004	1.412	0.900
Total	22,260	2,030,000	91.19				

Solutions to questions from the 2010 exam:

Question 29 – Model Solution - Part a.

The Adjusted PP approach can be performed using exposures adjusted by the exposure-weighted average relativity of all other variables (see (2) below).

The calculation of the current exposure-weighted average Marital Status relativities by territory is shown below:

Exposure Weighted Marital Status Relativity

Married: [123 (.60) + 79(1.0) + 87(.90)]/[123+79+ 87] = 231.1/289 = .7997

Single: [74(. 60) + 123 (1.0) + 33 (.90)]/[74+123+33] = 197.1/230 = .8570

Adjusted Pure Premium Method

Marital Status	Exposures	Exposure Adjustment	Adjusted Exposures	Loss and ALAE	Adjusted Pure Prem
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(4)/(3)
Married	289	0.7997	231.11	24,300	105.143
Single	230	0.857	197.11	25,700	130.384
			428.22	50,000	116.762
	Adjusted PP Rel	Ind Rel To Base			
	(6)=(5)/(5 tot)	(7)=(6)/(6 married)			
Married	0.9005				
Single	1.1167	**1.2401**			

(1) and (4) are given

Question 29 – Model Solution - Part b

The pure premium method gets distorted since it assumes uniform distribution of exposures across all other variables, thus ignoring the correlation between variables.

The adjusted pure premium method minimizes the impact of any distributional bias.

Solutions to questions from the 2011 exam:

a. (1.5 points) Calculate the total profit for Company A and Company B for Policy Year 2011.

b. (0.5 point) Co. A's goals were to improve profitability and increase market share. Did it achieve its goals?

c. (0.25 point) Provide one recommendation to Company A to help achieve its goals.

d. (0.5 point) Describe the impact of Company A's action on Company B.

Question 11 – Model Solution

[Co. A class 1 rate = **100**; Co. B class 1 rate = 150]; [Co. A class 2 rate = 200; Co. B class 2 rate = **150**]

Profitability = Sum[# of policies * (2011 rate – expected costs)]

- 10% of class 1 risks (from Co. B) shop for new insurance (due to a lower rate) = 10% * 5,000 = 500
- 20% of class 2 risks (from Co. A) shop for new insurance (due to a lower rate) = 20% * 5,000 = 1000

a. Class 1: 10% switch from B to A (500 new policies to A); Class 2: 20% switch from A to B (1000 policies)

A: 5500(=5000+500) * (100-100) + 4000(=5000-1000) * (200-200) = 0

B: 4500(=5000-500) * (150-100) + 6000(=5000+1000) * (150-200) = 225,000 – 300,000= -75,000

b. No. profit will always be zero as long as rates are equal to costs. Market share decreased. They lost more customers than they gained.

c. It should increase rates on Class 1, but not to 150 or more. It will attract business AND be profitable!

d. Company B will lose its Class1 customers, who are over-priced in that company. Company A will continue to send Class 2 customers to Company B, who ruin B’s profit margin. Company A can “skim the cream” while B is adversely selected against.

Solutions to questions from the 2011 exam:

- The effective date for the proposed rate change is January 1, 2012 and rates will be in effect for one year.
- Average date of loss is January 1, 2010.
- All policies are annual.
- Full credibility standard 11,050 exposures

15a. (2.75 points) Assuming Territory A is the base territory, calculate the credibility-weighted indicated relativities to the base territory.

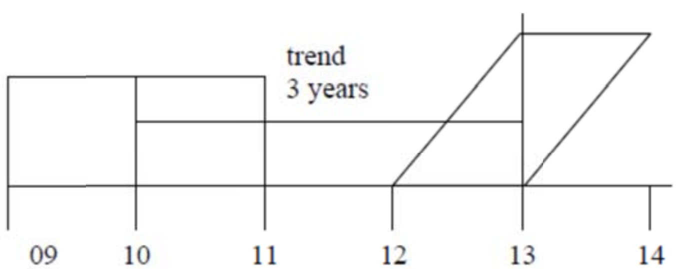
15b. (0.25 point) Briefly describe a reason multivariate classification techniques are preferred over univariate classification techniques when performing territorial relativity analyses.

Question 15 – Model Solution 1 – part a.

Terr	(1) PP = L&ALAE/EE	(2) Annual trend	(3) = (1) x (2) Trended PP	(4) = (3)/(3) tot Ind. Chg.
A	25	0.95^3	21.434375	0.979857
B	25	1^3	25	1.142857
C	16.667	1.1^3	22.183	1.014095
	21.875		21.875	

(5) Curr rel	(6) EE	(7) = (5)/(5) Tot Curr Rel	Cred(z) = Min($\sqrt{EE/11050}$,1.0)	(8) = (4)*z +(1-z)*(7) Cred weighted ind. chg	(9)=(8)/(8a) Cred weighted ind Chg to base
1.00	20k	0.919540	1	0.979857	1
0.95	5k	0.873563	0.672671794	1.0547097	1.076391
1.25	15k	1.103448	1	1.014095	1.03494
1.0875					

(5) total is exposure weighted; Trend from the avg. date of loss in the experience period to avg. date of loss in the exposure period (1 year after the effective date of the rates, since 1 year policies are issued)



Question 15 – Model Solution 1 – part b.

Because territorial relativities are generally highly dependent of other variables in the model. Thus, it is better to use a multivariate classification technique because it consider the exposure correlations between variables.

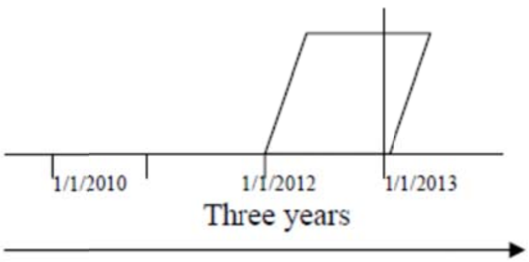
Solutions to questions from the 2011 exam (cont'd):

Question 15 – Model Solution 2 – part a.

Note: the difference between model solution 1 and model solution 2 lies in how the trended pure premium for all territories are calculated. In this solution it is calculated as Sum [losses * pp trend]/Sum[exposures]=22.161

Terr	Pure Prem	Pure Prem Trend	Trended Pure Prem	Ind Rel
A	25	0.95^3	21.43	0.9672
B	25	1	25	1.1281
C	16.67	1.1^3	22.18	1.0010
			22.161	

Trend period is shown below



Terr	Credibility	Curr Rel	Adj. Curr Rel	Cred weight Rel.
A	1.00	1.00	0.9195	0.9672
B	0.673	0.95	0.8739	1.0448
C	1.00	1.25	1.1494	1.001
		1.0875	1.00	

Terr	2nd Rel @ Base
A	1.00
B	1.08
C	1.03

Question 15 – Model Solution 2 – part b.

Territories are generally heavily correlated with other variables. Multivariate techniques take into account the effects of other variables, whereas univariate techniques do not.

Solutions to questions from the 2012 exam:

13. Use the loss ratio method to calculate indicated territorial relativities.

Question 13 – Model Solution 1 (Exam 5A Question 13)

First, calculate current premium for both territories.

→Territory 1 = 250(1)(.75)(750) [prem for good drivers]+ 250(1)(1.00)(250) [prem for remaining drivers]
= $203,125

→Territory 2 = 250 (1.1)(.75)(600) + 250 (1.1)(1.00)(150)= $165,000

Territory	Current relativity	(A) Loss& ALAE	(B) Current Prem	(C)=(A)/(B) Loss Ratio	(D) (C)/(C) for (1) indicated change factor	Proposed rel = current rel x (D)
1	1.000	$130,000	$203,125	0.64	1.000	1.000
2	1.100	$100,000	$165,000	0.606	0.947	1.042

Question 13 – Model Solution 2 (Exam 5A Question 13)

Terr	Curr Var Prem
1	750 x 250 x 0.75 + 250 x 250 = 203,125
2	600 x 250 x 0.75 x 1.1 + 150 x 250 x 1.1 = 165,000

Terr	OLEP	L+ALAE	LR	Indic Rd to	Indic Rd to Base
1	203,125	90k + 40k = 130	0.640	1 (base)	$\frac{0.60606 \times 1.1}{0.64}$ = 1.04167
2	165,000	80k + 20k = 100	0.606	1.0417	
	368,125	230k			

Examiner's Comments

Candidates in general performed well on this question. Most frequently candidates failed to use current rate level premium, which in this question is calculated via the extension of exposures method.

Candidates also frequently calculated only the indicated change factors to the current relativities, as opposed to calculating the final indicated relativity.

A subset of candidates misinterpreted the class plan and used the loss ratio method to solve for 4 different relativities concurrently (each combination of territory/good driver), as opposed to solving for the requested indicated territorial relativities.

A small group of candidates solved for indicated territory relativities by using a pure premium approach as opposed to the requested loss ratio approach. Some candidates made adjustments to the exposure bases to reflect the class plan relativities.

Chapter 10 – Multivariate Classification

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Shortcomings Of Univariate Methods 170 - 171

Class ratemaking:

- produces more equitable individual risk pricing by analyzing loss experience of groups of similar risks.
- protects the insurer against adverse selection.
- may provide insurers with a competitive advantage and help expand the types of risks the insurer is willing and able to write profitably.

Univariate class ratemaking approaches (pure premium or loss ratio) use loss experience of the levels within each rating variable to establish rate differentials to the base level.

The major shortcoming of univariate approaches:

Its failure to accurately account for the effect of other rating variables.

- The PP approach does not consider exposure correlations with other rating variables.

  If a rating algorithm contained several rating variables, this shortcoming could be mitigated using a two-way analysis or by making some manual adjustments.

  To illustrate the distortion created when using univariate methods, consider the following:

  Assume a one-way PP analysis for a personal auto book of business shows that older cars have high claims experience relative to newer cars.

  However, in reality it can be shown that this analysis is distorted by the fact that older cars tend to be driven by younger drivers (who have higher claims experience).

  Therefore, although the experience for both young drivers and old cars looks unfavorable, it does so primarily because of the youthful driver effect.
- The LR approach uses current premium to adjust for an uneven mix of business to the extent the premium varies with risk, but premium is only an approximation since it deviates from true loss cost differentials.

The adjusted pure premium approach multiples exposures by the exposure-weighted average of all other rating variables' relativities to standardize data for the uneven mix of business before calculating the one-way relativities. But, this is an approximation to reflect all exposure correlations.

2 Minimum Bias Procedures 171 - 174

Minimum bias procedures are iterative univariate approaches. Each procedure involves the:

- selection of a rating structure (e.g. additive, multiplicative or combined) and
- selection of a bias function (e.g. balance principle, least squares, χ^2, and maximum likelihood bias functions).

The bias function compares the procedure's observed loss statistics (e.g. loss costs) to indicated loss statistics and measures the mismatch.

Both sides of this equation are weighted by the exposures in each cell to adjust for an uneven mix of business.

"Minimum bias" refers to the balance principle that requires that the sum of the indicated weighted pure premiums to equal the sum of the weighted observed loss costs for every level of every rating variable (a.k.a. "minimizing the bias" along the dimensions of the class system).

The balance principle applied to a multiplicative personal auto rating structure is shown below.

- There are only two rating variables: gender and territory.
- Gender has values male (with a rate relativity g_1) and female (g_2).
- Territory has values urban (t_1) and rural (t_2).
- The base levels relative to multiplicative indications are female and rural (hence g_2 = 1.00 and t_2 = 1.00).
- The base rate is $100.

The actual loss costs (pure premiums) are as follows:

	Urban	Rural	Total
Male	$650	$300	$528
Female	$250	$240	$244
Total	$497	$267	$400

The exposure distribution is as follows:

	Urban	Rural	Total
Male	170	90	260
Female	105	110	215
Total	275	200	475

Step 1: Write four equations with observed weighted loss costs on the left and indicated weighted loss costs (the base rate, the exposure, and the indicated relativities) on the right.

Males 170 x $650 +90 x $300 = ($100 x 170 xg_1 x t_1) +($100 x 90 x g_1 x t_2)

Females 105 x $250 + 110 x $240 = $100 x 105 x g_2 x t_1 + $100 x 110 x g_2 x t_2

Urban 170 x $650+ 105 x $250 = $100 x 170 x g_1 x t_1 + $100 x 105 x g_2 x t_1

Rural 90 x $300+ 110 x $240 = $100 x 90 x g_1 x xt_2 + $100 x 110 x g_2 x t_2

Step 2: Choose initial (or seed) relativities for the levels of <u>one</u> of the rating variables.

A sensible seed is the univariate PP relativities.

The urban relativity is the total urban loss costs divided by the total rural loss costs:

$t1$ = 1.86 = ($497.27/$267.00)

$t2$ = 1.00.

Step 3: Substituting these seed values into the first two equations, solve for the first values of g_1 and g_2:

170 x \$650 + 90 x \$300 = (\$100 x 170 x g1 x 1.86) + (\$100 x 90 x g1 x 1.00)

\$137,500 = (\$31,620 x g1) + (\$9,000 x g1)

\$137,500 = \$40,620 x g_1

g_1 = 3.39.

105 x \$250 + 110 x \$240 = (\$100 x 105 x g_2 x 1.86) + (\$100 x 110 x g_2 x 1.00)

\$52,650 = (\$19,530 x g_2) + (\$11,000 x g_2)

\$52,650 = \$30,530 x g_2

g_2 = 1.72.

Step 4: Using these seed values for gender, g_1 and g_2, set up equations to solve for the new intermediate values of t_1 and t_2:

170 x \$650 + 105 x \$250 = (\$100 x 170 x 3.39 x t1) + (\$100 x 105 x 1.72 x t_1)

\$136,750 = (\$57,630 x t_1) + (18,060 x $_{t1}$)

\$136,750 = \$75,690 x t_1

t_1 = 1.81.

90 x \$300 + 110 x \$240 = (\$100 x 90 x 3.39 x t_2) + (\$100 x 110 x 1.72 x t_2)

\$53,400 = (\$30,510 x t_2) + (\$18,920 x t_2)

\$53,400 =\$49,430 x t_2

t_2 = 1.08.

This procedure is repeated (each time discarding the previous relativities and solving for new ones) until there is no material change in the values of g_1, g_2, t_1, and t_2.

Step 5: Upon convergence, normalize the base class relativities to 1.00.

Assuming the relativities derived above represent the final iteration, then normalizing the base class relativities to 1.00 would result in:

g_1 = 3.39 / 1.72 = 1.97

g_2 = 1.72 /1.72 = 1.00

t_1 = 1.81 /1.08 = 1.68

t_2 = 1.08 /1.08 = 1.00.

The initial univariate relativity for t_1 was 1.86, but after one iteration, the replacement value for t_1 is 1.68, (reflecting the fact that the cell for urban males has considerably more exposure than the other cells, and thus the experience in that cell is given more weight).

Step 6: Adjust the base loss cost (to a normalized basis):

Since the base levels are female and rural (g_2 and t_2), and since the base loss cost = \$100, then the Adjusted base loss cost = \$100 x 1.72 x 1.08 = \$185.76.

The example above only considers one minimum bias method (multiplicative structure with balance principle) using the pure premium statistic. In addition, it considers only two rating variables each with two levels.

The computation required to incorporate several rating variables requires at least spreadsheet programming.

Sequential analysis:

- is related to minimum bias analysis.
- is mandated as the only class ratemaking method for pricing private passenger auto insurance CA.
- uses an adjusted one-way PP approach on the first variable to determine the indicated relativities.

  exposures are adjusted using the adjusted one-way PP approach and indicated relativities are calculated for the second variable; this continues until indicated relativities for every variable have been calculated.
- involves making only <u>one</u> pass through the sequence of chosen rating variables (rather than iterating until convergence is achieved).

The main criticism of the non-iterative sequential approach: since it does not have a closed form solution; the results vary depending on the order of the rating variables in the sequence.

3 The Adoption of Multivariate Methods 174 -174

Minimum bias procedures are a subset of generalized linear models (GLMs).

Iterating the minimum bias procedure a sufficient number of times may result in convergence with GLM results (however GLMs are more computationally efficient).

Reasons for the adoption of GLMs for class ratemaking in the late 20th century/early 21st century:

1. Computing power increased.

2. New data warehousing improved the granularity and accessibility of data for ratemaking purposes (enhanced computing power and better data enabled its use in class ratemaking).

3. Competitive pressure called for adoption of multivariate methods (putting the rest of the industry in a position of adverse selection and decreased profitability).

4 The Benefits Of Multivariate Methods 174 -175

1. The main benefit: consideration of all rating variables simultaneously and automatically adjust for exposure correlations between rating variables
2. The methods attempt to remove unsystematic effects in the data (a.k.a. noise) and capture only the systematic effects (a.k.a. signal) as much as possible.

   This is not the case with univariate methods (which include both signal and noise in the results).
3. The methods produce model diagnostics (additional information about the certainty of results and the appropriateness of the model fitted).
4. They allow interaction between two or more rating variables.

   Interactions occur when the effect of one variable varies according to the levels of another (e.g. the effect of square footage varies across different levels of AOI).

   Clarifying interaction with exposure correlation:
   - Interaction (a.k.a. response correlation); Exposure correlation (describes a relationship between the exposures of one rating variable and another).
   - Examples:
     i. Gender exposures may be uniformly distributed across age (i.e. at any age there is an identical distribution of men and women and no exposure correlation exists), but the two variables may ***interact*** if the loss experience for men relative to women is distinctly different at the youthful ages than at the middle and senior ages.
     ii. A variable's exposures may be unevenly distributed across the levels of another rating variable (i.e. exposure correlation exists), ***yet no interaction is present***.
5. Benefits vary among different types of multivariate methods.

   GLMs are transparent; the model output includes parameter estimates for each level of each explanatory variable in the model, as well as a range of statistical diagnostics.

   In contrast, neural networks are criticized for a lack of transparency.

How the methods mentioned before stack up to this list of benefits/disadvantages:

Univariate methods:
- are distorted by distributional biases.
- heavily distorted by unsystemic effects (noise).
- require no assumptions about the nature of the underlying experience.
- produce a set of answers with no additional information about the certainty of the results.
- can incorporate interactions but only by expanding the analysis into two-way or three-way tables.
- scores high in terms of transparency (but is plagued by the inaccuracies of the method).

Minimum bias methods:
- account for an uneven mix of business but iterative calculations are computationally inefficient.
- require no assumptions about the structure of the model and the bias function.
- do not produce diagnostics
- scores high on transparency and outperforms univariate analysis in terms of accuracy (but does not provide all of the benefits of full multivariate methods).

GLMs are the standard for class ratemaking.

The iterations of a GLM can be tracked, and the output is a series of multipliers that can be used in rating algorithms and rating manuals.

A Mathematical Foundation for GLMs: Linear Models

A good way to understand GLMs is to first review linear models (LMs).

- Both LMs and GLMs express the relationship between an observed response variable (Y) and a number of explanatory variables (a.k.a. predictor variables). Example:
- The response variable may be claim frequency for homeowners insurance, and the predictor variables may include AOI, age of home, and deductible.

  Observations in the data (e.g. claims on individual exposures) are realizations of the response variable.

Linear models:

- express the response variable (Y) as the sum of its mean (μ) and a random variable (ε) (a.k.a. error term): $Y = \mu + \varepsilon$
- assume that the mean can be written as a linear combination of the predictor variables. Example:

  $Y = (\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4) + \varepsilon$ where $X_1,\ X_2,\ X_3,\ and\ X_4$ are each predictor variables,

  and $\beta_1, \beta_2, \beta_3, and\, \beta_4$ are the parameter estimates to be derived by the LM.

- assume that the random variable, ε , is normally distributed with a mean of 0 and constant variance, σ^2.
- attempt to find the parameter estimates, which, when applied to the chosen model form, produce the observed data with the highest probability.

  This is achieved using the likelihood function (or the log-likelihood), as maximum likelihood relies on linear algebra to solve a system of equations.

  Due to the high volume of observations in class ratemaking datasets, numerical techniques such as multi-dimensional Newton-Raphson algorithms are used. These techniques find the maximum of a function by finding a zero in the function's first derivative.

  The likelihood function is equivalent to minimizing the sum of squared error between actual and indicated.

Generalized Linear Models: Loosening the Restrictions

GLMs:

- are LMs that remove the restrictions of the normality assumption and a constant variance.
- use a link function to define the relationship between the expected response variable (e.g. claim severity) and the linear combination of the predictor variables (e.g. age of home, amount of insurance, etc.).

  Choice of link functions means predictor variables do not have to relate strictly in an additive fashion (as they do with LMs). Example: GLMs fit to claims experience for ratemaking often specify a log link function which assumes the rating variables relate multiplicatively to one another.

To solve a GLM, the modeler must:

- have a dataset with a sufficient number of observations of the response variable and associated predictor variables.
- select a link function defining the relationship between the systematic and random components.
- specify the distribution of the underlying random process (e.g. a member of the exponential family such as normal, Poisson, gamma, binomial, inverse Gaussian); this is done by specifying the mean and the variance of the distribution, the latter being a function of the mean.

The maximum likelihood approach:

- maximizes the logarithm of the likelihood function and
- computes the predicted values for each variable.

6 Sample GLM Output 177 - 179

GLMs are often performed on loss cost data (usually frequency and severity separately).

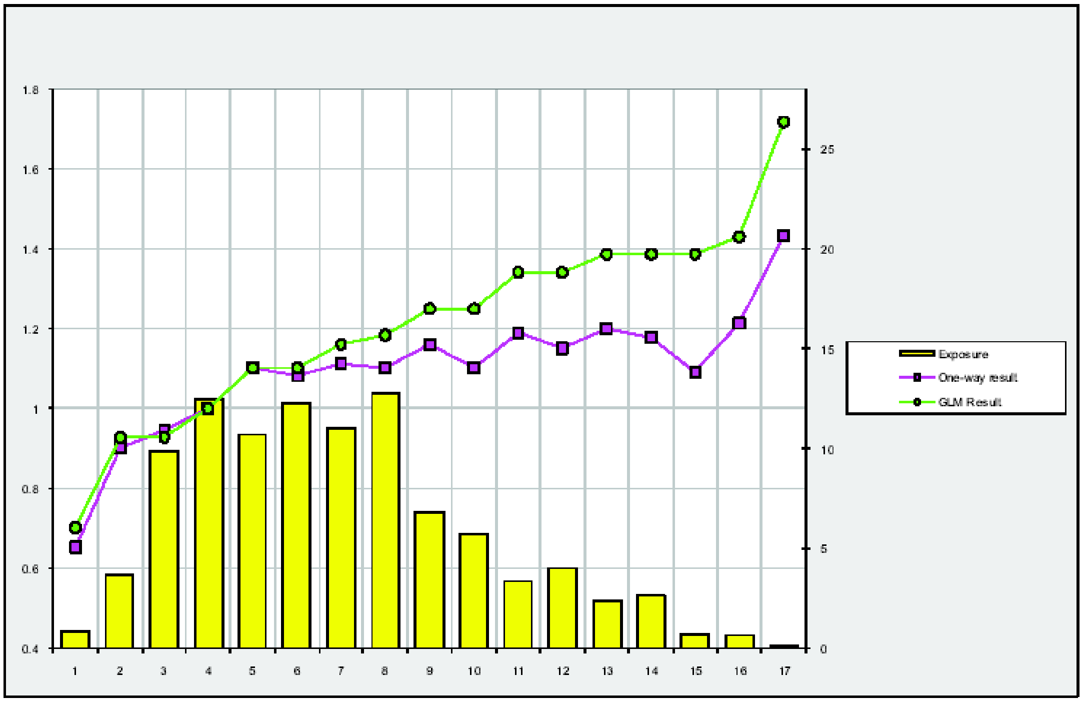
Statistical and practical reasons for doing so include:

- Modeling loss ratios requires premiums at a current granular rate level (which is difficult to obtain).
- An a priori expectation of frequency and severity patterns (e.g. youthful drivers have higher frequencies) are needed.
- LRMs are obsolete when rates and rating structures are changed.
- There is no commonly accepted distribution for modeling loss ratios.

Graphing GLM output is useful to strengthen an understanding of GLMs.

- The rating variable (vehicle symbol) has 17 discrete levels and each level's exposure count is shown as yellow bars (on the right y-axis).
- Each symbol groups vehicles having common characteristics (e.g. weight, number of cylinders, horsepower, and cost).
- Discrete variables (a.k.a. categorical factors), and continuous variables (a.k.a. variates) can be incorporated into GLMs. Variates can take the form of polynomials or splines (a series of polynomial functions with each function defined over a short interval) within GLMs.

Effect of Vehicle Symbol on Automobile Collision Frequency



The output is from a multiplicative model.

The base level (to which all other levels' parameter estimates are expressed relatively) is vehicle symbol 4.

- Its multiplicative differential is 1.00, and is chosen as one with the largest volume of exposure (so that statistical diagnostics are relative to a large and stable base).
- Notice that the GLM indicates that vehicle symbol 10 has a 25% higher indicated collision frequency than vehicle symbol 4, all other variables being considered.

- The pink line with square markers represents the results of a univariate analysis.
- The disparity b/t the GLM and univariate lines suggest vehicle symbol is strongly correlated with another variable in the model (e.g. age of driver, prior accident experience, etc).

It is important to understand the phrase "all other variables being considered."

- GLM results of one variable are only meaningful if the results for all other variables are considered at the same time (a.k.a. "all other variables being constant" or "all other variables at the base level.")
- Chapter 13 discusses how the insurer's final rate relativities often deviate from the actuary's indicated relativities for business reasons.

7 A Sample Of GLM Diagnostics 179 - 182

Statistical significance is an important criterion for evaluating rating variables, and statistical diagnostics are a major byproduct of GLMs. Statistical diagnostics:

- aid the modeler in understanding the certainty of the results and the appropriateness of the model.
- can determine if a predictive variable has a systematic effect on losses (and be retained in the model).
- assess the modeler's assumptions around the link function and error term.

A common statistical diagnostic for deciding whether a variable has a systematic effect on losses is the standard errors calculation.

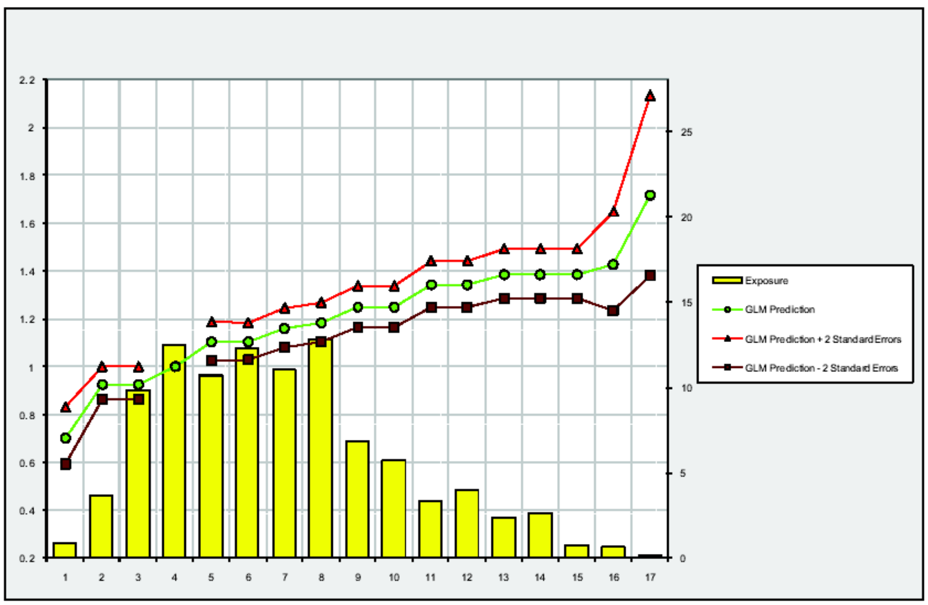
- "standard errors are an indicator of the speed with which the log-likelihood falls from the maximum given a change in parameter."
- 2 standard errors from the parameter estimates are akin to a 95% confidence interval.

  i. the GLM parameter estimate is a point estimate

  ii. standard errors show the range in which the modeler can be 95% confident the true answer lies within.

  The following graph is identical to the graph shown previously but now includes standard error lines for the non-base levels (i.e., +/- two standard errors from the differentials indicated by the GLM).

Standard Errors for Effect of Vehicle Symbol on Automobile Collision Frequency



Results:

- The upward pattern and narrow standard errors suggest this variable is statistically significant.
- Wide standard errors may suggest the factor is detecting mostly noise and be eliminated from the model.

  Symbol 17 shows wide standard errors, but that is a function of the small volume present in that level (and thus does not invalidate the strong results for symbols 1- 16, where most of the business lies).

Deviance measures (an additional diagnostic) assess the statistical significance of a predictor variable.

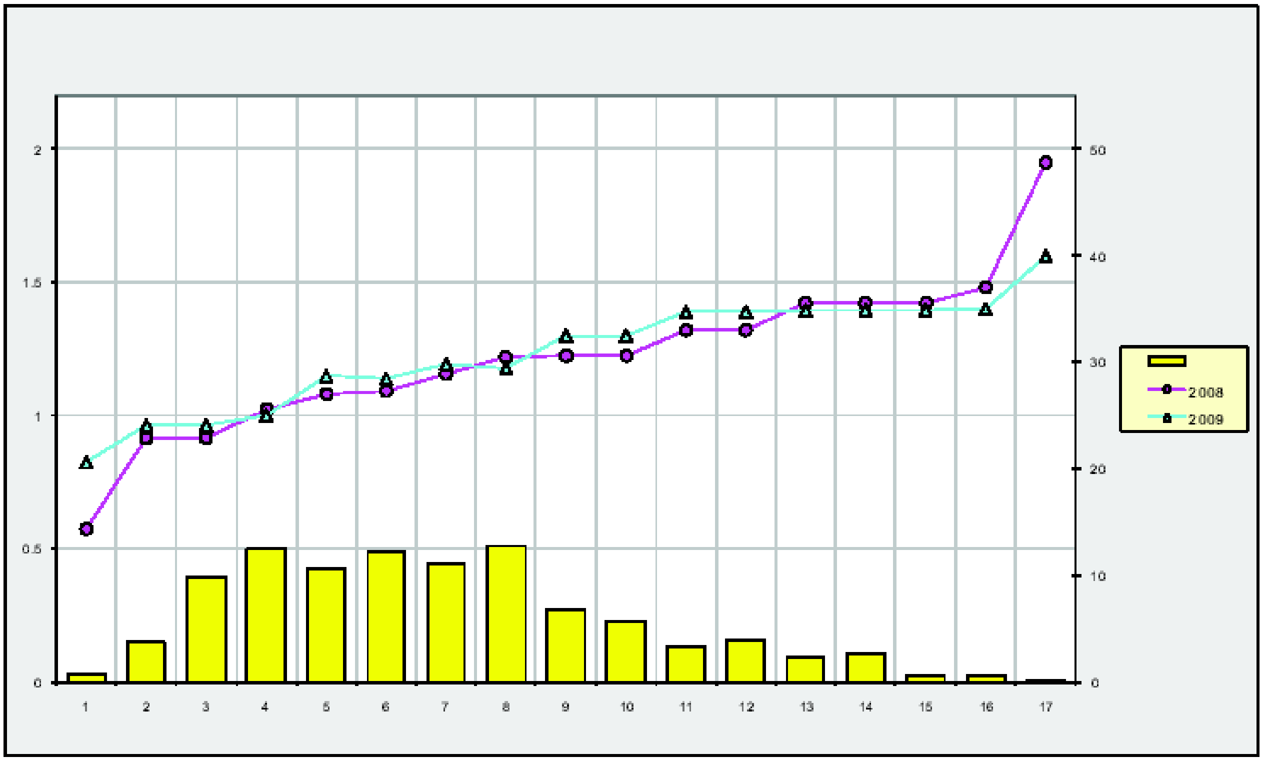
- Deviance measures of how much fitted values differ from the observations.
- Deviance tests are used when comparing nested models (one is a subset of the other) to assess whether the additional variable(s) in the broader model are worth including.

  i. The deviance of each model is scaled so that the results can be compared.

  ii. Chi-Square or F-test gauge the theoretical trade-off between the gain in accuracy by adding the variables versus the loss of parsimony in adding more parameter estimates to be solved.

A practical diagnostic in modeling is to compare GLM results for individual years to gauge consistency of results from one year to the next.

Consistency over time of vehicle symbol on auto collision frequency separately for the two years



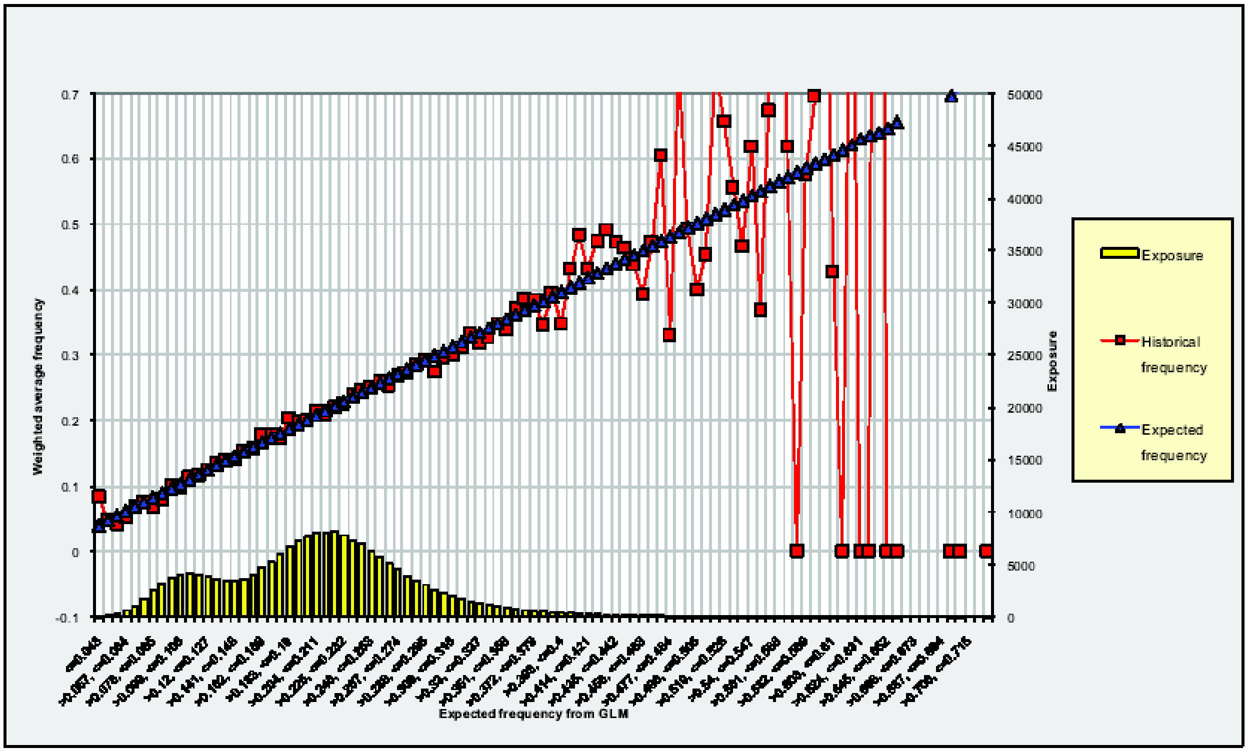
The two lines show some random differences but in general the patterns are the same.

Model validation techniques compare the expected outcome with historical results on a hold-out sample of data (i.e. data not used in developing the model so that it could be used to test the effectiveness of the model).

The following output is a validation of a frequency model.

- The bands of expected frequencies from the GLM (from lowest to highest) track closely to the actual weighted frequency of each band in the hold-out sample of data (for most of the sample)
- The volatile results for the high expected frequency bands are a result of low volume of data.

Model Validation



Over-fitting and Under-fitting Models:

- If the modeler retains variables that reflect a non-systematic effect on the response variable (i.e. noise) or over-specifies the model with high order polynomials, the result is over-fitting.

  The model will replicate historical data very well (including the noise) but will not predict future outcomes reliably (the future experience will not have the same noise).
- If the model is missing important statistical effects (containing few explanatory variables and fits to the overall mean), the result is under-fitting.

  This model will hardly help the modeler explain what is driving the result.

See Appendix F includes for additional examples and more details.

When using GLMs, the actuary should focus on:

- ensuring data is adequate for the level of detail of the class ratemaking analysis (avoiding the GIGO principle: Garbage In, Garbage Out)
- identifying when anomalous results call for additional exploratory analysis
- reviewing model results as it relates to both statistical theory and business application
- developing methods to communicate model results in light of an insurer's ratemaking objectives (e.g. policyholder dislocation, competitive position)

More work can be done.

- Retrieving of data requires careful consideration of needed volume of data; definition of homogeneous claim types; method of organization (e.g. PY vs. CAY); treatment of midterm policy changes, large losses, U/W changes during the experience period, and the effect of inflation and loss development.
- Balance stability and responsiveness as it relates to experience period as well as to geographies to be included in the analysis (e.g. countrywide versus individual state analysis).
- Commercial considerations (e.g. IT constraints, marketing objectives, and regulatory requirements) have to be carefully incorporated into the statistical analysis before any results are implemented in practice.

9 Data Mining Techniques 183 - 185

Data mining techniques are used to enhance classification analysis in the following **five** ways:

1. Factor Analysis

Factor analysis is a technique to reduce the number of parameter estimates in a class analysis (e.g. a GLM). This can be a reduction in the number of variables or a reduction in the levels within a variable.

Example:

- Summarize the exposure correlation between two variables in a scatter plot,
- Fit a regression line that summarizes the linear relationship between the two variables.
- A variable can then be defined that approximates this regression line.
- This combined variable replaces the original variables and thus reduces the parameter estimates of the model.

This technique can be used to compress a long list of highly correlated variables into a score variable that represents linear combinations of the original variables.

Examples:

- The vehicle symbols discussed earlier may have been derived as a linear combination of correlated variables (e.g. vehicle weight, vehicle height, number of cylinders, horsepower, cost when new, etc.).
- Combining geo-demographic variables which describe average characteristics of an area (e.g. population density, average proportion of home-ownership, average age of home, median number of rooms in the home, etc.)

2. Cluster Analysis

- combines small groups of similar risks into larger homogeneous categories or "clusters."
- minimizes differences within a category and maximizes differences between categories.
- is used in rating for geography, with actuaries starting with small geographic units (e.g. zip code)
- applies different algorithms to group these units into clusters based on historical experience, modeled experience, etc.

3. CART (Classification and Regression Trees)

CART is used to develop tree-building algorithms to determine a set of if-then logical conditions that help improve classification.

In personal auto, a tree may start with an if-then condition around gender.

- If the risk is male, the tree then continues to another if-then condition around age.
- If the risk is male and youthful, the tree may continue to an if-then condition involving prior accident experience.

Examining the tree may help actuaries identify the strongest list of initial variables and determine how to categorize each variable.

CART can also help detect interactions between variables.

4. MARS (Multivariate Adaptive Regression Spline)

MARS algorithm:

- operates as a piecewise linear regression where breakpoints define a region for a particular linear regression equation.
- is used to select breakpoints for categorizing continuous variables. Example:
  In HO insurance, AOI may be treated as a categorical factor despite being continuous in nature, and can help select the breakpoints used to categorize the AOI factor before using it in a GLM.
- can help detect interactions between variables.

5. Neural Networks

Neural networks are sophisticated modeling techniques but are criticized for their lack of transparency.

Test data is gathered and training algorithms are invoked to automatically learn the structure of the data (a.k.a. a recursion applied to a GLM).

The results of a neural network can be fed into a GLM (or vice versa), which helps highlight areas of improvement in the GLM (e.g. a missing interaction).

The data mining techniques listed above can enhance a ratemaking exercise by:

- whittling down a long list of explanatory variables to a more manageable list for use within a GLM;
- providing guidance in how to categorize discrete variables;
- reducing the dimension of multi-level discrete variables (i.e. condensing 100 levels, many of which have few or no claims, into 20 homogenous levels);
- identifying candidates for interaction variables within GLMs by detecting patterns of interdependency between variables.

10 Augmenting Multivariate Analysis With External Data 185 - 185

Insurers using GLMs seek to augment data that has already been collected and analyzed about their own policies with external data. This includes but is not limited to information about:

- geo-demographics (e.g. population density of an area, average length of home ownership of an area);
- weather (e.g. average rainfall or number of days below freezing of a given area);
- property characteristics (e.g. square footage of a home or business, quality of the responding fire department);
- information about insured individuals or business (e.g. credit information, occupation).

11 Key Concepts 187 - 187

1. Shortcomings of univariate approach
2. Minimum bias techniques
3. Circumstances that led to the adoption of multivariate techniques
   a. Computing power
   b. Data warehouse initiatives
   c. Early adopters attaining competitive advantage
4. Overall benefits of multivariate methods
   a. Adjust for exposure correlations
   b. Allow for nature of random process
   c. Provide diagnostics
   d. Allow interaction variables
   e. Considered transparent
5. Mathematical foundation of generalized linear models (GLMs)
6. Sample GLM output

7. Statistical diagnostics, practical tests, and validation techniques
   a. Standard errors
   b. Deviance tests
   c. Consistency with time
   d. Comparison of model results and historical results on hold-out sample
8. Practical considerations
9. Data mining techniques
   a. Factor analysis
   b. Cluster analysis
   c. CART
   d. MARS
   e. Neural networks
10. Incorporation of external data in multivariate classification analysis

12 Appendix F – A Multivariate Classification Example

The appendix includes output from a GLM analysis. It includes:

- several tests used to evaluate the predictive power of a potential rating variable
- **hold-out** sample testing used to evaluate the overall effectiveness of a particular model.

EXAMPLE - PREDICTIVE VARIABLE (a multiplicative GLM fit to homeowners water damage frequency data)

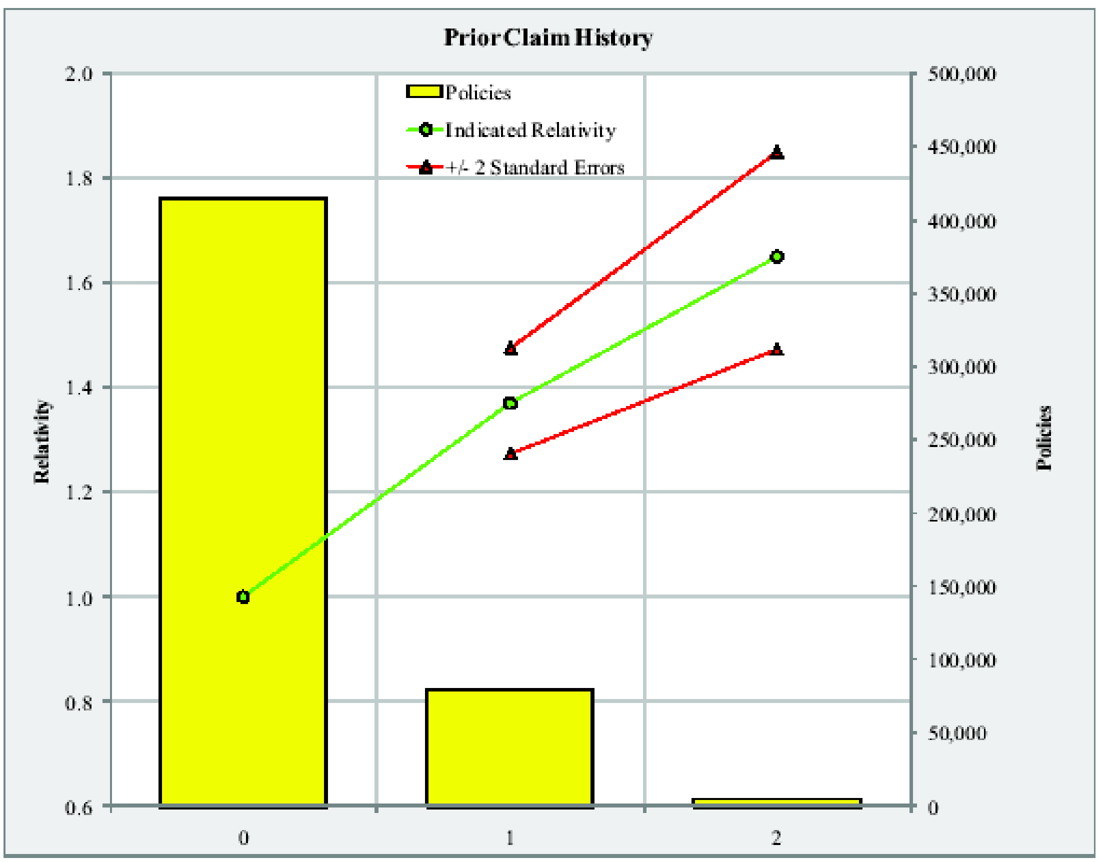
- The graphical output isolates the effect of the prior claim history variable as a significant predictor of water damage frequency, however
- The model contains other explanatory variables that must be considered in conjunction with the prior claims history effect.

Parameters and Standard Errors

The graph shows indicated frequency relativities for prior claims history (all other variables considered).

- The x-axis represents the levels of the variable (0, 1, or 2 claims), with the level for zero claims being the base level, and all other levels expressed relative to it.
- The bars relate to the right y-axis, which show the number of policies in each level. The line with the circle marker shows the indicated relativities, and the lines with the triangle markers represent two standard errors on either side of the indicated relativities.

Main Effect Test for Prior Claim History



Conclusions:

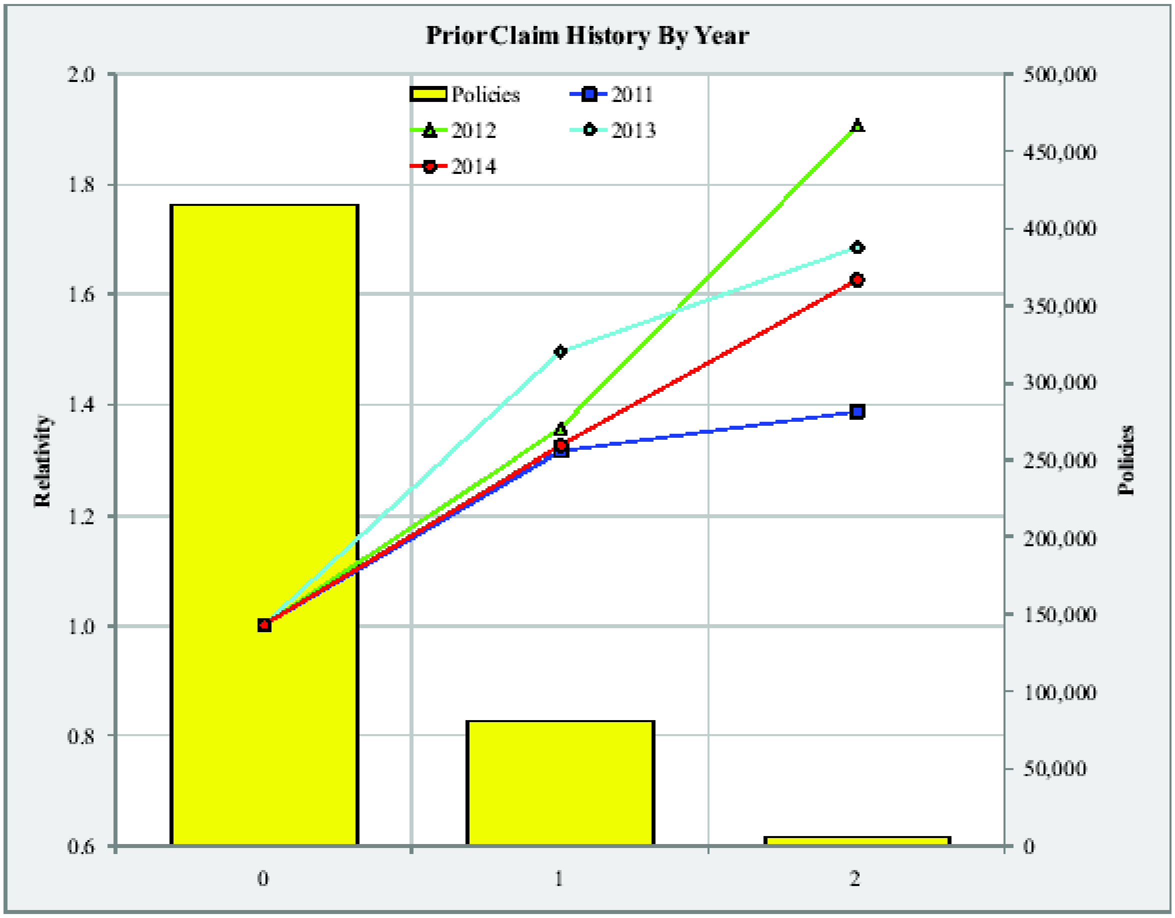
- The upward sloping indicated relativity line with relatively tight standard errors suggests that the expected frequency is higher for risks with prior claims.
- Risks with 1 or 2 prior claims have a frequency about 35% and 65% higher than risks with no prior claims.

Consistency Test

The prior graph shows the indicated relativities for the whole dataset.

- The following shows the pattern of relativities for each of the individual years included in the analysis.
- The lines represent the indicated frequency relativities for prior claims history, separately for each year.

Consistency Test for Prior Claim History



Each year's indicated line slopes upward with roughly the same shape suggests that the pattern is consistent over time, and provides the actuary with a test supporting the stability of this variable's predictive power.

Statistical Test

The actuary can test the predictive power of a variable using deviance diagnostics

- Using the Chi-Square test, the actuary fits models with and without the variable being studied and analyzes the trade-off between the increased accuracy of the model with the variable versus the additional complexity in having additional parameters to estimate.
- The null hypothesis is that the two models are approximately the same.
- Calculate a Chi-Square percentage based on the results of the two models (a percentage of less than 5% suggests the actuary should reject the null hypothesis that the models are the same and should use the model with the greater number of parameters).

Here, the Chi-Square percentage is 0%; the actuary rejects the null hypothesis and selects the model with the greater number of parameters (e.g. select the model with prior claims history variable in it).

Judgment

- Evaluate the reasonableness of the model and diagnostic results based on knowledge of the claims experience being modeled.
- In this case, the statistical results are consistent with what is intuitively expected (i.e. that frequency is higher given the presence of prior claims).

Decision

All four tests suggest the rating variable is predictive, should be included in the model, and ultimately the rating algorithm.

EXAMPLE UNPREDICTIVE VARIABLE (from a multiplicative GLM fit to HO wind damage frequency data).

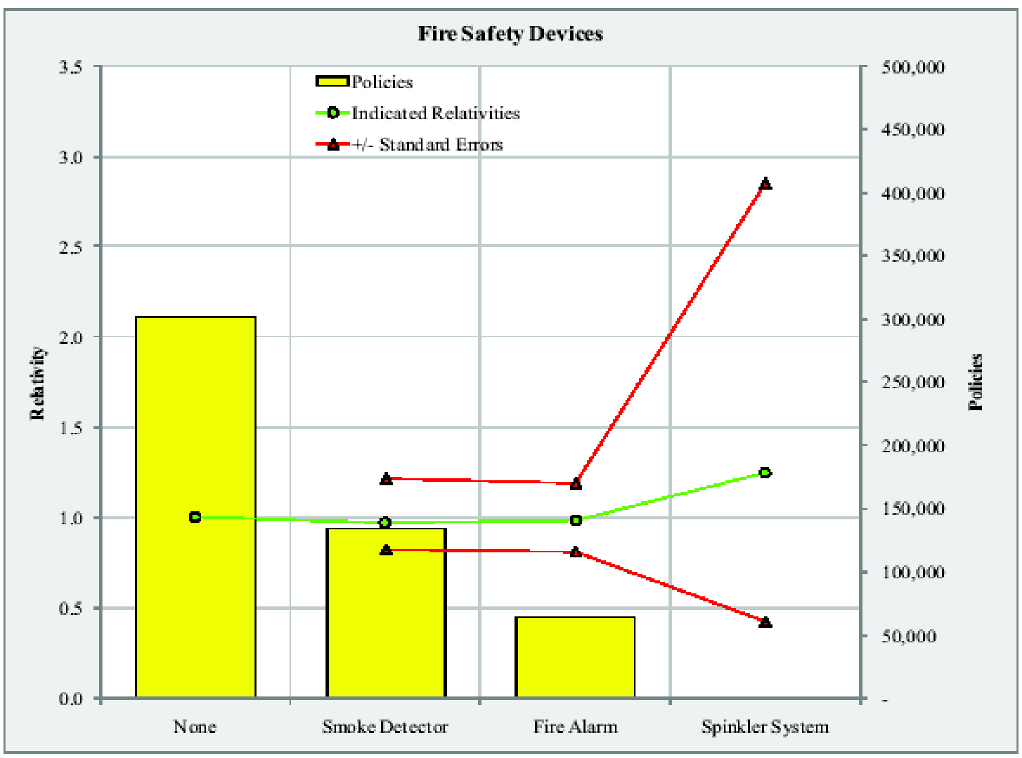
- The output isolates the effect of fire safety devices as an insignificant predictor of wind damage frequency, though
- The model contains other explanatory variables that must be considered in conjunction with this variable.

Parameters and Standard Errors

The graph shows indicated frequency relativities for the fire safety device variable (all other variables considered).

- The x-axis represents the different levels of fire safety devices (the base being the level "none")
- The bars are the number of policies in each level.
- The lines represent the indicated wind damage frequency relativities and two standard errors on either side of the indicated relativities.

Main Effect Test for Fire Safety Device

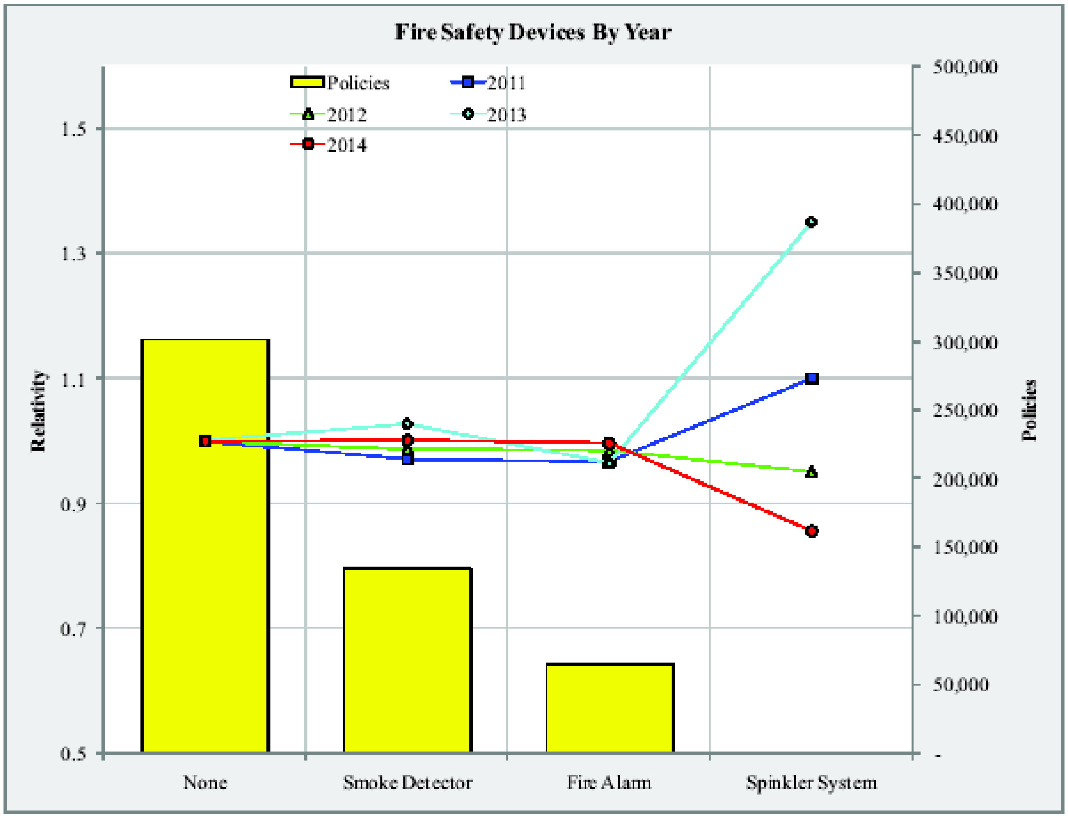


- The indicated line is flat (i.e. indicated relativities are close to 1.00) for the levels that have a significant number of policies. The sprinkler system has very wide standard errors around the indicated relativity, which is due to the small number of policies in that category.
- There is little variable predictive power, and should be removed from the wind damage frequency model.

Consistency Test

- The pattern for each of the individual years included in the analysis is shown below.
- The categories on the x-axis represent different fire safety devices, the bars are the number of policies in each level, and the lines represent the indicated relativities for each year.

Consistency Test for Fire Safety Device Claim



These results confirm the conclusions derived from the parameter results and standard errors.

- The patterns are consistent across the years for all categories but the sprinkler system.
- That sprinkler has little data, and the predictions are very volatile.

Statistical Test

The Chi-Square percentage for this variable is 74%.

- Percentages above 30% indicate that the null hypothesis that the models are the same should be accepted.
- If the models are "the same," the actuary should select the simpler model that does not include the additional variable (%s between 5% and 30% are often thought to be inconclusive based on this test alone).

Judgment

The existence of smoke detectors, sprinklers, and fire alarms does not seem to have any statistical effect on the frequency of wind damage losses (and consistent with intuition)

Decision

All four tests suggest the rating variable is not predictive (exclude it from the wind damage frequency model).

OVERALL MODEL VALIDATION

The most common test to analyze the overall effectiveness of a given model is one which compares predictions made by the model to actual results on a hold-out dataset (i.e. data not used to develop the model).

This test requires that insurers set aside a portion of the data for testing (although this may not be possible for smaller insurers).

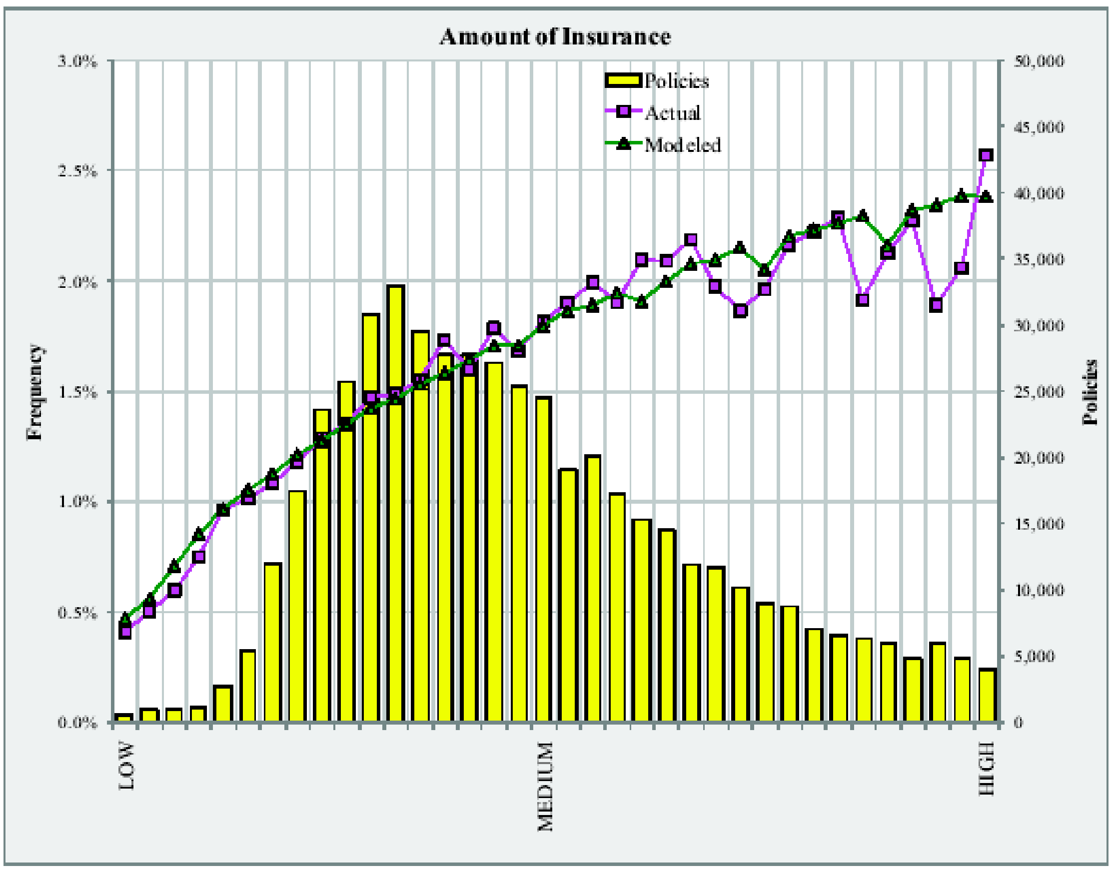
Validation Test Segmented by Variable

The following shows observed and predicted frequencies for various levels of AOI.

- If the model is predictive, the frequencies should be close for any level with enough volume to produce stable results.
- The insurance process is random and will create small differences between the lines; however, either large or systematic differences or both should be investigated as possible indicators of an ineffective model.

  Example: A model may contain too much noise from retaining statistically insignificant variables or not having enough explanatory power because statistically significant variables are omitted.

Actual Results v Modeled Results for AOI



The amount of insurance is a variable for which there is a natural order to view for the different levels.

- The modeled results for the first four levels appear to be higher than the actual results (i.e. the model may be over-predicting the frequency for homes with low AOI)
- Similar-sized discrepancies can be seen for medium AOI (actual results appear higher than the modeled results) and for high AOI (actual results appear lower than modeled results but with considerable volatility).

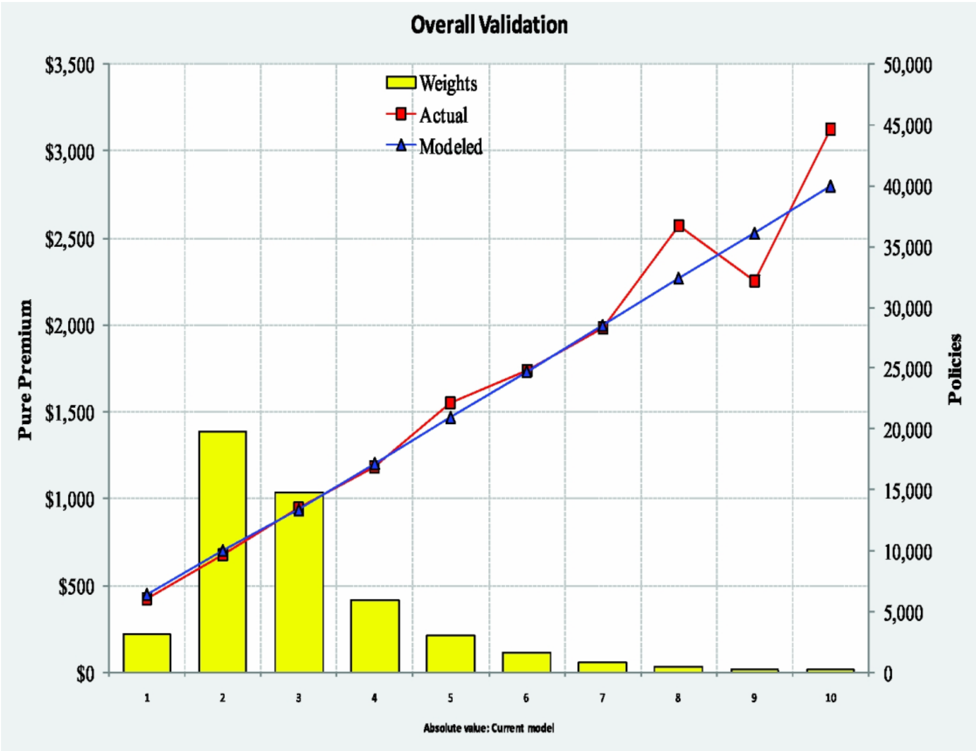
Validation Test Segmented by Fitted Value

1. Use the frequency and severity models to determine a modeled pure premium for each observation in a ***hold-out*** dataset.
2. Order each observation according to the modeled pure premium result from lowest to highest expected value.
3. Group the observations into 10 groups and compare actual and modeled results for each group on the chart.

** If the model is predictive, the actual result will be close to the modeled result for each group.

Special attention should be paid to the lowest and highest groups (where results are likely to deviate as models are generally less able to predict extreme observations).

Actual Results v Modeled Results



Conclusions:

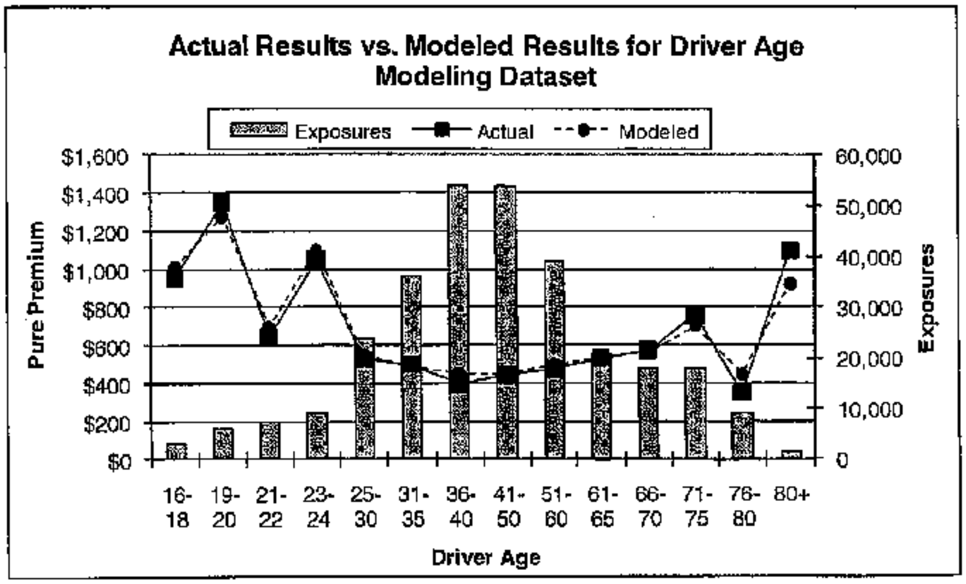
- Actual results are very close to the modeled results for the first seven groups.
- There appears to be a lot of difference between actual and modeled results for the last few groups (because the low volume in those groups suggests the results may be distorted by noise and therefore less valid).

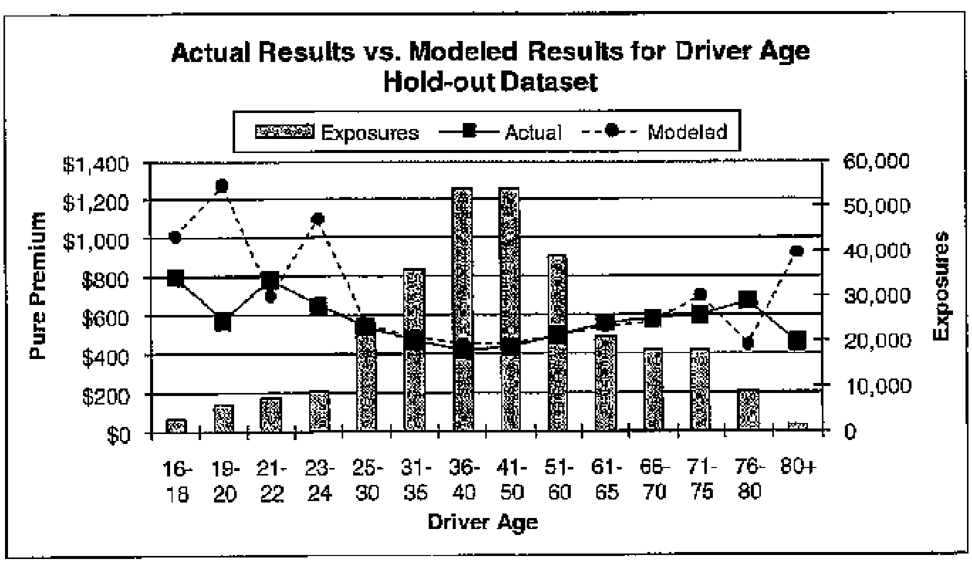
The predecessor papers to the syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous, but none covered the topics that are presented in this chapter. Thus, there are no past CAS questions that are relevant to the content covered in this chapter.

Questions from the 2010 exam

36. (1 point) Company XYZ applied generalized linear modeling to its personal auto data. Graphs of the actual and modeled pure premiums by the driver groupings were produced by the analysis. The first graph is a plot of the values using the modeling dataset. The second graph is a plot of the values using a hold-out dataset. The modeling dataset and the hold-out dataset have the same number of exposures.

    Explain whether or not the model appears to be appropriate.



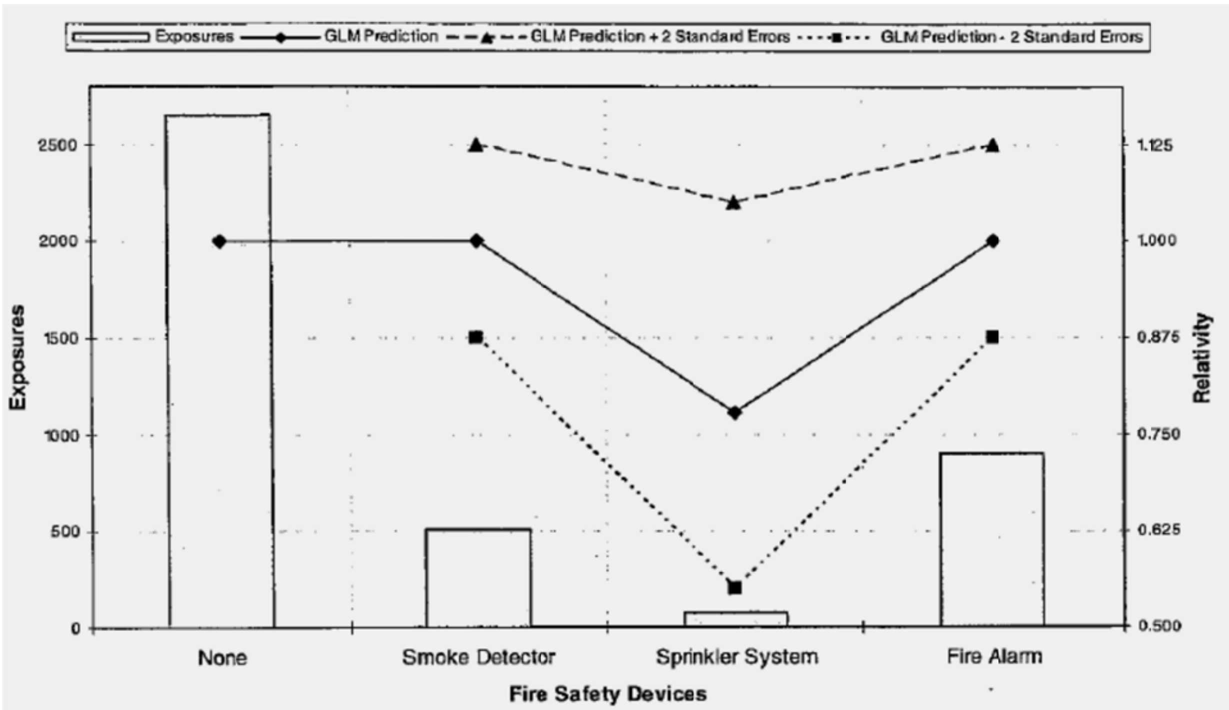


Questions from the 2011 exam

13. (1 point) A company applied generalized linear modeling to its homeowners data.

    A graph of indicated relativities and their standard errors for a fire safety device rating variable is shown below.

    Evaluate the effectiveness of the variable in the model.



The predecessor papers to the syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous, but none covered the topics that are presented in this chapter. Thus, there are no past CAS questions that are relevant to the content covered in this chapter.

Solutions to questions from the 2010 exam

36. (1 point) Company XYZ applied generalized linear modeling to its personal auto data. Graphs of the actual and modeled pure premiums by the driver groupings were produced by the analysis.

    The first graph is a plot of the values using the modeling dataset.

    The second graph is a plot of the values using a hold-out dataset. The modeling dataset and the hold-out dataset have the same number of exposures.

    Explain whether or not the model appears to be appropriate.

Question 36 – Model Solution

The model appears to be over fitted in that it's fitting the data's "noise" in addition to its "signal". This is why it fits the original data so well.

In the hold-out data, however, the model is projecting the same data fluctuations as in the original modeling dataset (in age ranges without many exposures, where experience is likely to be volatile).

Solutions to questions from the 2011 exam

13. A company applied generalized linear modeling to its homeowners data. A graph of indicated relativities and their standard errors for a fire safety device rating variable is shown below.
    Evaluate the effectiveness of the variable in the model.

Question 13 – Model Solution

This is not a good variable. "None," "Smoke Detector," and "Fire Alarm" all receive the same rate relatively. "Sprinkler system" receives a different relativity than the others, but it is a class with low volume.

The error bars are also very wide. Probably reject this rating variable.

Chapter 11 – Special Classification

BASIC RATEMAKING – WERNER, G. AND MODLIN, C.

1 Territorial Ratemaking 188 - 192

Certain rating variables and risk characteristics call for special ratemaking procedures.

Geography is a primary driver of claims experience and is a widely used rating variable.

Insurers define territories as small geographic units (e.g. postal/zip codes, counties, census blocks) and establish rate relativities for each territory.

Territorial ratemaking challenges.

1. Location is heavily correlated with other rating variables (e.g. high-value homes tend to be located in the same area) making univariate analysis of location susceptible to distortions.
2. Data in each individual territory is often sparse.

Territorial ratemaking generally involves two phases:

I. Establishing territorial boundaries

II. Determining rate relativities for the territories

I. Establishing Territorial Boundaries

In the past, most companies used the same or very similar boundaries, which were developed by a third-party (e.g. ISO or NCCI). Insurers subdivide/modify territories to gain a competitive advantage, using operational knowledge and judgment.

Recently actuaries

- apply more advanced methods (e.g. geo-spatial techniques) to develop or refine territorial boundaries.
- use both internal and external data in their analyses.

Step 1: Determining Geographic Unit

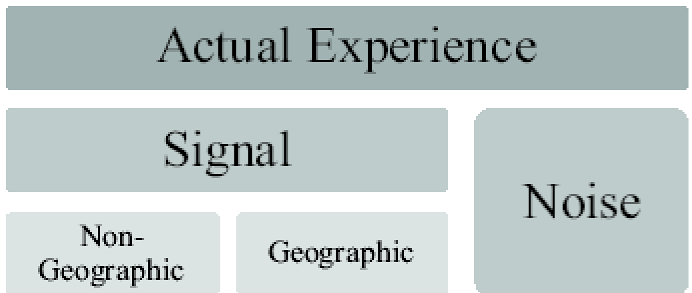
Typical units:

- should be homogenous with respect to geographic differences while still having observations in most units.
- are postal/zip codes, census blocks, counties, etc.
  - i. zip codes have the advantage of being readily available but the disadvantage of changing over time.
  - ii. counties have the advantage of being static and readily available, but due to their large size, tend to contain very heterogeneous risks.
  - iii. census blocks are static over time, but require a process to map insurance policies to the census blocks.

Next: Estimate the geographic risk associated with each unit.

- Actual experience contains both signal and random noise. The signal is driven by non-geographic elements (e.g. age, amount of insurance, number of employees) and geographic elements (e.g. density, weather indices, crime rates).
- ***The key*** to accurately estimating the geographic risk is ***isolating the geographic signal in the data***.

Components of Actual Experience



Step 2: Calculating the Geographic Estimator

Historically, actuaries used univariate techniques (e.g. pure premium approach) to develop an estimator for each geographic unit. Two major issues with this approach.

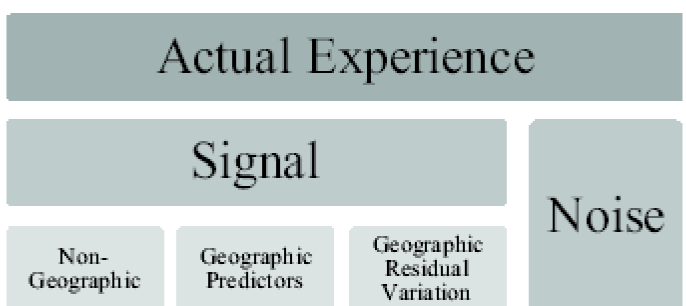
1. The geographic estimator reflects *both* the signal and the noise.

   Since geographic units tend to be small, the data is sparse and the resulting loss ratios or pure premiums or both will be too volatile to distinguish the noise from the signal.
2. Since location is highly correlated with other non-geographic factors, the resulting estimator is biased.

A better approach involves using a multivariate model (e.g. a GLM) on loss cost data using a variety of non-geographic and geographic explanatory variables.

- Non-geographic variables include rating variables (e.g. age of insured, claim history) as well as other explanatory variables not used in rating.
- Geographic variables include geo-demographic variables (e.g. population density) and geo-physical variables (e.g. average rainfall).

Components of Actual Experience Further Refined



- By including geographic and non-geographic predictors in the Signal model, the actuary controls for non-geographic effects and isolates the signal stemming from the geographic predictors.

  If the actuary cannot fully explain the geographic effect via the geographic predictors, there will be some systematic variation not captured by the geographic variables (a.k.a. geographic residual variation).
- The parameters from each geographic predictor, including the geographic residual variation, can be combined to form one composite risk index or score that represents the geographic signal for each unit.

Step 3: Spatial Smoothing

Geographic risk close in proximity tend to be similar.

Spatial smoothing techniques improve the estimate of any unit by using information from nearby units.

Two basic types of spatial smoothing: distance-based and adjacency-based.

1. The **distance-based** approach:
   - smoothes by weighting information from one unit with information from nearby geographic units *based on the distance from the primary unit and some measure of credibility*.
   - The influence of nearby areas diminishes with increasing distance.

   Advantage: Easy to understand and implement.

   Disadvantages:

   i. The assumption that a certain distance (e.g. a mile) has the same impact on similarity of risk regardless of whether it is an urban or rural area.

   ii. The presence of a natural or artificial boundary (e.g. river or highway) between two geographic units is not taken into consideration when determining distance.

2. **Adjacency-based** approach:
   - weights information *from one geographic unit with information estimators of rings of adjacent units* (i.e. immediately adjacent units get more weight than the units adjacent to adjacent units, etc).
   - handles urban/rural differences appropriately.
   - accounts for natural or artificial boundaries better than the distance-based smoothing.
   - is most appropriate for perils driven heavily by socio-demographic characteristics (e.g. theft).

Balance over and under-smoothing:

- Using too much smoothing (e.g. using data from dissimilar units in another part of the state) may mask the real spatial variation among the risks.
- Using not enough smoothing may leave noise in the estimator.

The mechanics of spatial smoothing techniques are beyond the scope of this text.

Smoothing techniques are applied in one of two ways.

1. Applied to the geographic estimators themselves (done when the geographic estimator is based on the univariate approaches as the estimators still contain a significant amount of noise).
2. Applied within a more sophisticated framework to improve the predictive power of a multivariate analysis of geographical effects.

   Smoothing techniques are applied to geographic residuals to see if there are any patterns in the residuals (i.e. to detect any systematic geographic patterns that are not explained by the geographical factors in the multivariate model).

   Any pattern in the residuals (i.e. all positive or negative in a certain region) indicates the existence of geographic residual variation. Spatially smoothed residuals can be used to adjust the geographic estimators to improve the overall predictive power of the model.

Step 4: Clustering

Units are grouped into territories to minimize within group heterogeneity and maximize between group heterogeneity.

Basic types of clustering routines include:

- Quantile methods: Create clusters based on equal numbers of observations (e.g. geographic units) or equal weights (e.g. exposure).
- Similarity methods: Create clusters based on how close the estimators are to one another. Closeness can be based on a different statistics:
  - i. The average linkage similarity method creates boundaries based on the overall average difference between the estimators from one cluster to the next (tends to join clusters with smaller variances).
  - ii. The centroid similarity method creates boundaries based on the overall average difference in estimators squared (tends to be more responsive to outliers).
  - iii. Ward's clustering method creates boundaries that lead to the smallest within cluster sum of squares difference (tends to produce clusters that have the same number of observations).

These types of clustering routines do not produce contiguous groupings (i.e. groupings that only include geographic units that are adjacent to each other). If contiguous territorial boundaries are desired, then a contiguity constraint needs to be added to the clustering routine.

Since geographic risk changes gradually, a discontinuity at self created boundaries will occur.

Thus, the actuary should select the number of clusters that minimizes noise without creating significant discontinuities.

Many insurers have eliminated grouping units into territories and simply derive rate relativities for each geographic unit (i.e. no different than creating a large number of small territories).

Rather than rating territories, insurers can geo-code every risk, and the latitude and longitude of the insured item creates a unique rate relativity that changes gradually from one location to the next.

II. Calculating Territorial Relativities

Rate relativities or differentials can be accomplished using the techniques described in chapters 9 and 10.

Since location tends to be highly correlated with other variables (e.g. low or high-valued homes tend to be concentrated in certain areas), perform this analysis using multivariate classification techniques (e.g. a new territorial boundary could be modeled along with other explanatory variables in a GLM).

2 Increased Limits Ratemaking 192 - 198

Insurance providing protection against third-party liability claims are offered at different limits of insurance.

The lowest limit offered is the basic limit (BL) and higher limits are referred to as increased limits (IL).

Reasons to establish rate relativities (i.e. to use increased limits ratemaking) for various limits:

1. As personal wealth grows, individuals have more assets to protect and need more insurance coverage.
2. Inflation drives up costs and trends in costs have a greater impact on IL losses than on BL losses.
3. The propensity for lawsuits and the amount of jury awards have increased significantly (i.e. social inflation) and this has a disproportionate impact on IL losses.

Lines of business in which IL ratemaking is used include private passenger and commercial auto liability, umbrella, any commercial product offering liability coverage (e.g. contractor's liability, professional liability, etc).

Two types of policy limits offered:

1. Single limits: Refers to the total amount the insurer will pay for a single claim (e.g. if an umbrella policy has a limit of $1,000,000, then the policy will only pay up to $1,000,000 for any one claim).
2. Compound limits: Applies two or more limits to the covered losses. Examples:
   i. *A split limit:* includes a per claimant and a per occurrence limit (e.g. in personal auto insurance, a split limit for bodily injury liability of $15,000/$30,000 means that if the insured causes an accident, the policy will pay each injured party up to $15,000 with total payment to all injured parties not to exceed $30,000).
   ii. *An occurrence/aggregate limit:* limits the amount payable for any one occurrence and for all occurrences incurred during the policy period (e.g. if an annual professional liability policy has a limit of $1,000,000/$3,000,000, the policy will not pay more than $1,000,000 for any single occurrence and will not pay more than $3,000,000 for all occurrences incurred during the policy period).

The text will focus determining indicated increased limit factors (ILFs) for a single limit (compound and split limits are more complex).

Standard Approach to Computing LAS and ILFs

The ILF is used to modify the base rate (B, which assumes the basic limit) if the insured selects a limit of liability (H) that is different than the basic limit: *Rate at Limit H = ILF for Limit H x B.*

Assuming all UW expenses are variable <u>and</u> variable expense and profit provisions do not vary by limit, the

$$Indicated\ ILF\ (H) = \frac{\overline{(L+E_L)_H}}{\overline{(L+E_L)_B}}$$ (derived in the same way as Chapter 9).

Actuaries may vary the profit provision by limit:

- because higher limits offer coverage for claims that are less frequent and very severe, and this variability adds uncertainty which makes it difficult to price and risky for insurers.
- to reflect the higher cost of capital needed to support the additional risk.

Assume frequency and severity are independent: $Indicated\ ILF(H) = \frac{Frequency_H x\ Severity_H}{Frequency_B x\ Severity_B}$

Assume frequency is the same regardless of the limit chosen: $Indicated\ ILF(H) = \frac{Severity_H}{Severity_B}$

For some lines of business, frequency may vary by the limit chosen.

Personal auto insureds who select a very high limit tend to have lower accident frequencies than insureds who select low limits. Selecting higher limit tends to be a sign of risk aversion and a higher degree of overall responsibility that also applies to driving behavior.

A severity limited at H is referred to as the limited average severity at H or LAS (H).

$$Indicated\ ILF(H) = \frac{LAS(H)}{LAS(B)}$$

- LAS (H) is the severity assuming every loss is capped at limit H (regardless of actual policy limit), and
- LAS (B) is the severity assuming every loss is capped at the basic limit.

Example: Given the following 5,000 reported uncensored claims categorized by the size of the loss (i.e. a $150,000 loss is slotted in the $100,000<X≤ $250,000 range):

Size of Loss Distribution

Size of Loss	Reported Claims	Reported Losses
X <= $ 100,000	2,324	$117,629,223
$ 100,000 < X <= $ 250,000	1,923	$307,599,929
$ 250,000 < X <= $ 500,000	680	$222,793,514
$ 500,000 < X <= $ 1,000,000	73	$43,047,470
Total	5,000	$691,070,136

LAS ($100,000) is calculated by capping every claim at $100,000 and dividing by the total number of claims.

- All 2,324 claims in the first interval have individual sizes of loss less than $100,000, so they are uncapped.
- The other 2,676 claims in the other three intervals have individual sizes of loss that exceed $100,000 and are capped at $100,000 [$267,600,000 (= 2,676 x $100,000)].
- LAS ($100,000) = ($385,229,223 = $117,629,223 + $267,600,000)/ total claim count.

Using this technique, the ILF for $250,000 is calculated as follows: $\text{Indicated ILF}(\$250K) = \frac{LAS(\$250K)}{LAS(\$100K)}$

$$LAS(\$100K) = \frac{\$117{,}629{,}223 + (1{,}923 + 680 + 73)\ x\ \$100{,}000}{5{,}000} = \$77{,}046$$

$$LAS(\$250K) = \frac{\$117{,}629{,}223 + \$307{,}599{,}929 + (680 + 73)\ x\ \$250{,}000}{5{,}000} = \$122{,}696$$

$$\text{Indicated ILF}(\$250K) = \frac{LAS(\$250K)}{LAS(\$100K)} = \frac{\$122{,}696}{\$77{,}046} = 1.59$$

Working with Censored Losses

Actuaries are often given loss data censored at the policy limit (the full amount of the loss is not known).

Example: An insured with a $50,000 policy limit has an at-fault accident in which the injured third party has $150,000 worth of medical costs. The claims database will reflect the amount paid by the insurer (i.e. $50,000) rather than the total claim amount ($150,000).

Assume that 2,019 of the 5,000 claims in the example above came from policies with a $100,000 limit.

The uncensored losses for these policies are as follows:

Uncensored Loss Distribution of Policies with $100,000 Limit

Size of Loss	Reported Claims	Reported Losses
X <= $ 100,000	922	$46,957,898
$ 100,000 < X <= $ 250,000	787	$127,573,028
$ 250,000 < X <= $ 500,000	282	$92,665,855
$ 500,000 < X <= $ 1,000,000	28	$16,640,606
Total	2,019	$283,837,387

However, if the insurer's data only contains censored losses, the loss distribution available to the actuary is shown in the right-hand portion of the table below:

Censored Loss Distribution of Policies with $100,000 Limit

	Uncensored		**Censored**	
Size of Loss	Claims	Losses	**Claims**	**Losses**
X <= $ 100,000	922	$46,957,898	**2019**	**$156,657,898**
$ 100,000 < X <= $ 250,000	787	$127,573,028		
$ 250,000 < X <= $ 500,000	282	$92,665,855		
$ 500,000 < X <= $ 1,000,000	*28*	$16,640,606		
Total	*2,019*	$283,837,387	**2,019**	**$156,657,898**

Note: $156,657,898 = $46,957,898 + (787+282+28)*$100,000

If the insurer writes three policy limits ($100,000, $250,000, and $500,000) and the historical database contains only censored losses, the 5,000 losses censored at the 3 policy limits are shown below:

Censored Loss Distribution of Policies with Policy Limit

	$100,000 Limit		**$250,000 Limit**		**$500,000 Limit**	
Size of Loss	**Claims**	**Losses**	**Claims**	**Losses**	**Claims**	**Losses**
X <= $ 100,000	2019	$156,657,898	690	$34,903,214	712	$35,768,111
$ 100,000 < X <= $ 250,000			773	$142,767,479	574	$90,009,422
$ 250,000 < X <= $ 500,000					232	$81,092,725
$ 500,000 < X <= $ 1,000,000						
Total	2,019	$156,657,898	1,463	$177,670,693	1,518	$206,870,258

To calculate LAS by limit, calculate a LAS for each layer of loss and combine the estimates for each layer taking into consideration the probability of a claim occurring in the layer.

The LAS of each layer is based solely on loss data from policies with limits as high as or higher than the upper limit of the layer.

Example: When calculating the LAS ($100K), use the experience from all policies limits censored at $100,000:

$$LAS(\$100K) = \frac{\$156,657,898 + \$34,903,214 + \$35,768,111 + \$100,000 * (773 + 574 + 232)}{5,000}$$

$$= \frac{\$385,229,223}{5,000} = \$77,046$$

Recall that LAS($100K)was computed as = $77,046=($117,629,223+ (1,923 +680 +73) $100,000)/5,000*

Note: When calculating LAS ($250,000), the actuary cannot use the policies that have a $100,000 limit as there is no way to know what the claim amounts would be if each of those policies had a limit of $250,000.

Calculating LAS ($250,000):

Combine LAS ($100K) with LAS for the layer ($100,000 to $250,000), after Step 2 adjustment.

Step 1: Determine the losses in the $100K - $250K layer.

i. Policies with a limit of $100,000 cannot contribute any losses to that layer and the data is not used.

ii. Of the 1,463 claims with policies having a $250K limit, 773 claims have losses in the $100K to $250K layer.
Total censored losses for those 773 claims are $142,767,479.
Eliminating the first $100K of each of those losses results in losses in the $100K to $250K layer.

$142,767,479 - 773 x $100,000 = $65,467,479

iii. Policies with a limit of $500K also contribute loss dollars to the $100K to $250K layer.
Of the 1,518 claims associated with a limit of $500K limit, 574 have losses in the $100K to $250K layer.
These claims contribute $32,609,422 (=$90,009,422 – 574 x $100,000) of losses to the layer.

Another 232 claims exceed $250,000, and each contributes $150,000 to the $100K to $250K layer.

$34,800,000 = 232x ($250,000- $100,000)

The sum of the above values are the losses in the $100K to $250K layer:

$65,467,479+ $32,609,422+ $34,800,000 = $132,876,901.

These loss dollars were derived from 1,579 (=773+574+232) claims.

Thus, LAS(100K-250K) = $\$84{,}153 = \dfrac{\$132{,}876{,}901}{1{,}579}$

Step 2: Before combining this with the LAS ($100K), adjust for the fact that these losses are based on a subset of the claims used to calculate the LAS ($100K).

The adjustment involves calculating the probability that the loss will exceed $100K, given that a claim occurs.

Since the actuary cannot know whether or not the claims from the policies with a $100K limit would have exceeded $100K, that data is not used for this calculation. To adjust this, the LAS for the $100K to $250K layer can be multiplied by the following probability:

$$Pr(\$100K \le X \le \$250K) = \frac{773+574+232}{1{,}463+1{,}518} = \frac{1{,}579}{2{,}981}.$$

The values above are the numbers of claims from the 250K policy limit and 500K policy limit for losses > 100K.

This is equivalent to dividing the losses in the layer by the total claim count for those policies:

$$\$44{,}575 = \$84{,}153 * \frac{1{,}579}{2{,}981} = \frac{\$132{,}876{,}901}{2{,}981}$$

Thus, $LAS(\$250K) = \$77{,}046 + \$44{,}575 = \$121{,}621$. *ILF (250K) = 121,621/77,046 = 1.5785*

Calculating LAS ($500,000) using the same techniques:

For losses in the $250K to $500K layer, only policies with a $500K limit or greater can be used:

$$\$15{,}213 = \frac{\$81{,}092{,}725 - 232 * \$250{,}000}{1{,}518}$$

Thus, $LAS(\$500K) = \$77{,}046 + \$44{,}575 + \$15{,}213 = \$136{,}834$

Other Considerations

Historical losses used in ILF analysis should be adjusted for any expected trend and for loss development.

Recall that loss trends have a leveraged effect on increased limits losses.

Assuming a constant positive percentage trend in total losses, the following relationship holds:

Basic Limits Trend ≤ Total Limits Trend ≤ Increased Limits Trend.

(See Chapter 6 for a numeric example that demonstrates this relationship).

Fitted Data Approach

Actuaries may fit curves to empirical data to smooth out the random fluctuations in the data.

Let *f(x)* represent a continuous distribution of losses of size *x,* and *H* be the limit being priced.

$$LAS(H) = \int_0^H xf(x)dx + H\int_H^\infty f(x)dx$$

The ILF for the limit H is represented as follows: $ILF(H) = \dfrac{\int_0^H xf(x)dx + H\int_H^\infty f(x)dx}{\int_0^B xf(x)dx + B\int_B^\infty f(x)dx}$

The challenge with this approach is determining a distribution that is representative of the expected losses.

ISO Mixed Exponential Methodology

- is designed to address some of the issues with the empirical data (trend, censoring by policy limits, etc.).
- is outside the scope of this text.

Multivariate Approach

Actuaries may analyze ILFs using GLMs which can more effectively deal with sparse data.

A major difference between a GLM approach and the univariate approaches using LAS is that the GLM does not assume the frequency is the same for all risks. Thus,

- GLM results are influenced by both the limiting of losses and the behavioral differences among insureds at different limits.
- This may produce counter-intuitive results (e.g., expected losses decrease as limit increases)

Therefore, actuaries may use both approaches to guide the selection of increased limit factors.

3 Deductible Pricing 199 - 204

Two basic types of deductibles: flat dollar deductibles and percentage deductibles.

Flat dollar deductibles are the most common.

i. A flat dollar deductible (e.g. $250 deductible) specifies a dollar amount below which losses are not covered by the policy.

ii. Flat dollar deductibles may range from small amounts (e.g. $100 or $250) on personal lines policies to large deductibles (e.g. $100,000 or more) on large commercial policies.

Percentage deductibles state the deductible as a % of the coverage amount (e.g. a 5% deductible on a home insured for $500,000 is equivalent to a flat dollar deductible of $25,000).

% deductibles are common property policies, and are applied specifically to perils that are susceptible to catastrophic losses (e.g. earthquake or hurricane).

Several reasons why deductibles are popular among both insureds and insurers:

- **Premium reduction**: A deductible reduces the rate as the insured pays a portion of the losses.
- **Eliminates small nuisance claims**: Deductibles minimize the filing of small claims (and the expense associated with investigating and handling small claims, which is often greater than the claim amount).
- **Provides incentive for loss control**: Since the insured is responsible for the first layer of loss, the insured has a financial incentive to avoid losses.
- **Controls catastrophic exposure**: For insurers writing a large number of policies in cat prone areas, the use of large cat deductibles can reduce its exposure to loss.

Loss Elimination Ratio (LER) Approach

Deductible relativities can be determined using a LER approach.

Assuming all expenses are variable and that variable expenses and profit are a constant % of premium, the indicated deductible relativity for deductible D is given by the following formula (where the base level in this example assumes no deductible): $Indicated\ Deductible\ Relativity = \dfrac{(\overline{L + E_L})_D}{(\overline{L + E_L})_B}$

The indicated deductible relativity is the ratio of ultimate losses and LAE after application of the deductible to ground-up ultimate losses and LAE.

In the LER approach, calculate the amount of losses that are eliminated going from full coverage to a deductible or by going from one deductible to a higher deductible:

$$LER(D) = \frac{Losses\ and\ LAE\ Eliminated\ by\ Deductible}{Total\ Ground\text{-}up\ Losses\ and\ LAE} = \frac{(L + E_L)_B - (L + E_L)_D}{(L + E_L)_B}$$

The formula is re-written as follows: $(L + E_L)_D = (L + E_L)_B \times (1.0 - LER(D))$.

The indicated deductible relativity can be restated as:

$$Indicated\ Deductible\ Relativity = \frac{(\overline{L + E_L})_B\ x(1.0 - LER(D))}{(\overline{L + E_L})_B} = (1.0 - LER(D)).$$

Empirical Distribution (Discrete Case)

The LER can be calculated as follows: $LER(D) = [1 - \dfrac{\sum_{AllLosses} Maximum[0, (Loss\ Amount - D)]}{\sum_{AllLosses} Loss\ Amount}]$

(assuming the ground-up loss is known for every claim)

Consider the size of loss distribution of ground-up homeowners losses:

Size of Loss Distribution

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses
X <= $ 100	3,200	$240,365
$ 100 < X <= $ 250	1,225	$207,588
$ 250< X <= $ 500	1,187	$463,954
$ 500 < X <= $ 1,000	1,845	$1,551,938
$ 1,000 < X	2,543	$11,140,545
Total	10,000	$13,604,390

To calculate LER ($250), compute the amount of losses in each layer that will be eliminated by the deductible.

- The first two rows contain losses less than $250 and are completely eliminated by the deductible.
- The remaining rows contain individual losses that are at least $250; thus $250 will be eliminated for each of the 5,575 claims (=1,187+1,845+2,543).

The LER = losses eliminated/ total losses:

$$LER(\$250) = \frac{(\$240,365 + \$207,588) + \$250 \times (1,187 + 1,845 + 2,543)}{\$13,604,390} = 0.135$$

The rate credit for going from full coverage to a $250 deductible is 13.5%; the deductible relativity is 0.865.

The following table shows the calculations discussed above:

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses	(4) Losses Eliminated By $250 Deductible
X <= $ 100	3,200	*$240,365*	*$240,365*
$ 100 < X <= $ 250	1,225	*$207,588*	*$207,588*
$ 250< X <= $ 500	1,187	**$463,954**	**$296,750**
$ 500 < X <= $ 1,000	1,845	**$1,551,938**	**$461,250**
$ 1,000 < X	2,543	**$11,140,545**	**$635,750**
Total	10,000	$13,604,390	$1,841,703
		(5) LER =	0.135

(4) Losses < 250 = (3)
(4) Losses>=250 = (2) x $250
(5) LER = (Tot4) / (Tot3)

Other Considerations

Insurers may not know the ground-up losses for every claim (e.g. insureds may not report claims that are less than the deductible on their policy).

When this is the case, data from policies with deductibles greater than the deductible being priced cannot be used to calculate the LER. For example:

- data from policies with a $500 deductible cannot be used to determine LERs for a $250 or $100 deductible, *however*
- data from policies with deductibles *less than the deductible being priced* can be used to determine LERs (e.g. data from policies with a $500 deductible can be used to determine the LER associated with moving from a $750 deductible to a $1,000 deductible).

Calculating the credit to change from a $250 to a $500 deductible.

LER Calculation to Move from a $250 to $500 Deductible

(1) Deductible	(2) Reported Claims	(3) Net Reported Losses	(4) Net Reported Losses Assuming $500 Ded	(5) Net Reported Losses Assuming $250 Ded	(6) Losses Eliminated Moving from $250 to $500
Full Cov	500	$680,220	$524,924	$588,134	$63,210
$100	680	$1,268,403	$1,049,848	$1,176,269	$126,421
$250	1,394	$2,940,672	$2,624,621	$2,940,672	$316,051
$500	2,194	$5,249,242	$5,249,242	Unknown	Unknown
$1,000	254	$859,755	Unknown	Unknown	Unknown
Total	5022	$10,998,292			
		(7) Net Reported Losses for Ded <=$250			$4,705,075
		(8) Losses Eliminated <=$250 Ded			$505,682
		(9)LER			0.107

(3)= Net of the deductible (4) =(3) Adjusted to a $500 deductible (5)=(3) Adjusted to a $250 deductible

(6)= (5) - (4) (7)= Sum of (5) for $0, $100, $250 Deductibles

(8)=Sum of (6) for $0, $100, $250 Deductibles (9)=(8)/(7)

- Each row contains data for policies with different deductible amounts.
- The analysis can only use policies with deductibles of $250 or less (since the goal is to determine the losses eliminated when changing from a $250 to a $500 deductible)
- Columns 4 and 5 contain the net reported losses in Column 3 restated to $500 and $250 deductible levels, respectively.

  Columns 4 and 5 are not Column 3 minus the product of Column 2 and the assumed deductible.

    This is because not every reported loss exceeds the assumed deductible.

    The losses in Columns 4 and 5 are based on an assumed distribution of losses by deductible and size of loss, and cannot be recreated given the data shown.

The comments made earlier with respect to trend and development in the ILF section apply to deductible pricing, too.

Fitted Data Approach

Let f(x) represent a continuous distribution of losses of size x, and D be the size of the deductible.

- This formula is very similar to the formula used in the ILF section
- The expected loss eliminated through the use of a deductible, D: $\int_0^D xf(x)dx + D\int_D^\infty f(x)dx$
- $LER(D) = \dfrac{\int_0^D xf(x)dx + D\int_D^\infty f(x)dx}{\int_0^\infty xf(x)dx}$

Practical Considerations

Like the ILF pricing, the LER approach assumes claim behavior is the same for each deductible.

This may not be the case (e.g. an insured with a $250 deductible and an insured with a $1,000 deductible both having a $1,100 loss <u>are both not likely to report</u> such a loss since the insured with the $1,000 deductible may choose not to report the claim for fear of an increase in premium from the insurer applying a claim surcharge).

Also, lower-risk insureds tend to choose higher deductibles, since they are unlikely to have a claim and are willing to accept the risk associated with a higher deductible.

Since the LER approach does not recognize these behavioral differences, higher deductible policies may end up being more profitable than lower deductible policies.

The LER approach determines an average % credit applied to all policies with a certain deductible amount.

- In the prior example, the credit for a $250 deductible is 13.5%.
- But, if the total policy premium is $3,000, then the credit for moving from full coverage to a $250 deductible is $405, and since premium savings exceeds the amount of the deductible, the insured will be better off to select the deductible.
- An insurer may handle this circumstance in different ways.
  - i. A cap on the amount of dollar credit from the deductible may be used (e.g. the maximum dollar credit for moving from full coverage to a $250 deductible might be $200)
  - ii. Calculate different set of credits for different policies (e.g. a homeowners insurer may have different deductible credits for low, medium, and high-valued homes)

Note: % deductibles do not have this issue since the deductible increases with the amount of insurance.

4 Size Of Risk For Workers Compensation 204 - 206

To account for differences in expense and loss levels for larger insureds, some WC insurers vary the expense component for large risks, incorporate premium discounts or loss constants, or all of these.

Expense Component

Commercial lines insurers use the All Variable Approach to determine the applicable expense provisions.

The assumption is that UW expenses are a constant % of the premium charged.

Since some expenses are fixed, using the all variable approach will cause policies with small average premium (i.e. small risks) to be undercharged and policies with large average premium (i.e. large risks) to be overcharged.

Insurers may adjust for this in a few different ways.

1. WC insurers may calculate a variable expense provision that only applies to the first $5,000 of standard premium (generally defined as premium before application of premium discounts and expense constants).

2. Insurers may charge an expense constant to all risks, which accounts for costs that are the same regardless of policy size (e.g. UW and administrative expenses). Since the expense constant is a flat dollar amount, it is a decreasing % of written premium as the size of the policy increases.

3. WC insurers apply a premium discount to policies with premium above a specified amount. The following shows the calculation of the premium discount for a policy with standard premium of $400,000.

Workers Compensation Premium Discount Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Premium Range		Premium in Range	Prod	General	Taxes	Profit	Total	Expense Reduction	Discount %	Premium Discount
$0	$5,000	$5,000	15.0%	10.0%	3.0%	5.0%	33.0%	0.0%	0.0%	$0
$5,000	$100,000	$95,000	12.0%	8.0%	3.0%	5.0%	28.0%	5.0%	5.4%	$5,130
$100,000	$500,000	$300,000	9.0%	6.0%	3.0%	5.0%	23.0%	10.0%	10.9%	$32,700
$500,000	above		6.0%	4.0%	3.0%	5.0%	18.0%	15.0%	16.3%	$0
Standard Premium		$400,000								**$37,830**

(3)= Min of [(2) - (1), Standard Premium - Sum Prior(3)]

(9)= $(8_{\text{Row 1}})$-(8)   (10)= (9)/[1.0 -(6) - (7)]   (11)= (3) x (10)

Loss Constants

Small WC risks tend to have less favorable loss experience (as a % of premium) than large risks for several reasons. Small companies:

- have less sophisticated safety programs because of the large amount of capital to implement and maintain.
- may lack programs to help injured workers return to work.
- premiums are unaffected or slightly impacted by experience rating; small insureds may not be eligible for ER and may have less incentive to prevent or control injuries than large insureds.

When WC insurers charge the same rate per exposure for small and large insureds, the premium will be inadequate for small companies and excessive for large companies.

A loss constant added to the premium for small risks equalizes the final expected loss ratios between small and large insureds.

WC Loss Constant calculation example:

(1) Premium Range	(2)	(3) Policies	(4) Premium	(5) Reported Loss	(6) Initial Loss Ratio	(7) Target Loss Ratio	(8) Premium Shortfall	(9) Loss Constant
$1	$2,500	1,000	$1,000,000	$750,000	75.0%	70.0%	$71,429	$71.43
$2,501	above	1,000	$5,000,000	$3,500,000	70.0%	70.0%	$0	$0.00

(6)= (5) / (4)   (7) = Given   (8)= [(5)/(7)] -(4)(9)= (8) / (3)

The unadjusted expected loss ratios for small (premium less than or equal to $2,500) and large (premium greater than $2,500) risks are 75% and 70% (see (6))

To achieve an expected loss ratio of 70% for both types of risks, the computations in (8) and (9) are performed.

With sophisticated multivariate techniques, insurers add a rating variable to account for the size of the risk, making the loss constant no longer necessary.

5 Insurance To Value (ITV) 206 - 213

Insurance to value (ITV) indicates how the level of insurance chosen relates to the overall value or replacement cost of the insured item, and thus how rates vary based on the policy limit chosen (e.g. if an item is insured to full value, then the AOI equals the total value or replacement cost).

Consider the following example:

- Two homes worth $250,000 and $200,000 are each insured for the full amount.
- Expected claim frequency is assumed to be 1% for both homes.
- Expected losses are uniformly distributed.

That information yields the following expected size of loss distributions and rates for each home:

Rate calculations for a $250,000 Home

Size of Loss ($000s)	(1) Loss Distribution	(2) Reported Loss ($000s)
$ - < X <= $ 25	10.0%	$13
$ 25 < X <= $50	10.0%	$38
$ 50 < X <= $75	10.0%	$63
$ 75 < X <= $100	10.0%	$88
$ 100 < X <= $125	10.0%	$113
$ 125 < X <= $150	10.0%	$138
$ 150 <X <= $175	10.0%	$163
$ 175 < X <= $200	10.0%	$188
$ 200 < X <= $225	10.0%	$213
$ 225 < X <= $250	10.0%	$238
Total	100.0%	$125
(3) Frequency		1%
(4) Pure Premium ($000s)		$1.25
(5) Amount of Insurance ($000s)		$250.00
(6) Rate per $1,000		$5.00

Rate calculation for a $200,000 Home

Size of Loss ($000s)	(1) Loss Distribution	(2) Reported Loss ($000s)
$ - < X <= $ 25	12.5%	$13
$ 25 < X <= $50	12.5%	$38
$ 50 < X <= $75	12.5%	$63
$ 75 < X <= $100	12.5%	$88
$ 100 < X <= $125	12.5%	$113
$ 125 < X <= $150	12.5%	$138
$ 150 <X <= $175	12.5%	$163
$ 175 < X <= $200	12.5%	$188
Total	100.0%	$100
(3) Frequency		1%
(4) Pure Premium ($000s)		$1.00
(5) Amount of Insurance ($000s)		$200.00
(6) Rate per $1,000		$5.00

(Tot 2)= (2) weighted by (1) (4)= (Tot2) x (3) (6)= [(4) / (5)] x $1,000

- The expected pure premium for the $250,000 home is $1,250 (=$125,000 x 0.01), and assuming no expenses or profit, the appropriate premium is $1,250.

  The rate is $5 per $1,000 of AOI (=($1,250/$250,000)x $1,000).
- The expected pure premium for a $200,000 home insured to full value is $1,000 (=$100,000 x 0.01), and the appropriate rate is $5 per $1,000 of AOI.

Underinsurance: Consider the case in which the $250,000 home is insured for only $200,000.

While the expected loss distribution remains unchanged, the expected claim payment is limited to the amount of insurance for the policy (i.e. $200,000):

Calculations for a $250,000 Home Insured for $200,000

Size of Loss ($000s)	(1) Loss Distribution	(2) Reported Loss ($000s)	(3) Average Payment ($000s)
$ - <X<= $ 25	10.0%	$12.5	$12.5
$ 25 <X<= $50	10.0%	$37.5	$37.5
$ 50 <X<= $75	10.0%	$62.5	$62.5
$ 75 <X<= $100	10.0%	$87.5	$87.5
$ 100 <X<= $125	10.0%	$112.5	$112.5
$ 125 <X<= $150	10.0%	$137.5	$137.5
$ 150 <X<= $175	10.0%	$162.5	$162.5
$ 175 <X<= $200	10.0%	$187.5	$187.5
$ 200 <X<= $225	10.0%	$212.5	$200.0
$ 225 <X<= $250	10.0%	$237.5	$200.0
Total	100.0%	$125.0	$120.0
(4) Frequency			1%
(5) Pure Premium ($000s)			***$1.20***
(6) Amount of Insurance ($000s)			$200.00
(7) Rate per $1,000			**$6.00**

(Tot2)= (2) weighted by (1) ; (Tot3)= (3) weighted by (1); (5)= (Tot3) x (4); (7)= [(5) / (6)] x $1,000

Two problems with underinsurance:

1. The insurance payment will be insufficient to cover the full loss amount 20% of the time.
2. If the insurer assumes all homes are insured to full value and uses a rate of $5 per $1,000, the premium will be insufficient to cover expected payments for a underinsured home, and thus rates will not be equitable.

Note: The inequity in the rates is caused by the fact that the homes are not insured to the same level.

If all homes are underinsured by the same % amount, then the resulting premium may not be adequate to cover all the losses, but the premium will be equitable.

Over time, the base rate will adjust so that aggregate premium covers the aggregate losses at the actual level of ITV present in the book of business.

A key point: The inequity and adequacy issues only exist *because partial losses are possible*.

The following shows a comparison if all claims are total losses:

Three Policies-Total Losses Only

	(1)	(2)	(3)
Full Value of Item ($000s)	$500	$500	$400
Amount of Insurance ($000s)	$500	***$400***	$400
Frequency	1%	1%	1%
Severity ($000s)*	$500	$400	$400
Pure Premium ($000s)	$5	$4	$4
Rate per $1,000	$10	$10	$10
Premium ($000s)	$5	$4	$4

*All losses are total losses.

The underinsured home (2) still receives a claim payment that is less than the full value of the item.

However, the total premium collected is adequate and the rates are equitable.

Coinsurance Clause

Coinsurance means 2 or more parties are participating in the insurance arrangement.

- In property insurance, the insurer may require a minimum ITV (e.g. 80% of full value) or else payment on covered losses are reduced proportionately by the amount of underinsurance.
- The purpose of coinsurance is to achieve greater equity among risks (although more so through loss payments than through rate adequacy).

Notation used in the coinsurance calculations:

I = indemnity received after loss
L = amount of loss after deductible
F = face value of policy (i.e. amount of insurance selected)
V = value of property
c = required coinsurance percentage
a = apportionment ratio
e = coinsurance penalty

Key!! (on the exam you will be asked to compute any one of the following * values):

* The coinsurance **requirement** (cV) is the coverage required so that no penalty is applied.
* The coinsurance **apportionment ratio** (a) is the factor applied to the loss amount to calculate the indemnity payment: $a = min\left[\frac{F}{cV}, 1.0\right]$
* The indemnity payment is given by the following basic formula: $I = L \times \frac{F}{cV},\ where\ I \le F\ and\ I \le L$
* The coinsurance penalty (e) is the reduction in the indemnity payment due to the coinsurance clause. A reduction occurs when the following three conditions apply:
  1. A non-zero loss has occurred (i.e. L > 0).
  2. The face amount of insurance is less than the coinsurance requirement (i.e. F < cV).
  3. The loss is less than the coinsurance requirement (i.e. L < cV).

  The amount of the penalty is as follows:

$$e = \begin{cases} L - I, & if\ L \le F \\ F - I, & if\ F < L < cV \\ 0, & if\ cV \le L \end{cases}$$

Example 1:

Assume a home valued at $500,000 is insured only for $300,000 despite a coinsurance requirement of 80% (or $400,000 in this case).

Since F is $300,000 a coinsurance deficiency exists and a = 0.75 (=$300,000 / $400,000).

The indemnity payments and coinsurance penalties for *a $200,000 loss* are:

$$I = L \times \frac{F}{cV} = \$200,000 \times \frac{\$300,000}{\$400,000} = \$150,000$$

$$e = L - I = \$200,000 - \$150,000 = \$50,000$$

Example 2:
The indemnity payments and coinsurance penalties for a $300,000 loss:

$$I = L \times \frac{F}{cV} = \$300,000 \times \frac{\$300,000}{\$400,000} = \$225,000$$
$$e = L - I = \$300,000 - \$225,000 = \$75,000$$

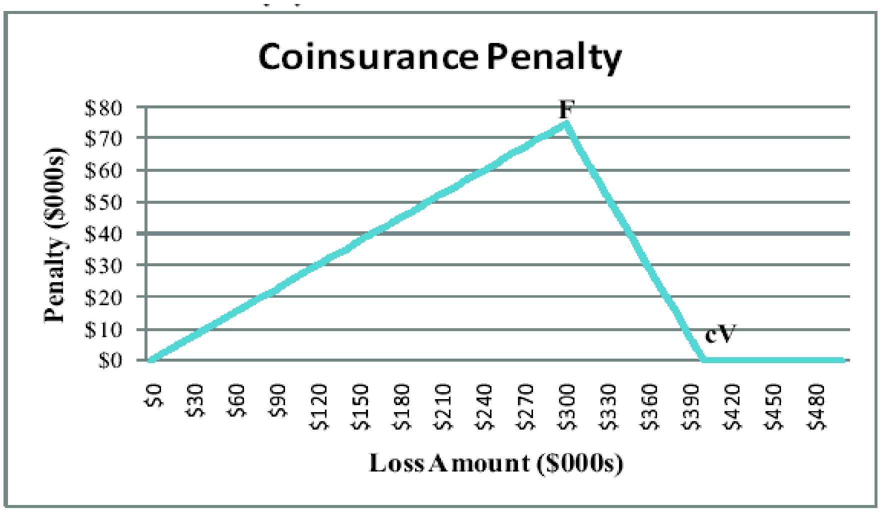
Example 3:
The following are the indemnity payments and coinsurance penalties for a $350,000 loss:

$$I = L \times \frac{F}{cV} = \$350,000 \times \frac{\$300,000}{\$400,000} = \$262,500$$
$$e = F - I = \$300,000 - \$262,500 = \$37,500$$

Example 4:
The following are the indemnity payments and coinsurance penalties for a $450,000 loss:

$$I = L \times \frac{F}{cV} = \$450,000 \times \frac{\$300,000}{\$400,000} = \$337,500, \textbf{ but } \$337,500 > F, \ so\ I = F = \$300,000$$
$$e = F - I = \$300,000 - \$300,000 = \$0.$$

The coinsurance penalty for loss values between $0 and $500,000 (i.e. the full value of the home):



The magnitude of the co-insurance penalty:

- the dollar coinsurance penalty increases linearly between $0 and F (where the penalty is the largest).
- the penalty decreases for loss sizes between F and cV.
- there is no penalty for losses larger than the cV, but the insured suffers a penalty in that the payment does not cover the total loss.

Achieving Rate Equity by Varying Rates Based on ITV Level

I. A coinsurance penalty corrects for inequity caused by similar homes insured to different ITV levels by adjusting the indemnity payment in the event of a loss.

II. Another way to achieve equity is to calculate and use rates based on the level of ITV.

Recall that the indicated rate per $1,000 of insurance was the same for the two homes insured to full value (i.e. $50 per $1,000 of insurance) and higher for the underinsured home (i.e. $60 per $1,000 of insurance).

If those indicated rates were used, the premium would have been equitable and no coinsurance penalty would have been necessary.

A rate can be calculated given the expected frequency, the size of loss distribution, and the full value of the property. Using the following notation:

f = frequency of loss
s(L) = probability of loss of a given size
V = maximum possible loss (which may be unlimited for some insurance)
F = face value of policy

The rate is the expected indemnity payment/policy face value (AOI is often shown in $100 or $1,000 increments).

Given an *empirical* distribution of losses, the rate is as follows:

$$Rate = \frac{f \times \left[\sum_{L=1}^{F} Ls(L) + F \times (1.0 - \sum_{L=1}^{F} s(L)) \right]}{F}$$

Given a continuous distribution of losses, the rate is as follows:

$$Rate = \frac{f \times \left[\int_{0}^{F} Ls(L)dL + F \times (1.0 - \int_{0}^{F} s(L)dL) \right]}{F}$$

If partial losses are possible, the rate per AOI decreases as F gets closer to the value of the insured item.

The ***rate of change*** of the decrease varies depending on the shape of the loss distribution:

- Left-skewed distribution (i.e. small losses predominate): the rate will <u>decrease at a decreasing rate</u> as F increases.
- Uniform distribution (i.e. all losses equally likely): the rate will <u>decrease at a constant rate</u> as F increases.
- Right-skewed distribution (i.e. large losses predominate): the rate will <u>decrease at an increasing rate</u> as F increases.

Under the rate (versus the co-insurance penalty) approach:

- the coinsurance is any portion of the loss that exceeds F should the insured choose F less than V.
- the major difficulty is determining the loss distribution.

Insurance to Value Initiatives

The HO policy settles losses based on replacement cost, subject to the policy limit.

- One policy feature encouraging insurance to full value is guaranteed replacement cost (GRC), allowing replacement cost to exceed F if the property is 100% insured to value <u>and</u> subject to annual indexation.
- Insurers are now using more sophisticated property estimation tools, with component indicator tools considering customized features of the home (e.g. granite countertops, hardwood floors, age of plumbing and electricity).

By increasing the AOI on underinsured homes to ITV level assumed in the rates, insurers generate additional premium without increasing rates.

- Since homeowners loss distributions are left-skewed (i.e. small losses predominate), the increased premium is more than the additional losses generated from this action.
- As the insureds receive increased coverage, they are more accepting of the increased premium than if rate increases were implemented.

Also, the industry has made better use of property inspections, indexation clauses, and education of insureds.

6 Key Concepts 215 - 215

1. Territorial ratemaking
   a. Establishing territorial boundaries
      i. Defining basic geographic units
      ii. Creating geographic estimators
      iii. Smoothing geographic estimators
      iv. Combining units based on clustering techniques
   b. Calculating territorial rate relativities

2. Increased limit factors
   a. Limited Average Severity
      i. Uncensored losses
      ii. Censored losses
   b. Fitted data approach
   c. Other considerations
   d. Multivariate approach
   e. ISO mixed exponential approach

3. Deductible LER approach
   a. Discrete approach
   b. Fitted data approach
   c. Practical considerations

4. Workers compensation size of risk
   a. Expense component
   b. Loss constants

5. Insurance to Value (ITV)
   a. Importance of ITV
   b. Coinsurance
      i. Penalty
      ii. Varying rates based on ITV level
   c. ITV initiatives

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Increased Limits Ratemaking

Questions from the 2004 exam

45. (2 points) Given the following data, calculate the annual claims inflation rate in the layer $50,000 excess of $50,000. Assume aground-up annual claims inflation rate of 15%. Show all work.

Date of Loss	Ground-up Loss
February 1, 2003	$37,000
July 15, 2003	$47,000
October 1, 2003	$64,000
December 1, 2003	$93,000

Note: This is more of a chapter 6 question

Questions from the 2005 exam

50. (1 point) Explain two reasons why claim inflation produces larger cost trends on increased limits coverage than on basic limits coverage.

Note: This is more of a chapter 6 question

Questions from the 2006 exam

31. (3.25 points)

a. (2 points) Given the following claim information for accident year 2005, calculate the annual inflation rate for claims in the layer $50,000 excess of $100,000 for 2006. Assume a ground-up annual claims inflation rate of 10%. Show all work.

Claim	Ground-up Loss
1	$75,000
2	100,000
3	125,000
4	150,000

b. (1.25 points) How would you expect the inflation rate in the layer $50,000 excess of $100,000 to differ from the inflation rate for claims limited to $100,000?

Explain two reasons for the difference between the inflation rates.

Note: This is more of a chapter 6 question

Questions from the 2007 exam

46. (2.0 points) You are given the following information:

Claim	Ground-up Uncensored Loss Amount
A	$35,000
B	125,000
C	180,000
D	206,000
E	97,000

If all claims experience an annual ground-up severity trend of 8.0%, calculate the effective trend in the layer $100,000 in excess of $100,000. Show all work.

Note: This is more of a chapter 6 question

47. (2.0 points) You are given the following information:

Claim	Ground-up Uncensored Loss Amount
A	$250,000
B	300,000
C	450,000
D	750,000
E	1,200,000
F	2,500,000
G	4,000,000
H	7,500,000
I	9,000,000
J	15,000,000

Basic limit is $1,000,000.

Using the methods described by Palmer in Increased Limits Ratemaking for Liability Ratemaking, calculate the following:

a. (1.25 points) The $5,000,000 increased limit factor.

b. (0.75 point) The limited average severity in the layer $4,000,000 in excess of $1,000,000. Show all work.

Questions from the 2008 exam
18. (1.25 points) You are given the following information:

Claim	Loss Amount
A	$50,000
B	$70,000
C	$90,000
D	$110,000
E	$20,000
Total	$340,000

- Total limit trend = 10%
- Basic limit = $50,000

a. (0.5 point) Calculate the basic limit trend.

b. (0.5 point) Calculate the excess limit trend.

c. (0.25 point) Identify a situation in which the excess limit trend will be less than the basic limit trend.

Note: This is more of a chapter 6 question

34. (2.0 points)

a. (1.0 point) You are given the following distribution of losses.

Layer of Loss Lower Limit ($)	Upper Limit ($)	Total $ Loss	Occurrences
$1	$10,000	$500,000	100
$10,001	$250,000	$16,000,000	80
$250,001	$500,000	$17,500,000	50
$500,001	$1,000,000	$11,500,000	20

Calculate the $500,000 increased limit factor assuming the basic limit is $250,000.

b. (1.0 point) Identify and briefly explain two issues that arise when using empirical data to construct increased limit factor tables.

Questions from the 2009 exam

36. (2 points) Given the following information:

- Basic Limit = $1,000,000
- ULAE Provision as % of Loss (Basic Limit) = 10.0%
- ULAE Provision as % of Loss (Increased Limit) = 20.0%
- Expected Frequency (Basic Limit) = 0.15
- Expected Frequency (Increased Limit) = 0.10
- Assume no risk load

Claim	Ground-Up Uncensored Loss
1	$300,000
2	$600,000
3	$750,000
4	$1,250,000
5	$4,500,000
6	$10,000,000

Calculate the increased limit factor at $5,000,000, assuming there is no ALAE.

Questions from the 2010 exam

31. (3 points) Given the following information:

Censored Loss Distribution by Policy Limit

			Policy Limit	
Size of Loss		$100,000	$300,000	$500,000
	X <= $100,000	$97,000,000	$46,000,000	$11,000,000
$100,000	< X <= $300,000		$150,000,000	$107,000,000
$300,000	< X <= $500,000			$160,000,000
Total		$97,000,000	$196,000,000	$278,000,000

Censored Claim Distribution by Policy Limit

		$100,000	Policy Limit	$500,000
Size of Loss			$300,000	
	X <= $100,000	1,573	753	168
$100,000	< X <= $300,000		637	561
$300,000	< X <= $500,000			407
Total		1,573	1,390	1,136

Calculate the increased limit factor for the $300,000 policy limit, assuming a basic limit of $100,000.

Questions from the 2012 exam

12. (1.25 points) Given the following information:

Paid Losses	Claim Counts by Policy Limit		
	$100,000	$300,000	$500,000
$50,000	30	25	80
$100,000	150	60	120
$300,000		35	50
$500,000			30
Total	180	120	280

Calculate an indicated increased limit factor for the $300,000 policy limit, assuming a basic limit of $100,000.

Section 2: Deductible Pricing

Questions from the 2003 exam:

38. (3 points) Given the information below, calculate the loss elimination ratio for ABC Company's collision coverage in State X at a $250 deductible. Show all work.
    - ABC insures 5,000 cars at a $250 deductible with the following fully credible data on the collision claims:
        - Paid losses are $1,000,000 per year.
        - The average number of claims per year is 500.
    - A fully credible study found that in State X:
        - The average number of car accidents per year involving collision damage was 10,000.
        - The average number of vehicles was 67,000.
    - Assume ABC Company's expected ground-up claims frequency is equal to that of State X.
    - Assume the average size of accidents that fall below the deductible is $150.

Questions from the 2004 exam:

39. (3 points) Given the information below, calculate the premium for a policy with a $5,000 deductible. Show all work.

Loss Distribution	
Frequency	Loss Amount
0.45	$500
0.35	$2,500
0.15	$10,000
0.05	$25,000

- First dollar premium is $500,000.
- Ground-up expected loss ratio is 60%.
- Allocated Loss Adjustment Expenses (as a percentage of loss) is 10%.
- Fixed expense is $95,000.
- Variable expense is 12%.
- Profit and contingency provision is 3%.
- Assume the deductible applies to loss and ALAE.

Questions from the 2005 exam:

19. Given the following information, calculate the loss elimination ratio at a $500 deductible.

Loss Amount	Claim Count	Total Loss
Below $500	150	$15,000
$500	6	$3,000
Over $500	16	$22,000

A. < 0.4　　B. $\geq$ 0.4, but < 0.5　　C. $\geq$ 0.5, but < 0.6　　D. $\geq$ 0.6, but < 0.7　　E. $\geq$ 0.7

Questions from the 2008 exam:

32. (2.5 points) Given the following information:

Ground-up Severity	Probability
\$100	20%
\$250	10%
\$500	15%
\$1000	30%
\$3000	20%
\$8000	5%

- Premium for a policy with no deductible = \$350
- Ground-up expected loss ratio = 60.9%
- Fixed expenses = \$31.70
- Variable underwriting expense provision = 22%
- Profit provision = 2%
- Allocated loss adjustment expenses (ALAE) are 10% of loss and are the responsibility of the insurer.

a. (1.0 point) Calculate the loss elimination ratio (LER) for a \$500 deductible.

b. (1.5 points) Calculate the premium for a policy with a \$500 deductible

Questions from the 2010 exam

30. (1 point) Given the following information:

Policy Deductible	Net Reported Losses	Net Reported Losses Assuming a \$250 Deductible	Net Reported Losses Assuming a \$500 Deductible
Full Coverage	\$680,000	\$590,000	\$525,000
\$250	\$2,900,000	\$2,900,000	\$2,600,000
\$500	\$5,200,000	N/A	\$5,200,000

Calculate the loss elimination ratio associated with moving from a \$250 deductible to a \$500 deductible.

Questions from the 2011 exam

14. (1.5 points) Given the following information:

Deductible	Reported Claim Counts	Net Reported Losses	Net Reported Losses Assuming $750 Deductible	Net Reported Losses Assuming $1000 Deductible
Full coverage	990	$1,347,000	$772,000	$605,000
$250	2,770	$5,167,000	$4,024,000	$3,505,000
$500	4,360	$9,198,000	$8,244,000	$7,345,000
$750	1,350	$3,230,000	$3,230,000	$2,926,000
$1,000	500	$1,692,000	Unknown	$1,692,000
Total	9,970	$20,634,000		

a. (1 point) Use the loss elimination ratio approach to deductible pricing to calculate the credit associated with moving from a $750 deductible to a $1,000 deductible.

b. (0.5 point) An assumption of the loss elimination ratio approach is that claim behavior will be the same for each deductible. Describe why this assumption may not hold in practice.

Section 3: Size of Risk for Workers Compensation

3a. Premium Discounts

Questions from the 2000 exam

52. (2 points) Based on Schofield, "Going from a Pure Premium to a Rate," and the following information, use the Workers' Compensation Method to calculate the dollar amount of Premium Discount.
   - Standard premium = $ 475,000
   - Expense Table:

     Expense Provisions

Premium Range ($)	Production	General	Taxes	Profit and Contingencies
1 – 5,000	12.0%	10.0%	4.0%	2.5%
5,001 - 100,000	9.0%	7.5%	4.0%	2.5%
100,001 - 500,000	7.0%	5.0%	4.0%	2.5%
500,001 +	6.0%	2.5%	4.0%	2.5%

Questions from the 2002 exam

29. (3 points) Based on Schofield, "Going From a Pure Premium to a Rate," and the information below, use the Worker's Compensation Method to calculate the discounted premium. Show all work.
   - Standard Premium of 500,000
   - For each premium gradation of 200,000 above 10,000, commissions and general expenses decrease by 25%.
   - For the first 10,000 of Standard Premium commissions are 15% and general expenses are 10%.
   - All other expenses total 8% of the discounted premium.

Questions from the 2011 exam

16. (1.75 points) Workers compensation insurers often offer a premium discount for large premium dollar accounts. Given the following expense information for workers compensation policies:

	Expense Percentage by Type:			
Premium Range	Production	General	Taxes	Profit
$0 - $7,500	14%	10%	3%	5%
$7,500 - $75,000	10%	8%	3%	5%
$75,000 - $200,000	7%	6%	3%	5%
$200,000 & above	5%	4%	3%	5%

Calculate the total amount of premium discount for a policy with premium of $180,000.

3b. Loss Constants

Questions from the 1995 exam

35. Feldblum, "Workers' Compensation Ratemaking," states that loss experience for large risks tends to be better than for small risks.
   (a) (1 point) Give two explanations that support this observation.
   (b) (2 points) In 1990 the NCCI recommended application of loss constants to all risks, rather than to small risks only. Using Feldblum's methodology and the information below, calculate the appropriate loss constant to be applied to all risks.

Premium Size	Number of Risks	Earned Premium	Incurred Losses	Loss Ratio
Small Risk $0 - $2,000	100	$75,000	$63,000	84.0%
Large Risk $2,001 or more	50	$200,000	$144,000	72.0%

   (c) (1 point) This question is no longer applicable to the content covered in this chapter

Questions from the 1998 exam

34. Based on Feldblum, "Workers' Compensation Ratemaking," answer the following.

a. (1 point) Give two reasons why small risks generally show higher loss ratios than larger risks.

b. (1 point) Using the information below, calculate the loss constant necessary to bring the experience of the smaller risks in line with the experience of the larger risks.

Premium Range	Number of Risks	Earned Premium	Incurred Loss
$0-1,000	1,000	1,200,000	1,100,000
>1,000	2,000	13,000,000	10,000,000

Questions from the 2000 exam

48. (3 points) Based on Feldblum, "Workers' Compensation Ratemaking," answer the following questions.
   a. (1/2 point) What is the purpose of an Expense Constant?
   b. (1/2 point) Why is an Expense Constant important for small policies?
   c. (1/2 point) What is the purpose of a Loss Constant?
   d. (1 1/2 points) Given the following data, calculate the loss constant. Assume loss constants are to be used for risks with annual premium of $1,000 or less.

Premium Range	# of Risks	Earned Premium	Incurred Loss
$ 0 - 1,000	200	$130,000	$104,000
> $1,000	200	$960,000	$720,000

Section 4: Insurance to Value (ITV)

Questions from the 1990 exam

49. (3 Points)

a. (2 Points) A building is insured for $150,000 under an agreed value policy. Assume a 12.5% loss frequency and the following size of loss distribution. Using the methods discussed by Head "Insurance to Value," calculate the pure premium rate per $100 for the building.

Size of Loss (L)	Number Of Losses	Dollars Of Loss
0 < L <$ 50,000	340	$3,762,000
$50,000 < L < 100,000	75	5 625,000
$100,000 < L < $150,000	50	6,375,000
$150,000 < L < $200,000	25	4,463,000
$200,000 < L < $250,000	10	2,275,000
$250,000 < L	0	0
TOTAL	500	$22,500,000

b. (1 Point) Is this rate higher or lower than the rate for a comparable building insured for $200,000? Why?

Question from the 1992 exam

5. According to the Study Note Reading: Head, G.L.; Insurance to Value, if losses less than the policy face are possible, which of the following are true concerning the pure premium rate as the coinsurance percentage increases?

1. If small losses outnumber large ones, pure premium rates should decrease at a decreasing rate.
2. If large losses outnumber small ones, pure premium rates should decrease at a decreasing rate.
3. If losses of all sizes are equally numerous, pure premium rates should decrease at a constant rate.

A. 1 B. 3 C. 1, 3 D. 2, 3 E. 1, 2, 3

Questions from the 1994 exam

43.

(a) (2 points) Using the methods described by Head in the Study Note Reading Insurance to Value, calculate the pure premium rate per $100 for 20%, 50%, and 80% coinsurance. You have the following data:

- The value of property insured is $200,000.
- Loss frequency is 2%.

Coinsurance Percentage (C_n)	Conditional Probability of Losses in Interval (C_{n-1}, C_n]	Arithmetic Mean Loss of Losses in Interval as % of Total Value
20%	.50	5%
50%	.20	35%
80%	.05	60%

(b) (1 point) This question no longer applies to the content covered in this chapter

Questions from the 1995 exam

46. (4 points) You are given:

Replacement Cost	Loss Frequency	Size of Losses in Interval ($000)	Conditional Probability of Losses in the Interval	Arithmetic Mean Loss of Losses in Interval ($000)
$100,000	10%	$ 0- 20	.80	$ 2
		21- 50	.10	3
		51- 80	.08	60
		81-100	.02	95
$200,000	10%	$ 0- 20	.70	$ 3
		21- 50	.15	35
		51- 80	.09	65
		81-100	.04	95
		101-160	.01	150
		161-200	.01	190

A client has asked you to determine the pure premium cost of insuring his house with a $200,000 replacement cost.

(a) (1 point) As described in the study note reading by Head, " Insurance To Value," determine the pure premium rate per $100 for insuring this house for $100,000.

(b) (1.5 points) How does this pure premium per $100 compare to the rate for this house if it were insured for $200,000? Explain.

(c) (1.5 points) Would the pure premium rate per $100 derived in (a) match that of a house with a replacement cost of $100,000 and insured for $100,000? Why or why not?

Questions from the 1996 exam

44. (3 points) You are given:

Coinsurance Percentage (C_n)	Conditional Probability of Losses in Interval $[C_{n-1}, C_n]$	Arithmetic Mean Loss in Interval $[C_{n-1}, C_n]$
40%	65%	$100,000
60%	20%	$250,000
80%	10%	$350,000
100%	5%	$500,000

- Value of Property: $500,000
- Loss Frequency: 5%

(a) (2 points) Using the methods described by Head, "Insurance to Value," calculate the pure premium rate per $100 for 60% coinsurance.

(b) (1 point) The property is actually insured for $200,000, with a 60% coinsurance clause. A loss of $80,000 occurs. What is the total indemnity amount payable to the insured?

Questions from the 1998 exam

5. Based on Head, Insurance to Value, calculate the pure premium rate per $100 of insurance for a $100,000 risk and a 50% coinsurance percentage.

Losses		Unconditional Probability	Arithmetic Mean
At Least	Less Than	Of Loss	Loss
0%	10%	.0100	4%
10%	20%	.0075	14%
20%	30%	.0050	23%
30%	40%	.0035	33%
40%	50%	.0020	43%
50%	60%	.0010	53%
60%	70%	.0005	62%
70%	80%	.0003	72%
80%	90%	.0002	82%
90%	100%	.0005	98%

A. < $1.00 B. ≥ $1.00 but < $1.05 C. ≥ $1.05 but < $1.10 D. ≥ $1.10 but < $1.15 E. ≥ $1.15

Questions from the 1999 exam

15. (1 point) Based on Head, "Insurance to Value," and given the information below, what is the coinsurance penalty applicable to the insured?

Coinsurance Requirement:	80%
Full Value of Structure:	$1,000,000
Amount of Insurance on Structure:	$700,000
Amount of Loss:	$600,000

A. < $20,000 B. ≥ $20,000 but < $40,000 C. ≥ $40,000 but < $60,000
D. ≥ $60,000 but < $80,000 E. ≥ $80,000

Questions from the 2000 exam

24. Based on Head, Insurance to Value, and the following information, calculate the absolute difference between the pure premium rate per $100 for a 50% coinsurance clause and a 75% coinsurance clause.
- The value of the insured property is $100,000.
- The loss frequency is 5%.

Loss, as Percentage of Total Property Value	Conditional Probability of a Loss in Interval	Arithmetic Mean Loss in Interval, as a Percent of Total Value
Less than or equal to 10%	0.50	4%
11 % to 25%	0.25	18%
26% to 50%	0.15	40%
51 % to 75%	0.07	70%

A. < 0.10 B. ≥ 0.10 but < 0.20 C. ≥ 0.20 but < 0.30 D. ≥ 0.30 but < 0.40
E. ≥ 0.40

Questions from the 2001 exam

Question 7. Based on Head, Insurance to Value, and the following information, calculate the ratio of the pure premium rate per $100 for a 60% coinsurance clause to the pure premium rate per $100 for a 40% coinsurance clause.

Loss, as a Percentage of Total Property Value	Unconditional Probability of a Loss in Interval	Arithmetic Mean Loss in Interval as a Percent of Total Value
Less than or equal to 20%	0.050	12%
21% to 40%	0.025	30%
41% to 60%	0.015	52%
61% to 80%	0.007	75%
80% to 100	0.003	95%

A. < 0.65 B. $\geq$ 0.65 but < 0.75 C. $\geq$ 0.75 but < 0.85 D. $\geq$ 0.85 but < 0.95 E. $\geq$ 0.95

Questions from the 2002 exam

42. (2 points) Based on Head, Insurance to Value, and the following information, calculate the pure premium rate per $100 for a 50% coinsurance clause.

The value of the insured property is $200,000. The loss frequency is 3%.

Loss, as Percentage of Total Property Value	Conditional Probability of a Loss in Interval	Arithmetic Mean Loss in Interval as a Percent of Total Value
Less than or equal to 25%	0.75	9%
26% to 50%	0.12	40%
51% to 75%	0.08	70%

Questions from the 2003 exam

40. (2.25 points) An insurer writing fire insurance uses coinsurance in its rating structure by means of an "average clause." A coinsurance percentage of 80% applies to all policies. Based on the following information, answer the questions below. Show all work

Policy	Amount of Loss	Property Value	Face Amount of Insurance
1	$50,000	$200,000	$150,000
2	$155,000	$160,000	$120,000
3	$375,000	$480,000	$400,000

a. (1.5 points) For each of the policies above, calculate the indemnity payment made by the insurer.

b. (0.75 points) For each of the policies above, calculate the additional insurance, if any, that would have been required for the insurance company to indemnify the full amount of the loss.

Questions from the 2004 exam

41. (4 points) Given the following information on an individual property policy, answer the questions below. Show all work.
    - The property value is $200,000.
    - Assume no deductible applies.
    - The frequency of non-zero loss is 10%.
    - The severity of loss distribution is as follows:
        - 70% at 10% of value
        - 20% at 50% of value
        - 8% at 80% of value
        - 2% at 90% of value
    - Coinsurance to 80% underlies the expected rate.
    - Permissible loss ratio is 65%.

    a. (2 points) The insured purchases a policy insuring the property to 80% of value. Determine the premium charged for the policy.

    b. (1 point) The insured instead purchases a policy insuring the property to 70% of value. Assuming the same rate per $100 of insured value as in part a. above, determine the expected loss ratio for this policy.

    c. (1 point) Assume the insurer incorporates a coinsurance clause into the policy. The insured continues to insure the property to 70% of value. What is the expected loss ratio for this policy? Briefly explain your answer.

Questions from the 2005 exam

51. (2 points) Using the following information, answer the questions below. Show all work.
    - All properties are valued at $500,000.
    - The company writes 1,000 policies.
    - Each policy has a face value equal to the value of the insured property.
    - Assume only one loss per policy per period is possible, and exactly 20 insureds will incur a loss of some size during any one policy period.
    - Assume no coinsurance clause or deductible applies

    Assume losses are distributed as shown:

    50% at $50,000

    20% at $250,000

    30% at $500,000

    a. (1 point) Calculate the pure premium rate per $100 of insurance for a policy face equaling $300,000.

    b. (1 point) Does the pure premium rate per $100 of insurance for a $500,000 policy face differ from the rate for the $300,000 policy face? Briefly explain your answer.

Questions from the 2006 exam

44. (2.5 points) You are given the following assumptions for an insured book of property business:

- A company writes 1,000 property policies.
- Each property is valued at $500,000.
- Exactly 20 of these properties will experience a loss during one policy period.
- The losses are distributed as shown in the table below:

S(L)	L
50%	$100,000
20%	200,000
10%	300,000
5%	400,000
15%	500,000

Find the premium rate per $100 of insurance for a policy face equaling $400,000. Show all work.

Questions from the 2007 exam

49. (1.0 point) A property is valued at $300,000. The coinsurance requirement for the policy is 80% of the property value. The insured chooses a $200,000 face value. Assume there is no deductible.

Calculate each of the following:

a. (0.25 point) Coinsurance requirement.

b. (0.25 point) Coinsurance apportionment ratio.

c. (0.25 point) Coinsurance deficiency.

d. (0.25 point) Maximum coinsurance penalty.

Show all work.

Questions from the 2008 exam

36. (2.0 points) You are given the following information:

- Home is valued at $350,000.
- Coinsurance requirement = 80% of the property value
- Face value of policy = $275,000

a. Calculate the coinsurance deficiency.

b. Calculate the coinsurance apportionment ratio.

c. Calculate the maximum coinsurance penalty possible.

d. Calculate the coinsurance penalty for a $300,000 loss.

Questions from the 2009 exam

40. (2 points) Given the following:

- Property is valued at $500,000.
- Coinsurance requirement is 88% of the property value.
- Policy face value is $300,000.

Graph and label the coinsurance penalty function.

Questions from the 2010 exam

32. (2 points) Given the following information:
    - Amount of loss = $200,000
    - Amount of coverage = $350,000
    - Replacement cost of property = $450,000
    - Minimum insurance-to-value requirement = 80%

a. (1 point) Calculate the coinsurance penalty.

b. (0.5 point) Identify the problem with underinsurance from the insurer's perspective.

c. (0.5 point) Identify the problem with underinsurance from the insured's perspective.

Questions from the 2012 exam

15. (2.25 points) You are given the following information on expected claim payment distribution for properties with a replacement cost of $350,000.

Claim Payment	Probability
$0	97.0%
$10,000	1.5%
$50,000	0.8%
$200,000	0.5%
$350,000	0.2%

- Assume no expenses or profit.

a. (0.5 point) Assuming all homeowners purchase full coverage, calculate the pure premium per $1,000 of insurance.

b. (0.75 point) Demonstrate with an example that the use of a fixed rate per $1,000 of insurance is inequitable if a subset of the insured group purchases only partial coverage.

c. (1 point) Describe two insurer initiatives that would reduce the inequity from part b. above, including an explanation of how the inequity would be reduced.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Section 1: Increased Limits Ratemaking

Solutions to questions from the 2004 exam:

45. (2 points) Calculate the annual claims inflation rate in the layer $50,000 excess of $50,000. Assume aground-up annual claims inflation rate of 15%. Show all work.

Date of Loss	Ground-up Loss
February 1, 2003	$37,000
July 15, 2003	$47,000
October 1, 2003	$64,000
December 1, 2003	$93,000

Note: This is more of a chapter 6 question

To determine the annual claims inflation rate in the layer $50,000 excess of $50,000, compare losses in the layer 50,000 excess of $50,000 prior to inflation with losses in the layer $50,000 excess of $50,000 after inflation. Be sure to trend **ground up claims by** the annual claims inflation rate of 15% prior to computing losses in the layer. Then ratio the losses in the layer prior to, and post the application of inflation.

Date of Loss	Ground-up Loss	Losses 50K xs 50K	Ground-up Annual Claims inflation Rate	Trended Ground-up Loss	Trended Losses 50K xs 50K	Annual Layer Claims Inflation Rate
	(1)	(2)	(3)	(4)=(1)*(3)	(5)	(6)=(5)/(2)-1.0
2/1/03	37,000	0	1.15	42,550	0	
7/15/03	47,000	0	1.15	54,050	4,050	
10/1/03	64,000	14,000	1.15	73,600	23,600	
12/1/03	93,000	43,000	1.15	106,950	50,000	
	241,000	57,000		277,150	77,650	**0.3623**

Col (2) and Col (5) are capped at 50,0000

Solutions to questions from the 2005 exam

50. (1 point) Explain two reasons why claim inflation produces larger cost trends on increased limits coverage than on basic limits coverage.

Note: This is more of a chapter 6 question

1. For losses above the basic limit, inflation will impact the increased limits portion of the loss only.
2. For losses near the basic limit, inflation may cause the loss to pierce the increased limit layer, resulting in increased frequency of increased limit losses.

Alternatively:

"First, the whole effect of the trend is in the excess portion of the increased limits claim while the effect on the basic limits portion is zero. Second, although uniform frequency trends affect equally basic and increased limits, a rising cost trend causes a rise in increased limits claim frequency since additional claims (previously only basic limits losses) break through the lower boundary of the increased limits layer of losses becoming new excess claims."

Solutions to questions from the 2006 exam

31. (3.25 points)

a. (2 points) Calculate the annual inflation rate for claims in the layer $50,000 excess of $100,000 for 2006.

2005 Ground-up Loss	2005 Losses 50K xs100K	Ground-up Annual Claims inflation Rate	2006 Trended Ground-up Loss	Trended 2006 Losses 50K xs100K	Annual Layer Claims Inflation Rate
(1)	(2)	(3)	(4)=(1)*(3)	(5)	(6)=(5)/(2)-1.0
75,000	0	1.10	82,500	0	
100,000	0	1.10	110,000	10,000	
125,000	25,000	1.10	137,500	37,500	
150,000	50,000	1.10	165,000	50,000	
450,000	75,000		495,000	97,500	**0.3000**

Col (2) and Col (5) are capped at 50,0000

b. (1.25 points) How would you expect the inflation rate in the layer $50,000 excess of $100,000 to differ from the inflation rate for claims limited to $100,000? Explain two reasons for the difference between the inflation rates.

Note: This is more of a chapter 6 question

The excess layer inflation rates are greater than the basic limit inflation rates for two reasons:

1. For losses already in the excess layer, inflation impacts only the portion of the loss in the excess layer. The basic limits portion does not change.
2. For losses near the basic limit, inflation causes the losses to pierce the increased limits layer, resulting in increased frequency of increased limits losses.

Solutions to questions from the 2007 exam

46. If all claims experience an annual ground-up severity trend of 8.0%, calculate the effective trend in the layer $100,000 in excess of $100,000. Show all work.

Note: This is more of a chapter 6 question

Initial comments: Analysis of trend on excess loss layers.

Two factors need to be considered.

1. The portions of losses below the layer are removed from both the pre-trend and post-trend loss amounts. See columns (2) and (5) below.

   This is a smaller % of the post-trend loss, which produces a "leveraging" effect.
   Compare [1.0 - (2)/(1)] to [1.0 - (5)/(4)].
2. However, some losses may be capped by the upper limit of the layer, mitigating the effect (See claim D below).

Claim	Ground-up Loss	Losses 100K xs100K	Ground-up Annual Claims inflation Rate	Trended Ground-up Loss	Trended Losses 100K xs100K	Effective Trend Rate in the 100K XS 100K Layer
	(1)	(2)	(3)	(4)=(1)*(3)	(5)	(6)=(5)/(2)-1.0
A	35,000	0	1.08	37,800	0	
B	125,000	25,000	1.08	135,000	35,000	
C	180,000	80,000	1.08	194,400	94,400	
D	206,000	100,000	1.08	222,480	100,000	
E	97,000	0	1.08	104,760	4,760	
Total	643,000	205,000		694,440	234,160	**0.1422**

Col (1) and Col (3) are given
Col (2) equals Col (1) - 100,000, capped at 100,000, if (1) is greater than 100,000
Col (5) equals Col (4) - 100,000, capped at 100,000, if (4) is greater than 100,000

Thus the effective trend in the 100K xs 100K layer is 234,160/205,000 - 1.0 = 0.1422 = 14.22%

Solutions to questions from the 2007 exam (continued):

47. (2.0 points) Using the methods described by Palmer in Increased Limits Ratemaking for Liability Ratemaking, calculate the following:

a. (1.25 points) The $5,000,000 increased limit factor.

b. (0.75 point) The limited average severity in the layer $4,000,000 in excess of $1,000,000. Show all work.

Initial comments:

An Increased Limit Factor (ILF) at limit L relative to basic limit B can be defined as:

$$ILF(L) = \frac{\text{Expected Indemnity Cost(L)}}{\text{Expected Indemnity Cost(B)}}$$

ILFs are developed on a per-claim or per-occurrence basis:

- A per-claim limit is a limit on the amount that will be paid to a single plaintiff for losses arising from a single incident.
- A per-occurrence limit is a limit on the total amount that will be paid to all plaintiffs for losses arising from a single incident.

To evaluate an appropriate provision for indemnity costs at various limits of liability, we develop (LAS) at various limits of liability. LAS is the average size of loss when all losses have been capped at the given limit.

Part A				**Part B**
Claim	**Ground-up Loss Amount (1)**	**Loss at \$1,000,000 Limit (2)**	**Loss at \$5,000,000 Limit (3)**	**Losses in the 4M x/s 1M Layer (4)**
A	250,000	250,000	250,000	0
B	300,000	300,000	300,000	0
C	450,000	450,000	450,000	0
D	750,000	750,000	750,000	0
E	1,200,000	1,000,000	1,200,000	200,000
F	2,500,000	1,000,000	2,500,000	1,500,000
G	4,000,000	1,000,000	4,000,000	3,000,000
H	7,500,000	1,000,000	5,000,000	4,000,000
I	9,000,000	1,000,000	5,000,000	4,000,000
J	15,000,000	1,000,000	5,000,000	4,000,000
	Limited Average	**775,000**	**2,445,000**	**2,783,333**

Col (2) equals Col (1) capped at 1,000,000; Col (3) equals Col (1) capped at 5,000,000
Col (4) equals Col (1) - 1,000,000, capped at 4,000,000, if (1) is greater than 1,000,000

a. The indemnity-only ILF at 5,000,00 given a basic limit of 1,000,000 equals 2,445,000/775,000 = 3.1548

b. LAS (4M xs 1M) = (200,000 + 1,500,000 + 3,000,000 + [3 x 4,000,000])/6 = 2,783,333, or
LAS (4M xs 1M) = (2,445,000 – 775,000)/0.6 = 2,783,333, where .60 is equal to the probability that a loss is greater than 1M, given that a loss has occurred, or
[(3 * 5,000,000 + 4,000,000 + 2,500,000 + 1,200,000]/6 - [(6 * 1,000,000]/6 = 3,783,333 -1,000,000 = 2,783,333

Solutions to questions from the 2008:

Model Solution – Question 18

a. Calculate the basic limit trend and b. Calculate the excess limit trend

Note: This is more of a chapter 6 question

a. Basic limits trend: All losses except the $20K loss are at or exceed the basic limit of $50,000.
So the BL trend is simply [($50+$50+$50+$50+$20*1.1)/($50+$50+$50+$50+$20)] -1.0 = 1%

b. Excess limits trend is computed as [($50+$70+$90+$110]*1.1 -$ 50*4)]/[0+0+20+40+60] – 1.0 = 26.7%
This can also be computed as follows:

$$Excess\ Limits\ Trend = \left[\sum_{x=50,000}^{110,000} (x*1.1 - 50,000)\right] / \sum_{x=50,000}^{110,000} (x - 50,000)$$

Alternatively, the basic limits trend and excess limits trend can be computed as follows:

Effects of +10% Trend on Basic (50,000) and Excess Loss Limits

Loss Amount ($)	$50,000 Limit		Excess Limit	
	Pre Trend($)	Post Trend($)	Pre Trend($)	Post Trend($)
20,000	20,000	22,000	0	0
50,000	50,000	50,000	0	5,000
70,000	50,000	50,000	20,000	27,000
90,000	50,000	50,000	40,000	49,000
110,000	50,000	50,000	60,000	71,000
Total	220,000	222,000	120,000	152,000
Trend [Post ($)/Pre ($)]		1.00%		27.00%
		0.009		0.267

Note: 22,000 = 20,000 * 1.1; 27,000=70,000 * 1.1 - 50,000

c. When loss trends are negative.

Solutions to questions from the 2008 (continued):

Model Solution – Question 34

a. Initial comments:

An Increased Limit Factor (ILF) at limit (L) relative to basic limit (B) can be defined as:

$$ILF(L) = \frac{\text{Expected Indemnity Cost(L)}}{\text{Expected Indemnity Cost(B)}}$$

Step 1: Write an equation to determine the \$500,000 ILF given a \$250,000 basic limit

$$ILF(500{,}000) = \frac{\text{Expected Indemnity Cost(500,000)}}{\text{Expected Indemnity Cost(250,000)}} = \frac{LAS(500)}{LAS(250)}$$

Step 2: Recall that to evaluate LAS at \$5000,000, include all loss dollars from losses of:

i. \$500,000 or less, plus

ii. the first \$500,000 of each loss that is in excess of \$500,000.

The same holds true when computing LAS at \$250,000, except that \$250,000 is used in i. and ii. above.

Finally, recognize that since LAS is the <u>average</u> size of loss when all losses have been capped at a given limit, we must divide the loss amounts describe above by the total number of loss occurrences.

Step 3: Using the guidance in Step 2, and the data given in the problem, compute LAS (500K) and LAS (250K).

$$LAS(500k) = \frac{\$500,000 + \$16,000,000 + \$17,500,000 + 20 * \$500,000}{100 + 80 + 50 + 20} = \frac{\$44,000,000}{250} = \$176,000$$

$$LAS(250k) = \frac{\$500,000 + \$16,000,000 + 70 * \$250,000}{100 + 80 + 50 + 20} = \frac{\$34,000,000}{250} = \$136,000$$

Notes:

i. The losses given in this problem are assumed to be the total losses that actually occurred. None of the losses were limited, or "censored," by the insured's policy limit. For more information on working with losses that are limited, or "censored," by the insured's policy limit, see Section 4 in your manual.

ii. There are only 20 losses in excess of \$500,000, while there are 70 losses in excess of \$250,000.

Step 4: Using the equation in Step 1, and the results from Step 3, solve for the \$500,000 ILF

$$ILF(500k) = \frac{LAS(500k)}{LAS(250k)} = \frac{\$176,000}{\$136,000} = 1.294$$

b. Two issues with using empirical data are:

1. Credibility - Data could be sparse for large losses, which makes ILFs susceptible to random fluctuations and therefore unreliable (or less credible).
2. Ground-up loss data may not be available, especially for first party coverages where small losses under the policy deductible are not reported.

Solutions to questions from the 2009 exam

Question: 36

Initial comments: In the predecessor paper to WM, Palmer states that:

An Increased Limit Factor (ILF) at limit L relative to basic limit B can be defined as:

$$ILF(L) = \frac{\text{Expected Indemnity Cost(L)+ALAE (L) +ULAE(L) +RL(L)}}{\text{Expected Indemnity Cost(B) +ALAE(B) +ULAE(B) +RL(B)}}$$, where

ALAE(X) = the Allocated Loss Adjustment Expense provision at each limit,

ULAE(X) = the Unallocated Loss Adjustment Expense provision at each limit, and

RL(X) = the Risk Load provision at each limit.

In addition, for illustrative purposes, examine the "indemnity-only" ILF:

$$ILF(L) = \frac{\text{Expected Indemnity Cost(L)}}{\text{Expected Indemnity Cost(B)}}$$

Assumptions:

**Key: When working with ILFs, it's often assumed that frequency is independent of severity. **

The above formula can then be expressed as:

$$ILF(L) = \frac{\text{Expected Frequency (L)} \times \text{Expected Severity (L)}}{\text{Expected Frequency (B)} \times \text{Expected Severity (L)}}$$

However, it is generally assumed that the frequency is independent of the policy limit purchased (i.e. Expected Frequency (L) = Expected Frequency (B))

Problem specific solution

ILF = [LAS (5,000,000) + ULAE (5M)] x Freq(5M)/ [LAS (1,000,000) + ULAE (1M)]x Freq(1M)

Compute the following:

$$LAS(1,000,000) = [300,000 + 600,000 + 750,000 + 3(1,000,000)] / 6 = 775,000$$

$$LAS(5,000,000 = [300,000 + 600,000 + 750,000 + 1,250,000 + 4,500,000 + 5M] / 6 \quad = 2,066,667$$

Thus, ILF = [LAS (5,000,000) + ULAE (5M)] x Freq(5M)/ [LAS (1,000,000) + ULAE (1M)]x Freq(1M)

= [2,066,667 x 1.2 x .10]/ [775,000 x 1.1 x .15] = 1.9394

Solutions to questions from the 2010 exam

Question: 31

Calculate the increased limit factor for the $300,000 policy limit, assuming a basic limit of $100,000.

$$Indicated\ ILF(\$300K) = \frac{LAS(\$300K)}{LAS(\$100K)}$$

To calculate LAS by limit, calculate a LAS for each layer of loss and combine the estimates for each layer taking into consideration the probability of a claim occurring in the layer.

The LAS of each layer is based solely on loss data from policies with limits as high as or higher than the upper limit of the layer.

Example: When calculating the LAS ($100K), use the experience from all policies limits censored at $100,000:

$$LAS(\$100K) = \frac{\$97M + \$46M + 637(\$100K) + \$11M + (561+407)\$100K}{(1,573+1,390+1,136)} = \frac{\$314,500,000}{4,099} = \$76,726$$

Note: When calculating LAS ($300,000), the actuary cannot use the policies that have a $100,000 limit as there is no way to know what the claim amounts would be if each of those policies had a limit of $300,000.

Calculating LAS ($300,000):

Combine LAS ($100K) with LAS for the layer ($100,000 to $300,000).

Step 1: Determine the losses in the $100K - $300 K layer.

i. Policies with a limit of $100,000 cannot contribute any losses to that layer and the data is not used.

ii. Of the 1,390 claims with policies having a $300K limit, 637 claims have losses in the $100K to $300K layer.

Total censored losses for those 637 claims are $150,000,000.

Eliminating the first $100K of each of those losses results in losses in the $100K to $300K layer.

$150,000,000 - 637 x $100,000 = $86,300

iii. Policies with a limit of $500K also contribute loss dollars to the $100K to $300K layer.

Of the 1,136 claims associated with a limit of $500K limit, 561 have losses in the $100K to $300K layer.

These claims contribute $50,900,000 (=$107,000,000 – 561 x $100,000) of losses to the layer.

Another 407 claims exceed $300,000, and each contributes $200,000 to the $100K to $300K layer.

$81,400,000 = 407x ($300,000- $100,000)

The sum of the above values are the losses in the $100K to $300 layer:

$86,300,000+ $50,900,000+ $81,400,000 = $218,600,000.

These loss dollars were derived from 1,605 (=637 + 561 + 407) claims.

LAS(100K-300K) = $\$136,199 = \frac{\$218,600,000}{1,605}$

Thus, LAS(100K-300K)*Pr(100<X<300) = $136,199 * \frac{1,605}{2,526} = \$86,540 = \frac{\$218,600,000}{2,526}$

Step 2: Compute $LAS(\$300K) = \$76,726 + \$86,540 = \$163,266$

Step 3: Compute $Indicated\ ILF(\$300K) = \frac{LAS(\$300K)}{LAS(\$100K)} = \frac{163,266}{76,726} = 2.13$

Solutions to questions from the 2012 exam

12. Calculate an indicated increased limit factor for the $300,000 policy limit, assuming a basic limit of $100,000.

Question 12 – Model Solution (Exam 5A Question 12)

Increased Limit Factor (300k) = LAS (300K)/LAS (100K)

LAS (300k) = LAS (100k) + LAS (Layer 100k -300k) * Probability on eligible claim reaches the layer

Limited Average Severity (100,000)

$$=\frac{(30+25+80)\cdot 50,000+(150+60+120)\cdot 100,000+(35+50+30)\cdot 100,000}{180+120+280}= 88,362.07$$

Limited Average Severity (Layer 100k -300k)

$$=\frac{(35+50)\cdot 200,000+30\cdot 200,000}{35+50+30}=200,000$$

P{Claim has a loss in layer / claim has a policy limit entering layer}

$$= \frac{35+50+30}{120+280}= 0.2875$$

LAS (300k) = LAS (100k) + LAS (Layer 100k -300k) * Probability on eligible claim reaches the layer
= 88,362.07 + 200,000 * 0.2875 = 145862.07

Increased Limit Factor (300k) = $\frac{\text{LAS}(300k)}{\text{LAS}(100k)}=\frac{145,862.07}{88,362.07}=1.651$

*I'm assuming that frequency is the same for both limits.

Examiner's comments

A majority of candidates received full credit.

Some candidates used the data available incorrectly, either including data that shouldn't be used (100K limit data to calculated losses in the 100K-300K range) or not using enough data (ignoring the 500K data).

Section 2: Deductible Pricing

Solutions to questions from the 2003 exam

38. (3 points) Calculate the loss elimination ratio for ABC Company's collision coverage in State X at a $250 deductible. Show all work.

Step 1: Write an equation to determine the loss elimination ratio for ABC Company's collision coverage in State X at a $250 deductible. $LER_{250} = \frac{E[X;\$250]}{E[X]}$

Step 2: Using the data from the fully credible study conducted in State X, determine the overall claim frequency.

$$Overall\ Claim\ Frequency = \frac{Avg\ .No.\ of\ \ claims\ per\ year}{Avg.\ No.\ of\ \ Exposures} = \frac{10,000}{67,000} = .1493$$

Step 3: Determine the total number of claims per year incurred by the ABC company:

Total number of claims per year = No. of exposures written * overall claim frequency

= 5,000 * .1493 = 747

Step 4: Determine the estimated number of claims that fall below ABC's deductible.

Estimated number of claims that fall below ABC's deductible = 747 – 500 = 247.

Step 5: Determine total expected ground up losses, E(x)

Total expected ground up losses = Losses below the deductible + Losses paid excess of the deductible + number of losses excess of the deductible * deductible.

= $150 * 247 + $1,000,000 + 500 * $250 = $1,162,050.

Step 6: Determine the limited expected losses at State X's $250 deductible:

E[x;250] = $150 x 247 + $250 * 500 = $162,050

Step 7. Using the equation in Step 1, and the values in Steps 5 and 6, compute the LER

LER = E[x;250] / E(x) = $162,050 / $1,162,050 = 13.95%

Solutions to questions from the 2004 exam

39. (3 points) Calculate the premium for a policy with a $5,000 deductible. Show all work.

Step 1: Write an equation to determine the premium for a policy with a $5,000 deductible.

$$\text{Premium}_{5K} = \frac{[\text{1st \$ Premium*ELR*(1-LER)*ALAE factor + Fixed Expense}]}{(\text{1-Variable Expense-Profit\&Contingency})}$$

Step 2: Solve for the terms in the Step 1 equation that are not given in the problem (i.e. the LER)

$$\text{Loss Elimination Ratio}_{5K} = \frac{[\text{Loss and ALAE under the 5,000 deductible}]}{(\text{Total Loss and ALAE})}$$

Frequency (1)	Loss + ALAE Amount (2)	Loss + ALAE Limited to Deductible (3)	(4)=(1)*(2)	(5)=(1)*(3)	**LER** (6)=(5)tot/(4)tot
0.45	$550	$550	$248	$248	
0.35	$2,750	$2,750	$963	$963	
0.15	$11,000	$5,000	$1,650	$750	
0.05	$27,500	$5,000	$1,375	$250	
Total	$41,800		$4,235	$2,210	0.5218

(3) = Min [(2), 5,000 policy deductible]

Step 3: Using the results from Step 2, the equation from Step 1 and the data given in the problem, solve for $5,000 deductible policy premium.

$$\text{Premium}_{5K} = \frac{[\$500,000*.60*(1-.5218)*1.10 \ + \ \$95,000]}{(1-.12-.03)} = \$297,402.60$$

Solutions to questions from the 2005 exam

19. Calculate the loss elimination ratio at a $500 deductible.

Step 1: Write an equation to determine the loss elimination ratio (LER) at a $500 deductible

$$\text{LER}_{500} = \frac{[\text{Losses} < \$500 + (\text{\# of claims} \geq \ \$500)*\$500]}{\text{Total Loss}}$$

Step 2: Using the equation in Step 1, and the data given in the problem, solve for the LER at a $500 deductible

$$\text{LER}_{500} = \frac{[\$15,000 + (16+6)*\ \$500]}{\$40,000} = \frac{\$26,000}{\$40,000} = .65$$

Answer D: ≥ 0.6, but < 0.7

Solutions to questions from the 2008 exam

Model Solution - Question 32

Part a. Calculate the loss elimination ratio (LER) for a $500 deductible.

Step 1: Write an equation to determine the LER for a $500 deductible.

The loss elimination ratio (LER) $= \dfrac{E[X;D]}{E[X]} = \dfrac{\sum_{x=1}^{x=D} x * f(x)dx + D[1-F(d)]}{E[X]}$

Step 2: Using the equation in Step 1, and the data given in the problem, solve for the LER for a $500 deductible.

$$E[X;500] = 100(0.2) + 250(0.1) + 500(1-0.2-0.1) = 395$$

$$E[X] = 100(0.2) + 250(0.1) + 500(0.15) + 1000(0.30) + 3000(0.20) + 8000(0.05) = 1,420$$

Thus, the $LER = \dfrac{395}{1,420} = 0.278169 = 27.82\%$

Part b. Calculate the premium for a policy with a $500 deductible

Step 1: Write an equation to determine the premium for a $500 deductible policy

$$\text{Prem}_{500\text{Ded}} = \frac{\text{Losses above ded + ALAE + Fixed Exp}}{\text{1.0 - \%Comm Exp- \%Other Var Exp-\%P\&C}}$$

Step 2: Compute losses excess of the deductible and ALAE

Expected losses X/S of the deductible = Expected losses * X/S ratio

= SP * ELR * X/S ratio = $350 * .609 * (1 - .2782) = $153.8583

Note: the X/S ratio = 1 - LER

ALAE = Expected losses * ALAE % of loss = SP * ELR * ALAE % = $350 * .609 * .10 = $21.315

Step 3: Using the equation in Step 1, the results from Step 2 and the givens in the problem, solve for $100,000 deductible policy premium.

$$\text{Prem}_{500\text{Ded}} = \frac{\$153.8583 + \$21.315 + 31.70}{1.0 - .22 - .02} = \$272.20$$

Solutions to questions from the 2010 exam

Question 30 Calculate the LER associated with moving from a $250 deductible to a $500 deductible.

In the LER approach, calculate the amount of losses that are eliminated going from full coverage to a deductible or by going from one deductible to a higher deductible:

$$LER(D) = \frac{\textit{Losses and LAE Eliminated by Deductible}}{\textit{Total Ground - up Losses and LAE}} = \frac{(L + E_L)_B - (L + E_L)_D}{(L + E_L)_B}$$

Ignore $500 data due to censoring of data.

Losses eliminated = (2,900,000 + 590,000) – (2,600,000 + 525,000) = 365,000

LER (500) = 365,000/(2,900,000+590,000) = 0.10458

Solutions to questions from the 2011 exam

14a. (1 point) Use the loss elimination ratio approach to deductible pricing to calculate the credit associated with moving from a $750 deductible to a $1,000 deductible.

14b. (0.5 point) An assumption of the loss elimination ratio approach is that claim behavior will be the same for each deductible. Describe why this assumption may not hold in practice.

Initial comments

Insurers may not know the ground-up losses for every claim (e.g. insureds may not report claims that are less than the deductible on their policy).

When this is the case, data from policies with deductibles greater than the deductible being priced cannot be used to calculate the LER. For example:

- data from policies with a $500 deductible cannot be used to determine LERs for a $250 or $100 deductible, however
- data from policies with deductibles less than the deductible being priced can be used to determine LERs (e.g. data from policies with a $500 deductible can be used to determine the LER associated with moving from a $750 deductible to a $1,000 deductible).

LER Calculation to Move from a $750 to $1000 Deductible

(1) Deductible	(2) Reported Claims	(3) Net Reported Losses	(4) Net Reported Losses Assuming $1000 Ded	(5) Net Reported Losses Assuming $750 Ded	(6) Losses Eliminated Moving from $750 to $1000
Full Cov	990	$1,347,000	$605,000	$772,000	$167,000
$250	2770	$5,167,000	$3,505,000	$4,024,000	$519,000
$500	4360	$9,198,000	$7,345,000	$8,244,000	$899,000
$750	1350	$3,230,000	$2,926,000	$3,230,000	$304,000
$1,000	500	$1,692,000	$1,692,000	Unknown	Unknown
Total	9970	$20,634,000			
		(7) Net Reported Losses for Ded <=$750			$16,270,000
		(8) Losses Eliminated <=$750 Ded			$1,889,000
		(9)LER			0.1161

(3)= Net of the deductible (4) =(3) Adjusted to a $1000 deductible (5)=(3) Adjusted to a $750 deductible

(6)= (5) - (4) (7)= Sum of (5) for $0, $250, $500, 750 Ded

(8)=Sum of (6) for $0, $250, $500, $750 Deductibles (9)=(8)/(7)

- Each row contains data for policies with different deductible amounts.
- The analysis can only use policies with deductibles of $750 or less (since the goal is to determine the losses eliminated when changing from a $750 to a $100 deductible)
- Columns 4 and 5 contain the net reported losses in Column 3 restated to $1000 and $750 deductible

  Columns 4 and 5 are not Column 3 minus the product of Column 2 and the assumed deductible.

  This is because not every reported loss exceeds the assumed deductible. The losses in Columns 4 and 5 are based on an assumed distribution of losses by deductible and size of loss, and cannot be recreated given the data shown.

Question 14 – Model solution

a. LER = [(772 - 605) + (4024 - 3505) + (8244 - 7345) + (3230 - 2926)] / (772 + 4024 + 8244 + 3230)

= [16,270 - 14381] / 16,270 = 0.1161 Credit

b. Low risk drivers more likely to purchase higher deductibles

Section 3: Size of Risk for Workers Compensation

3a. Premium Discounts

Solutions to questions from the 2000 exam

Question 52.
Calculate the dollar amount of Premium Discount.

• Given Standard premium = $ 475,000

1. Partition the $475,000 into "gradations" (the first $5,000 of premium; the next $95,000 of premium, etc.)
2. Compute Premium in Range:

Premium Range ($)	Gradation of Premium	Premium in the range	Production	General	(3)	Taxes	Profit and Contingencies
			(1)	(2)	(1)+(2)	(4)	(5)
1 - 5,000	5,000	5,000	12.0%	10.0%	22%	4.0%	2.5%
5,001 - 100,000	95,000	95,000	9.0%	7.5%	16.5%	4.0%	2.5%
100,001 - 500,000	400,000	375,000	7.0%	5.0%	12%	4.0%	2.5%
500,001 +	500,000+	0	6.0%	2.5%	8.5%	4.0%	2.5%

3. Compute the Expense reduction
   The expense reduction in expenses is simply the difference between the expenses in a particular Premium Range and those expenses in the Premium Range of $1 - $5,000.
   Note: Each gradation of premium has a set of expense percentages associated with it.
   The Production and General Expenses percentages vary with the premium gradation and represent percentages of Standard Premium (taxes and P&C contingencies are fixed %s).
4. Compute the Discount Percent is calculated as:

$$Discount\ Percent = \frac{Expense\ Reduction}{1\text{-"all other expenses" as a \% of discounted premium}} = \frac{Expense\ Reduction}{1.0\text{-}Taxes\text{-}Profit\ \&\ Cont.}$$

Premium Range ($)	Premium in the range	Expense Reduction	Discount Percent	Premium Discount
	(6)	(7)	(8) = (7)/[1.0-[(4)+(5)]	(9)=(6)*(8)
1 - 5,000	5,000	0%	0	0
5,001 - 100,000	95,000	22%-16.5%= 5.5%	5.882%	5,588
100,001 - 500,000	375,000	22%-12%= 10%	10.695%	40,106
500,001 +	0	22%-8.5%= 13.5%	14.439%	0
				45,694

5. $Total\ Discount = \sum_{premium\ range} (Discount\ Percent)*(Premium\ in\ range)$ = 45,694.

Solutions to questions from the 2002 exam

29. Use the Worker's Compensation Method to calculate the discounted premium. Show all work.

Given Standard premium = $500,000

Step 1. **Partition** the $500,000 into "gradations" as stated in the problem (the first $10,000 of premium; the next $200,000 of premium, etc.)

Step 2. **Compute Premium in Range** and the reduction of commissions and general expenses by gradation.

Step 3. **Compute the Expense reduction** (the difference between the expenses in a particular Premium Range and those expenses in the Premium Range of $0 - $10,000).

Step 4. **Compute the Discount Percent,** which is calculated as:

$$\textit{Discount Percent} = \frac{\textit{Expense Reduction}}{\textit{1-"all other expenses" as a \% of discounted premium}}$$

Premium Range ($)	Premium in the range	Commissions	Gen Exp		All Other Expenses	Expense Reduction	Discount Percent
	(1)	(2)	(3)	(4)=(2)+(3)	(5)	(6)	(7)
0 – 10,000	10,000	15.0%	10.0%	25%	8.0%	0.00%	0.00%
10,001 - 210,000	200,000	11.25%	7.5%	18.75%	8.0%	6.25%	6.79%
210,001 - 410,000	200,000	8.44%	5.63%	14.07%	8.0%	10.93%	11.88%
410,001 – 610,000	90,000	6.33%	4.22%	10.55%	8.0%	14.45%	15.71%

$(2_{i+1}) = (2_i) * .75$. $(3_{i+1}) = (3_i) * .75$.

(6) = [(.15+.10) - (4)]. (7) = (6)/[1.0 - (5)]

Step 5: Compute the premium discount and the discounted premium.

Premium discount = Sumproduct[(1)*(7)] = [200,000 * .0679 + 200,000 * .1188 + 90,000 * .1571] = 51,483

Discounted premium = 500,000 – 51,483 = **448,516**.

Solutions to questions from the 2011 exam

16. Calculate the total amount of premium discount for a policy with premium of $180,000.

Question 16 – Model Solution

Prem Range	(1) Prem in Range	(2) Prod + Gen	(3) Diff. From 1st Range	(4) = (3) / (1-.08) Discount	(5) = (4) * (1) $Discount
0-7500	7500	.24	0	0	0
7500-75000	67500	.18	.06	.06522	4402.17
75000-200000	105000	.13	.11	.1196	12554.35
200000+	0	.09	.15	.163	0
					16956.52

(1)= 7,500 – 0; 75,000-7,500; 180,000-75,000; (3)= $(2_{\text{Row 1}})$-(2); (4) = (3)/[1.0 –taxes - profit)]

3b. Loss Constants

Solutions to the questions from the 1995 exam

Question 35.

(a) 1. The experience of large firms receives greater credibility than that of small firms, and thus large firms have greater incentives to reduce losses.
2. Safety programs require large fixed costs, which may be more cost effective for larger firms.

(b) Chosen such that loss ratio for small risks (with premium < 2,000) = loss ratio for large risks (with premium > 2,000).

Let X = the loss constant per risk. Solve the equation for $X. ,

$$\frac{\$63{,}000}{\$75{,}000 + 100 * \$X} = \frac{\$144{,}000}{\$200{,}000 + 50 * \$X}.$$ $X = 160.

(c) This question is no longer applicable to the content covered in this chapter

Solutions to questions from the 1998 exam

Question 34.

a. Explanations to why loss experience tends to be better for large risks than for small risks.
1. Good loss experience reduces the cost of future insurance. Since experience rating gives more weight (more credibility) to a larger risk's experience, it gives them more incentive to reduce losses.
2. The large expenditures required to implement safety programs are more cost effective for larger risks than for smaller risks.
3. Post injury and back-to-work programs may not be offered by smaller risks, since severe injuries do not occur with great frequency.

b. Loss constants are flat dollar premium additions designed to flatten loss ratios by size of risk.

The loss constant can be calculated in two ways.

Method 1. Loss Constants Applied to Small Risks Only.

The loss constant is chosen such that loss ratio for small risks (with premium < $1000) is equal to the loss ratio for large risks (with premium > 1,000).

Based on the given information, compute the loss ratios for small risks and large risks:

	Number of Risks	Premium Range	Earned Premium	Incurred Losses	Loss Ratio
Small Risks	1,000	$ 0 - 1,000	1,200,000	1,100,000	.917
Large Risks	2,000	> $1,000	13,000,000	10,000,000	.769

Let X = the total loss constant premium. Solve for X such that the loss ratio for small risks will equal the loss ratio produced by large risks.

$$\frac{1{,}100{,}000}{1{,}200{,}000 + X} = .769.$$ X = 230,429. Since there are 1,000 small risks, the loss constant equals $230.43

Method 2. Loss Constants Applied to All Risks.

The use of a loss constant for all risks flattens the loss ratio for small risks.

$$\frac{1{,}100{,}000}{1{,}200{,}000 + X} = \frac{10{,}000{,}000}{13{,}000{,}000 + 2X}.$$ X = 294, 871.

Given 1,000 small risks, the loss constant equals $294.87

Solutions to the questions from the 2000 exam

Question 48.

a. The purpose of an expense constant is to charge for expenses which do not vary by policy size (e.g. setting up files), and is uniform for all risks.

b. An expense constant is important for small policies since it ensures that an adequate premium is being charged. Without an expense constant, the premium computed for small insureds may be so low that it would be inadequate to cover the expenses of writing the policy.

c. Loss constants (flat dollar premium additions either for all or small insureds) are a means of flattening the loss ratios by size of risk.

d. Given the following data, calculate the loss constant. Assume loss constants are to be used for risks with annual premium of $1,000 or less.

The loss constant is chosen such that loss ratio for small risks (with premium < $1000) is equal to the **loss ratio for large risks (with premium > 1,000).**

Based on the given information, compute the loss ratios for small risks and large risks:
Let X = the total loss constant premium. Solve for X such that the loss ratio for small risks will equal the loss ratio produced by large risks.

Premium Range	# of Risks	Earned Premium	Incurred Loss	Loss ratio
$ 0 - 1,000	200	$130,000	$104,000	.80
> $1,000	200	$960,000	$720,000	.75

Method 1. Loss Constants Applied to Small Risks Only.

$\frac{104,000}{130,000+X} = .75$. X = 8,666.66. Since there are 200 small risks, the loss constant equals $43.33

Section 4: Insurance to Value (ITV)

Solutions to questions from the 1990 exam
Question 49.

Size of Loss (L)	Number Of Losses	Conditional Pr[of Loss]	Unconditional Pr[of Loss]	Dollars Of Loss	Pure premium
(1)	(2)	(3)=(2) / 2(tot)	(4) = (3)*.125	(5)	(6)=[(5)/(2)]*(4)
0 < L <$ 50,000	340	.68	.085	$ 3,762,000	941
$50,000 < L < 100, 000	75	.15	.01875	5,625,000	1,406
$100,000 < L < $150,000	50	.10	.0125	6,375,000	1,594
$150,000 < L < $200,000	25	.05	.00625	4,463,000	**938**
$200,000 < L < $250,000	10	.02	.0025	2,275,000	**375**
$250,000 < L	0	0	0	0	0
TOTAL	500			$22,500,000	5,254

Note: For L > 150,000, column (6) pure premium = $150,000 * (4)

The pure premium rate per $100 for the $150,000 building = 5,254 / [150,000/100] = 3.502.

(b). This rate is higher.
Whenever losses < F are possible, the PP rate should decrease as F increases.

Solutions to questions from the 1992 exam
Question 5.

1. T.
2. F.
3. T. Answer C.

Solutions to questions from the 1994 exam

Question 43.

(a).

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1-\int_0^C s(L)dL]}{F/100}\right)$$

Co-Ins %	General Pure premium rate Equation	Pure prem rate per $100
.20	$.02^*\dfrac{[.50(10{,}000) + (1-.50)*(40{,}000)]}{40{,}000/100}$	1.25
.50	$02^*\dfrac{[.50(10{,}000)+.2*70{,}000+(1-.70)*(100{,}000)]}{100{,}000/100}$	.98
.80	$02^*\dfrac{[.50*10{,}000+.2*70{,}000+.05*120{,}000+(1-.75)*(160{,}000)]}{160{,}000/100}$	.8125

(b). This question no longer applies to the content covered in this chapter

Solutions to questions from the 1995 exam

Question 46.

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1 - \int_0^C s(L)dL]}{F/100}\right).$$

Note the mistake in the example. For a replacement cost of $100,000 and a size of loss interval between 21,000 and 50,000, the arithmetic mean loss cannot be 3,000, but is more likely to be 30,000.

See (b) below.

(a). $200,000 replacement cost, at 50% co-insurance . C = cV = .50 * 200,000 = 100,000.
.10[.70*(3,000) + .15*(35,000) + .09*(65,000) + .04*(95,000) + .02*(100,000)] / [100,000 / 100] = $1.90.

(b). The pure premium per $100 computed in (a) of $1.90 is higher than the computed pure premium rate for the house if it were insured for 200,000 (which is equivalent to a 100 % co-insurance rate).
Whenever losses < F are possible, the PP rate should decrease as F increases, even if large losses predominate.

200,000 replacement cost, at 100% co-insurance . C = cV = 1.0 * 200,000 = 200,000.
.10[.70*(3,000) + .15*(35,000) + .09*(65,000) + .04*(95,000) + .01*(150,000) + .01(190,000)] / [200,000 / 100] = $1.02.

(c). $100,000 replacement cost, at 100% co-insurance . C = cV = 1.0*100,000 = 100,000.
.10[.80*(2,000) + .10*(30,000) + .08*(60,000) + .02*(95,000)] / [100,000 / 100] = $1.13.

Since there is a probability of a loss > 100,000 associated with a $200,000 replacement cost policy, and since the policy limit of $100,000 caps the indemnity at $100,000 on a $100,000 policy, the pure premium rate associated with the latter (1.13) is < the pure premium rate associated with the former (1.90).

Solutions to questions from the 1996 exam

Question 44.

(a) The computation of % coinsurance rates. Begin with the pure premium rate equation.

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1-\int_0^C s(L)dL]}{F/100}\right)$$

Symbol	Description
f	frequency of loss
c	coinsurance %
V	property value
F	policy face (expressed in $'s)
C	cV
L	Loss amount

Assume that L is a continuous variable, "because this assumption clarifies some relationships which might be nearly unintelligible in discrete notation."

"Pure premium coinsurance rates are computed on the assumption of a policy face equal to the coinsurance requirement."

Since the assumed policy face, F, = C = cV = .60 * $500,000, and using the information in the table below, we can compute the pure premium rate per $100 for 60% coinsurance as follows:

Coinsurance Percentage (Cn)	Conditional Probability of Losses in Interval $[C_{n-1}, C_n]$	Cumulative Conditional Probability of Loss > Cn	Arithmetic Mean Loss in Interval $[C_{n-1}, C_n]$	C = cV
.40	65%	.35	$100,000	$200,000
.60	20%	.15	$250,000	$300,000
.80	10%	.05	$350,000	$400,000
1.00	5%	0	$500,000	$500,000

Therefore, $R = .05 * \left[\frac{\$100,000*.65 + \$250,000*.20 + \$300,000*(1.0 - .85)}{\$300,000/100}\right] = 2.67$.

(b) "If a policy should be less that its agreed amount, coinsurance reduces every indemnity payment **proportionately**."

The proportion is based on the ratio of the amount of insurance purchased to the amount of insurance assumed in the pure premium coinsurance rate calculation.

We are given that the insured purchased a $200,000 policy. The 60% coinsurance requirement called for the purchase of a $300,000 ($500,000 * .60) policy.

Therefore, the indemnity paid to the insured = $\$80,000*\left(\frac{\$200,000}{\$300,000}\right)$ = $53,333.33.

Solutions to questions from the 1998 exam

Question 5.

The formula to calculate the pure premium rate per $100 of insurance:

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1 - \int_0^C s(L)dL]}{F/100}\right)$$

Losses		Unconditional Probability	Arithmetic Mean Loss	
At Least	Less Than	Of Loss	(%)	100,000 risk
0%	10%	.0100	4%	4,000
10%	20%	.0075	14%	14,000
20%	30%	.0050	23%	23,000
30%	40%	.0035	33%	33,000
40%	50%	.0020	43%	43,000
50%		.0025	50%	50,000

Note that the unconditional probability of a loss exceeding 50% of its value is .0010+.0005+.0003+.0002+.0005 = .0025. In addition, the policy face equals the co-insurance requirement (C = cV = .50 (100,000) = 50,000).

Co-Insurance %	Pure premium rate per $100
.50	$\frac{[.01*4{,}000+.0075*14{,}000+.005*23{,}000+.0035*33{,}000+.002*43000+.0025*50{,}000]}{50{,}000/100}$ = $1.17

Answer E.

Solutions to questions from the 1999 exam

Question 15.

Given:

Coinsurance Requirement:	80%	c
Full Value of Structure:	$1,000,000	V
Amount of Insurance on Structure:	$700,000	F
Amount of Loss:	$600,000	L

Since $I \le L\left(\frac{F}{cV}\right)$, then $I \le \$600,000 * \left(\frac{700,000}{.80*1,000,000}\right) = 525,000$

The coinsurance penalty equals loss amount - the indemnity payment = 600,000- 525,000 = 75,000.

Answer D.

Solutions to questions from the 2000 exam

Question 24.

The general pure premium rate equation for percentage co-insurance is :

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1-\int_0^C s(L)dL]}{F/100}\right)$$

Co-Ins %	General Pure premium rate Equation	Pure prem rate per $100
.50	$.05*\frac{[.50(.04*100{,}000)+.25*(.18*100{,}000)+.15*(.40*100{,}000)+(1-.90)*(.50*100{,}000)]}{50{,}000/100}$	1.75
.75	$.05*\frac{[.50(.04*100{,}000)+.25*(.18*100{,}000)+.15*(.40*100{,}000)+.07*(.70*100{,}000)]}{75{,}000/100}+$ $.05*\frac{[(1-.97)*(.75*100{,}000)]}{75{,}000/100}$	1.31

the absolute difference between the pure premium rate per $100 for a 50% coinsurance clause and a 75% coinsurance clause is 1.75 – 1.31 = .44. **Answer E.**

Solutions to questions from the 2001 exam

Question 7.

The general pure premium rate equation for percentage co-insurance is :

$$R = f\left(\frac{\int_0^C Ls(L)dL + F[1-\int_0^C s(L)dL]}{F/100}\right)$$

Unlike problem 24 from the 2000 exam, we are not given in this particular problem the value of the insured property, nor the loss frequency (f). However, this information is not necessary to compute the ratio of the pure premium rate per $100 for a 60% coinsurance clause to the pure premium rate per $100 for a 40% coinsurance clause.

Co-Ins %	General Pure premium rate Equation	Pure prem rate per $100
.40	$\frac{[.05*.12+.025*.30+(.015+.007+.003)*.40]}{.40}$	.0588
.60	$\frac{[.05*.12+.025*.30+.015*.52+(007+.003)*.60]}{.60}$	.0455

The ratio of the pure premium rate per $100 for a 60% coinsurance clause to the pure premium rate per $100 for a 40% coinsurance clause is .0455 ÷ .0588 = .77381 **Answer E.**

Solutions to questions from the 2002 exam
Question 42

The general pure premium rate equation for percentage co-insurance is $R=f\left(\frac{\int_0^C Ls(L)dL+F[1-\int_0^C s(L)dL]}{F/100}\right)$:

Using the data given in the problem, and the discrete counterpart to the continuous function above, the pure premium rate per $100 for a 50% coinsurance clause is computed as follows:

General Pure premium rate <u>Equation</u>	Pure prem <u>rate per $100</u>
$.03*\frac{[.75(.09*\$200,000)+.12*(.40*\$200,000)+.08*(.50*\$200,000)+(1\text{-}.95)*(.50*\$200,000)]}{(.50*\$200,000)/100}=$	1.083

Solutions to questions from the 2003 exam

40. (2.25 points) An insurer writing fire insurance uses coinsurance in its rating structure by means of an "average clause." A coinsurance percentage of 80% applies to all policies. Based on the following information, answer the questions below. Show all work

Policy	Amount of Loss	Property Value	Face Amount of Insurance
1	$50,000	$200,000	$150,000
2	$155,000	$160,000	$120,000
3	$375,000	$480,000	$400,000

a. (1.5 points) For each of the policies above, calculate the indemnity payment made by the insurer.

Note: "Insurance to value" (ITV) exists only if property is insured to the exact extent ($ amount or % value) assumed in the rate calculation. To evaluate coinsurance applications, the following formulas are given: the coinsurance requirement C = cV the coinsurance deficiency d = [cV – F] CAR = a = [F/cV] < 1.00.

Compute ITV for each policy:

For policy 1, ITV = $150,000/$200,000 = .75. This policy <u>does not</u> meet the coinsurance requirement.

For policy 2, ITV = $120,000/$160,000 = .75. This policy <u>does not</u> meet the coinsurance requirement.

For policy 3, ITV = $400,000/$480,000 = .833. This policy <u>does</u> meet the coinsurance requirement.

Note: A standard coinsurance clause may be represented algebraically as follows:

I = L*[F/cV], subject to two constraints:

1. I < L The indemnity payment cannot exceed the loss. This constraint is in concert with the principle of indemnity, which states that no insured should profit from any loss.
2. I < F The indemnity payment cannot exceed the policy face. This sets the overall limit on the amount insurance payable from a single occurrence.

For policy 1, $I = L*\frac{FV}{cV} = \$50{,}000*\frac{\$150{,}000}{.80*\$200{,}000} = \$46{,}875$. For policy 2, $I = L*\frac{FV}{cV} = \$155,000*\frac{\$120{,}000}{.80*\$160{,}000} = \$145,312$, but is capped at policy limits of $120,000. For policy 3, since the coinsurance requirement was met and the loss was less than policy face, indemnity equals loss amount $375,000.

b. (0.75 points) For each of the policies above, calculate the additional insurance, if any, that would have been required for the insurance company to indemnify the full amount of the loss.

For policy 1, the coinsurance requirement is $160,000, so an additional $10,000 is needed. For policy 2, an additional $35,000 is needed ($155,000 - $120,000). For policy 3, no additional amount is needed, since the policy limits purchased meet the coinsurance requirement and the loss is less than the policy limit.

Solutions to questions from the 2004 exam

41. (4 points) Given the following information on an individual property policy, answer the questions below. Show all work.

a. (2 points) The insured purchases a policy insuring the property to 80% of value. Determine the premium charged for the policy

Step 1: Write an equation to compute the premium charged for a policy insuring the property to 80% of value:

$$\text{Premium}=\left(\frac{\text{Expected Losses}}{\text{PLR}}\right)=\left(\frac{E(I)=f*\left(\sum_{L=1}^{L=F}L*s(L)dL+F[1-\sum_{L=1}^{L=F}s(L)]\right)}{\text{PLR}}\right)$$

Step 2: Using the equation in Step 1, and the data given in the problem, solve for the expected losses under the policy and then for the premium.

$$E(I)=\$200,000*.10*[(.70*.10+.20*.50+(1-.70-.20)*.80])=\$5,000$$

Premium = $5,000/.65 = $7,692

b. (1 point) The insured instead purchases a policy insuring the property to 70% of value. Assuming the same rate per $100 of insured value as in part a. above, determine the expected loss ratio for this policy.

Step 1: Determine the rate per $100 charged under the policy insuring the property to 80% of value, and then compute the premium charged for a policy insuring the property to 70% of value.

The rate per $100 charged under the policy insuring the property to 80% of value is Premium/[AOI/100]. In this problem, the rate per $100 is $7,692/[.80 * 200,000/100] = $4.81

Thus, the premium charged for a policy insuring the property to 70% of value is $4.81 * [200,000/100 * .70] = $6,734.

Step 2: Determine the Expected Losses under the policy:

$$E(I)=\$200,000*.10*[(.70*.10+.20*.50+(1-.70-.20)*.70])=\$4,800$$

Step 3: Compute the loss ratio as the ratio of the results from Step 2 and Step 3:

Loss Ratio = $4,800/$6,734 = .7131= 71.3%

c. (1 point) Assume the insurer incorporates a coinsurance clause into the policy. The insured continues to insure the property to 70% of value. What is the expected loss ratio for this policy? Briefly explain your answer.

Once the insurer incorporates a coinsurance clause into the policy, the expected loss ratio for the policy will equal the permissible loss ratio underlying the expected rate, which in this case is 65%. This is due to the fact that indemnification for losses under the policy will be reduced by the amount of coinsurance the insured maintains relative to the amount the insured is required to maintain (80% in this problem). This can be demonstrated numerically as follows:

$$E(I)=\$200,000*.10*[(.70*.10*.7/.80)+(.20*.50*.7/.8)+(1-.70-.20)*.70])=\$4,375$$

Loss Ratio = $4,375/$6,731 = 65.0%

Solutions to questions from the 2005 exam

51. (2 points)

a. (1 point) Calculate the pure premium rate per $100 of insurance for a policy face equaling $300,000.

Step 1: Write an equation to determine the insured's pure premium rate for each unit of face amount.

$R = f*\left(\sum_{L=1}^{L=F} L*s(L)dL + F[1-\sum_{L=1}^{L=F} s(L)]\right)/[F/100]$, where f is the frequency of loss (i.e. the number of insureds divided by the number of policies).

Step 2: Using the equation in Step 1, and the data given in the problem, compute the pure premium rate per $100 of insurance for a policy face equaling $300,000.

f = 20/1,000 = .02

$$R = 2\%*\frac{[.50(\$50,000) + (.20)*(\$250,000)+(1\text{-}.70)*(\$300,000)]}{\$300,000/100} = \$1.10$$

b. (1 point) Does the pure premium rate per $100 of insurance for a $500,000 policy face differ from the rate for the $300,000 policy face? Briefly explain your answer.

As the policy face (F) increases, the pure premium rate decreases at a decreasing rate, if small losses outnumber large ones. Here, the second derivative is negative $\frac{dR}{dF} = \frac{-f*\int_0^F L*s(L)dL}{F^2}$.

Since small losses predominate in this example, we show the pure premium rate per $100 of insurance for a $500,000 policy is smaller than that for a $300,000 policy face as follows:

$$R = 2\%*\frac{[.50(\$50,000) + (.20)*(\$250,000)+(.3)*(\$500,000)]}{\$500,000/100} = \frac{\$4,500}{\$5,000} = \$0.90$$

Solutions to questions from the 2006 exam

44. (2.5 points) Find the premium rate per $100 of insurance for a policy face equaling $400,000. Show all work.

Step 1: Write an equation to determine the insured's pure premium rate per $100 of insurance for a policy face equaling $400,000.

$R = f*\left(\sum_{L=1}^{L=F} L*s(L)dL + F[1-\sum_{L=1}^{L=F} s(L)]\right)/F$, where f is the frequency of loss (i.e. the number of losses divided by the number of exposures), and $s(L)$ represents the percentage of losses exactly equaling L, or the conditional probability of a loss of L, given some loss greater than zero.

Step 2: Using the equation in Step 1, and the data given in the problem, compute the pure premium rate per $100 of insurance for a policy face equaling $400,000.

f = 20/1,000 = .02

$$R = 2\%*\frac{[.50(\$100,000) + (.20)*(\$200,000)+(.10)*(\$300,000)+(1\text{-}.80)*(\$400,000)]}{\$400,000/100} = \$1.00$$

Solutions to questions from the 2007 exam

49. (1.0 point) Calculate each of the following:
    a. (0.25 point) Coinsurance requirement.
    b. (0.25 point) Coinsurance apportionment ratio.
    c. (0.25 point) Coinsurance deficiency.
    d. (0.25 point) Maximum coinsurance penalty.

Model Solution

a. The coinsurance requirement may be in the form of a stated sum or a specified % of the value of the insured property. Thus, the coinsurance requirement equals $300,000 * 0.80 = $240,000

b. The coinsurance apportionment ratio (CAR) is the ratio of the amount of insurance purchased to either a (i) stated sum, or (ii) a specified % of the value of the insured property. The maximum coinsurance apportionment ratio is 1.00. Thus, the $200,000/$240,000 = 0.83333

c. The coinsurance deficiency is the amount by which a coinsurance requirement exceeds the amount of the carried insurance. Thus, the coinsurance deficiency equals $240,000 - $200,000 = $40,000

d. A coinsurance penalty is the amount by which the indemnity payment resulting from a loss is reduced due to the coinsurance clause. The face amount that should have been purchased (given the coinsurance requirement) equals $240,000. Since $200,000 was purchased instead, the maximum penalty = $200,000 * (1 - $200,000/$240,000) =$33,333.33. Due to underinsurance, the maximum penalty occurs when the loss equals the face value of policy.

Solutions to questions from the 2008 exam

Model Solution – Question 36

a. Calculate the coinsurance deficiency.
b. Calculate the coinsurance apportionment ratio.
c. Calculate the maximum coinsurance penalty possible.
d. Calculate the coinsurance penalty for a $300,000 loss.

a. The coinsurance deficiency is the amount by which a coinsurance requirement exceeds the amount of the carried insurance. Algebraically, this is computed as cV – F, where c is the co-insurance requirement as a % of the insured property, V = the value of the insured property and F = Face value of the property.

   Based on the givens in the problem, the coinsurance requirement equals 0.80 * $350,000 = $280,000, F = $275,000 and thus, the coinsurance deficiency equals $280,000 - $275,000 = $5,000

b. The coinsurance apportionment ratio (CAR) is the ratio of the amount of insurance purchased to either a (i) stated sum, or (ii) a specified % of the value of the insured property. The maximum coinsurance apportionment ratio is 1.00. Thus, $275,000/$280,000 = 0.9821.

c. The maximum coinsurance penalty occurs when the Loss = F. Since CAR = 0.9821, the maximum indemnity payment is 0.9821 * $275,000 = $270,089.28. Therefore, if L equaled F, then the maximum coinsurance penalty would equal $275,000 - $270,089.28 = $4,910.72

d. The coinsurance <u>penalty</u> = e = L – I if L < F

   e = F – I if F ≤ L ≤ cV

   e = 0 if L > cV

   First compute I. I = L * CAR = $300,000 * 0.98211 = 294,633

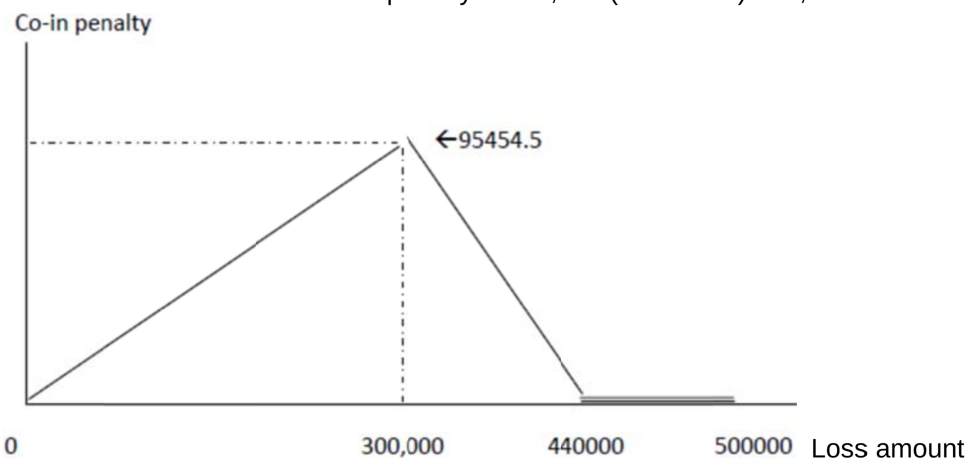
   But since L = 300,000 > cV = $280,000 (the 3rd condition shown above), there is no co-insurance penalty.

Solutions to questions from the 2009 exam

Question: 40

Property value = 500,000
Coins. Req. = 500,000 x 0.88 = 440,000
Face value = 300,000
Coinsurance apportionment ratio = 300/440 = 68.18% (which is applied to the loss to determine the indemnity).
Max co-in penalty occurs when loss is = 300,000 (the face value of the policy)

penalty = 300,000 (1– 0.6818)= 95,454.50



Solutions to questions from the 2010 exam

Question 32.

a. (1 point) Calculate the coinsurance penalty.

We are given the following: L = 200,000 = amount of loss, V = value of property = 450,000,

F= face amount = 350,000 C = Co-ins req = 80%

The home is valued at $450,000 and is insured only for $350,000 despite a coinsurance requirement of 80% (or $360,000 in this case).

Since F is $350,000 a coinsurance deficiency exists and a = 0.9722 (=$350,000 / $360,000), where a = apportionment ratio.

The indemnity payments and coinsurance penalties for a <u>$200,000 loss</u> are:

$$I = L \times \frac{F}{cV} = \$200,000 \times \frac{\$350,000}{\$360,000} = \$194,444.44$$

$$e = L - I = \$200,000 - \$194,144.44 = \$5,555.55$$

b. (0.5 point) Identify the problem with underinsurance from the insurer's perspective.

If policyholders are underinsured this is a problem from insurer's perspective because if rates are calculated assuming all properties are insured to value, the premium charged will not be adequate to cover expected losses arising from those policies not insured to value.

c. (0.5 point) Identify the problem with underinsurance from the insured's perspective.

The insured may pay a lower premium if home is underinsured but in the case of a total loss, insured won't get payment for full value of home. If there is a co-ins penalty partial losses will be subject to that penalty, so insured is still not compensated for full value of loss.

Solutions to questions from the 2012 exam (cont'd)

15a. (0.5 point) Assuming all homeowners purchase full coverage, calculate the pure premium per $1,000 of insurance.

15b. (0.75 point) Demonstrate with an example that the use of a fixed rate per $1,000 of insurance is inequitable if a subset of the insured group purchases only partial coverage.

15c. (1 point) Describe two insurer initiatives that would reduce the inequity from part b. above, including an explanation of how the inequity would be reduced.

Question 15 – Model Solution 1 (Exam 5A Question 15)

a. Expected loss = (0) (97%) + 10k(1.5%) + 50 k (.8%) + 200k (.5%) + 350k (.2%) = 2,250
PP rate = 2,250/ (350k /1,000) = $6.43

b. Assume the purchase of 10k coverage
expected loss = 0 (97%) + 10k (1-97%) = 300
if used fixed rate, the premium = $6.43\times\frac{10k}{1k}=64.3$
Thus the premium is inequitable 64.3 vs. 300

c. –Offer incentive for higher ITV (guaranteed replacement cost @ 100% ITV)
- More insureds purchase high ITV reducing inequity

-Coinsurance clause
- Reduces amount of loss paid (by ratio of face/requirement) and keeps the premium to loss adequate

Question 15 – Model Solution 2 (Exam 5A Question 15)

a. PP = .015 x 1 0k + .008 x 50k + .005 x 200k + .002 x 350k = 2,250
PP rate = 2,250/ (350k /1,000) = $6.429

b. example: insured w/ 80% ITV. Face Value is 80% x 350K = 280k
PP = .015 x 10k +.008 x 50k + .005 x 200k + .002 x 280k = 2,110
PP rate = 2,110/(280k/1,000) = $7.536

If charge the rate from (a) assuming insured to full value, the home will be undercharged by 7.536 - 6.429 = $1.107 per $1000 of coverage.

c(1). a coinsurance clause would reduce the indemnity payments by the proportion of selected coverage out of the required coverage. This would reduce the loss ratios for underinsured homes to the same loss ratio as fully insured homes.

c(2). could begin initiatives to increase ITV through home inspections, etc, forcing underinsured homes to purchase the right amount. This would increase premiums for underinsured homes and equalize loss ratios.

Question 15: Examiner's Comments

a. This question was generally well-answered by candidates. A common mistake was to forget to divide by the amount of insurance. Another common mistake was to divide by 1000s of premium instead of amount of insurance.

b. Many amounts of insurance were commonly used by candidates and were deemed acceptable.

   A common demonstration by candidates was to calculate the premium that would be charged with the rate in A) and compare this with the expected loss of underinsured risk to demonstrate the inadequacy.

   Some candidates calculated loss ratios or compared the fixed rates that should be charged in a) with b) to demonstrate an inequity. All those solutions were accepted and received full marks.

   Many candidates demonstrated poorly the inequity created by the situation in b). Some only calculated the rate per $1000 of insurance for underinsured risks and did not explain why there was an inequity.

c. A common mistake for candidates was to simply list and describe initiatives to increase insurance to value. However, the question clearly asked for an explanation of how the measure reduces inequity.

   Another common mistake was to identify an ITV initiative that would have no impact on the example in b). For example, the indexing of amounts of insurance at each renewal for all risks would not reduce inequity over time caused by a subset buying partial coverage.

1 Necessary Criteria For Measures Of Credibility 216 - 216

The credibility (Z) given to observed experience, assuming homogenous risks, is based on three criteria:

1. $0 \leq Z \leq 1$ (i.e. no negative credibility and capped at fully credible).
2. Z should increase as the number of risks increases (all else being equal).
3. Z should increase at a non-increasing rate.

2 Methods For Determining Credibility Of An Estimate 216 - 223

As defined in Actuarial Standard of Practice (ASOP) No. 25, credibility is "a measure of the predictive value in a given application that the actuary attaches to a particular body of data."

Two common credibility methods are classical credibility and Bühlmann credibility.

Both methods calculate a measure of credibility to blend subject experience and related experience.

A third method, Bayesian analysis, introduces related experience into the actuarial estimate in a probabilistic measure (it does not explicitly calculate a measure of credibility).

1. Classical Credibility Approach

The classical credibility approach (a.k.a. limited fluctuation credibility) is the most frequently used method in insurance ratemaking. The goal is to limit the effect that random fluctuations in the observations have on the risk estimate.

Z is the weight assigned to the observed experience (a.k.a. subject experience or base statistic) and the complement of Z is assigned to some related experience (as shown in the following linear expression):

Estimate = Z x Observed Experience + (1.0 - Z) x Related Experience.

First, determine the expected number of claims, (E(Y), for the observed experience to be fully credible (Z=1.00).

The observed experience is fully credible when the probability (p) that the observed experience will not differ significantly from the expected experience by more than some arbitrary amount (k).

Stated in probabilistic terms: $Pr[(1-k)E(Y) \leq Y \leq (1+k)E(Y)] = p$

According to the Central Limit Theorem, $\dfrac{S-E(S)}{\sqrt{Var(S)}} \sim N(0,1)$.

Therefore, the probabilistic expression can be transformed as follows:

$$\Pr\left[\frac{(1-k)E(S)\text{ - }E(S)}{\sqrt{Var(S)}} \le \frac{S-E(S)}{\sqrt{Var(S)}} \le \frac{(1+k)E(S)\text{ - }E(S)}{\sqrt{Var(S)}}\right] = p$$

Since the normal distribution is symmetric about its mean, this is equivalent to:

$\left[\dfrac{(1+k)E(S)-E(S)}{\sqrt{Var(S)}}\right] = z_{(p+1)/2}$, where $z_{(p+1)/2}$ is the value in the Standard Normal (SN) table for values (p+1)/2.

Make simplifying assumptions about the observed experience:

- Exposures are homogeneous (i.e. each exposure has the same expected number of claims).
- Claim occurrence follows a Poisson distribution; thus E(Y) = Var(Y).
- There is no variation in the size of loss (i.e. constant severity).

Based on those assumptions, the expression above can be simplified to: $\left[\dfrac{kE(Y)}{\sqrt{E(Y)}}\right] = z_{(p+1)/2}$

Thus, the expected number of claims needed for full credibility can be expressed as: $E(Y) = \left(\dfrac{z_{(p+1)/2}}{k}\right)^2$

Example: Full and Partial Credibility Calculations

Assume an actuary regards the loss experience fully credible if there is a 90% probability that the observed experience is within 5% of its expected value.

- This is equivalent to a 95% probability that observed losses are no more than 5% above the mean. In the SN table, the 95th percentile is 1.645 standard deviations above the mean; therefore, the expected number of claims needed for full credibility is: $E(Y) = \left(\dfrac{1.645}{0.05}\right)^2 = 1,082$
- If the number of observed claims ≥ the standard for full credibility (1,082 in the example), the measure of credibility (Z) is 1.00: $Z = 1.00 \text{ } where \text{ } Y \ge E(Y)$
- If the number of observed claims is < the standard for full credibility, the square root rule is applied to calculate Z: $Z = \sqrt{\dfrac{Y}{E(Y)}},\ where\ Y < E(Y).$

  In the example, if the observed number of claims is 100, $Z = \sqrt{\dfrac{100}{1,082}} = 0.30.$

  The square root formula, with a maximum of 1.0, meets the three criteria for Z.

Example: A full credibility standard based on the number of exposures (rather than the number of claims).

The exposure standard is calculated by [number of claims needed for full credibility/ expected frequency].
The number of claims and exposures needed for <u>full credibility</u> using example values for k and p:

(1) k	(2) p	(3) $Z_{p/2}$	(4) Number of Claims for Full Credibility	(5) Projected Frequency	(6) Number of Exposures for Full Credibility
5%	90%	1.645	1,082	5.0%	21,640
10%	90%	1.645	271	5.0%	5,420
5%	95%	1.960	1,537	5.0%	30,740
10%	95%	1.960	384	5.0%	7,680
5%	99%	2.575	2,652	5.0%	53,040
10%	99%	2.575	663	5.0%	13,260

(3)= From Normal Distribution Table
(4)= [(3) / (1)]^2
(6)= (4) / (5)

Assuming there is *variation in the size of losses*, the number of claims needed for observed data to be considered fully credible is as follows:

$$E(Y) = \left(\frac{z_{p/2}}{k}\right)^2 \times \left(1 + \frac{\sigma_s^2}{\mu_s^2}\right),$$ where $\frac{\sigma_s^2}{\mu_s^2}$ is the coefficient of variation squared.

Example - Calculating the credibility-weighted pure premium estimate

Assume:

- Full credibility is set so that the observed value is to be within +/-5% of the true value 90% of the time.
- Exposures are homogeneous, claim occurrence follows a Poisson distribution, and no variation in claim costs exists.
- The observed pure premium of $200 is based on 100 claims.
- The pure premium of the related experience is $300.

Based on values of k and p above, the corresponding value on the SN table is 1.645.

- The standard for full credibility is therefore: $E(Y) = \left(\frac{1.645}{0.05}\right)^2 = 1,082$
- Since observed claims are < 1,082, compute Z using square root rule: $Z = Min\left[\sqrt{\frac{100}{1,082}}, 1.00\right] = 0.30$

The credibility-weighted estimate is $270 (=0.30 x $200 + (1-0.30) x $300).

Comments on Classical Credibility Approach

3 Advantages:

1. It is the most commonly used and thus generally accepted.
2. The data required is readily available.
3. The computations are straightforward.

Disadvantage: Simplifying assumptions may not be true in practice (e.g. no variation in the size of losses).

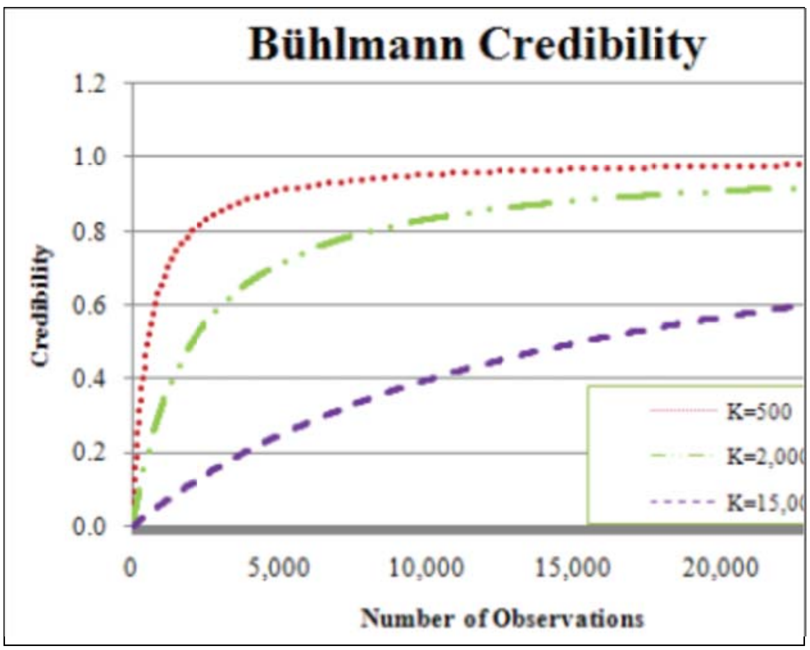
2. Bühlmann Credibility

The goal of Bühlmann credibility (a.k.a. least squares credibility): minimize the square of the error between the estimate and the true expected value of the quantity being estimated.

The credibility-weighted estimate is defined as: Estimate = Z x Observed Experience + (1.0 - Z) x Prior Mean.

This formula considers a prior mean, the actuary's a priori assumption of the risk estimate (whereas classical credibility considered related experience).

Z is defined as follows: $Z = \dfrac{N}{N+K}$ A comparison of Z for different values of K is shown below.

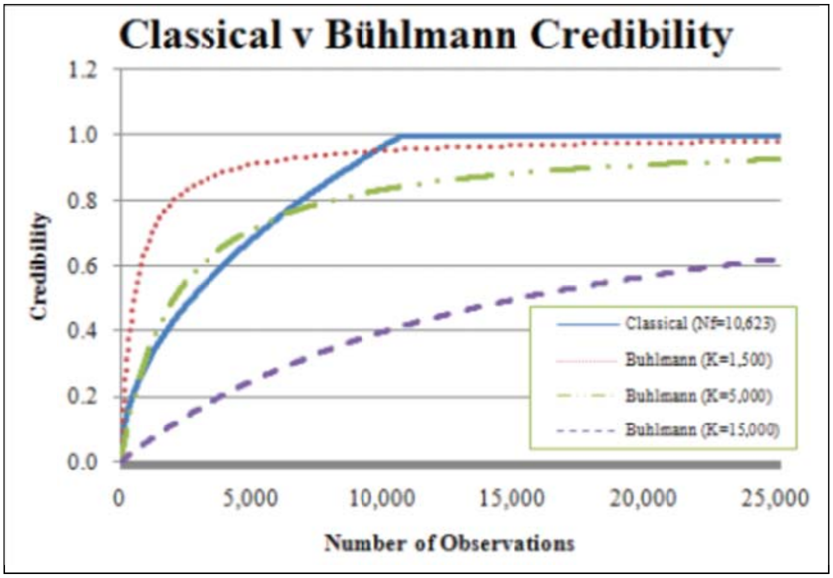


- N represents the number of observations
- K is the ratio of the expected value of the process variance (EVPV) to the variance of the hypothetical means (VHM) (i.e. the ratio of the average risk variance to the variance between risks).
  i. K can be difficult to calculate and the method of calculation is beyond the scope of this text.
  ii. Since K is a constant (for a given situation), Z meets the criteria listed earlier.

The chart demonstrates this visually:

Z approaches 1.0 asymptotically as N gets larger (the classical credibility measure equals 1.0 at the point the number of claims or exposures equals the full credibility standard (N_f))

The chart below shows a comparison of Z at different numbers of observations (N) under classical and Bühlmann approaches.



Comments:

- Bühlmann credibility estimate is closest to the classical credibility estimate when K equals 5,000 (i.e. the line with dashes and dots is close to the solid line), for these specific values of N_f and K and for a relatively small number of observations.
- As N gets larger, the Bühlmann credibility estimate is closest to the classical credibility estimate when K equals 1,500 (i.e. the dotted line).
- Practitioners using classical credibility assume there is no variation in the size of losses and that the risks in the subject experience are homogeneous. If these assumptions are made with least squares credibility, then
  i. VHM = 0 (because all exposures have exactly the same claim distribution).
  ii. when VHM = 0, then Z = 0 (no credibility is assigned to the observed experience).

The assumptions under the Bühlmann credibility formula are as follows:

* (1.0 - Z) is applied to the prior mean.
* Risk parameters and risk process do not shift over time.
* The EVPV of the sum of N observations increases with N.
* The VHM of the sum of N observations increases with N.

Simple Example

Calculate the Bühlmann credibility-weighted estimate assuming the following:

- The observed value is $200 based on 21 observations.
- EVPV = 2.00, VHM = 0.50 and the prior mean is $225.

Thus, $K = \frac{EVPV}{VHM} = \frac{2.00}{0.50} = 4.00, \;\; Z = \frac{21}{21+4.00} = 0.84;$ and

Bühlmann Credibility-weighted Estimate = 0.84 x $200 + (1- 0.84) x $225 = $204.

Comments on Least Squares Credibility (LSC)

- It is used and is generally accepted.
- The major challenge is determining EVPV and VHM.
- It is based on assumptions that needs to be evaluated for suitability purposes (like classical credibility).

Bayesian Analysis

- There is no calculation of Z, but a distributional assumption must be made.
- Is based on a prior estimate to be adjusted to reflect the new information (introduced into the prior estimate in a probabilistic manner, via Bayes Theorem).

  This differs from LSC where new information is introduced into the prior estimate via credibility weighting.
- Bayesian analysis is not used as commonly as Bühlmann credibility (due to the greater complexities of its probabilistic nature).

Notes:

- Bühlmann credibility is the weighted least squares line associated with the Bayesian estimate.
- The Bayesian estimate is equivalent to the LSC estimate (in certain mathematical situations).

3 Desirable Qualities Of A Complement Of Credibility 223 - 224

The credibility-weighted actuarial estimate using classical credibility is:

Estimate = Z x Observed Experience + (1- Z) x Related Experience.

Note: Theoretically when credibility is based on the Bühlmann approach, the complement of credibility should be the prior mean (however, actuaries have used other related experience when Bühlmann credibility is used).

Once Z is determined, the next step is to select the related experience (the “complement of credibility”). According to ASOP 25, the related experience:

i. should have frequency, severity, or other characteristics to be similar to the subject experience.

ii. should not be used (if it does not or cannot be adjusted to meet such criteria).

The complement of credibility (CC) can be more important than the observed data (e.g. if the observed experience varies around the true experience with a standard deviation equal to its mean, it will probably receive a very low credibility. Therefore, the majority of the rate (in this context, expected loss estimate) will be driven by the complement of credibility.

In “Complement of Credibility” Boor states desirable qualities for a complement of credibility:

1. **Accurate:** A CC that causes rates to have a low error variance around the future expected losses being estimated is considered accurate.
2. **Unbiased:** Differences between the complement and the observed experience should average to 0 over time.

   Accurate vs. Unbiased:
   - An accurate statistic may be consistently higher or lower than the following year’s losses, but it is always close.
   - An unbiased statistic varies randomly around the following year’s losses over many successive years, but it may not be close.
3. **Independent:** The complement should also be statistically independent from the base statistic (otherwise, any error in the base statistic can be compounded).

4 and 5. **Available and Easy to Compute**: If not, the CC is not practical and justification to a third party (e.g. regulator) for approval is needed.

6. **Logical relationship** (to the observed experience): is easier to support to any third party reviewing the actuarial justification.

4 Methods For Developing Complements Of Credibility 224 - 236

A variety of complements are used in practice.

- First dollar ratemaking is performed on products that cover claims from the first dollar of loss (or after some small deductible) up to some limit (e.g. personal auto, HO, WC, and professional liability insurance)
- Excess ratemaking is performed on insurance products covering claims that exceed some high attachment point (e.g. personal umbrella policies, large deductible commercial policies, and excess reinsurance).

I. First Dollar Ratemaking

Boor describes six commonly used methods for developing complements for first dollar ratemaking:

- Loss costs of a larger group that includes the group being rated
- Loss costs of a larger related group
- Rate change from the larger group applied to present rates
- Harwayne's method
- Trended present rates
- Competitor's rates

The complements are discussed in terms of pure premium ratemaking (although some methods can be used with loss ratio methods by replacing the exposure units with earned premium).

1. Loss Costs of a Larger Group that Include the Group being Rated

This complement considers a larger group's experience to which the subject experience belongs.

Examples that may apply:

* A multi-state insurer using data from regional states to supplement the state experience being reviewed.
* A medical malpractice insurer using experience of all primary care physicians to supplement the experience of primary care pediatricians.
* An auto insurer using data of all 16-19 year old insureds to supplement the experience of 16- year-olds.
* An insurer using data from a longer-term period to credibility-weight experience that is short-term.

Consider the following data and possibilities for a complement of credibility to the observed experience, the latest year pure premium from Rate Group A, Class 1 (= $50).

		Latest Year		Latest 3 Years	
Rate Group	Class	Exposures	Pure Premium	Exposures	Pure Premium
A	1	100	$ 50	250	$ 64
	2	300	$ 67	850	$ 65
	3	400	$ 48	1,100	$ 50
	Subtotal	800	$ 55	2,200	$ 57
B	Subtotal	600	$ 48	1,700	$ 32
C	Subtotal	1,000	$ 72	2,800	$ 86
D	Subtotal	1,600	$ 94	5,600	$ 87
Total	Total	4,000	$ 74	12,300	$ 74

Candidates for complement of credibility are:

- the 3-year pure premium for Rate Group A, Class 1;
- the 1 or 3-year pure premium for Rate Group A;
- the 1 or 3-year pure premium for the total of all experience.

Another option is the total of all Class 1 experience across all rate groups (not shown).

Advantages and disadvantages of complement of credibility candidates.

* The 3-year pure premium of Rate Group A, Class 1 experience (i.e., $64) is problematic.
  i. Lack of independence (the 1-year experience comprises over 1/3rd the exposures of the 3-year experience).
  ii. Bias. The huge difference between the 1-year pure premium ($50) and the3-year pure premium ($64) indicates the 3-year data may be biased (i.e. changes in loss costs makes older data less relevant).

* Using the total of all experience combined is:
  i. Better with respect to *independence* (Rate Group A, Class 1 is a small portion of the total experience (100 out of 4,000 exposures)).
  ii. Biased. The difference between the 1-year Rate Group A, Class 1 pure premium ($50) and the 1-year total pure premium ($74) implies a bias may be present.

* The 1-year Rate Group A experience appears to be the best.
  i. The Rate Group A data should reflect risks that are more similar to Class 1.
  ii. The 1-year pure premium ($55) and 3-year pure premium ($57) suggests it has a low process variance.
  iii. The 1-year result is not too different than the 1-year Rate Group A, Class 1 result, which suggests little bias.

* If the Class 1 data from all rate groups combined were available, it may be a reasonable option.

Complement Evaluation

1. It has a lower process variance (because the complement is based on a greater volume of data than the subject experience).
2. The subject experience has been split out of the larger group suggests that the actuary believes the subject experience is different than the larger group.
   i. If so, the larger group is a biased estimator of the subject experience.
   ii. The actuary may be able to make an adjustment to reduce this bias.

   The complement can include or exclude the subject experience.
   i. If it excludes the subject experience, it is likely to be independent.
   ii. If it includes the subject experience, ensure it does not dominate the group.

3. Loss cost data of the larger group is typically available and the loss cost is easy to compute.
4. There is a logical connection between the complement and the subject experience (as long as all the risks in the larger group have something in common).

2. Loss Costs of a Larger Related Group

Use loss costs of a separate but similar large group (e.g. a HO insurer may use the contents loss experience from the owners forms to supplement the contents experience for the condos form).

Complement Evaluation

1. It is biased (though the magnitude and direction of bias are unknown)
   i. If the related experience can be adjusted to match the exposure to loss in the subject experience, the bias can be reduced.
   ii. In the example, consider how the exposure to loss for condos differs from owned homes and adjust the experience accordingly.
2. Independent (since the complement does not contain the subject experience)
3. The data is readily available and the loss cost is easy to compute
4. It may be difficult to explain adjustments made to the related experience to correct for bias
5. The complement will have a logical relationship to the base statistic (if the groups are closely related)

3. Rate Change from the Larger Group Applied to Present Rates

This approach mitigates bias by using the rate change indicated for a larger group and applying it to the current loss cost of the subject experience (rather than using the larger group's loss costs directly)

The complement (C) can be expressed as:

$$C = Current\ Loss\ Cost\ of\ Subject\ Experience \times \left(\frac{Larger\ Group\ Indicated\ Loss\ Cost}{Larger\ Group\ Current\ Average\ Loss\ Cost} \right)$$

Assume the following:

- Current loss cost of subject experience is \$200.
- Indicated loss cost of larger group is \$330.
- Current average loss cost of larger group is \$300.

Then the complement of credibility is calculated as follows: C = \$200 x \$330/300 = \$220.

Complement Evaluation

1. This complement is largely unbiased (even when the overall loss costs for the subject experience and the larger group are different).
2. It is likely to be accurate (assuming the rate changes are relatively small).
3. The level of independence depends on the size of the subject experience relative to the larger group.
4. The data is readily available and the calculations are very straightforward.
4. It is logical that the rate change indicated for a larger related group is indicative of the rate change for the subject experience.

4. Harwayne's Method

- Is used when the subject experience and related experience have different distributions (the related experience requires adjustment before it can be blended with the subject experience).
- can be applied to the subject experience within a geographical area (e.g., a state), and the desired complement of credibility considers related experience in other geographical areas (e.g., other states).

  Other states may have distinctly different cost levels than the subject experience due to legal environment and population density.

Example:

The complement of credibility is determined using countrywide data (excluding the base state being reviewed), but the countrywide data is adjusted to remove overall differences between states.

Steps to calculate the complement for class 1 of state A.

State	Class	Exposure		Losses	Pure Premium
A	1	100	$	250	2.50
	2	125	$	500	4.00
	Subtotal	225	$	750	3.33
B	1	190	$	600	3.16
	2	325	$	1,500	4.62
	Subtotal	515	$	2,100	4.08
C	1	180	$	500	2.78
	2	450	$	1,800	4.00
	Subtotal	630	$	2,300	3.65
All	1	470	$	1,350	2.87
	2	900	$	3,800	4.22
	Total	1,370	$	5,150	3.76

Step 1: Calculate the average pure premium for state A: $\overline{L_A} = \dfrac{100 \times 2.50 + 125 \times 4.00}{100 + 125} = 3.33.$

Step 2: Calculate the average pure premium for states B and C based on the state A exposure distribution by class:

$$\hat{L}_B = \frac{100 \times 3.16 + 125 \times 4.62}{100 + 125} = 3.97,\ \hat{L}_C = \frac{100 \times 2.78 + 125 \times 4.00}{100 + 125} = 3.46,$$

Step 3: Compute adjustment factors by dividing the average pure premium for state A by the reweighted average pure premium for B and C:

$$F_B = \frac{\hat{L}_A}{\hat{L}_B} = \frac{3.33}{3.97} = 0.84,\ F_C = \frac{L_A}{\hat{L}_C} = \frac{3.33}{3.46} = 0.96$$

Step 4: Apply the adjustment factors to the class 1 pure premium in states B and C, to adjust for the difference in loss costs by state A. The adjusted loss costs for class 1 in states B and C, respectively, are:

$$\hat{L}_{1,\,B} = \overline{L_{1,B}} \times F_B = 3.16 \times 0.84 = 2.65,\ \hat{L}_{1,C} = \overline{L_{1,C}} \times F_C = 2.78 \times 0.96 = 2.67$$

Step 5: Compute (C) by combining the adjusted Class 1 loss costs by state into a single Class 1 loss cost according to the proportion of class 1 risks in each state:

$$C = \frac{\hat{L}_{1,B} \times X_{1,B} + \hat{L}_{1,C} \times X_{1,C}}{X_{1,\,B} + X_{1,C}} = \frac{2.65 \times 190 + 2.67 \times 180}{190 + 180} = 2.66$$

Complement Evaluation

1. It is unbiased as it adjusts for the distributional differences.
2. It is accurate as long as there is sufficient countrywide data to minimize the process variance.
3. It is independent since the subject experience and related experience consider data from different states.
4. The data for the complement is available but the computations can be time-consuming and complicated.
5. The complement has a logical relationship to the subject experience.
6. The complement may be harder to explain because of the computational complexity.

5. Trended Present Rates

Actuaries may rely on the current rates as the best available proxy for the indicated rate (when there is no larger group to use for the complement).

Two adjustments are made before using the current rates:

1. Adjust current rates to what was previously indicated rather than what was implemented (since insurers do not always implement the rate that is indicated, see reasons for this in chapter 13).
2. Adjust for changes in trends due to changes in loss cost level may have occurred between the time the current rates were implemented and the time of the review. (e.g. due to changes in monetary inflation, distributional shifts, safety advances, etc).

   Trend from the <u>original target effective date</u> of the current rates to the target effective date of the new rates.

$$C = Present\ Rate \times Loss\ Trend\ \ Factor \times \frac{Prior\ Indicated\ Loss\ Cost}{Loss\ Cost\ Implemented\ with\ Last\ Review}$$

Example: Assume the following:

- Present average rate is $200.
- The selected annual loss trend is 5%.
- The rate change indicated in the last review was 10%, and the target effective date was 1/1/2011.
- The rate change implemented with the last review was 6%, and the actual effective date was 2/1/2011.
- The proposed effective date of the next rate change is 1/1/2013.

Before calculating the complement of credibility, the loss trend length must be measured.

This is the length from the target effective date of the last rate review (1/1/2011) to the target effective date of the next rate change (1/1/2013), or two years.

Then the complement of credibility is calculated as follows:

$$C = \$200 * (1.05)^2 * \frac{1.10}{1.06} = \$229$$

This procedure can also be used to calculate a complement for an indicated rate change factor when using the loss ratio approach:

$$C = \frac{\textit{Loss Trend Factor}}{\textit{Premium Trend Factor}} \times \frac{\textit{(1.0 + Prior \% Indication)}}{\textit{(1.0 + Prior \% Rate Change)}}$$

$$C = \frac{\text{Loss Trend Factor}}{\text{Premium Trend Factor}} \times \frac{\text{Prior Indicated Rate Change Factor}}{\text{Prior Implemented Rate Change Factor}}.$$

Complement Evaluation

1. Accuracy depends largely on the process variance of the historical loss costs (that is why it is used primarily for indications with voluminous data)
2. It is unbiased since pure trended loss costs (i.e. no updating for more recent experience) are unbiased.
3. It may or may not be independent depending on the historical experience used to determine the subject experience and complement (e.g. if the complement comes from a review that used data from 2007 through 2010, and the subject experience is based on data from 2008 through 2011, the two are not independent).
4. The data required is readily available, the calculations are very straightforward, and the approach is easily explainable.

6. Competitors' Rates

- New or small companies with small volumes of data find their own data too unreliable for ratemaking.
- The rationale for using competitors' rates as a complement is that if competitors have a much larger number of exposures, the competitors' statistics have less process error.

Evaluation

1. Competitors' manual rates are based on their marketing considerations, judgment, and the effects of the regulatory process—all of which can introduce inaccuracy to the rates.
2. Bias from competitors having different underwriting and claim practices may be difficult to quantify.
3. The competitors' rates will be independent of the company data.
4. The calculations may be straightforward, but the data needed may be difficult or time-consuming to obtain.
5. Rates of a similar competitor have a logical relationship and are accepted as a complement by regulators.
6. This complement is often the only viable alternative.

II. Excess Ratemaking

- Deals with volatile and low volumes of data so the complement is more important than the subject experience.
- Actuaries try to predict the volume of excess loss costs below the attachment point (since there are very few claims in the excess layers).
- Losses for liability lines of business are slow to develop, and inflation inherent in excess layers is higher than that of the total limits experience.

Four methods that can be used to determine the complement of credibility for excess ratemaking analyses:

- Increased limits analysis
- Lower limits analysis
- Limits analysis
- Fitted curves

The first 3 methods use loss data and ILFS to calculate the complement of credibility.

The last method relies on historical data to fit curves, and the complement is calculated from the distribution.

1. Increased Limits Factors (ILFs) Methods

- are used when data is available for ground-up loss costs through the attachment point (i.e., losses have not been truncated at any point below the bottom of the excess layer being priced).
- are used to adjust losses capped at the attachment point to produce an estimate of loss costs in the specific excess layer.

The complement is defined as follows: $C = \overline{L}_A \times \left(\frac{ILF_{A+L} - ILF_A}{ILF_A} \right) = \overline{L}_A \times \left(\frac{ILF_{A+L}}{ILF_A} - 1.0 \right)$, where

* $\overline{L}_A$ is the loss cost capped at the attachment point A;
* ILF_A is the increased limits factor for the attachment point A;
* ILF_{A+L} is the ILF for the sum of the attachment point A and the excess insurer's limit of liability L.

Example: Calculate the complement of credibility for the excess layer between \$500,000 and \$750,000 (i.e. \$250,000 of coverage in excess of \$500,000).

Assume losses capped at \$500,000 are \$2,000,000 and the following ILFs apply:

Limit of Liability	Increased Limits Factor
\$100,000	1.00
\$250,000	1.75
\$500,000	2.50
\$750,000	3.00
\$ 1,000,000	3.40

$$C = \$2,000,000 \times \left(\frac{3.00}{2.50} - 1.0 \right) = 400,000.$$

Complement Evaluation
1. Biased results will occur if the subject experience has a different size of loss distribution than that used to develop the ILFs (i.e. if the ILFs are based on industry data rather than the insurer's own data). Despite the issues with accuracy, this is often the best available estimate.
2. The error is parameter error associated with the selected ILFs (the error associated with this estimate tends to be independent of the error associated with the base statistic).
3. To the extent that ILFs (preferably industry factors) and ground-up losses that have not been truncated below the attachment point is available, the procedure is practical.
4. In terms of acceptability, the estimate is more logically related to the data below the attachment point (which is used for the projection) than to the data in the layer (and this may be controversial).

2. Lower Limits Analysis

Losses capped at the attachment point are used to estimate the losses in the excess layer being priced.

If losses are too sparse use losses capped at a limit lower than the attachment point (i.e. the basic limit).

$$C = \overline{L_d} \times \left(\frac{ILF_{\text{A+L}} - ILF_A}{ILF_d} \right) \text{ where}$$

- L_d is the loss cost capped at the lower limit, d;
- ILF_A is the ILF for the attachment point A;
- ILF_d is the ILF for the lower limit, d;
- $ILF_{\text{A+L}}$ is the ILF for the sum of the attachment point A and the excess insurer's limit of liability L (i.e. this sum is the top of the excess layer being priced).

Note the first excess procedure is a special case of this procedure where d = the attachment point.

Example: Calculate the complement of credibility for the layer between $500,000 and $750,000.
Assume losses capped at $250,000 are $1,500,000, and the ILFs from the prior Table apply.

$$C = \$1,500,000 \times \left(\frac{3.00 - 2.50}{1.75} \right) = \$428,571.$$

Evaluation
1. It is difficult to determine whether this is more or less accurate than the previously complement.
2. It is more biased (as the differences in size of loss distributions will be exacerbated when using losses truncated at lower levels).
3. Stability of the estimate is increased when using losses capped at lower limits.
4. The error is generally independent of the error of the base statistic.
5. The data may not be available if some other lower limit is chosen, and the calculations are simple.
6. The complement is more logically related to the lower limits losses that to the losses in the layer being priced.

3. Limits Analysis

Insurers sell policies with a wide variety of policy limits.

- Some policy limits fall below the attachment point and some extend beyond the top of the excess layer.
- Thus, each policy's limit and ILF needs to be considered in the calculation of the complement.
  - i. Policies at each limit of coverage are analyzed separately.
  - ii. Estimated losses in a layer are computed using the premium and expected loss ratio in that layer.
  - iii. An ILF analysis on each first dollar limit's loss costs is performed.

$$C = LR \times \sum_{d \geq A} P_d \times \frac{(ILF_{\min(d,A+L)} - ILF_A)}{ILF_d}$$, where

LR = Total loss ratio,

P_d= Total premium for policies with limit d.

Calculate expected loss for the layer between $500,000 and $750,000 assuming a total limits loss ratio of 60%.

(1) Limit of Liability (*d*)	(2) Premium	(3) Expected Loss Ratio	(4) = (2)*(3) Expected Capped Losses	(5) ILF @ *d*	(6) ILF @ *A*	(7) ILF @ *A+L*	(8) % Loss In Layer	(9) = (4)*(8) Expected Loss in Layer
$ 100,000	$1,000,000	60.0%	$ 600,000	1.00	2.50	3.00	0.0%	
$ 250,000	$ 500,000	60.0%	$ 300,000	1.75	2.50	3.00	0.0%	
$ 500,000	$ 200,000	60.0%	$ 120,000	2.50	2.50	3.00	0.0%	
$ 750,000	$ 200,000	60.0%	$ 120,000	3.00	2.50	3.00	16.7%	$20,040
$ 1,000,000	$ 75,000	60.0%	$ 45,000	3.40	2.50	3.00	14.7%	$6,615
Total	$1,975,000		1,185,000					$26,655

(8): if d< =A then 0.0%; if A < d ≤ A +L then [(5)- (6)]/(5); if d >A+L then [(7)- (6)]/(5)

Complement Evaluation

1. It is biased and inaccurate to the same extent as the prior two complements, and it assumes that ELR does not vary by limit.
2. It may be the only method available for reinsurers that use this method and do not have access to the full loss distribution
3. It is more time-consuming to compute, but the calculations are straightforward.
4. It is not based on actual data from the layer being priced.

4. Fitted Curves

Curves are fit curves to smooth out the volatility of the data and to extrapolate the distribution to higher limits.

The techniques described in Chapter 11 can determine the expected losses in the layer being priced.

The percentage of the curve's total losses expected in the excess layer is:

$$\%\ of\ Losses\ in\ Layer(A, A+L) = \frac{\int_{A}^{A+L}(x-A)f(x)dx + \int_{A+L}^{\infty}(A+L)f(x)dx}{\int_{-\infty}^{\infty}xf(x)dx}$$

This % is applied to total limits loss costs to determine the expected losses in the layer.

Evaluation

1. It is less biased and more stable than the other excess methods (assuming the fitted curve replicates the shape of the actual data).
2. It is more accurate than the others when there are few claims in the higher layers.
3. It is dependent on the existence or non-existence of larger claims because of the curve-fitting process.
4. The error is less independent than complements determined from the other approaches.
5. It is the most computationally complex and requires data that may not be readily available.
6. It is the most logically related to the losses in the layer than the others (as the data is more fully used).
7. Its computational complexity may make it difficult to communicate.

5 Credibility When Using Statistical Methods 236 –236

When performing a multivariate classification analysis (e.g. a GLM), diagnostics from the model results gauge to what extent the model results are meaningful given the data provided.

- Statistical diagnostics include standard errors of the parameter estimates and standardized deviance tests (e.g. Chi-Square or F-test), as well as practical tests such as consistency of model results over time.
- Statistical methods also provide diagnostics (deviance residual plots and leverage plots) that inform the modeler of the appropriateness of the model assumptions (e.g. the link function or error term selected).

Typically, the results of a multivariate classification analysis are not credibility-weighted with traditional (univariate) actuarial estimates.

6 Key Concepts 238 - 238

1. Criteria for measures of credibility

2. Methods for determining credibility
   a. Classical credibility
   b. Bühlmann credibility
   c. Bayesian analysis

3. Desirable qualities for the complement of credibility
   a. Accurate
   b. Unbiased
   c. Independent
   d. Available
   e. Easy to calculate
   f. Logical relationship to the base statistic

4. Methods for determining the complement of credibility
   a. First dollar ratemaking
      i. Loss costs of a larger group that includes the group being rated
      ii. Loss costs of a larger related group
      iii. Rate change from the larger group applied to present rates
      iv. Harwayne's method
      v. Trended present rates
      vi. Competitors' rates
   b. Excess ratemaking
      i. Increased limits analysis
      ii. Lower limits analysis
      iii. Limits analysis
      iv. Fitted curves

5. Credibility when using statistical modeling methods

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 1996 exam

Question 42. (3 points) You are given:

Great Northeast Insurance Company

State	Class	Exposures	Losses	Pure Premium
Vermont	1	200	600	3.00
	2	500	2,000	4.00
	Subtotal	700	2,600	3.71
Maine	1	150	600	4.00
	2	600	2,700	4.50
	Subtotal	750	3,300	4.40
New Hamp.	1	100	350	3.50
	2	400	1,800	4.50
	Subtotal	500	2,150	4.30
Countrywide	1	450	1,550	3.44
	2	1,500	6 500	4.33
	Total	1,950	8,050	4.13

In his article "The Complement of Credibility," Boor discusses a method used by Harwayne to determine a complement of credibility that involves a separate adjustment to each state's data. You are reviewing Class 1 rates for Vermont. Using Harwayne's method:

(a) (2 points) Calculate the adjusted Class 1 pure premiums for Maine and New Hampshire.

(b) (1 point) To the extent that Vermont Class 1 experience is not fully credible, calculate the pure premium to be used for the complement of credibility.

Questions from the 1997 exam

7. You are given:

Limit of Liability	Increased Limit Factors	Historical Losses Capped at Limit
$50,000	1.00	$350,000
$100,000	1.65	$650,000
$250,000	2.00	$800,000
$500,000	2.75	$1,050,000
$1,000,000	3.30	$1,200,000

Based on methodology described by Boor, "The Complement of Credibility," and using losses capped at $100,000, in what range does the complement fall for losses in the layer $500,000 to $1,000,000?

A. < $150,000 B. ≥ $150,000, but < $200,000 C. ≥ $200,000, but < $250,000
D. ≥ $250,000, but < $300,000 E. ≥ $300,000

21. (3 points) Boor, "The Complement of Credibility," discusses using competitor's rates as the complement when one is faced with ratemaking data that is unreliable.

According to Boor, what are three desirable characteristics and three undesirable characteristics of using competitor's rates as complements?

Questions from the 1998 exam

4. In Boor, "The Complement of Credibility," a First Dollar Ratemaking procedure is discussed in which the rate change from the larger group is applied to present rates.

   Use this procedure and the following data to determine in which range the complement of credibility for Class 1 loss costs falls.

Class 1 present loss cost	$125
Class 1 indicated loss cost	$115
All Class present average loss cost	$150
All Class indicated loss cost	$165

A. < $110 B. $\geq$ $110 but < $120 C. $\geq$ $120 but < $130 D. $\geq$ $130 but < $140 E. $\geq$ $140

53. (2 points) Using the Limits Analysis as described in Boor, "The Complement of Credibility," and the following data, calculate the complement of credibility that could be used to estimate the losses in the layer of insurance between $250,000 and $500,000.

Limit of Liability	Premium	Increased Limits Factor
$250,000	$1,000,000	1.80
$500,000	$700,000	2.60
$1,000,000	$500,000	3.20

Estimated All Limits Loss Ratio = 65.0%

Questions from the 1999 exam

50. (2 points) Boor in 'The Complement of Credibility," suggests that trended present rates may provide an appropriate complement of credibility for use in ratemaking. Using the trended present rates method outlined in the reading and the information shown below, calculate the complement of credibility.

<u>Information from the Previous rate chance which established the current rates:</u>

Target effective date:	4/1/97
Actual effective date:	6/15/97
Requested change:	+19.6%
Approved and implemented change:	+ 4.0%

<u>Information on current filing being Prepared:</u>

Present pure premium rate:	$325
Target effective date:	10/1/99
Expected regulatory delay (not contemplated in target effective date):	6 months
Annual frequency trend:	+ 3.5%
Annual severity trend:	+11.4%

Questions from the 1999 exam

53. (3 points) The Actuarial Standard of Practice (SOP) No. 25, "Credibility Procedures Applicable to Accident and Health, Group Term Life, and Property/Casualty Coverages " lists the following as criteria for selecting credibility procedures:
    - The procedure does not tend to bias the results in a material way.
    - The procedure is practical to implement.

    Boor, in 'The Complement of Credibility' lists a number of credibility complements used in (first dollar) ratemaking for a given class. For each of the credibility complements given below, explain how they fit (or do not fit) the SOP No. 25 criteria listed above.

    1. Loss Costs of a larger group including the class - Classic Bayesian
    2. Trended Present Rates
    3. Competitors Rates

Questions from the 2000 exam

23. Based on Boor, "The Complement of Credibility," and the following data, calculate the complement of credibility "C" using the "trended present rates" method.

    - Proposed rate change effective date = January 1, 2000
    - Present pure premium rate = $200
    - Annual inflation (trend) = 3.0%
    - Amount requested (indicated) in last rate change = +10.0%
    - Effective date requested for last rate change = January 1, 1998
    - Rate request approved by regulator = +5.0%
    - Effective implementation date of last rate change = July 1, 1998

A. < $210 B. ≥ $210 but < $220 C. ≥ $220 but < $230 D. ≥ $230 but < $240
E. ≥ $240

Questions from the 2001 exam

Questions 17. Based on Boor, “The Complement of Credibility,” and the following information, calculate the complement of credibility for class 2.

Class	Indicated Loss Cost Rate	Current Loss Cost Rate	Complement of Credibility
1	150	120	140
2	160	150	

A. < 155 B. ≥ 155 but < 170 C. ≥ 170 but < 185 D. ≥ 185 but < 200 E. ≥ 200

Questions from the 2002 exam

10. Boor, "Complement of Credibility," discusses using competitor's rates as the complement of credibility when using ratemaking data that is unreliable. Derive the pure premium complement of credibility for Small Company, Class 1, pure premium using the data below.

<u>Small Company, Class 1</u>	
Present manual rate	$80
Permissible loss ratio	60%
<u>Competitor Company, Class 1</u>	
Present manual rate	$70
Permissible loss ratio	62%
Projected Loss Ratio from Schedule P Analysis	75%
Average frequency of loss per exposure	0.040

Due to the assumed growth of Small Company, 10% more losses are expected for Small Company than Competitor Company.

A. < $45 B. $\geq$ $45, but < $50 C. $\geq$ $50, but < $55 D. $\geq$ $55, but < $60 E. $\geq$ $60

Questions from the 2003 exam

39. (3 points) In "The Complement of Credibility," Boor discusses several methods for calculating complements of credibility in first dollar ratemaking. Briefly discuss three of these methods and comment on the effectiveness of each method as a complement of credibility.

Questions from the 2004 exam

46. (2 points) Boor, in "The Complement of Credibility," discusses using the trended present rates as the complement of credibility when using ratemaking data that is not fully credible.
   a. (1 point) Derive the pure premium complement of credibility using the data below. Show all work.
      - Present pure premium rate is $150.
      - Annual inflation rate is 4%.
      - Original target effective date of the current rates was October 1, 2002.
      - Amount indicated and requested in last rate change was 18%.
      - Actual effective date was February 1, 2003.
      - Amount approved in last rate change was 10%.
      - Target effective date of the new rates is December 1, 2004.
   b. (1 point) State and briefly describe one advantage and one disadvantage of using this complement of credibility.

Questions from the 2005 exam

18. Using the following data, calculate the complement of credibility for class 3 based on the rate change-for the larger group applied to the present rate.

Class	Exposures	Losses	Present Pure Premium
1	200	$100,000	$550.00
2	300	$135,000	$500.00
3	500	$215,000	$455.00
Total	1,000	$450,000	$487.50

A. < 400 B. ≥ 400, but < 425 C. ≤ 425, but < 450 D. ≥ 450, but < 475 E. ≥ 475

Questions from the 2006 exam

There were no questions drawn from the content within this article appearing on the above referenced exam.

Questions from the 2007 exam

32. (3.0 points) Using the following data, calculate the complement of credibility for the pure premium of Class 1 in State A, using Harwayne's full method. Show all work.

State	Class	Exposure	Losses
A	1	$130	$180
A	2	160	450
B	1	150	330
B	2	200	600
C	1	130	180
C	2	180	500
D	1	140	320
D	2	250	500

Questions from the 2008 exam

22. (1.5 points)

a. (1.0 point) You are given the following information:

- Present average rate = $200
- Annual loss trend = 10%
- 20% rate change requested in last filing.
- 15% rate change approved with last filing.
- Effective date requested in last filing was January 1, 2006.
- Actual effective date of last change was June 1, 2006.
- Proposed effective date of next change is January 1, 2008.

Calculate the complement of credibility using the trended present rate approach.

b. (0.5 point) Identify one advantage and one disadvantage to using the trended present rate as the complement of credibility.

Questions from the 2009 exam

32. (2 points) Given the following information:

- Current State X loss cost = $1,600
- Current countrywide loss cost = $1,800
- Indicated countrywide loss cost = $1,710
- State X losses and LAE = $1,000,000
- State X exposures = 1,000
- State X fixed expenses = $200,000
- Variable expense factor = 25%
- Profit and contingency factor = 5%
- Full credibility standard is 16,000 exposures.
- Partial credibility is assigned using the square root rule.
- Complement of credibility is determined using the "Rate Change from a Larger Group" method.

Calculate the credibility-weighted indicated rate for State X.

Questions from the 2012 exam

9. (1.75 points) Given the following information:

- Projected Loss and LAE Ratio = 58.5%.
- Projected Fixed Expense Provision = 11.5%.
- Variable Expense Provision =15%.
- Underwriting Profit Provision = 5%.
- Credibility of the indicated rate change = 0.7.
- Last rate change was taken January 1, 2012, the entire indicated change was implemented.
- Proposed effective date of next rate change is July 1, 2013.
- Annual Loss Ratio Trend = +2.5%.

Calculate the credibility-weighted indicated rate change.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Solutions to questions from the 1996 exam

42(a) The adjusted Class 1 pure premiums for each state is computed as follows:

$$P'_{c,j} = F_j\, P_{c,j} = (P_s\ /\ \bar{P}_j)\ {*}P_{c,j} = \left(P_s\ /\ \sum_m E_{m,s} * P_{m,j} \Big/ \sum_m E_{m,s}\right) {*}P_{c,j.}$$

Step 1: Compute the **base** state average pure premium, P_s $\quad P_s = \sum_i L_{i,s} \Big/ \sum_i E_{i,s}$.

(total state losses divided by total state exposure units) This is given in the problem as 3.71.

Step 2: Compute the state average pure premium, $\bar{P}_j$.

$$\bar{P}_j = \sum_m E_{m,s} * P_{m,j} \Big/ \sum_m E_{m,s}$$

(combine the state j class pure premiums using the base state exposure distribution).

For Maine, $\bar{P}_j = \dfrac{[200 * 4.00 + 500 * 4.50]}{(200 + 500)} = 4.36.$

For New Hampshire, $\bar{P}_j = \dfrac{[200 * 3.50 + 500 * 4.50]}{(200 + 500)} = 4.21.$

Step 3: Compute the individual state adjustment factors, F_j .

$$F_j = P_s \big/ \bar{P}_j$$

For Maine, F_j = 3.71 / 4.36 = .851

For New Hampshire, F_j = 3.71 / 4.21 = .881

Step 4: Compute the **class 1** adjusted pure premium, $P'_{c,j}$.

$P'_{c,j} = F_j\, P_{c,j}$

For Maine, $P'_{c,j}$ = .851* 4.00 = 3.40.

For New Hampshire, $P'_{c,j}$ = .881* 3.50 = 3.08.

(b) The pure premium to be used for the complement of credibility is computed as follows:

$$C = \sum_j E_{c,j}\, P'_{c,j} \Big/ \sum_j E_{c,j}$$

$$C = \frac{[150 * 3.40 + 100 * 3.08]}{(150 + 100)} = 3.27$$

Solutions to questions from the 1997 exam

7. Using losses capped at $100,000, compute the complement of credibility for losses in the layer $500,000 to $1,000,000.

Step 1: Write an equation to determine the complement for losses in the layer $500,000 to $1,000,000.

$$C = P_d\left[\frac{ILF_{A+L} - ILF_A}{ILF_d}\right]$$, where

Symbol	Description
P_d	Historical losses capped at limit 100,000.
A	Attachment Point = $500,000.
L	Layer Limit = $1,000,000.

Step 2: Using the equation in Step 1, and the data given in the problem, solve for the complement of credibility.

$$C = 650{,}0000^*\left[\frac{3.30}{165} - \frac{2.75}{165}\right] = \$216{,}667.$$

Answer C.

Question 21.

Boor discuses the advantages and disadvantages when using competitor's rates on pages 23 and 24.

Statistic's Quality	Statistic's Desireable Characteristic:
Independence	Prediction errors in the competitor's rates are independent of the subject loss costs. (Errors stem mostly from inter-company differences)
Availability	Competitor's rates are generally available through a regulatory agency
Process Error	A competitor may write more exposures and thus have have less process error

Statistic's Quality	Statistic's UnDesireable Characteristic:
Explainable relationship	It can be difficult to explain since the competitor's rates may be unrelated to the subject loss costs.
Bias	Might be biased due to different underwriting and claim practices.
Computation	This data does not exist in any other part of the rate filing and will have to be posted manually.

Solutions to questions from the 1998 exam

4. Determine the range the complement of credibility for Class 1 loss costs falls in using the present rates adjusted for rates changes in a larger group method.

Step 1: Write an equation to determine the complement using the present rates adjusted for rates changes in a larger group method.

The formula to compute this statistic is $C = R_c\left(1+\frac{P_g - R_g}{R_g}\right)$

Notation	Description
R_c	Class 1 present loss cost
P_g	All class indicated loss cost
R_g	All class present average loss cost

Step 2: Using the equation in Step 1, and the data given in the problem, solve for C.

$C = 125 * \left(1+\frac{165-150}{150}\right) = 137.50$ Answer D.

53. Calculate the complement of credibility that could be used to estimate the losses in the layer of insurance between \$250,000 and \$500,000.

Step 1: Use a limits analysis when losses limited to a single capping point are not available.

This method assumes that all the limits will experience the same loss ratio (in this case, .65).

ILFs can be used to determine the percentage of losses in the layer. The sum of losses within a layer can be used as the complement of credibility.

The formula to compute the complement of credibility is: $C = LR_T * \sum_{d \geq A} W_d \left(\frac{ILF_{\min(d,A+L)} - ILF_A}{ILF_d}\right)$, where

Symbol	Description
LR_T	Estimated total limits loss ratio
W_d	The premium with policy limits of d
A	Attachment Point (in this case \$250,000).
L	Layer Limit (in this case, \$250,000).

Step 2: Using the equation in Step 1, and the data given in the problem, solve for the complement of credibility to estimate the losses in the layer of insurance between \$250,000 and \$500,000.

Policy Limit	Premium	ILF	ELR	Expected Losses at a 65% Loss ratio	% of Expected Losses in the layer 250K - 500K	Expected Losses in the layer 250K - 500K
(1)	(2)	(3)	(4)	(5) = (2)*.65	(6)	(7) = (5) * (6)
250,000	1,000,000	1.80	.650	650,000	(1.8-1.8)/1.8= 0.0	0
\$500,000	\$700,000	2.60	.65	455,000	(2.6-1.8)/2.6 = .308	140,140
\$1,000,000	\$500,000	3.20	.65	325,000	(2.6-1.8)/3.2 = .25	81,250
						221,390

Thus, C = 221,390

Solutions to questions from the 1999 exam

Question 50

The formula for the complement of credibility using trended present rates. $C = R_L * T^t * \left[\frac{P_L}{P_C}\right]$

Symbol	Definition	As Given in the Problem
T	the annual trend factor, expressed as (1+ the inflation rate). In the problem, it is the frequency and severity trend.	(1.035)(1.114) = 1.15299
t	the number of years between the target effective date of the current rates and that of the new rates	4/1/97 - 10/1/99 = 2.5 years
R_L	Loss cost presently in the rate manual.	$325
P_L	The last indicated (requested) pure premium (rate change).	1.196
P_C	The pure premiums actually being charged (rate change approved) in the current manual. This may differ from R_L because P_L and P_C may be taken from a broader group.	1.04

The factor $\left[\frac{P_L}{P_C}\right] = \left[\frac{\textit{last}\text{ indicated pure premium}}{\text{actual pure premium in present rates}}\right]$ adjusts the loss cost in the present rates, R_L, for inadequacies which stem from the current rate being less than the indicated rate at the last rate filing.

Based on the above, $C = \$325 * (1.15299)^{2.5}\left[\frac{1.196}{1.04}\right] = \$533.51$

Question 53

Complement	Does not tend to bias the results in a material way.	Practical to implement.
Loss Costs of a larger group	Since the true class expected losses are not equal to the group expected losses, this statistic is biased.	Very practical, as long as all the classes in the group have something in common. Using national or statewide averages in the ratemaking process is common.
Trended Present Rates	The pure trended loss costs are unbiased since they are based on present rates which are presumed to be unbiased.	Same rationale as above
Competitors Rates	Might be biased due to different underwriting and claim practices.	They are often available from regulators, although the process takes some work. It is also a manually intensive and time consuming process.

Solutions to questions from the 2000 exam

23. Calculate the complement of credibility "C" using the "trended present rates" method.

Step 1: Write an equation to determine the complement of credibility "C" using the "trended present rates" method: $C = T^t * R_L * \left[\frac{P_L}{P_c}\right]$.

- The factor $\left[\frac{P_L}{P_c}\right] = \left[\frac{\text{last indicated pure premium}}{\text{actual pure premium in present rates}}\right]$ adjusts the loss cost in the present rates, R_L, for inadequacies which stem from the current rate being less than the indicated rate at the last rate filing.
- t is the number of year between the original target effective date of the current rates (not necessarily the date they actually went into effect), and the target effective date of the new rates.

Step 2: Using the equation in Step 1, and the data given in the problem, solve for C

$C = \$200 * 1.03^2 \left[\frac{1.10}{1.05}\right] = \$222.28$ **Answer C.**

Solutions to Questions from the 2001 exam

17. Calculate the complement of credibility for class 2 using a “Rate Change from the larger Group Applied to Present Rates”

Step 1: Write an equation to determine the complement of credibility "C" using the “Rate Change from the larger Group Applied to Present Rates”: $C = R_c \left[1 + \frac{P_g - R_g}{R_g}\right]$.

Step 2: Compute $\left[1 + \frac{P_g - R_g}{R_g}\right]$. $140 = 120 * \left[1 + \frac{P_g - R_g}{R_g}\right]$; $Thus \left[1 + \frac{P_g - R_g}{R_g}\right] = \frac{140}{120} = 1.1666$

Step 3: Using the equation in Step 1, the results from Step 2, and the data given in the problem, solve for the complement of credibility for class 2. $C_2 = 150 * 1.1667 = 175$. **Answer C.**

Solutions to questions from the 2002 exam

Question 10. Derive the pure premium complement of credibility for Small Company, Class 1, pure premium.

Since new companies and companies with small volumes of data often find their own data too unreliable for ratemaking, actuaries use competitor’s rates for the complement of credibility. In this problem, we are also told that due to the assumed growth of Small Company, 10% more losses are expected for Small Company than Competitor Company.

Compute the pure premium complement of credibility as follows:

Pure premium complement of credibility = Competitor present manual rate * Competitor Projected loss ratio * Company expected % increase loss per exposure = $70 * .75 * 1.10 = $57.75. **Answer D.**

Solutions to questions from the 2003 exam

39. (3 points) In "The Complement of Credibility," Boor discusses several methods for calculating complements of credibility in first dollar ratemaking. Briefly discuss three of these methods and comment on the effectiveness of each method as a complement of credibility.

1. Classic Bayesian credibility uses a larger group mean (including the base class) to compute the complement. This complement is biased and inaccurate, independent if the base class doesn't predominate the data, is readily available, easy to compute, and has an explainable relationship to the base class.
2. The trended present rates method uses the present rate, which is adjusted for the residual indication and trended from the last filing's target effective date, as the complement. It is unbiased, accurate, independent, available, easy to compute, and easy to explain since it is using the rates of the base class.
3. The rate change from a larger group is applied to present rates. A rate change from a larger group is applied to present rates. This complement is unbiased, accurate, independent, available, easy to compute, and easily explainable.

Solutions to Questions from the 2004 exam

46. (2 points)

a. (1 point) Derive the pure premium complement of credibility using the trended present rates method.

- Present pure premium rate is $150.
- Annual inflation rate is 4%.
- Original target effective date of the current rates was October 1, 2002.
- Amount indicated and requested in last rate change was 18%.
- Actual effective date was February 1, 2003.
- Amount approved in last rate change was 10%.
- Target effective date of the new rates is December 1, 2004.

The formula for the complement of credibility using trended present rates. $C = R_L * T^t * \left[\frac{P_L}{P_C}\right]$.

The factor $\left[\frac{P_L}{P_C}\right] = \left[\frac{\textit{last} \text{ indicated pure premium}}{\text{actual pure premium in present rates}}\right]$ adjusts the loss cost in the present rates, R_L, for inadequacies which stem from the current rate being less than the indicated rate at the last rate filing.

Symbol	*Definition*	*As Given in the Problem*
T	*the annual trend factor, expressed as (1+ the inflation rate).*	*1.04*
t	*the number of years between the target effective date of the current rates and that of the new rates*	*10/1/02 - 12/1/04 = 2.167 years*
R_L	*Loss cost presently in the rate manual.*	*$150*
P_L	*The last indicated (requested) pure premium (rate change).*	*1.18*
P_C	*The pure premiums actually being charged (rate change approved) in the current manual.*	*1.10*

Based on the above, $C = \$150 * (1.04)^{2.167} \left[\frac{1.18}{1.10}\right] = \$175.183$

b. (1 point) State and briefly describe one advantage and one disadvantage of using this COC.

Advantage: It is unbiased in the sense that pure trended loss costs (e.g. with no updating for more current loss costs) are unbiased.

Disadvantage: It is less accurate for loss costs with high process variance.

Solutions to questions from the 2005 exam

18. Using the following data, calculate the complement of credibility for class 3 based on the rate change-for the larger group applied to the present rate.

Class	Exposures	Losses	Present Pure Premium
1	200	$100,000	$550.00
2	300	$135,000	$500.00
3	500	$215,000	$455.00
Total	1,000	$450,000	$487.50

The complement of credibility approach using a "Rate Change from the larger Group Applied to Present Rates". The formula for the complement of credibility is as follows:

$$C = R_c \left[1 + \frac{P_g - R_g}{R_g}\right]$$, where

C is the compliment of credibility

R_C is the present pure premium (present manual loss cost) for the class under consideration

P_G is the indicated loss cost for the entire group of classes

R_G is the average loss cost for the entire group of classes

Using the above equation, and the data given in the problem, compute the compliment

$$C = \$455.00\left[1 + \frac{(\$450,000/1,000) - \$487.50)}{\$487.50}\right] = 420$$

Answer B. $\geq$ 400, but < 425

Solutions to questions from the 2006 exam

There were no questions drawn from the content within this article appearing on the above referenced exam.

Solutions to questions from the 2007 exam

32. (3.0 points) Using the following data, calculate the complement of credibility for the pure premium of Class 1 in State A, using Harwayne's full method. Show all work.

Step 1: Write an equation to determine the complement of credibility "C" for the pure premium of Class 1 in State A, using Harwayne's full method

$C = \sum_j E_{c,j} P'_{c,j} \Big/ \sum_j E_{c,j}$. The numerator is the sum product of the adjusted class 1 pure premiums and their class 1 exposures, summed over all states other than state A.

Also, compute the following pure premiums:

State	Class	Pure Premium=Loss/Exposure
A	1	180/130=1.38
A	2	2.81
B	1	2.20
B	2	3.00
C	1	1.38
C	2	2.78
D	1	2.29
D	2	2.00

The adjusted Class 1 pure premiums for each state are computed as follows:

Step 2: Compute the **base** state average pure premium, P_s $\quad P_s = \sum_i L_{i,s} \Big/ \sum_i E_{i,s}$

Total state losses divided by total state exposure units: P_A = (180+450)/(130+160) = 2.172.

Step 3: Compute the state average pure premium, $\overline{P}_j$.

$\overline{P}_j = \sum_m E_{m,s} * P_{m,j} \Big/ \sum_m E_{m,s}$

Combine state j class pure premiums using the base state exposure distribution

PB = (2.20* 130 + 3.00* 160)/(130 + 160) = 2.641

PC = (1.38*130 + 2.78*160)/(130 + 160) = 2.153

PD = (2.29*130 + 2.00*160)/(130 + 160) = 2.130

Step 4: Compute the individual state adjustment factors, F_j and then compute the **class 1** adjusted pure premium, $P'_{c\,j}$

$F_j = P_s \Big/ \overline{P}_j \qquad P'_{c\,j} = F_j P_{c\,j}$

$P'_{B1} = P_A / P_B * P_{B1}$ = 2.172/2.641 *2.20 = 1.809

$P'_{C1} = P_A / P_C * P_{C1}$ = 2.172/2.153 *1.38 = 1.392

$P'_{D1} = P_A / P_D * P_{D1}$ = 2.172/2.130 * 2.29 = 2.335

Step 5: The pure premium to be used for the complement of credibility is computed as follows:

$C = \sum_j E_{c,j} P'_{c,j} \Big/ \sum_j E_{c,j}$ C = (1.809*150 + 1.392*130 + 2.335*140)/(150 + 130 + 140) = 1.855

Solutions to questions from the 2008 exam

22. Calculate the complement of credibility using the trended present rate approach.

Step 1: Write an equation to determine the COC of credibility using trended present rates: $C = R_L * T^t * \left[\frac{P_L}{P_C}\right]$.

The factor $\left[\frac{P_L}{P_C}\right] = \left[\frac{\textit{last}\text{ indicated pure premium}}{\text{actual pure premium in present rates}}\right]$ adjusts the loss cost in the present rates, R_L, for inadequacies which stem from the current rate being less than the indicated rate at the last rate filing.

Symbol	Definition	As Given in the Problem
T	*the annual trend factor, expressed as (1+ the inflation rate).*	*1.10*
t	*the number of years between the target effective date(not necessarily the date they actually went into effect) of the current rates and that of the new rates*	*1/1/06 - 1/1/08 = 2 years*
R_L	*Loss cost presently in the rate manual.*	*$200*
P_L	*The last indicated (requested) pure premium (rate change).*	*1.20*
P_C	*The pure premiums actually being charged (rate change approved) in the current manual.*	*1.15*

Step 2: Using the equation in Step 1, and the data given in the problem, solve for C.

$$C = \$200 * (1.10)^2 \left[\frac{1.20}{1.15}\right] = \$252.52$$

b. (1 point) State and briefly describe 1 advantage and 1 disadvantage of using this complement of credibility.

Advantage: It is unbiased in the sense that pure trended loss costs (e.g. with no updating for more current loss costs) are unbiased.

Disadvantage: It is less accurate for loss costs with high process variance.

Solutions to questions from the 2009 exam

Question 32

$$C = \textit{Current Loss Cost of Subject Experience} \times \left(\frac{\textit{Larger Group Indicated Loss Cost}}{\textit{Larger Group Current Average Loss Cost}}\right)$$

Complement = 1,600 x (1,710/1,800) =1,520

Credibility= $Z = \sqrt{\frac{Y}{E(Y)}},\ where\ Y < E(Y);$ Z= $\sqrt{\frac{1,000}{16,000}} = .25$

Indicated loss lost = $\frac{1,000,000}{1000} = 1000$

Credibility weighed indicated loss costs = .25 (1,000) + .75 (1520) = 1,390

Indicated Rate = $\frac{\left[\overline{L+E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]} = \frac{\left[{(L+E_L)}/{X} + {E_F}/{X}\right]}{\left[1.0 - V - Q_T\right]}$

Credibility weighed indicated rate (1390 + 200,000/1,000)/(1.0 - .25 -.05) = 2,271.43

Solutions to questions from the 2012 exam

9. Calculate the credibility-weighted indicated rate change.

Question 9 – Model Solution (Exam 5A Question 9)

An equation to determine the COC of credibility using trended present rates: $C = R_L * T^t * \left[\frac{P_L}{P_C}\right]$.

The factor $\left[\frac{P_L}{P_C}\right] = \left[\frac{\textit{last}\ \text{indicated pure premium}}{\text{actual pure premium in present rates}}\right]$ adjusts the loss cost in the present rates, R_L, for inadequacies which stem from the current rate being less than the indicated rate at the last rate filing.

Complement of credibility = Trended present rate = (indicated/approved) (loss trend)^ t -1
t = from 1/1/12 last date to 7/1/13 next date
COC = (1) (1.025)^1.5 -1 = 3.7733%

Ind Rate Change -> LR Method = (0.585 + .115) / (1.0 - .15 - .05) -1 = -12.5%
(.70) (-12.5%) + (1.0 - .70)(3.7733%) = -7.618%

Examiner's Comments

Candidates typically lost points on the compliment of credibility.

Given the information in the question, using 0 was determined to not be worth full credit.

Candidates lost varying amount of points for using 0 as a compliment depending on the completeness of the explanation. Other candidates trended a projected loss ratio that was already trended.

1 Regulatory Constraints 239 - 241

This chapter outlines some reasons why a company might implement rates and/or rating differentials other than those calculated using techniques from prior chapters (that balance the fundamental insurance equation).

Those reasons are:

- Regulatory constraints
- Operational constraints
- Marketing considerations

The U.S. P&C insurance industry is highly regulated through state law and state regulatory agencies.

Regulatory scrutiny varies by jurisdiction and by insurance product. Examples:

- Scrutiny is high for personal auto insurance (since car owners have to meet state-mandated financial responsibility requirements by purchasing this coverage)
- However, oversight is lower for other types of commercial insurance (e.g. directors and officers insurance), which may not be compulsory and are purchased by more sophisticated buyers.

U.S regulation often requires insurers to file proposed manual rates with the state insurance department.

Filing requirements vary considerably by jurisdiction and product.

- Some regulation requires regulator's approval of the new rates before the company can use them.
- Other regulation requires a copy of the manual rates to be on file with the regulator.
- Regulators may promulgate rates to be used but allow a specified range of deviation from these rates (in some extreme cases).

In Canada, insurance rate regulation is executed by the individual provinces. For the personal auto product:

i. some provinces require approval of filed rates; others operate more on open competition.

ii. a few provinces have a government insurer for compulsory liability coverages, but allow open competition for other coverages.

The United Kingdom has less rigid rate regulation than in the U.S. (and relies on competitive pressures to "regulate" the market).

In Latin American markets:

- regulation is focused more on rate adequacy (i.e. ensuring that insurers collect the minimum premium to meet their obligations) than equity among classifications.
- rating plans are unsophisticated.

  One exception is Brazil; carriers use a wider range of rating variables on some products (e.g. personal auto) and rates are required to be filed with the regulators for approval.

In many developing markets (e.g. India) rate regulation is heavier on compulsory coverages (e.g. personal auto liability), but other insurance products are deregulated and operate on open competition.

Examples of U.S. Regulatory Constraints

Regulatory constraints, causing insurers to implement rates different from those indicated by its ratemaking analyses, follow.

1. Regulations that limit the amount of an insurer's rate change (to either the overall average rate change for the jurisdiction or to the change in premium for any individual or group of customers, or both)

   Example: A jurisdiction may prohibit a rate change that generates an overall premium increase greater than 25% and/or a rate change that results in a significant number of existing customers getting an increase greater than 30%.

2. Regulatory requirements regarding the magnitude of the requested change.

   Example: An insurer may be required to provide written notice to all insureds or hold a public hearing in the event a proposed rate change exceeds some specified threshold (but may decide to implement a rate change that is less than the threshold to avoid the extra requirements).

3. Regulations prohibiting the use of a characteristic for rating (even if it can be demonstrated to be statistically strong predictors of risk).

   Example: The use of insurance credit score for underwriting or rating personal lines insurance (e.g. personal automobile or homeowners).

   i. An individual's insurance credit score is a strong predictor of risk in personal lines.
   ii. Where allowed, insurers charge higher premium for individuals with poor credit scores than for individuals with good credit scores.
   iii. Because credit score is perceived to be correlated with certain socio-demographic variables, some jurisdictions have placed limitations on the use of credit and some have banned the use of credit

4. Regulations prescribing the use of certain ratemaking techniques.

   Examples: The state of Washington requires that multivariate classification analysis be used to develop rate relativities if insurance credit score is used to differentiate premium in personal auto insurance.

   Other states mandate the use of a certain method for incorporating investment income in the derivation of the target underwriting provision.

5. Regulators disagreeing with actuarial ratemaking assumptions (e.g. a regulator may disagree with the method the actuary used to calculate loss trend, or may disagree with the trend selected).

   There may be a cost (e.g. delayed implementation of new rates, requirement of specialized staff resources) associated with negotiating with the regulator to resolve such differences.

Insurer actions that can be taken with respect to regulatory restrictions:

- An insurer can take legal action to challenge the regulation.
- An insurer may revise its U/W guidelines to limit business written at what it considers to be inadequate rate levels (although some locations require insurers to "take all comers" for personal lines).
- An insurer may change marketing directives to minimize new applicants whose rates are thought to be inadequate (e.g. concentrate its advertising on areas in which it believes the rate levels to be adequate).
- In the case of banned or restricted usage of a variable (e.g. insurance credit scores), an insurer can use a different allowable rating variable (e.g. payment history with the company) it believes can explain some or all of the effect associated with the restricted variable.

2 Operational Constraints 241 - 244

Operational constraints include items like systems limitations and resource constraints. For example:

Modifying rating algorithms can require significant systems changes, and the complexity of the change depends on:

- The extent of the changes (e.g. the number of rating variables, the number of levels within each rating variable, how the rating variables are applied in the rating algorithm)
- The number of systems (e.g. quotation, claims, monitoring, etc.) impacted by the rate change

Also, implementing a new rating variable may require data that has not been previously captured.

- It is often necessary to get this data directly, either through a questionnaire sent to insureds or by visually inspecting the insured item.
- These approaches can call for additional staff with unique skills.

- When an operational constraint arises, a cost-benefit analysis can determine the appropriate course of action. The cost of implementing the change is the cost associated with modifying the system.
- The benefit is the incremental profit that can be generated by charging more accurate rates, and attracting more appropriately priced customers.

Cost-benefit analysis example:

Assume that:

- a risk characteristic accounts for a 10% difference in projected ultimate losses and expenses between Class A and Class B.
- the characteristic is not currently reflected in the rates (both classes are charged a rate of $1,050, and that this average rate reflects a target profit provision of 5.2 %.)

The table below depicts the number of risks for each class, as well as the projected costs, current rates, and actual profit for each class.

Calculation of Profit (Current Rate)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Projected				
		Projected	Losses &	Current	Target		
		Losses &	Expenses	Rate per	Profit	Actual Profit	
Class	# Risks	Expenses	per Risk	Risk	%	$	%
A	50,000	$45,000,000	$900	$1,050		$7,500,000	***14.3%***
B	1,000,000	$1,000,000,000	$1,000	$1,050		$50,000,000	***4.8%***
Total	1,050,000	$1,045,000,000	$995	$1,050	**5.2%**	$57,500,000	**5.2%**

(3) = (2)/(1)

(6) = [(4)-(3)]x(1)

(7) = (6)/[(4)x(1)]

- using the current average rate, Class A risks will be more profitable than Class B risks.
- if the rating variable is implemented, the company can decrease the rate for Class A and increase the rate for Class B in line with the difference in expected costs.

Instead of charging $1,050 for all risks, charge Class A risks $950 and Class B risks $1,055.

Assuming no change in the risks insured, there will be no change in the total profit but the cross-subsidy will be eliminated (as shown in the table below).

Calculation of Profit (After Rate Change)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Class	# Risks	Projected Losses & Expenses	Projected Losses & Expenses per Risk	Current Rate per Risk	Target Profit %	Actual Profit $	Actual Profit %
A	50,000	$45,000,000	$900	***$950***		$2,500,000	***5.3%***
B	1,000,000	$1,000,000,000	$1,000	***$1,055***		$55,000,000	***5.2%***
Total	1,050,000	$1,045,000,000	$995	$1,050	**5.2%**	**$57,500,000**	**5.2%**

(3) = (2)/ (1)

(6) = [(4) - (3)] x (1)

(7) = (6)/ [(4) x (1)]

If rate changes are made, the insurer will write more Class A risks and possibly fewer Class B risks.

Assuming the change results in 25% more Class A business and no change in Class B business, the profit projections are as follows:

Calculation of Profit (After Rate Change and Distributional Shift)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Class	# Risks	Projected Losses & Expenses	Projected Losses & Expenses per Risk	Current Rate per Risk	Target Profit %	Actual Profit $	Actual Profit %
A	***62,500***	***$56,250,000***	$900	$950		$3,125,000	5.3%
B	1,000,000	$1,000,000,000	$1,000	$1,055		$55,000,000	5.2%
Total	1,062,500	$1,056,250,000	$994	$1,049	**5.2%**	**$58,125,000**	**5.2%**

(3) = (2)/ (1)

(6) = [(4) - (3)] x (1)

(7) = (6)/ [(4) x (1)]

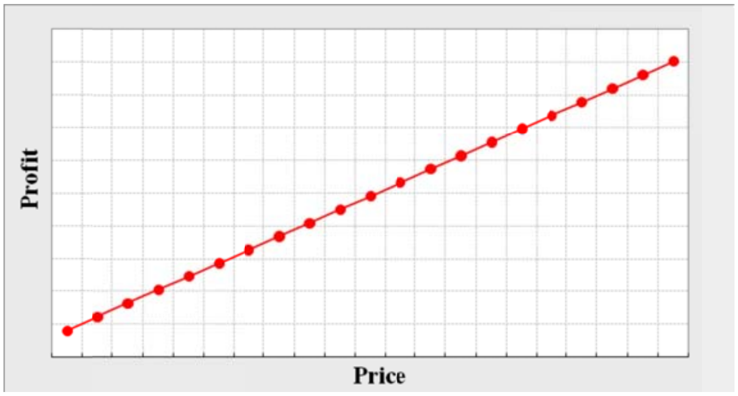
Conclusion/Course of Action:

- Implementing the rating variable will generate an additional $625,000 (= $58,125,000 - $57,500,000) in profits.
- Compare the profit to the cost of making the change to determine the appropriate course of action.
- There may also be other costs associated with this change (e.g. changes in staffing for the UW department to handle the increased number of Class A insureds).

3 Marketing Considerations 244 - 260

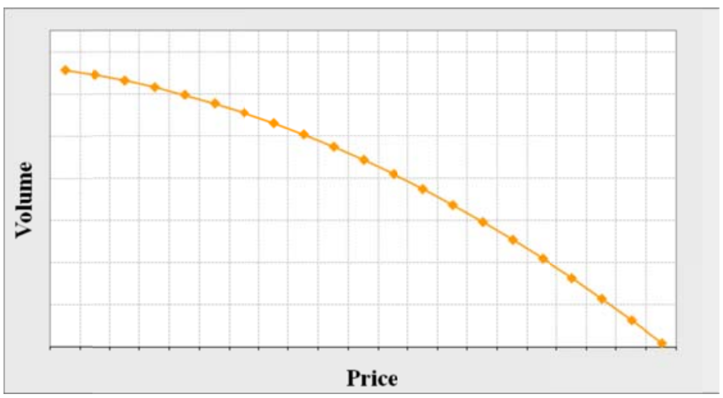
The relationship between price and profit (assuming the number of policies is fixed) is shown below:

Profit Assuming Fixed Volume



A demand curve shows that that the demand for a product decreases as the price increases.

Sample Demand Curve



To determine true expected profitability, the two curves should be considered simultaneously.

Expected profit as a function of price is an arc-shaped curve.

Expected Profit Considering Demand

Total profit increases to the price at which lost business outweighs the benefit associated with higher prices on the business that remains.

This does not mean that the actuarial rate indication is incorrect (since the latter is determined without regard to whether or not the product will be purchased).

Thus, the insurer should consider both the cost-based rate indication and marketing conditions.

Marketing considerations:

Insurers often categorize insureds into new and renewal business.

- These groups are analyzed separately since purchasing behavior and expected profitability of each group can be quite different.
- Factors that affect an insured's propensity to renew an existing product or purchase a new product are:
  1. **Price of competing products**: If the same product is offered at a lower price, they are likely to purchase the competing product.
  2. **Overall cost of the product**: If the product is costly, insureds are likely to compare prices to determine any potential savings (and vice versa).
  3. **Rate changes**: Significant increases (or decreases) in premium for an existing policy can cause existing insureds to look for better options.
  4. **Characteristics of the insured**:
     i. A large established business may be less sensitive to the price of its commercial package policy than a sole practitioner.
     ii. A young policyholder may shop (and change insurers) more frequently than an older policyholder.
  5. **Customer satisfaction and brand loyalty**: Poor claims handling or a bad customer service experience may cause existing insureds to explore other options.

Notes:

- The above are more relevant for personal lines insureds than for larger commercial lines purchasers.
- Commercial entities have less access to competitive price information and stay with an existing carrier based on service.

Techniques for Incorporating Marketing Considerations

The decision-maker considers the traditional actuarial rate indication along with marketing information (incorporated judgmentally) to determine the set of rates to be implemented.

Marketing information includes:

* Competitive comparisons
* Close ratios, retention ratios, growth
* Distributional analysis
* Dislocation analysis

1. Competitive Comparisons via Premiums Charged

All information needed to accurately determine the premium charged by competitors can be difficult to obtain.

* U.S. commercial lines insurers adjust the manual rate via schedule and experience rating (see Chapter 15).
* For U.S. personal lines, estimating a competitor's premium is difficult if the competitor makes extensive use of risk placement to vary the rate charged (e.g. insurers use U/W tiers that function as a rating variable, but the guidelines or algorithms that allocate risks into tiers are not always publicly available).

In sophisticated, less regulated markets (e.g. the U.K.), rate manuals may not be available, and rates may change (as frequently as daily).

Insures may rely on obtaining competitive price quotes from brokers, questioning potential or existing customers about price information, or surveying Web-based quoting engines.

Though data is hard to obtain, it is valuable to compare premium to competitors'. Insurers are interested in 2 levels of competitiveness:

1. how competitive their rates are on **average** (i.e. for all risks combined, a.k.a. a base rate advantage).
2. how competitive their rates are for **individual risks or groups of risks** (e.g. for new homes or claims-free drivers).

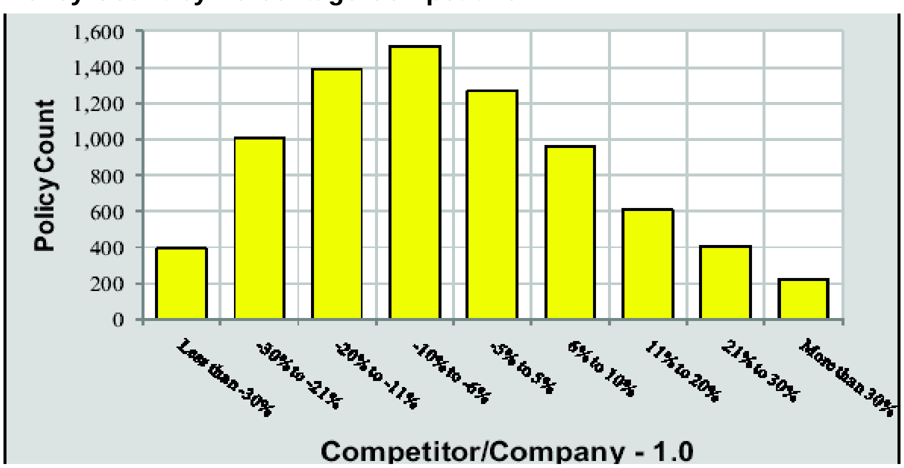
Overall competitive position compares premiums for a set of sample risks, for all quoted risks (for new business), or for all existing insureds (for renewal competitiveness).

When doing so, companies typically focus on one or more of the following metrics:

- $\%\ Competitive\ Position = \dfrac{Competitor\ Premium}{Company\ Premium}(or\ the\ reciprocal) - 1.0$
- $\$\ Competitive\ Position = Competitor\ Premium - Company\ Premium\ (or\ the\ reverse)$
- $\%Win = \dfrac{Number\ of\ Risks\ Meeting\ Criteria\ (e.g.\ Premium\ Lower\ than\ Competitor\ )}{Total\ Number\ of\ Risks}$
- $Rank = Rank\ of\ Company\ Premium\ when\ compared\ to\ the\ premium\ from\ several\ competitors$

The chart below shows a distribution of policies for different ranges of the percentage competitive measure:

Policy Count by Percentage Competitive



The x-axis represents different ranges of the % competitive position.

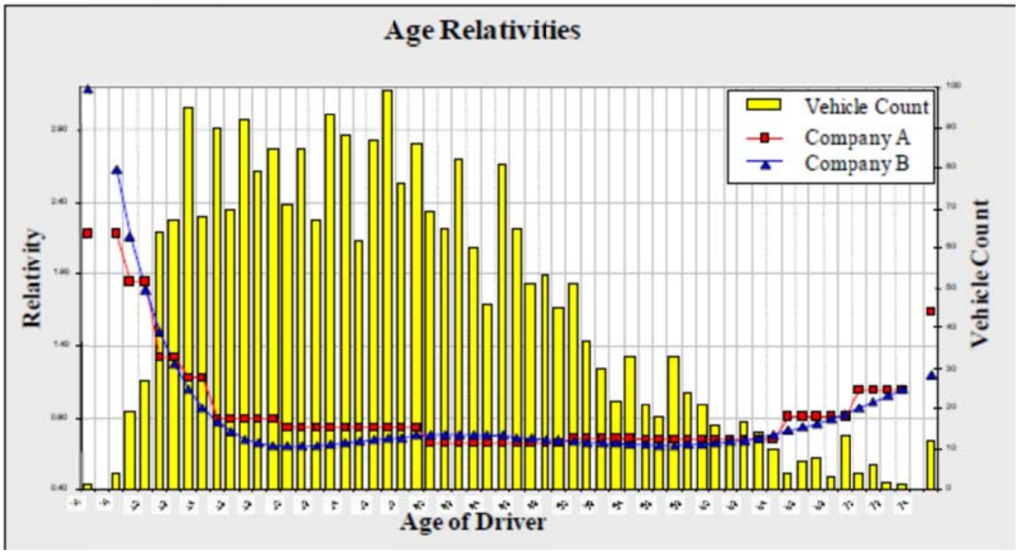
i. if 2 insurers charge the same premium, then all policies are in the range containing 0% (i.e. -5% to 5%).
ii. if the competitor has a different premium structure, the bars will be dispersed across the different ranges.
   a. the overall average competitive position is -7% (on average, the competitor's premium is 7% lower than the insurer's premium), but the competitiveness ranges from -60% to over 100%.
   b. this variation highlights significant differences in the rating algorithms/relativities between the 2 insurers.

Competitive Analysis using Rate Relativities

The chart below shows a comparison of age relativities for personal auto coverage.

- the x-axis shows the different age levels of the variable being studied (i.e. ages)
- the bars represent the number of vehicles for each level of age (right y-axis),
- the lines represent the rate relativities by company (left y-axis).

13.8 Relativity Comparison



This type of competitive analysis is effective when rating algorithms are similar between companies.

However, rating algorithms have become much more complex (and include many more risk characteristics, thus individual rate relativity comparisons may be less meaningful). Examples:

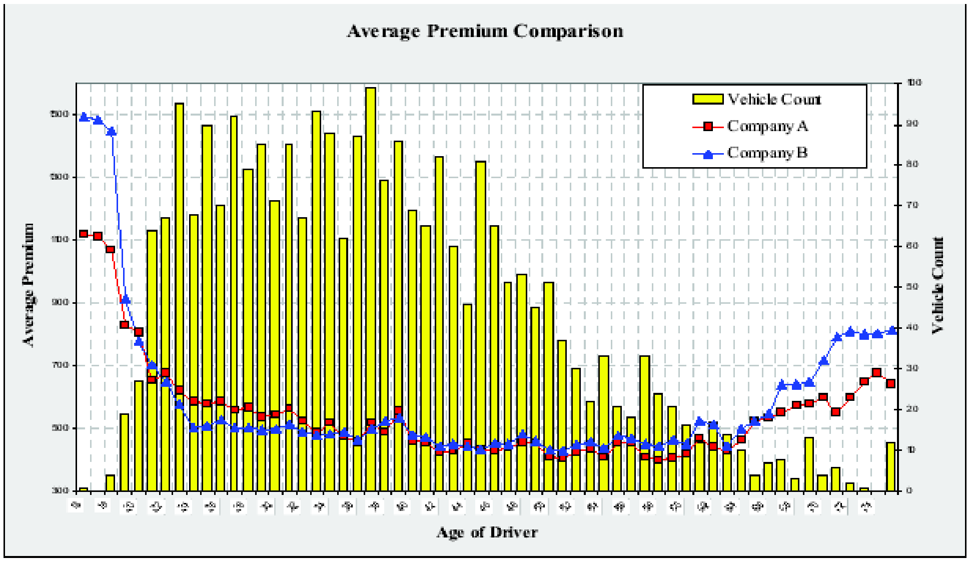
i. Comparing age relativities may not be useful if one insurer includes other age-related factors in its rating algorithm (e.g. retiree discounts, inexperienced operator surcharges) while the other insurer does not.

ii. Rating variables may be additive for one insurer and multiplicative for another insurer.

Thus, **use total premium comparisons for groups of risks sharing the rating characteristic of interest**.

The chart on the next page shows the average premium by age rather than the rate relativities by age.

Average Premium Comparisons



This shows where competitive threats and opportunities exist for the company's existing rating variables.

When using this type of analysis, note that a change in one variable's rate relativities can have an unintended impact on the average premium of a certain level of another variable. Example:

If square footage introduced as a rating variable in HO insurance, it may significantly change the average premium of certain territories or AOI levels (since those are highly correlated with square footage).

2 Close Ratios, Retention Ratios, Growth

The **Close ratio** (a.k.a. **hit ratio**, **quote-to-close ratio**, or **conversion rate**) measures rate at which prospective insureds accept new business quotes: $Close\ Ratio = \dfrac{Number\ of\ Accepted\ Quotes}{Total\ Number\ of\ Quotes}$

- If an insurer issues 25,000 quotes in a month and generates 6,000 new policies then the close ratio is 24% (= 6,000 / 25,000).
- Understand the data used to calculate the denominator of the ratio. Example:
  i. Insurer A may include all quotes issued, while insurer B may only include one quote per applicant.
  ii. Insurer A will have a lower close ratio if applicants request more than one quote before making a decision (e.g. if an applicant gets several quotes with different limits).

The **Retention ratio** (a.k.a. **persistency ratio**) measures the rate at which existing insureds renew their policies upon expiration: $Retention\ Ratio = \dfrac{Number\ of\ Policies\ Renewed}{Total\ Number\ of\ Potential\ Renewal\ Policies}$

- If 30,000 policies are up for renewal in a month and 24,000 renew, then the retention ratio is 80% (= 24,000 / 30,000).
- Renewal customers are less expensive to service and generate fewer losses than new customers.
- Understand the data used to calculate the denominator of retention ratio.

  If insurer A excludes all policies that were non-renewed (because they no longer met the eligibility criteria), and insurer B includes them, then insurer A will have a better retention ratio than insurer B.

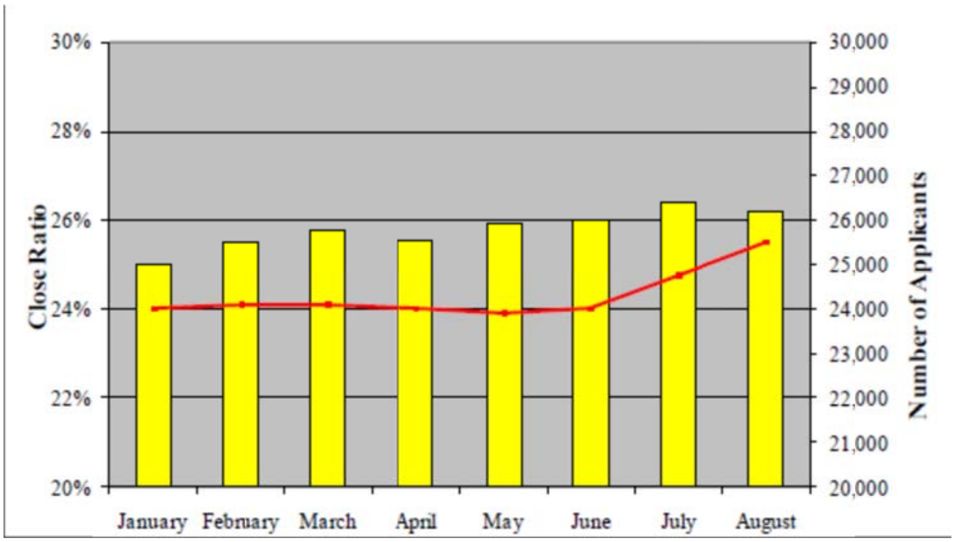
Both absolute ratios and changes in the close and retention ratios are analyzed.

- Insurers rely on close ratios and retention ratios as primary signals of the competitiveness of rates for new business and renewal customers, respectively.
- Changes in ratios are used to gauge changes in competitiveness.
- Close ratios and retention ratios are reviewed when rate changes are implemented. Rate changes:
  i. affect renewal business directly (since any change can motivate existing customers to shop elsewhere).
  ii. influence the insurer's competitive position (e.g. If an insurer takes a rate decrease, the expectation is that the close and retention ratios will improve, and vice versa)

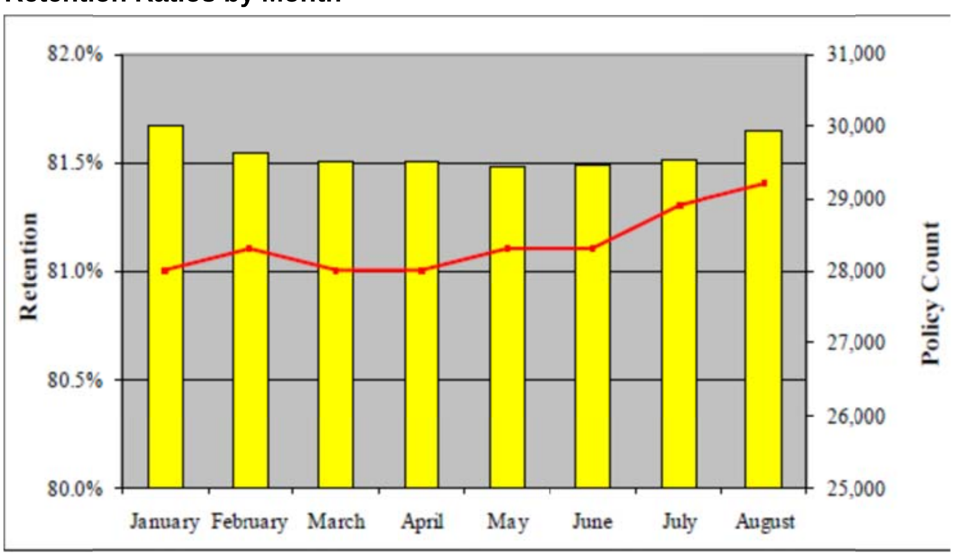
The following are charts comparing close ratios and retention by month (x-axis).

- The bars represent the number of applicants or renewals (right y-axis) for each month.
- The line represents the close or retention ratio (left y-axis) for each month.
- The increase in each ratio over the last couple months coincides with a rate decrease implemented in July.

Close Ratios by Month



Retention Ratios by Month



Growth captures new business obtained and existing customers retained.

Policy growth rate is defined as:

$$\%PolicyGrowth = \frac{(New\ Policies\ Written - Lost\ Policies)}{Policies\ at\ Onset\ of\ Period} = \frac{Policies\ at\ End\ of\ Period}{Policies\ at\ Onset\ of\ Period} - 1.0$$, where

a "lost policy" can either be a cancelled or non-renewed policy.

Example:

- Assume there were 360,000 policies at the beginning of the month.
- If 9,600 new policies were added and 6,000 policies were lost during the month, then the monthly policy growth is 1.0% (= [9,600 - 6,000] / 360,000).

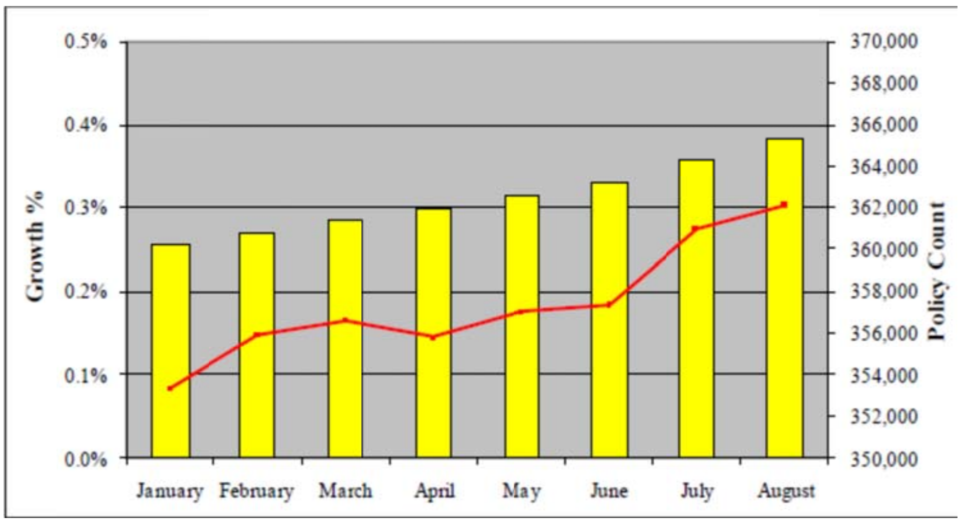
Growth percentages are tracked over time.

i. Low or negative growth can indicate uncompetitive rates and vice versa.

ii. Changes in growth can also be significantly impacted by items other than price. Example:

If an insurer tightens or loosens the underwriting standards, growth can be affected.

Policy Growth by Month

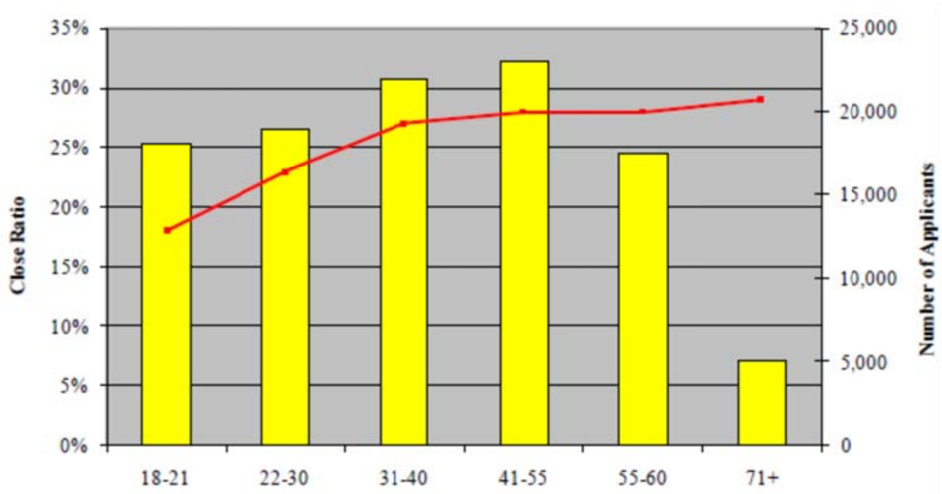


The close, retention, and growth ratios may be tracked for specific groups of insureds.

- If any of the ratios look worse for a segment despite having similar competitiveness as other segments, then it may indicate that:
  - i. the segment is more price sensitive
  - ii. competitive rate comparisons are not valid, or
  - iii. something other than price is driving the purchasing decision.

- Consider the char below of close ratios by age of named insured.
  - i. The bars represent the number of applicants (right y-axis)
  - i. the line represents the close ratio (left y-axis) by age of applicant (x-axis).

Close Rates by Age of Named Insured



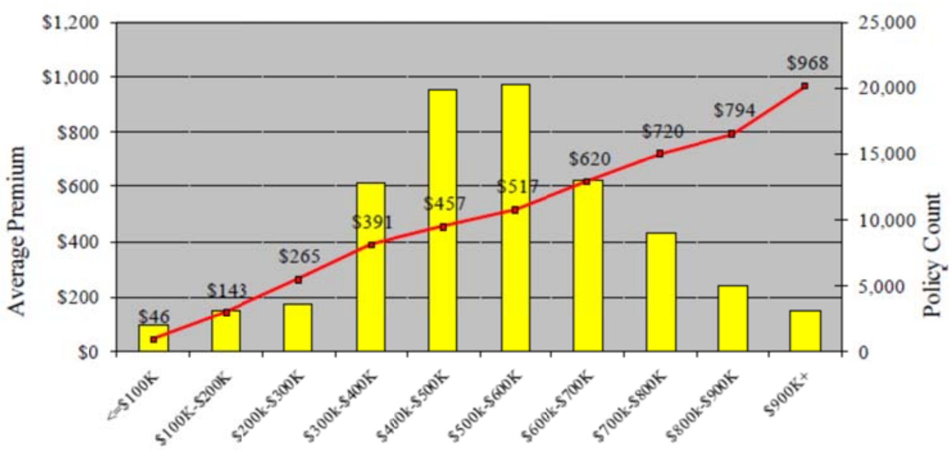
- Even if the competitive position is similar across all age groups, the close rate is the lowest for the younger insureds (since younger insureds tend to be more price-sensitive).
- Similar analysis can be performed for retention and growth.

3. Distributional Analysis

A distributional analysis includes both the distribution by segment at a given point of time and changes in distributions over time. For example,

An insurer may wish to review its distribution of HO policies by amounts of insurance (AOI)

Policies and Average Premium by AOI Range



- the distributional analysis may uncover that while 15% of homes in a market are valued under $200,000, only 5% of the homes in the insurers portfolio have an AOL in that range. Reasons for this include:
  i. insurer rates for homes in this range are uncompetitive.
  ii. poor marketing or inadequate agent placement.
- a comparison of distributions over time can reveal whether this low penetration has been consistent or if it is a recent development (if the latter, it could indicate that a competitor began targeting homes valued less than $200,000 via marketing strategy, price strategy, etc).

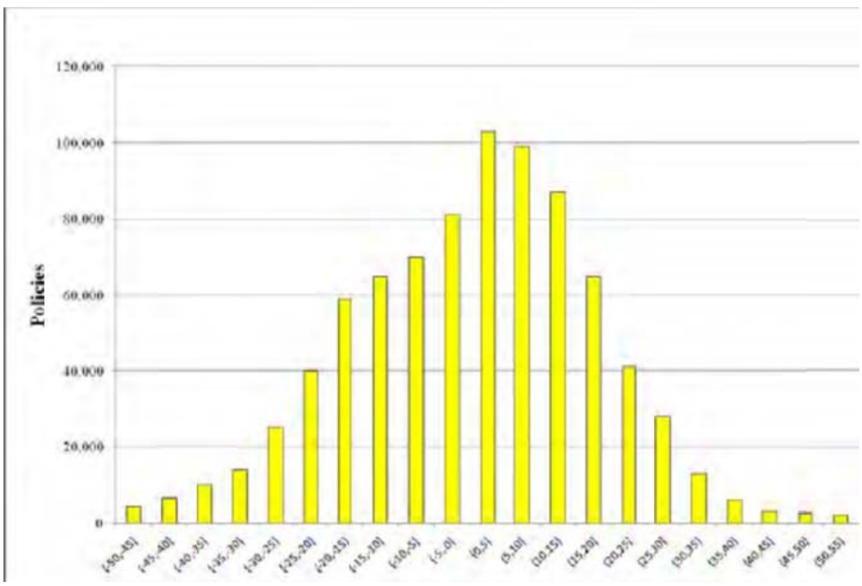
4. Policyholder Dislocation Analysis

Quantifies the number of existing customers that will receive specific amounts of rate change.

- It is used to extrapolate how the rate change may affect retention.
- Thresholds define the magnitude and dispersion of rate changes that the insurer believes will produce an unacceptable effect on retention (in total or by customer segment).

  If the effects are outside the tolerance level, the insurer could revise the proposed rate change.
- Knowledge of the expected dislocation can be shared with the sales and customer support units (e.g. call centers) prior to implementation to prepare them for customer response (e.g. a customer calling an agent about a large premium increase).
- When a base rate change is made, the amount of dislocation is uniform across all insureds.
- If rate relativities also change, the amount of dislocation can vary significantly for different insureds or classes of insureds.

  Rate Change Distribution



Assimilating the Information

One must weigh all information and select rates that best meet the insurer's goals (done judgmentally).

Assume the following about a class of business:

- Current average premium = $1,000
- Indicated average premium = $1,200 (or 20% increase)
- Competitor's average premium = $1,000
- Close ratio, retention ratio, and growth are all significantly below target

Options/Impacts:

1. Implementing a 20% increase will cause significant loss of renewal customers and prohibit business growth.
2. If the insurer decides not to implement the full increase, it can consider other non-pricing solutions to improve profitability (e.g. revise UW guidelines or marketing strategies).

Systematic Techniques for Incorporating Marketing Considerations

These techniques incorporate both marketing information and actuarial indications when proposing rates.

1. Lifetime Value Analysis

Examines the profitability of an insured over a long period of time noting that not all insureds will renew.

To do this, assumptions are made regarding the:

i. propensity of the insured to renew (see (6) below)
ii. expected profitability of the insured over the time period being projected (see (3) and (4) below).

The following is a personal auto lifetime value calculation analyzing the long term profitability of a 22-year-old and a 70-year-old.

Four-Year Time Horizon for 22-Year-Old

Year	(1) Age	(2) Prem	(3) Losses	(4) Expense	(5) Profit	(6) Renewal Prob	(7) Cumulative Persistency	(8) Adj Profit	(9) PV of Adj Profit	(10) PV of Premium	(11) Profit%
1	22	$810	$800	$35	($25)	100.00%	100.0%	($25.00)	($25.00)	$810.00	**-3.1%**
2	23	$800	$750	$15	$35	75.00%	75.0%	$26.25	$25.00	$571.43	4.4%
3	24	$790	$700	$15	$75	75.00%	56.3%	$42.19	$38.27	$403.06	9.5%
4	25	$780	$650	$15	$115	80.00%	45.0%	$51.75	$44.70	$303.21	**14.7%**
Total		$3,180	$2,900	$80	$200			$95.19	$82.97	$2,087.70	4.0%

Four-Year Time Horizon for 70-Year-Old

Year	(1) Age	(2) Prem	(3) Losses	(4) Expense	(5) Profit	(6) Renewal Prob	(7) Cumulative Persistency	(8) Adj Profit	(9) PV of Adj Profit	(10) PV of Premium	(11) Profit%
1	70	$600	$550	$35	$15	100.00%	100.0%	$15.00	$15.00	$600.00	***2.5%***
2	71	$600	$578	$15	$7	95.00%	95.0%	$6.65	$6.33	$542.86	1.2%
3	72	$600	$606	$15	($21)	96.00%	91.2%	($19.15)	($17.37)	$496.33	-3.5%
4	73	$600	$640	$15	($55)	97.00%	88.5%	($48.66)	($42.03)	$458.51	***-9.2%***
Total		$2,400	$2,374	$80	($54)			($46.16)	($38.07)	$2,097.69	-1.8%

(5)= (2) - (3) - (4); (7)= (6) x (Prior7); (8)= (5) x (7); (9)= (8) discounted by 5% per annum;
(10)= (2) x (7)discounted by 5% per annum; (11)= (9) / (10)

Conclusions:

- The % profit over a one-year time horizon (i.e. the first row in each table) show that a **70-year-old is more profitable** to insure than a 22-year-old.
- When persistency is considered over a four-year time horizon, **the 22-year-old** (age 25 at the end of the time period) **is more profitable** than the 70-year-old (age 73 by the end of the time period).

Improvements to this type of analysis include:

- refining the assumptions
- increasing the time horizon
- incorporating results from other products the customer may purchase.

For related information on lifetime value analysis, see "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurance" (Feldblum 1996), which is also part of the CAS Exam 5 Syllabus of Readings.

2. Optimized Pricing

Multivariate statistical modeling techniques are being applied to develop renewal and conversion models (i.e. customer demand models). These models are used to estimate the probability that:

- an applicant will accept a quote (i.e. conversion model) or
- an existing customer will accept the renewal offer (i.e. retention model).

Historical data used to develop these models includes:

- a series of observations and
- a corresponding response for each observation.

Examples of model datasets:

i. a conversion model dataset contains a series of new business quotes and whether each quote was accepted or rejected.

ii. a retention model dataset contains a series of renewal offers and whether each offer was accepted or not.

Each dataset should include relevant information about each observation (e.g. risk characteristics such as amount of premium quoted, rate change information (for retention models), and an indicator of the competitiveness of the premium).

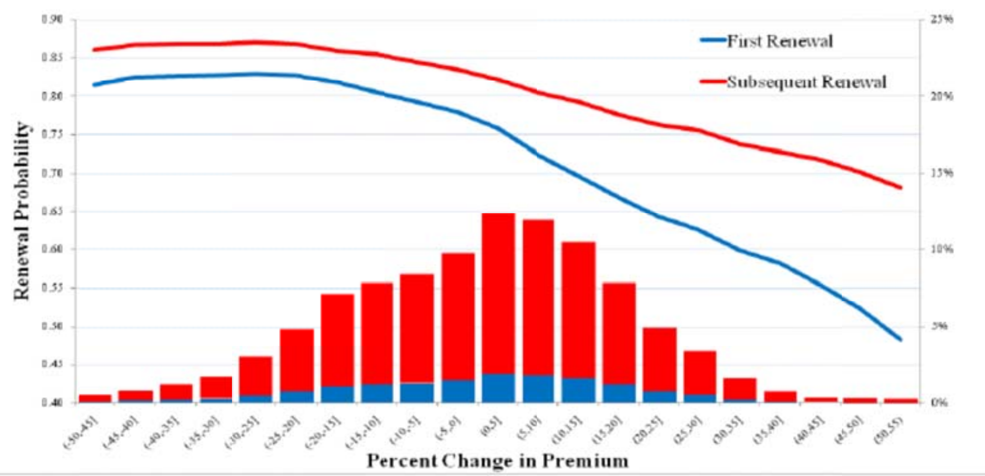
The models help predict the change in close rate or retention rate in response to a proposed rate change.

The chart below is an output from a retention model.

- The bars represent the % of policies (right y-axis) getting different % change in premium (x-axis).
- The lines illustrate the insured's propensity to renew (left y-axis) depending on whether it is the first or subsequent renewal for the insured.

As premium changes increase, the blue (bottom) line drops more steeply than the red (top) line, suggesting that the longer the insured is with the carrier, the less sensitive he or she is to premium increases.

Retention Model Output



Scenario testing rate changes (a precursor to full price optimization):

A loss cost model and a customer demand model can be jointly used to estimate expected premium volume, losses, and total profits for a given rate proposal.

- For renewal business, the loss cost and retention models project the expected profitability and probability of renewal for each risk at a given price.
- Using these models, an insurer can test several rate change scenarios on the in-force distribution to determine the expected volume, premium, losses, and profit of each scenario.
  i. The objective: Identify the rate change that best achieves the company's profitability and volume goals on the renewal portfolio.
  ii. Added benefit: This same process can test multiple rate scenarios on new business by applying the results of loss cost models and conversion models on a portfolio of quotes.

Optimization algorithms:

- incorporate loss cost models, demand models, and other assumptions as inputs, and generate hundreds of thousands of scenarios to determine the premium for each individual risk that optimizes overall profit while achieving an insurer's overall volume goals (or optimize volume while achieving an insurer's overall profitability goals).
- require the actuary to translate individually optimized premium into a manual rate structure, depending on the product being priced.

In summary, optimized pricing systematically combines knowledge of loss costs and customer demand to develop rates that meet volume and profitability objectives of the insurer.

3. Underwriting Cycles

The industry undergoes cyclical results (i.e. overall industry profitability oscillates systematically), and understanding which phase of the cycle one is in is important when determining which rates to implement.

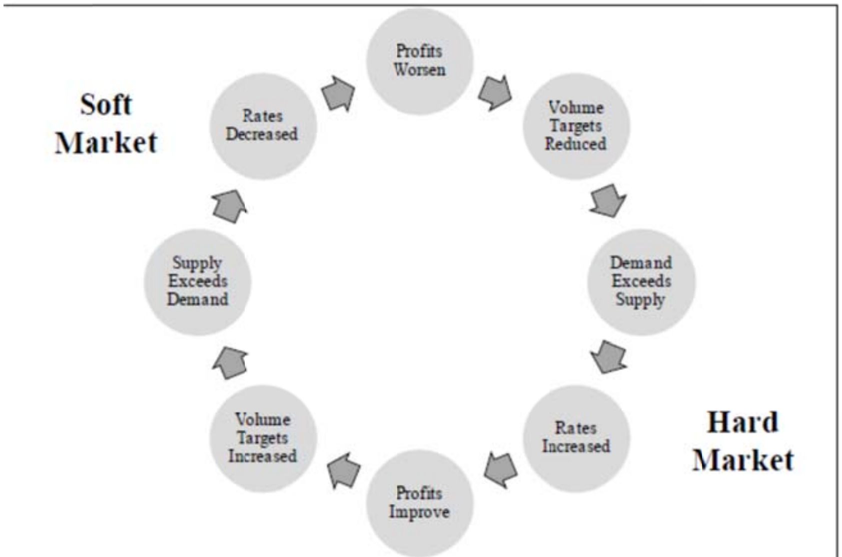
The terms "hard market" and "soft market" refer to the highs and lows of the cycle.

- The hard market refers to periods of higher price levels and increased profitability.
  i. insurers respond to this profitability by trying to expand their market share.
  ii. insurers become more aggressive in their pricing (deviating from actuarial indications), which puts pressure on other insurers to reduce prices.
- This leads to a soft market, during which profits are lower. In response to the low profits, insurers focus more on the actuarial indications and take appropriate rate increases.

Thus, competitive pressures ease and the cycle begins again. The U/W cycle is shown below.

The U/W cycle

13.19 Underwriting Cycle



When making pricing decisions, the actuary must understand the existence of U/W cycles and consider the current cycle stage of the industry.

Refer to "The Impact of the Insurance Economic Cycle on Insurance Pricing" (Boor 2004) for more detailed information on U/W cycles.

4 Key Concepts 262 - 262

1. Regulatory constraints

2. Operational constraints
   a. Types of operational constraints
   b. Cost-benefit analysis

3. Market considerations
   a. Traditional analysis
      i. Competitive comparisons
      ii. Close ratios
      iii. Retention ratios
      iv. Distributional analysis
      v. Policyholder dislocation analysis

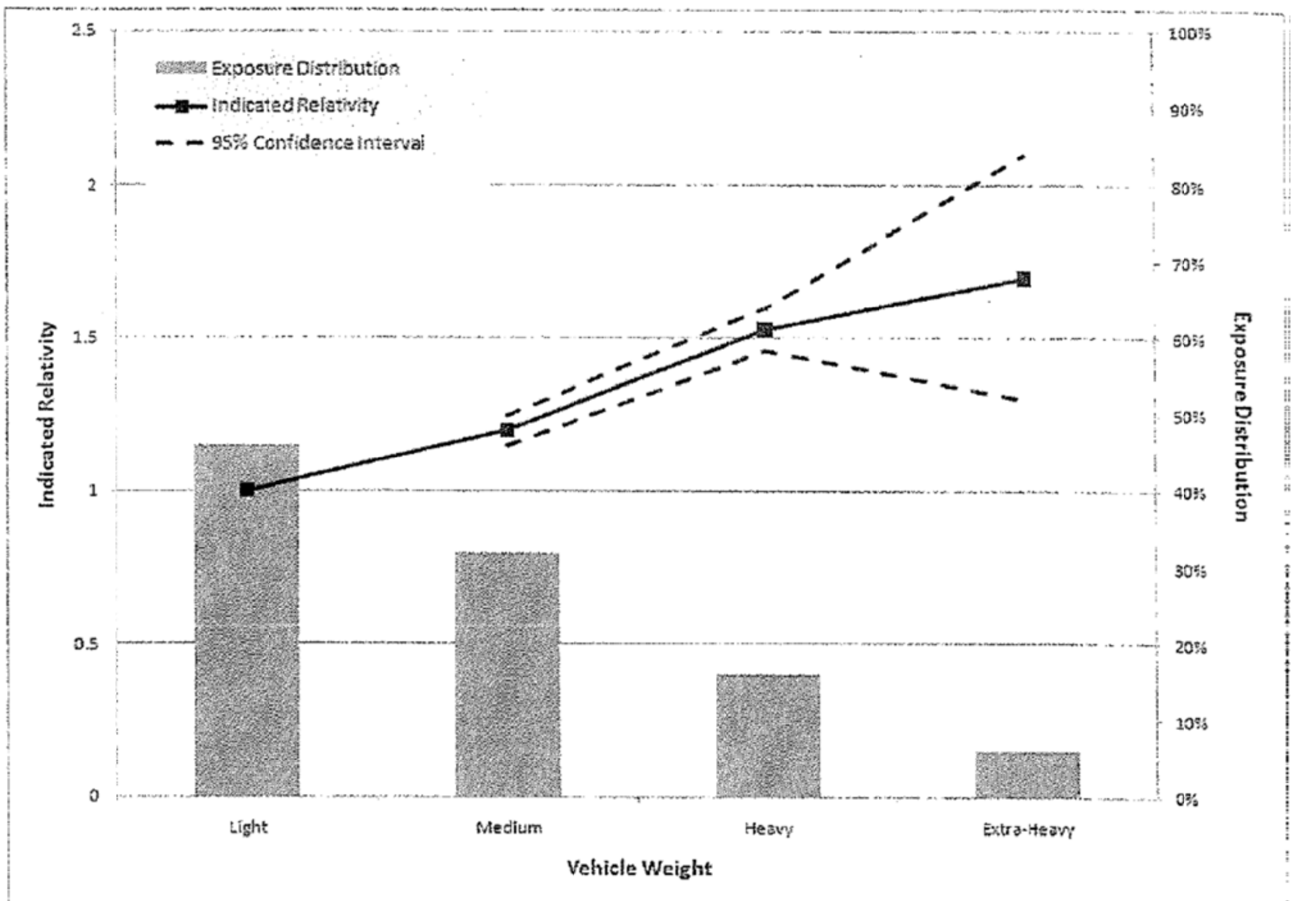
   b. Systematic analysis
      i. Lifetime customer value
      ii. Optimized pricing

   c. Underwriting cycles

The predecessor papers to the syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous, but none covered the topics that are presented in this chapter. Thus, there are no past CAS questions that are relevant to the content covered in this chapter.

Questions from the 2012 exam:

11. (1.5 points) An insurer uses several rating variables, including vehicle weight, to determine premium charges for commercial automobiles. Your manager has requested a review of the vehicle weight rating relativities. The following diagnostic chart displays the results for vehicle weight from a generalized linear model.



Company management plans to expand its commercial auto market-share with an emphasis on writing more businesses that operate with extra-heavy weight vehicles. Management wants to charge the same rates for both heavy and extra-heavy weight vehicles.

Based on the model results, provide your recommendation to management and explain the considerations supporting your position. Include a discussion of any potential risks associated with it

The predecessor papers to the syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous, but none covered the topics that are presented in this chapter. Thus, there are no past CAS questions that are relevant to the content covered in this chapter.

Solutions to Questions from the 2012 exam:

Question 11 – Model Solution (Exam 5A Question 11)

- The error bars are fairly wide around the relativity for the extra-heavy vehicles due to low volume of data for this level.
- The relativity for heavy vehicles, of about 1.55 is found in the 95% confidence interval for extra heavy vehicles.
- Finally, since management wants to expand its comm. auto market share, and given the two facts above, I suggest we charge the same relativities for heavy and extra-heavy.
- The risk is that when we gather enough data over time, we may realize that the rate for extra-heavy vehicles turns out to be insufficient. At this point we can adjust the rate accordingly.

Examiner's Comments

Many candidates lost points for not including any discussion of potential risks or for incomplete considerations supporting the recommendation.

Chapter 14 - Implementation

BASIC RATEMAKING – WERNER, G. AND MODLIN, C

1 Example Imbalance 263 – 263

This chapter discusses actions an insurer can take if its current rates do not produce an average premium equal to the sum of the expected costs and target underwriting profit.

This chapter uses the notation found in the Foreword to this text, and uses the same pricing example and assumptions described in prior chapters (a.k.a. the "simple example"):

* The average expected loss and LAE ($(\bar{L}+\bar{E}_L)$) for each policy is $180.
* For each policy written, the insurer incurs $20 in fixed expenses $(\bar{E}_F)$ for costs associated with printing and data entry, etc.
* 15% of each dollar of premium collected covers expenses (V) that vary with the amount of premium, such as premium taxes.
* The target profit provision (Q_T) is 5% of premium (determined by management)

The indicated average premium per exposure is $250 (= ($180 + $20) / (1.0 - 0.15 - 0.05)).

If the projected average premium per exposure is $235, the fundamental insurance equation is not in balance. The insurer can bring the equation into balance by reducing its costs (non-pricing solutions), increasing its rates, or both.

2 Non-Pricing Solutions 263 - 264

1. Balance can be achieved through expense reductions (i.e. reduction in UW or LAE expenses, by reducing the marketing budget or staffing levels).
   i. if fixed expenses are reduced from $20 to $8, or variable expenses are reduced from 15% to 10%, the equation will be brought into balance.
   ii. if the actuary projects a reduction in expenses, recalculate the overall rate level indication.

2. Balance can be achieved by reducing the average expected loss as follows:
   a. **Change the make-up of the portfolio of insureds.**
      i. An insurer may tighten the U/W criteria or non-renew policies with grossly inadequate premium.
      Note: When the portfolio changes, expected losses and expected premium change; but if the loss reduction is greater than the premium reduction, the UW action could move the fundamental equation to the balanced position.
      ii. If the insurer does this, adjust the premium and loss projections and recalculate the overall rate level indication.
   b. **Reduce the coverage provided by the policy (a.k.a. a coverage level change).**
      Example: A HO insurer may adjust the policy to exclude coverage for mold losses.
      i. If this eliminates previously covered losses and rates are not decreased accordingly, then this coverage level change is equivalent to a rate level increase.
      In the simple example, the insurer needs to reduce the average expected loss and LAE from $180 to $168 to bring the fundamental insurance equation into equilibrium.
      ii. If an insurer does this, adjust the premium and loss projections and recalculate the overall rate level indication.
   c. **Institute better loss control procedures.**
      Example: A WC insurer may reduce average severity by applying proactive medical management procedures and return-to-work programs for disability claims likely to escalate.

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Most insurers choose to change current rates (i.e. implement a rate change) to get closer to the desired equilibrium (since achieving the target U/W profit is important). However:

- Chapter 13 addressed reasons why an insurer may implement rates different from those indicated.
- If the insurer decides that $235 is the most that can be charged in the short run, it is forced to accept a target U/W profit provision of -0.1% [= ($235 - $180 - $20 – (0.15 x $235)) / $235] until rates can be increased.

To calculate a final set of rates for an existing product, the insurer must:

1. **Select an overall average premium target** for the future policy period (see chapter 8).
2. Finalize the **structure of the rating algorithm** (see chapter 2, and the example below).
3. Select the **final rate differentials** for each of the rating variables (see chapters 9 - 11, 13).
4. Calculate **proposed fixed expense fees**, if applicable (see example below).
5. **Derive the base rate** necessary to achieve the overall average premium target (see example below).

Example Rating Algorithm

Assume a simple multiplicative rating algorithm includes:

- a base rate (*B*),
- an additive fixed policy fee (*A*),
- two multiplicative rating variables (*R1* and *R2*),
- [1.0 - two discounts (*D1* and *D2*)]

P and X are used to denote premium and exposures, respectively.

Subscript P refers to “proposed” and subscripts i, j, k, m refer to different levels for the different rating variables/discounts.

The proposed rating algorithm for a given risk is defined as follows:

$$P_{P,\ ijkm} = [B_P \times R1_{P,\ i} \times R2_{P,\ j} \times (1.0 - D1_{P,\ k} - D2_{P,m}) + A_P] \times X_{ijkm}$$

The portion of the premium:

- calculated prior to adding the fixed policy fee and other dollar additives is the **variable premium**
- derived from the additive fixed policy fee and other dollar additives is the **flat or additive premium**.

Example Rating Variables

Assume the insurer relies on the following data to select proposed rate differentials for each rating variable:

R1	Current Differential	Indicated Differentia	Competitor Differential	Proposed Differential
1	0.8000	0.9000	0.9200	0.9000
2	1.0000	1.0000	1.0000	1.0000
3	1.2000	1.2500	1.2500	1.2500

R2	Current Differential	Indicated Differential	Competitor Differential	Proposed Differential
A	1.0000	1.0000	1.0000	1.0000
B	1.0500	0.9000	0.9500	0.9500
C	1.2000	1.3000	1.3500	1.3000

D1	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	5.0%	4.0%	5.0%	5.0%
N	0.0%	0.0%	0.0%	0.0%

D2	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	10.0%	2.5%	7.5%	5.0%
N	0.0%	0.0%	0.0%	0.0%

Calculation of Fixed Expense Fees and Other Additive Premium

Scenario 1: When a rating algorithm incorporates fixed expenses through an **additive per exposure expense fee**, the fee is based on the average fixed expense per exposure ($\overline{E_F}$).

Also, the fee must be adjusted to account for V and Q_T in the same way that losses and LAE per exposure are adjusted for these items in the rate level indication formulae (e.g. the insurer incurs variable expenses and expects target profit on all premium, including that which comes from fixed expense fees).

- The adjustment is the average fixed UW expense divided by the variable permissible loss ratio:

$$A_P = \frac{\overline{E_F}}{(1.0 - V - Q_T)}$$

- Calculation of the proposed expense fee:

(1) Average Fixed Expense	\$20.00
(2) Variable Expense %	15.0%
(3) Target Profit %	5.0%
(4) Variable Permissible Loss Ratio	80.0%
(5) Proposed Fee	\$25.00

(4)= 1.0 - (2) - (3)   (5) = (1)/(4)

Here, the proposed \$25 additive fee includes \$20 to cover the fixed expenses and \$5 to cover the variable expense (e.g. premium tax) and profit associated with the \$20.

Some insurers use a **fixed per policy expense fee** rather than a fixed per exposure expense fee in the rating algorithm.

It is important that base rate derivation formulae (see next section) combine average variable premium and average flat premium on a consistent basis (i.e. per policy or per exposure). A per policy expense fee can be converted to a per exposure expense fee by dividing by the average number of exposures per policy.

Scenario 2: The (V) used to adjust the flat fee may differ from the (V) used in calculating the overall rate level indication.

Insurers may elect not to apply certain aspects of the variable expenses to the flat fee (i.e. some insurers may not make the flat fee subject to agent commissions).

If the premium-based expense projection method is used (see chapter 7), a fixed expense **ratio** is calculated (rather than a fixed expense **dollar** amount).

- The ratio can be converted to a dollar amount by multiplying it by the projected premium per exposure, as shown in the following table.

Calculation of $Fee (Using the Fixed Expense Ratio)

(1) Fixed Expense Ratio	8.0%
(2) Projected Average Premium per Exposure	$250.00
(3) Average Fixed Expense	$20.00
(4) Variable Expense %	15.0%
(5) Target Profit %	5.0%
(6) Variable Permissible Loss Ratio	80.0%
(7) Proposed Fee	$25.00

(3) = (1) x (2); (6) = 1.0 – (4) – (5); (7) = (3) / (6)

Some rating algorithms have other additive premium components (in addition to fixed expense fees):

- In HO insurance, endorsements that add or extend coverage are priced separately and are added to the variable premium of the standard policy.
- The same adjustment (described above for fixed expense fees) applies to other additive premium.

Derivation of Base Rate: No Rate Differential Changes

The base rate is derived:

- so that proposed average premium (or change in average premium) is expected to be achieved.
- after the actuary selects:
  i. the proposed average premium per exposure (or change in proposed average premium),
  ii. the proposed rate differentials,
  iii. the proposed fixed expense fees, and other additive premium
- to achieve the target UW profit.

Consider the **simple scenario when there is only variable premium and rate differentials are not changing**. Here, the proposed base rate (PBR) = current base rate (CBR) times the ratio of the proposed average premium to current average premium: $B_p = B_C \times \frac{\overline{P_P}}{\overline{P_C}}$

If there are flat premium components (and rate differentials are still not changing), the PBR equals

$$B_p = B_C \times \frac{(\overline{P_P} - A_P)}{(\overline{P_C} - A_c)}$$

Note: The when a 5.0% overall average premium change is targeted, it can be achieved by:

i. increasing the base rate 5.0% and increasing the flat premium 5.0%, or
ii. increasing the base rate by 5.56% in order to achieve the 5.0% overall change (i.e. 5.0% = 90% (5.56%) + 10% (0.0%)), assuming the flat premium is 10% of the total average premium.

Derivation of Base Rate: Rate Differential Changes

Three approaches for deriving the proposed base rate:

1. Extension of exposures
2. Approximated average rate differential
3. Approximated change in average rate differential

- The extension of exposures method is the most direct and most accurate.
- The approximated methods are used when the extension of exposures is not practical for the product being priced.

1. Extension of Exposures Method

The same technique (see chapter 5) is applied when deriving a proposed base rate.

Proposed rate differentials ($R1_P$, $R2_P$, $D1_P$, $D2_P$), a proposed fixed expense fee per policy (A_P), and a starting value for the proposed base rate (B_S) is used to rerate individual policies (a.k.a. a "seed" base rate).

The proposed premium per policy is:

$$P_{S,ijkm} = [[B_S \times R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) + A_P] \times X_{ijkm}$$

The proposed average premium (assuming the seed base rate) is:

$$\overline{P}_S = \frac{\sum_i \sum_j \sum_k \sum_m [[B_S \times R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) + A_P] \times X_{ijkm}]}{X}$$, which can be simplified as:

$$\overline{P}_S = B_S \times \frac{\sum_i \sum_j \sum_k \sum_m [R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) \times X_{ijkm}]}{X} + A_P$$

Using the extension of exposures method, the resulting proposed average premium assuming a base rate seed of $215 is $246.83.

Extension of Exposures (Assuming Seed Base Rate)

(1) Exposures	(2) R2	(3) R2	(4) D1	(5) D2		(6) Proposed Premium (assuming Seed Base Rate =$215)
10,000	1	**A**	*Y*	***Y***	$	1,991,500.00
7,500	2	**A**	*Y*	***Y***	$	1,638,750.00
3,000	3	**A**	*Y*	***Y***	$	800,625.00
9,000	1	B	*Y*	***Y***	$	1,713,982.50
20,000	2	B	*Y*	***Y***	$	4,176,500.00
5,000	3	B	*Y*	***Y***	$	1,273,960.00
1,875	1	***C***	*Y*	***Y***	$	471,365.63
5,000	2	***C***	*Y*	***Y***	$	1,382,750.00
2,000	3	***C***	*Y*	***Y***	$	678,875.00
3,500	1	A	***N***	***Y***	$	730,887.50
7,500	2	A	***N***	***Y***	$	1,719,375.00
3,500	3	A	***N***	***Y***	$	981,093.75
15,000	1	B	N	***Y***	$	2,994,667.50
36,000	2	B	N	***Y***	$	7,885,350.00
9,000	3	B	N	***Y***	$	2,407,873.50
3,750	1	C	N	***Y***	$	989,896.88
10,000	2	C	N	***Y***	$	2,905,250.00
2,000	3	C	N	***Y***	$	713,834.00
3,500	1	**A**	Y	**N**	$	730,887.50
7,500	2	**A**	Y	**N**	$	1,719,375.00
3,500	3	**A**	Y	**N**	$	981,093.75
15,000	1	B	Y	N	$	2,994,667.50
36,000	2	B	Y	N	$	7,885,350.00
9,000	3	B	Y	N	$	2,407,873.50
3,750	1	C	Y	**N**	$	989,896.88
10,000	2	C	Y	**N**	$	2,905,250.00
5,000	3	C	Y	**N**	$	1,784,585.00
48,000	1	A	***N***	***N***	$	10,488,000.00
112,500	2	A	***N***	***N***	$	27,000,000.00
25,000	3	A	***N***	***N***	$	7,343,750.00
11,000	1	B	N	N	$	2,297,075.00
250,000	2	B	N	N	$	57,312,500.00
65,000	3	B	N	N	$	18,220,312.50
28,125	1	C	N	N	$	7,777,968.75
68,000	2	C	N	N	$	20,706,000.00
15,000	3	C	N	N	$	5,615,625.00
869,500					$	214,616,746.63
(7) Avg Prop Prem (Base Seed = $215)						***246.83***

(6)= Calculated via extension of exposures with BS =$215; (7)= (Tot6) / (Tot 1)

The proposed average premium assuming a seed base rate is lower than the target average premium of $250 so the seed base rate needs to be increased.

1A. Pure Premium Method (PPM):

If the pure premium method has been used for the overall rate level indication, ($\overline{P}_S$) is compared to the target average premium, and if these values are not equal, the seed base rate needs to be adjusted.

- The actuary can derive $\overline{P}_S$ via trial and error (i.e. testing various base rates until the target average premium is achieved).
- Alternatively, the actuary can calculate the amount the (B_S) needs to be adjusted via formula.

The formula for proposed average premium (assuming a <u>seed</u> base rate) is:

$$\overline{P_S} = B_S \times \frac{\sum_i \sum_j \sum_k \sum_m [R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) \times X_{ijkm}]}{X} + A_P$$

The formula for proposed average premium (assuming a <u>proposed</u> base rate) is:

$$\overline{P_P} = B_P \times \frac{\sum_i \sum_j \sum_k \sum_m [R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) \times X_{ijkm}]}{X} + A_P$$

Rearranging the terms and dividing one formula by the other yields:

$$\frac{(\overline{P_P} - A_P)}{(\overline{P_S} - A_P)} = \frac{B_P}{B_S}$$

Thus, the PBR via extension of exposures is given by the following: $B_p = B_S \times \frac{(\overline{P_P} - A_P)}{(\overline{P_S} - A_P)}$

If no fixed expense fee or other additive premium applies, $B_p = B_S \times \frac{\overline{P_P}}{\overline{P_S}}$

The table summarizes the calculation of the proposed base rate

Proposed Base Rate Calculation (Extension of Exposures)

(1) Seed Base Rate	$	215.00
(2) Average Premium assuming Seed Base Rate	$	***246.83***
(3) Proposed Fixed Fee per Policy	$	25.00
(4) Proposed Average Premium	$	250.00
(5) Proposed Base Rate	$	**218.07**

(2)= from table above. (5)= (1) x [(4) - (3)] /[(2) - (3)]

1B. Loss Ratio Method (LRM):

If the LRM is used to calculate an overall rate level indication, the *change* in average premium is computed.

The proposed average premium based on the selected change (Δ) is $\overline{P_P} = (1+\Delta\%) \times \overline{P_C}$

This can then be used in the base rate derivation formula: $B_P = B_S \times \dfrac{\overline{P_P} - A_P}{\overline{P_S} - A_P} = B_S \times \dfrac{(1+\Delta\%) \times \overline{P_C} - A_P}{\overline{P_S} - A_P}$

Assume that current average premium (using extension of exposures on current rates) is $242.13.

If the indicated % change in average premium is 3.25%, the resulting proposed average premium is $250.

Proposed Base Rate (Extension of Exposures, Loss Ratio Method)

(1) Target % Change in Average Premium	3.25%
(2) Current Average Premium	$242.13
(3) Proposed Average Premium	$250.00
(4) Seed Base Rate	$215.00
(5) Average Premium assuming Seed Base Rate	$246.83
(6) Proposed Fixed Fee per Policy	$25.00
(7) Proposed Base Rate	$218.07

(3)= (1.0 + (1)) x (2). (7)= (4) x [(3) - (6)] /[(5) - (6)]

2a. Approximated Average Rate Differential Method

An insurer may not be able to retrieve the detailed data to perform the extension of exposures method for deriving the PBR. One alternative method involves estimating the weighted average proposed rate differential across all rating variables (a.k.a. $\overline{S_P}$). Using the extension of exposures technique the proposed average premium is:

$$\overline{P_P} = B_P \times \frac{\sum_i \sum_j \sum_k \sum_m [[R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) \times X_{ijkm}]}{X} + A_P$$

$\overline{S_P}$ is substituted for the weighted average proposed rate differential across all rating variables:

$$\overline{S_P} = \frac{\sum_i \sum_j \sum_k \sum_m [[R1_{P,i} \times R2_{Pj} \times (1.0 - D1_{P,k} - D2_{P,m}) \times X_{ijkm}]}{X}$$

Solve for the PBR: $B_P = \dfrac{\overline{P_P} - A_P}{\overline{S_P}}$

When a rating algorithm is purely multiplicative, $\overline{S_P}$ is typically approximated as the product of the exposure-weighted average differentials for each of the rating variables.

In our example rating algorithm, which has discounts that are additive in nature:

$$\overline{S_P} \approx \frac{\sum_i X_i \times R1_{P,i}}{X} \times \frac{\sum_j X_j \times R2_{Pj}}{X} \times \left[1.0 - \left[\frac{\sum_k X_k \times D1_{P,k}}{X} + \frac{\sum_m X_m \times D2_{P,m}}{X}\right]\right]$$

The following tables show the approximation of $\overline{S_P}$ for the example, using exposures as weights:

Proposed Differentials Wtd by Exposures

(1) R1	(2) Exposures	(3) Proposed Differential
1	152,500	0.9000
2	570,000	1.0000
3	147,000	1.2500
Total	869,500	1.0247

(1) R2	(2) Exposures	(3) Proposed Differential
A	235,000	1.0000
B	480,000	0.9500
C	154,500	1.3000
Total	869,500	1.0257

(1) D1	(2) Exposures	(3) Proposed Discount
Y	156,625	0.0500
N	712,875	0.0000
Total	869,500	0.0090

(1) D2	(2) Exposures	(3) Proposed Discount
Y	153,625	0.0500
N	715,875	0.0000
Total	869,500	0.0088

(Tot3) = (3) weighted by (2). $\boxed{(4)\ \overline{S_p} = 1.0323}$ (4) = $(Tot3_{R1}) \times (Tot3_{R2}) \times (1.0 - Tot3_{D1} - Tot3_{D2})$

The proposed base rate, assuming the exposure-weighted average proposed rate differential across all rating variables from the table above, is: $B_P = \dfrac{\overline{P_P} - A_P}{\overline{S_P}} = \dfrac{\$250 - \$25}{1.0323} = \$217.96$

This proposed base rate ($217.96) is different than that which was calculated using the extension of exposures method ($218.07).

- Exposure-weighting each variable's differentials independently and then combining those averages according to the rating algorithm ignores **the dependence of the exposure distribution by level** of one rating variable on the level of another rating variable (i.e. the distributional bias between variables, discussed in Chapters 9 and 10).
- The example data was not largely biased, but in practice **bias can drive larger discrepancies** in the PBR. To mitigate this bias, use variable premium at current rate level and at base level instead of exposures for weights in the approximation.
  i. Variable premium is the premium before addition of any fixed expense fees or other additive premium.
  ii. The current rate level adjustment for the premium in this analysis should be done at the class level (i.e. applying the parallelogram method to fully aggregated data would not be suitable).

iii. The phrase "at base level" means that the variable premium for non-base levels is adjusted to remove the effect of the current rate differential.

* For multiplicative factors, divide the variable premium for each non-base level by the current rate differential for the given variable. Assuming the rating algorithm is entirely multiplicative, calculating variable premium at base level may be a feasible improvement.
* When the rating algorithm has both multiplicative and additive components, deriving variable premium at current rate level and at base level becomes so challenging that the effort to improve the approximation would be better spent compiling data to use the extension of exposures technique.

2. Approximated <u>Change</u> in Average Rate Differential Method

One issue with this method is that the actuary still needs to calculate the average proposed and current rate relativities for each rating variable.

For rating algorithms that are complex, the actuary may prefer using the following approach which:

- is used when overall rate level indications are performed with the LRM.
- calculates *the change in the average rate differential.*

The proposed average premium is the current average premium multiplied by the proposed overall change in average premium: $\overline{P_P} = (1.0 + \Delta\%) \times \overline{P_c}$

The proposed *overall change* in average premium is comprised of a change to the variable and additive premium components ($\Delta_v\%$ and $\Delta_A\%$) . Thus, $\overline{P_P} = (1.0 + \Delta_v\%) \times (\overline{P_c} - A_C) + (1.0 + \Delta_A\%) \times (A_C)$

* The last term on the right side of the equation is A_P; Thus, $(\overline{P_P} - A_P) = (1.0 + \Delta_V\%) \times (\overline{P_C} - A_C)$
* The proposed change in *variable* premium given the overall change, the current average premium, and the current and proposed additive premium is $(1.0 + \Delta_v\%) = \dfrac{\overline{P_P} - A_P}{\overline{P_C} - A_C} = \dfrac{(1.0 + \Delta\%)\,\overline{P_C} - A_C}{\overline{P_c} - A_C}$
* The change in variable premium is comprised of the change in base rate and the change in the average rate differential: $(1.0 + \Delta_V\%) = \dfrac{B_P}{B_C} \times \dfrac{\overline{S_P}}{\overline{S_C}}$
* The base rate adjustment is $\dfrac{B_P}{B_C} = \dfrac{(1.0 + \Delta\%)\,\overline{P_C} - A_P}{\overline{P_c} - A_C} \times \dfrac{\overline{S_C}}{\overline{S_P}}$

Finally, using the $\Delta_B\%$ and $\Delta_S\%$ as the % base rate change and the % change in average rate differential, the equation becomes: $1.0 + \Delta_B\% = \dfrac{(1.0 + \Delta\%)\,\overline{P_C} - A_P}{\overline{P_c} - A_C} \times \dfrac{1.0}{(1.0 + \Delta_S\%)}$

Comments:

- The final term of the equation (the reciprocal of the adjustment to the rate differentials) is a.k.a. **the off-balance factor** (OBF)
- OBF is the amount the base rate needs to be adjusted to balance the change in the rate differentials.

Calculation of the change in the average rate differentials (Δ_S).

- If current and proposed average differentials are available, use them as they are an exact calculation (as described earlier in the extension of exposures section).
- If the data is not available, the change in average rate differentials is approximated as the product of the change in the average rate differential for each of the rating variables (w) that are changing with the review: $1.0 + \Delta_S\% \approx \prod_w (1.0 + \Delta_{S,w}\%)$

  The formula for the change in average rate differential for R1 is given as:

$$(1.0 + \Delta_{S,R1}\%) = \frac{\sum_i \frac{R1_{P,i}}{R1_{C,i}} \times (P_{C,i} - A_C)}{\sum_i (P_{C,i} - A_C)}$$

  This formula is the change in the current variable premium due to the change in the rate differentials for the given rating variable.

The use of variable premium as weights may be difficult for various reasons.

1. It may be difficult to obtain the current variable premium data (particularly at current rate level).
2. Weighting by variable premium is challenging when a rating algorithm has additive components.

Therefore, one may choose to measure the average change in rating differentials using exposures as weights.

- This method of weighting introduces the same distributional bias as discussed in the previous section, but it may be the most feasible alternative.
- In the example rating algorithm, the additive discounts can be combined and restated as a single multiplicative variable (i.e. $1 - D_1 - D_2$). The formula for the average rate differential across all variables in the example is as follows:

  $1.0 + \Delta S\% \approx (1.0 + \Delta_{S,R1}\%) \times (1.0 + \Delta_{S,R2}\%) \times (1.0 + \Delta_{S,(1 - D1 - D2)}\%)$

Actuaries approximate the average rate differential changes for multiplicative variables (e.g. R1) as follows:

$(1.0 + \Delta_{S,R1}\%) \approx \dfrac{\overline{R1}_P}{\overline{R1}_C}$, where the current and proposed average differentials are determined using exposures as weights: $\overline{R1}_P \approx \dfrac{\sum_i R1_{P,i} \times X_i}{X}$ and $\overline{R1}_C \approx \dfrac{\sum_i R1_{C,i} \times X_i}{X}$

The change in (1 - D1 - D2) can be approximated as follows: $(1.0 + \Delta_{S,(1-D1-D2)R1}\%) \approx \dfrac{1 - \overline{D1}_p - \overline{D2}_P}{1 - \overline{D1}_C - \overline{D2}_C}$,

where the current and proposed average discounts are determined using exposures as weights, as shown below for D1: $\overline{D1}_P \approx \dfrac{\sum_i D1_{P,i} \times X_i}{X}$ and $\overline{D1}_C \approx \dfrac{\sum_i D1_{C,i} \times X_i}{X}$

The following table shows the approximation of the average change in differentials ((1.0 + ΔS%) for the example using exposures as weights.

Proposed Average Change in Differentials (Using Exposures)

(1) D1	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	156,625	0.0500	0.0500
N	712,875	0.0000	0.0000
Total	869,500	0.0090	0.0090

(1) D2	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	153,625	0.1000	0.0500
N	715,875	0.0000	0.0000
Total	869,500	0.0177	0.0088

(Tot3) = (3) Weighted by (2)   (Tot4) = (4) Weighted by (2)

(5) R1	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
1	152,500	0.8000	0.9000	1.1250
2	570,000	1.0000	1.0000	1.0000
3	147,000	1.2000	1.2500	1.0417
Total	869,500	0.9987	1.0247	1.0260

(5) R2	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
A	235,000	1.0000	1.0000	1.0000
B	480,000	1.0500	0.9500	0.9048
C	154,500	1.2000	1.3000	1.0833
Total	869,500	1.0631	1.0257	0.9648

(10) 1-D1-D2	(11) Exposures	(12) Current Differential	(13) Proposed Differential	(14) Proposed / Current
Total	235,000	0.9733	0.9822	1.0091

(15) Average Change in Differential	**0.9989**

(9)= (8) / (7)
(Tot9)= (9) Weighted by (6)
(12)= 1 - (Tot3D1) - (Tot3D2)
(13)= 1 - (Tot4D1) - (Tot4D2)
(14)= (13) / (12)
(15) = (Tot9R1) x (Tot9R2) x (Tot14)

Using the results from the prior table and $(1.0+\Delta_B\%)=\dfrac{(1.0+\Delta\%)\times\overline{P_C}-A_P}{\overline{P_C}-A_C}\times\dfrac{1.0}{(1.0+\Delta_S\%)}$, the proposed base rate can be calculated as shown in the following table.

Proposed Base Rate (Approximated Method)

(1) Current Base Rate	$210.00
(2) Current Average Premium	$242.13
(3) Target Change in Average Premium	3.25%
(4) Proposed Average Premium	$250.00
(5) Proposed Additive Premium per Policy (same as Current)	$ 25.00
(6) Average Rating Differential Adjustment	0.9989
(7) Proposed Base Rate Adjustment	1.0374
(8) Proposed Base Rate	$217.85

(4)= (1.0 + (3)) x (2) (7)= [(4) - (5)] / [(2) - (5)] x [1.0 /(6)] (8)=(1) x (7)

Other Considerations

Minimum Premium

A minimum premium ensures that, on an individual risk basis, premium covers the expected fixed expenses plus some minimum expected loss

- Insurers that use a minimum premium requirement do not have additive fixed expense fees in their rating algorithms.
- Implementing a minimum premium can increase total premium. The effect is calculated as follows:

$$Effect=\frac{Premium\ With\ Minimum}{Premium\ Without\ Minimum}-1.0$$

- To offset this increase in premium, the base rate should be multiplied by the following factor:

$$Offset\ Factor=\frac{1.0}{1.0+Effect}$$

Limiting the Premium Effect of a Single Variable

Actuaries may decide to limit the premium impact caused by the change in rate differentials for a rating variable.

Example: A territorial analysis may be performed to determine a set of proposed relativities.

i. After taking into account business considerations (e.g. marketing) the actuary may decide to limit or “cap” the premium impact on any one territory by adjusting the proposed relativities.

ii. If a proposed relativity for any one territory is capped, this reduces the proposed average rate differential, which will necessitate an offsetting increase in the proposed base rate to achieve the target average premium for all territories combined.

The following outlines a rate change scenario with the insurer is targeting an overall rate level change of 15.0%.

- Also, the insurer is revising relativities for a particular rating variable, and management requires that the premium increase for any level of this variable not exceed 20%.
- The table below shows the current and selected relativities (prior to capping) in Columns (3) and (4).
  - i. these relativity changes would result in an off-balance factor of 0.9749 (= 1/(1+2.57%)).
  - ii. The total change to each level is shown in Column (8).

Rate Change Before Capping

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Off-	Selected		Premium on
				Relativity	Balance	Overall	Total	Proposed
Level	Premium	Current	Selected	Change	Factor	Change	Change	Rates
1	$138,000	0.8000	0.9000	12.50%	0.9749	15.0%	26.13%	174,063
2	$659,000	1.0000	1.0000	0.00%	0.9749	15.0%	12.12%	738,855
3	$203,000	1.2000	1.2500	4.17%	0.9749	15.0%	16.79%	237,082
Total	$1,000,000			2.57%	0.9749	15.0%	15.00%	1,150,000

(5)= (4) / (3) - 1.0; (Tot5) = (5) weighted by (2)

(6)= 1.0 / (1.0 + (Tot5))

(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0

(9)= (2) x (1.0 + (8))

Interpreting the Results:

- The total change for Level 1 is 26.13%, which exceeds the desired maximum change of 20.0%.
- The new capped relativity for Level 1 (a.k.a. X) equals the product of the relativity change factor (new capped relativity for Level 1 / current relativity for Level 1 = X / 0.8000), the off-balance factor (0.9749), and the overall change factor (1.1500) that results in a 20% total change.

  The new capped relativity for Level 1 (X) that satisfies this equation is 0.8563.

If the total change for Level 1 were limited to 20.0%, the premium would be $165,600 (=$138,000 x 1.20).

- This results in a shortfall of $8,459 (=$174,059 - $165,600) which needs to be made up by charging the other levels (Levels 2 and 3) higher premium.
- The premium proposed for Levels 2 and 3 is $975,889 (= $738,805 + $237,084). This premium must be increased to cover the $8,459 shortfall.
  - i. One way to achieve this is to increase the base rate by 0.87% (=$8,459 / $975,889).
  - ii. However, since all levels are affected by any base rate change, the premium for capped Level 1 will increase beyond the desired 20% limit. Therefore, the capped relativity for Level 1 must be further reduced by 0.87% to undo the effect of the base rate increase on this level.

    This adjustment results in a relativity for Level 1 of 0.8489 (= 0.8563 / 1.0087).

The table below summarizes these calculations

Rate Change after Capping Non-Base Level at 20%

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Level	Premium	Current	Selected	Differential Change	Off-Balance Factor	Selected Overall Change	Total Change	Premium Above 20% Cap
1	$138,000	0.8000	0.9000	12.50%	0.9749	15.0%	26.13%	8,459
2	$659,000	1.0000	1.0000	0.00%	0.9749	15.0%	12.11%	0
3	$203,000	1.2000	1.2500	4.17%	0.9749	15.0%	16.79%	0
Total	$1,000,000			2.57%	0.9749	15.0%	15.00%	8,459

(10)	Proposed Premium from Non-capped Levels (2, 3)	$975,889
(11)	Proposed Level 1 Relativity to Comply with Cap	0.8563
(12)	Base Rate Adjustment to cover Shortfall	1.0087
(13)	Proposed Lev 1 relativity adjusted for base rate offset	0.8489

(5)= (4) / (3) - 1.0

(Tot5)= (5) weighted by (2)

(6)= 1.0 / (1.0 + (Tot5))

(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0

(9)= max of [(2) x ((1.0 + (8))] - [(2) x (1.0 + 20%)] and 0

(10)= (2) x (1+(8)) summed over Levels 2 and 3

(11)= [(1.0 + 20%) / ((6Row 1) x (1.0 + (7Row 1))] x (3Row 1)

(12)= 1.0 + (Tot9) / (10)

(13)= (11) / (12)

The final base rate offset factor equals the original off-balance factor (0.9749) times the base rate adjustment to cover the premium shortfall from capping (1.0087).

- The revision to the Level 1 relativity achieves the 20% desired cap, and the adjustment to the base rate ensures the overall change is still 15.0%.
- The calculations are slightly different if capping is necessary for the base class.

The table below shows a rate change scenario (with the same selected overall change and same premium capping requirement) in which the base class exceeds the premium cap.

Rate Change Before Capping Base Level Impact

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Level	Premium	Current	Selected	Relativity Change	Off-Balance Factor	Selected Overall Change	Total Change	Premium on Proposed Rates
1	$138,000	0.8000	0.6500	-18.75%	1.0541	15.0%	-1.51%	135,916
2	$659,000	1.0000	1.0000	0.00%	1.0541	15.0%	21.22%	798,840
3	$203,000	1.2000	1.0500	-12.50%	1.0541	15.0%	6.07%	215,322
Total	$1,000,000			-5.13%	1.0541	15.0%	15.01%	1,150,078

(5)= (4) / (3) - 1.0; (Tot5) = (5) weighted by (2)

(6)= 1.0 / (1.0 + (Tot5))

(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0

(9)= (2) x (1.0 + (8))

Interpreting the Results:

- The base rate is adjusted downward to cap the change for the base level.
- The non-base relativities are adjusted upward to cover the amount of premium shortfall due to the cap and to offset the effect of the base rate change in the non-base levels.
  - i. To limit the total change for Level 2 to 20.0%, the base rate is decreased by a factor of 0.9899 (= 1.2000/1.2122). This results in a shortfall in Level 2 premium of $8,040 (= (21.22% - 20.00%) x $659,000). The premium collected from the non-base levels need to make up for that shortfall.
  - ii. Prior to capping, the premiums from Levels 1 and 3 was $351,238 (=135,916 + 215,322).
    The relativities for these levels need to increase by 2.29% (=$8,040/$351,238).
    Also, the relativities for Level 1 and Level 3 need to be adjusted to negate the effect of the base rate offset.
    Thus, the final adjustment factor for these levels' relativities is 1.0333 (=1.0229 / 0.9899).

The following table summarizes these calculations.

Rate Change After Capping Non-Base Level at 20%

(1) Level	(2) Premium	(3) Current	(4) Selected	(5) Differential Change	(6) Off-Balance Factor	(7) Selected Overall Change	(8) Total Change	(9) Premium Shortfall if Total Change capped to 20%
1	$138,000	0.8000	0.6500	-18.75%	1.0541	15.0%	-1.51%	0
2	$659,000	1.0000	1.0000	0.00%	1.0541	15.0%	21.22%	8,040
3	$203,000	1.2000	1.0500	-12.50%	1.0541	15.0%	6.07%	0
Total	$1,000,000			-5.13%	1.0541	15.0%	15.00%	8,040

(10)	Base Rate Adjustment to Comply with Cap	0.9899
(11)	Premiuim from Non-capped Levels (1,3)	$351,238
(12)	Adjustment to Level 1,3 Relativities due to Cap	1.0229
(13)	Total Adjustment to Level 1,3 Relativities	1.0333

(5)= (4) / (3) - 1.0; (Tot5)= (5) weighted by (2)

(6)= 1.0 / (1.0 + (Tot5))

(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0

(9)= max of [(2) x ((1.0 + (8))] - [(2) x (1.0 + 20%)] and 0

(10)= (1.0 + 20.0%) / (1.0 + (8Row 2))

(11)= (2) x (1+(8)) summed over Levels 1 and 3

(12)= 1.0 + (9) / (11)

(13)= (12) / (10)

Interpreting the Results:

- The revised Level 1 selected differential is 0.6716 (= 0.6500 (selected) x 1.0333) and the Level 3 selected differential is 1.0850 (=1.0500 (selected) x 1.0333).
- The final base rate offset factor (1.0435) = the original off-balance factor (1.0541) * the base rate adjustment to comply with the cap (0.9899).

  These changes result in a 15.0% overall change with no level's premium exceeding the 20.0% limit.

Premium Transition Rules

A premium transition rule dictates the maximum and/or minimum amount of change in premium that an insured can receive at a single renewal. Example:

- An insurer may cap the renewal premium increase for each individual insured to 15%.
- If the insurer's rate change results in an insured receiving a 20% premium increase, the insured will receive a:
  i. 15% rate change at the first renewal following the implementation of the rate change, and
  ii. the remaining 4.3% (= 1.20 / 1.15 - 1.0) at the second renewal.

Some key considerations when using a premium transition rule:

* The insurer needs to determine the maximum and minimum premium change amounts (test various scenarios of min and max amounts, to determine the optimal selections)
* Often premium transition rules apply only to premium changes resulting from insurer initiated rate changes.
  i. If premium change is affected by a change in risk characteristics (e.g. the insured buys a newer car), the transition rule algorithm must be adjusted to neutralize the effect of the risk characteristic change.
  ii. The premium change may be calculated as the ratio of [new premium on new risk characteristics/ old premium on new risk characteristics].
* The time needed to fully transition the renewal portfolio to the manual rates depends on the proposed rate change and the premium transition rule implemented.
* The effect on the average premium level should also be considered and the base rate altered.
  i. Decide whether the base rate should be set so that the equilibrium is achieved over the whole time the proposed rates are in effect, or by the expected end of the transition period.
  ii. Example: if the insurer is targeting an average premium of $250 and using a premium transition rule that is expected to span 2 years, then the insurer needs to decide whether the base rate should be set so that average premium will equal $250 over the two years combined or at the end of the two-year period.
  This is important since the cap does not apply equally to premium increases and decreases, and the rate changes are not uniformly distributed.

Expected Distribution

Actuaries often use the latest in-force distribution of policies as the best estimate of the expected future distribution.

- By doing so, the actuary assumes the rate change will not alter the existing portfolio.
- The validity of that assumption can vary significantly based on product, market conditions, and the extent of the proposed changes.
  Example: Assume a non-standard auto insurer implements a significant rate change that varies widely by age of insured.
  i. the insurer is likely to see a significant change in the overall volume and distribution of business (i.e. insureds receiving large rate changes may non-renew their policies).
  ii. the actual average premium change realized is likely to differ than what is proposed using the latest in-force distribution.
    * if all risks are equally profitable, then loss of premium will be offset by a loss in expected costs, and the overall rate level adequacy will be unaffected.
    * If the risks are not equally profitable, then the distributional shift can affect the adequacy of the overall rates.

This is a shortcoming of standard actuarial techniques.

Price optimization techniques (Chapter 13), address this by taking into consideration how the rate change is expected to affect demand (i.e. volume).

4 Calculating New Rates Based On Bureau Or Competitor Rates 285-286

When writing a new insurance product, insurers often do not have the data to generate rates, and often rely on similar products sold by competitors (if the data is publicly available), or data from rating bureaus, and make adjustments.

If the insurer has rates from a related product or rating bureau, the insurer still needs:

- a copy of the relevant rating manual or rating bureau filing.
- a copy of the competitor's underwriting guidelines (which may not be available).
- to obtain information regarding the relative expense levels and profitability of the target competitor (which can be obtained from recent rate filings or from annual statement data).

The insurer may use the competitor's manual as a starting point and make adjustments (the following are a few examples):

1. **Estimate whether its <u>fixed expenses</u> will be higher or lower than those of the target competitor.**
   i. the insurer can increase or decrease the competitor's <u>expense fee</u> by the appropriate percentage.
   ii. if the insurer estimates its fixed expenses will be 10% lower than the competitor's, and the competitor has an expense fee of \$25.00, then the insurer should implement an expense fee of \$22.50 (= \$25 multiplied by a factor of 0.90 (= 1.0 - 0.10).

2. **Estimate whether its <u>variable expenses</u> will be higher or lower than those of the target competitor.**
   i. the insurer can adjust the <u>base rate</u> and the <u>expense fee</u> by the ratio of [the target competitor's variable permissible loss ratio/ the expected variable permissible loss ratio].
   ii. if the insurer plans to use a commission % that is 5 percentage points higher than the competitor's, and that the competitor's variable expense ratio is 15% and the target profit % is 5%, then the insurer should adjust the competitor's base rate and expense fees by 1.067 [= (1.0- 0.15 - 0.05) / (1.0 - 0.20 - 0.05)].

3. **Estimate whether its <u>expected loss costs</u> will be different than the target competitor's due to operational differences or a lack of experience with the product, and change the base rate.**
   If the insurer feels its lack of experience in settling claims for the new product will result in expected costs that are 5% to 10% higher than those of the target competitor's, it should increase the base rates by 5% to 10% to account for this.

4. **Target a certain segment of the market that the competitor does not seem to be targeting.**
   If the insurer chooses to reduce the rate differential in that territory, it can adjust the base rate to offset the change in the average territorial differential.

5 Communicating and Monitoring 286 -287

Prior to implementing a final set of rates, the actuary will communicate the expected rate change effect to regulators and insurer management.

If the proposed rates apply to a brand new product, then communication to regulators may be limited to the source of the derivation of rates (e.g. competitor or bureau rates) and some justification for any judgmental adjustments made.

If the insurer is implementing rate changes that will impact existing policies, then the communications will be more extensive.

- Internal management may want to understand the assumptions and selections involved in the overall rate level indication or rate differential changes, and will want to understand the impact on competitive position, expected volume, and expected profitability.
- The actuary will often prepare competitive comparisons (e.g. % wins) under the current and final proposed rates, as well as policyholder dislocation analysis for insurer management (in total as well as by key segments as discussed in Chapter 13).

  This is useful for marketing, sales, and customer service to prepare for any potential repercussions of large policyholder premium impacts or to focus advertising on customer segments that will be priced more competitively.
- Some insurers use models to estimate the conversion and retention rates (per individual risk and in aggregate) expected after implementation of a rate change.
  i. These can be used to estimate future expected loss costs, premium, and expenses on these risks.
  ii. This allows calculation of expected profitability after the rate change.
- Regulators may require considerable detail about the methods and assumptions underlying the overall rate level and rate differential indications and selections, and may want to understand the expected policyholder dislocation.

It is important to monitor the actual effect of the rate change against the expected effect (e.g. comparing actual and expected close rates, retention rates, distributions, and claim frequencies against those expected).

6 Key Concepts 288 - 288

1. Non-pricing solutions to an imbalanced fundamental insurance equation
    a. Reduce expenses
    b. Reduce loss costs

2. Pricing solutions for an existing product
    a. Calculation of additive fixed expense fee and other additive premium
    b. Derivation of base rate
        i. Extension of exposures method
        ii. Approximated average rate differentials method
        iii. Approximated change in average rate differentials method
    c. Other considerations
        i. No fixed expense fees or additive premium
        ii. Minimum premium
        iii. Limit on the premium effect of a single variable
        iv. Premium transition rules
        v. Expected distribution

3. Pricing solutions for a new product
    a. Use of related data, competitor's rates, or bureau rates
    b. Consideration of differences in expected loss, expense, and target segments

4. Communicating rate change effect to key stakeholders
    a. New product
    b. Existing product

The predecessor papers to the current syllabus reading “Basic Ratemaking” by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.
By relevant, we mean the concepts tested on past CAS exams relating to Expense Fee Ratios and Expense Fees are similar to the concepts found in this chapter.

Questions from the 2000 exam

29. Based on Schofield, "Going from a Pure Premium to a Rate," and the following information concerning Private Passenger Auto Bodily Injury Liability Coverage, calculate the Expense Fee Ratio.

Expense Type	Total Expense	% Fixed
Commission	0.180	0%
Other Acquisition	0.030	75%
General	0.050	80%
Taxes, Licenses and Fees	0.025	15%
Profit and Contingencies	0.035	0%

A. < 0.085 B. $\geq$ 0.085 but < 0.095 C. $\geq$ 0.095 but < 0.105 D. $\geq$ 0.105 but < 0.115
E. $\geq$ 0.115

Questions from the 2002 exam

4. Based on Schofield, "Going From a Pure Premium to a Rate," and the following data, use the Expense Fee Methodology to calculate the expense fee.

Earned Premium at Current Rate Level	325,000
Earned Exposures	1,100
Total Fixed Expense Ratio	0.13
Total Variable Expense Ratio including Profit and Contingency Provision	0.23

A. < \$40 B. $\geq$ \$40, but < \$60 C $\geq$ \$60, but < \$80 D. $\geq$ \$80, but < \$100 E. $\geq$ \$100

Questions from the 2007 exam

41. (3.5 points) You are given the following information about an automobile book of business:

Expense Category	Countrywide Total Expenses	% of Expenses Assumed to Be Fixed
Commissions	\$1,400,000	0%
General Expenses	1,200,000	50%
Other Acquisition	400.000	100%
Premium Tax	300.000	0%
Licenses & Fees	100.000	100%

- Countrywide total premium volume: \$10,000,000
- Profit and contingencies provision: 5%

a. (2.0 points) Calculate the countrywide expense fee ratio.

Questions from the 2009 exam

38. (3.5 points) Given the following information:

Class	On-Level Premium	Current Relativity	Proposed Relativity
1	$500,000	1.00	1.00
2	$100,000	1.25	1.15
3	$400,000	1.60	1.40
Total	$1,000,000		

- Class 1 will remain the base class.
- The current base rate is $100.
- The proposed overall change is 15%.

a. (1 point) Calculate the revised base rate.

b. (2.5 points) Assume the actuary wants to cap all class changes at 20% while still achieving the overall change of 15%. Calculate the revised base rate and class relativities.

Questions from the 2010 exam

28. (2.25 points) Given the following information:

- Current base rate $90
- Current average premium per exposure = $110
- Loss and LAE ratio = 75%
- Fixed expense ratio = 10%
- Variable expense ratio = 15%
- Target profit provision = 5%
- Rating algorithm = {Base Rate x Factor x (1.0 - Discount)} + Expense Fee•
- Selected rate change = indicated rate change

Factor	Current Differential	Proposed Differential
1	0.95	0.95
2	1.00	1.00

Discount	Current Discount	Proposed Discount
Yes	5.0%	10.0%
No	0.0%	0.0%

Factor	Discount	Exposures
1	Yes	100
1	No	200
2	Yes	300
2	No	400

a. (0.75 point) Calculate the indicated rate change.

b. (0.5 point) Calculate the proposed expense fee.

c. (1 point) Calculate the proposed base rate.

Questions from the 2011 exam

18. (1.25 points) An insurance company is planning to implement new rates and expects the following:

Premium Range	Policy Count	Avg Premium at Proposed Rates
\$0-\$50	26	\$35
\$51-\$100	34	\$80
\$101-\$200	45	\$150
\$201-\$500	150	\$300

The resulting base rate from the proposal is \$100.

a. (0.75 point) Calculate the new base rate that achieves a revenue-neutral impact if the company were to implement a minimum premium of \$100.
b. (0.5 point) Explain the purpose of a minimum premium.

Questions from the 2012 exam

14. (4 points) An insurance company sells auto insurance where the premium for each car is the same, equal to the current statewide average pure premium. The company is considering developing a more sophisticated rating structure to better compete in the marketplace and has determined the following information about three potential rating variables for its existing book of business.

Garaging Location	Exposures	Losses	Base Class
Urban	800	\$430,000	Yes
Rural	200	\$70,000	No

Driver Skill	Exposures	Losses	Base Class
High	950	\$476,000	Yes
Low	50	\$24,000	No

Marital Status	Exposures	Losses	Base Class
Married	500	\$210,000	No
Single	500	\$290,000	Yes

- The garaging location is determined by the garaging zip code of the vehicle being insured.
- Driver skill is determined by self-assessment when the policy is originally issued.
- Marital status of the principal operator determined as of the policy's effective date.
- Assume that each variable is independent.

a. (2.25 points) For each potential rating variable, recommend whether the variable should be used and justify the recommendation.
b. (1.75 points) Develop a base rate and rating factors for the rating plan structure recommended in part a. above.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.
By relevant, we mean the <u>concepts</u> tested on past CAS exams relating to Expense Fee Ratios and Expense Fees are similar to the <u>concepts</u> found in this chapter.

Solutions to questions from the 2000 exam

Question 29.

The Expense Fee Ratio is the proportion of the total rate that is needed to cover the fixed expenses (i.e. the fixed expense ratio loaded for variable expenses).

F = fixed expenses per exposure

H = fixed expense ratio (fixed expenses as a proportion of the rate)

V = variable expense ratio (variable expenses as a proportion of the rate)

Using the given information from the problem (columns (1) and (2)) below, Compute columns (3) and (4).

Expense Type	Total Expense	% Fixed	**Fixed**	Variable
	(1)	(2)	(3)=(1)*(2)	(4)=(1)*(1.0 - (2))
Commission	0.180	0%	0.0000	.1800
Other Acquisition	0.030	75%	0.0225	.0075
General	0.050	80%	0.04	.01
Taxes, Licenses and Fees	0.025	15%	0.00375	.02125
Profit and Contingencies	0.035	0%	<u>0</u>	<u>.035</u>
			.06625	.25375
			H = .06625	**V+Q = 0.25375**

$$Expense\ Fee\ Ratio = \frac{H}{1-V-Q} = \frac{.06625}{1-.25375} = .0887$$

Answer B.

Solutions to questions from the 2002 exam

Question 4. Use the Expense Fee Methodology to calculate the expense fee.

Step 1: Write an equation to compute the expense fee.

$$Expense\ Fee = \frac{F}{1-V-Q} = \frac{H*R}{1-V-Q}$$, where H = fixed expense ratio (fixed expenses as a % of the rate).

Step 2: Assign symbols to the given data in the problem and solve for any unknown terms:

Description	Amount	Symbol
Earned Premium at Current Rate Level	325,000	
Earned Exposures	1,100	
Total Fixed Expense Ratio	0.13	H
Total Variable Expense Ratio including Profit and Contingency Provision	0.23	V+Q

Note: R = rate per unit of exposure = 325,000 ÷ 1,100 = 295.45

Step 3: Using the equation in Step 1, and the data from Step 2, solve for the expense fee.

$$Expense\ Fee = \frac{.13 * 295.45}{1-.23} = 49.88.$$

Answer B

Solutions to questions from the 2007 exam

41. a. (2.0 points) Calculate the countrywide expense fee ratio.

Step 1: Write an equation to determine the expense fee ratio.

Expense Fee Ratio = H/(1.0 - V - Q), where H is the proportion of countrywide total expenses that are assumed to be fixed, V is the percentage of expenses assume to be variable, and Q is the profit and contingencies provision.

Step 2: Construct a table similar to the one below to compute H and V.

Expense Type	Total Expense (1)	% Fixed (2)	Fixed Expense (3)=(1)*(2)	Variable Expense (4)=(1)*(1.0 - (2))
Commissions	1,400,000	0.00%	0	1,400,000
General Expenses	1,200,000	50.00%	600,000	600,000
Other Acquisition	400,000	100.00%	400,000	0
Premium Tax	300,000	0.00%	0	300,000
Licenses & Fees	100,000	100.00%	100,000	0
			1,100,000	2,300,000
Countrywide total premium	10,000,000		***H = 0.11***	***V = 0.23***

Thus, the Expense Fee Ratio = H/(1.0 - V - Q) = 0.11/(1.00-0.23-0.05) = 0.1528

Solutions to questions from the 2009 exam

Question 38

a. Revised Base Rate = Current Base Rate * Proposed Overall Change * Off-balance factor

$$Off\ \ balance\ factor\ = \frac{\sum On\text{-}Level\ EP}{\sum On\text{-}Level\ EP * \dfrac{indicated\ relativity}{current\ relativity}}$$

Premium weighted ratio of proposed relativity to current relativity

= 500/1 x 1 + 100/1.25 x 1.15 + 400/1.6 x 1.4= 942

Off-balance factor = 1,000/942 = 1.062

Revised Base = 1.062 x 1.15 x 100 = $ **122.08**

b. Determine if any class experiences changes greater than 20% (the cap)

Class	Base rate * Cur Rel	Rev Base rate * Prop Rel	% change in rate
1	100	122.08	22.08% .0208 (500K) =10,400 must be spread to 2 & 3
2	125	140.392	12.31%
3	160	170.91	6.08%

Class 2 and 3 proposed relativities need to be increased because the class 1 base rate is being reduced to 20%

Revised Base Rate= 100 x 1.2 = **$120**

Factor to apply to relativities $\dfrac{10,400}{(100,000 \times 1.1231 + 400,000 \times 1.068)} = .0193$, and $1.0193 \times \dfrac{1.2208}{1.2} = 1.037$

Revised proposed class relativities

Class	Revised Relativities
1	1
2	1.15 x 1.037 = **1.193**
3	1.40 x 1.037 = **1.452**

Solutions to questions from the 2010 exam
Question 28

a. $\textit{Indicated Rate Change} = \dfrac{\left[{(L+E_L)}/{P_C} + F\right]}{[1.0 - V - Q_T]} - 1.0$; $IRC = \dfrac{0.75+0.10}{1-0.15-0.05} - 1.0 = .0625$;

b. Calculation of $Fee (Using the Fixed Expense Ratio)

(1) Fixed Expense Ratio	10.0%	(given)
(2) Proj Av Premium per Exposure (110 * 1.0625)	$116.88	(given Current Avg Prem per Exp * 1.0625)
(3) Average Fixed Expense	$11.68	
(4) Variable Expense %	15.0%	(given)
(5) Target Profit %	5.0%	(given)
(6) Variable Permissible Loss Ratio	80.0%	
(7) Proposed Expense Fee	$14.60	

(3) = (1) x (2); (6) = 1.0 – (4) – (5); (7) = (3) / (6)

Alternatively, Expense Fee = $\dfrac{110\times(1.0625)\times(0.1)}{1\text{-}V\text{-}Q} = \dfrac{110\times(1.0625)\times(0.1)}{1\text{-}0.15\text{-}0.05}$ = 14.609

c. **Calculation of the <u>change</u> in the average rate differentials (Δ_S). Under this method,**

Proposed Base Rate = Current Base Rate * Proposed Base Rate Adjustment

Proposed Base Rate Adjustment = $(1.0+\Delta_B\%) = \dfrac{(1.0+\Delta\%)\times\overline{P_C} - A_P}{\overline{P_C} - A_C} \times \dfrac{1.0}{(1.0+\Delta_S\%)}$,

Proposed Base Rate Adjustment = (Proposed Avg Prem - Proposed Expense Fee)/(Current Avg Prem - Current Expense Fee)*(1/Average Change in Differential)

Computation of the proposed average change in differentials (using exposures)

Factor	Discount	Exposure	Current Differential	1.0 - Current Discount		Proposed Differential	1.0 - Proposed Discount	
			(1)	(2)	(3) = (1)*(2)	(4)	(5)	(6) = (4)*(5)
1	Y	100	0.95	95.00%	0.9025	0.950	90.00%	0.8550
1	N	200	0.95	100.00%	0.9500	0.950	100.00%	0.9500
2	Y	300	1.00	95.00%	0.9500	1.000	90.00%	0.9000
2	N	400	1.00	100.00%	1.0000	1.000	100.00%	1.0000
			Exposure weighted =		0.9653	Exposure weighted =		0.9455

Average Change in Differential = 0.9455/0.9653 = 0.9795
Ac = (110 * .10)/(1-.20) = 13.75

Proposed BR = 90 * (110 * 1.0625 - 14.61)/(110 - 13.75)*(1.0/0.9795) = 97.62
Note: In the text, the proposed additive premium Ap = Ac.

Solutions to questions from the 2011 exam

18a. (0.75 point) Calculate the new base rate that achieves a revenue-neutral impact if the company were to implement a minimum premium of $100.

18b. (0.5 point) Explain the purpose of a minimum premium.

Initial comments:

A minimum premium ensures that, on an individual risk basis, premium covers the expected fixed expenses plus some minimum expected loss.

- Insurers that use a minimum premium requirement do not have additive fixed expense fees in their rating algorithms.
- Implementing a minimum premium can increase total premium. The effect is calculated as follows:

$$Effect = \frac{Premium\ With\ Minimum}{Premium\ Without\ Minimum} - 1.0$$

- To offset this increase in premium, the base rate should be multiplied by the following factor:

$$Offset\ Factor\ =\ \frac{1.0}{1.0\ +\ Effect}$$

Question 18 – Model Solution 1

a.

Policy Count	Avg Premium at Proposed Rates	Total Prem w/o minimum		Total Prem with minimum
(1)	(2)	(3)=(1)*(2)	(4)	(5)=(1)*(4)
26	$35	910	$**100**	2600
34	$80	2720	$**100**	3400
45	$150	6750	$150	6750
150	$300	<u>45000</u>	$300	<u>45000</u>
		55,380		57,750

Effect = 57,750/55,380 = 1.0428 = 4.28% . Base Rate = 100*1/1.0428 = $95.90

b. The purpose of a minimum premium is to cover expected fixed expenses and some expected losses.

Question 18 – Model Solution 2

a. Total Prem required = 26 * 35 + 34 * 80 + 45 * 150 + 150 * 300 = 55,380

	Avg. w/ min prem
0-50	100
51-100	100
101-200	150x
201-500	300x

Total w/ Min = 26 * 100 + 34 * 100 + x[45 * 150 + 150 * 300] = 6,000 + 51,750x

Set = 55380 →x = .9542

New base rate = 100*.9542 = $\boxed{95.42}$

b. Minimum premium ensures that the company collects an amount of premium that is enough to cover fixed expenses and a minimum risk provision for small-premium policies.

Solutions to questions from the 2012 exam

14a. (2.25 points) For each potential rating variable, recommend whether the variable should be used and justify the recommendation.

14b. (1.75 points) Develop a base rate and rating factors for the rating plan structure recommended in part a. above.

Question 14 – Model Solution – part a (Exam 5A Question 14a)

Compute pure premiums for each of the rating variables given in the problem since the company sells auto insurance where the premium for each car is the same, equal to the current statewide average pure premium.

pure premium = losses/exposures

Urban 537.5	High 501	Married 420
Rural 350	Low 480	Single 580

- Garaging location should be used because loss costs differ significantly, the variable is easy to identify and "measureable" based on zip code, and it is also easy to verify.
- Driver skill should not be used. The fact that it is self-identified by the insured and very open to interpretation means it is not measureable and open to moral hazard. Further, it obviously does not work based on experience. It makes no sense that loss costs for highly skilled drivers would be higher.
- Marital status should be used. It can be verified by public records and is straight-forward categorization. Loss costs also differ significantly.

Examiner's comments

A variety of reasons whether a characteristic should be included were accepted. However, we didn't expect the candidate to identify all critical pieces of evidence as long as there was sufficient justification for including or excluding a variable.

Question 14 – Model Solution – part b (Exam 5A Question 14b)

Garaging	Pure Prem=loss/ exp	PP Rel	ARF=wtd avg of exp+factor
Urban	537.5	1.00	
Rural	350.0	0.65	
TOTAL	500.0		0.93

Marital Status	Pure Prem	PP rel	ARF
Married	420	0.72	
Single	580	1.00	
TOTAL	500		0.86

Assume this data is representative of SW Avg PP => $500

$$\text{Bp} = \frac{500}{0.7998} = 625.16$$

Examiner's comments

Candidates lost points for various reasons like: used the wrong characteristic as the base class, calculating separate base rates for marital status and garaging location, and calculating the base rate as a simple average of the pure premiums for single policyholders and urban policyholders.

Chapter 15 – Commercial Lines Rating Mechanisms

BASIC RATEMAKING – WERNER, G. AND MODLIN, C

1 Manual Rate Modification Techniques 289 - 298

Commercial Risks manual rates are modified to adjust for past experience and/or risk characteristics not adequately reflected in the manual rates.

There are two types of manual rate modification techniques: Experience Rating and Schedule rating.

Experience Rating (ER)

ER is used when an individual insured's past experience, with adjustments, can be predictive of the future experience. Eligibility for ER is often based on size of manual premium.

The ER adjustment for the future policy period manual premium equals the credibility weighting of:

i. adjusted past experience (a.k.a. the "experience" component) and

ii. expected results (a.k.a. the "expected" component).

Recall: Techniques to derive credibility measures and ways to develop the complement of credibility are discussed in Chapter 12.

The experience component and the expected component should be consistent (e.g. ALAE should be included in the experience component if it is included in the expected component).

Comparison of experience and expected components can be performed in different ways:

1. **Actual paid** loss (and ALAE) compared to **expected paid** loss (and ALAE) for the experience period as of a particular date.
2. **Actual reported** loss (and ALAE) compared to **expected reported** loss (and ALAE) for the experience period as of a particular date.
3. **Projected ultimate** loss (and ALAE) compared to **expected ultimate** loss (and ALAE) for the experience period.
4. **Projected ultimate loss** (and ALAE) for the experience period that has been adjusted to current exposure and dollar levels compared to **expected ultimate** loss (and ALAE) based upon the current exposure and dollar levels

Key components of the ER formula, including necessary adjustments to each, follows.

Experience Component

1. Determine the length of the historical experience period to be used in the ER formula.

   The experience period usually ranges from 2-5 policy years, ending with the last complete year.

   i. a shorter experience period is *more responsive* to changes, but *more subject to large fluctuations* (due to its relative loss immaturity and reduced aggregate exposure of the shorter period).

   ii. a longer experience period is *less subject to large fluctuations* in the experience, but is *less responsive to changes*.

2. Adjust the historical experience for extraordinary losses.
   - Many ER plans apply per occurrence caps on the losses to exclude unusual or catastrophic losses.
     i. This is referred to as the maximum single limit per occurrence or MSL.
     ii. The caps could apply to losses only (or loss and ALAE).
     iii. If the actual losses are subject to a per occurrence cap, then the expected losses need to be as well.
   - Caps may also be applied to the aggregate of all losses in the policy period.

3. If the experience modification (emod) is based on projected ultimate losses, then historical losses and ALAE (assuming ALAE is included) need to be developed to an ultimate level (see chapter 6).
   - Expected losses also need to be at an ultimate level.
   - If capped losses are used, the LDFs should be developed from data that has also been capped.

4. If the ER formula is based on projected ultimate losses at current exposure and dollar levels (i.e. the 4th comparison listed above), adjustments for economic and social inflation (e.g. changes in judicial decisions or litigiousness) as well as changes in risk characteristics (e.g. size and type of entity) and changes in policy limits are needed.
   i. Historical losses are developed to ultimate, trended to current cost levels, and totaled.
   ii. If the exposure base is sensitive to inflation (e.g. payroll), trend and sum historical exposures.
   iii. The ratio of [i./ii.] is then multiplied by a current exposure measure.

Trended Projected Ultimate Losses & ALAE at Current

Policy Year	(1) Trended Ultimate Losses & ALAE	(2) Exposures	(3) Pure Premium	(4) Current Exposures	(5) Projected Ultimate Losses & ALAE @ Current Exposures
2006	$2,568,325	688			
2007	$1,954,725	564			
2008	$1,465,741	414			
Total	$5,988,791	1,666	$3,594.71	400	$1,437,885

(3) = (Tot1) / (Tot2) (4) = Number of Vehicles Currently Insured (5) = (Tot3) x (Tot4)

Expected Component

The expected component should relate to the experience component.

For the comparisons listed above, the first three use past exposure and the fourth uses current exposure.

Expected losses are the product of an expected loss rate and an exposure measure.
- The expected loss rate is the expected loss cost in the manual rates.
- If the loss rates are needed for a prior period, the expected loss rate can be based on:
  i. the manual rates for the prior period or
  ii. the manual rates for the current period, adjusted to the appropriate level (i.e. de-trended).

Other Considerations

The e-mod may be subjected to maximum or minimum changes.

When the total premium under the ER plan does not equal the total expected premium, an off-balance correction is needed (see Chapter 14.)

Example ER Plan – Commercial General Liability

The following is a simplified version of the ER portion of the 1997 ISO CGL ER and SR Plan ("company" refers to the insurer using the ER plan).

The ER debit/credit is:

$$CD = \frac{(AER\ -\ EER)}{EER} \times Z$$, where

CD = Credit/debit percentage

AER = Actual experience ratio (i.e. the experience component)

EER = Expected experience ratio (i.e. the expected or exposure component)

Z = Credibility

Assume the following:

- The policy being experience rated is an occurrence policy with an annual term, and the effective date is 7/1/2010.
- The experience period consists of the last three completed policies effective 7/1 to 6/30 (i.e. annual policies originating in July 2006, 2007, and 2008), evaluated at 3/31/2010.
- Losses are capped at basic limits, and ALAE are unlimited.
- A MSL is applied to the basic limits losses and unlimited ALAE combined.
- The Z of the company is 0.44.
- The expected experience ratio (EER) is 0.888.

Table 1 shows the calculation of the ER debit/credit. Table 2 supports the derivation of certain inputs to Table 1.

Table 1 and Table 2 are shown on the next page.

- Actual experience is the ultimate losses and ALAE for the 3-year experience period, consisting of:
  i. reported losses and ALAE as of 3/31/2010 [given as 1(a) in Table 1] and
  ii. expected unreported losses and ALAE at 3/31/2010 (derived in column 8 of Table 2).
  For both the reported and unreported losses and ALAE, losses are capped at basic limits and a MSL is applied to the basic limited losses and ALAE combined.
- Company subject basic limit loss and ALAE costs [1(d) in Table 1] represent expected loss and ALAE underlying the current rating manual rates adjusted to the dollar level of the experience period (see Table 2).
- The actual experience ratio (AER) is [ultimate losses and ALAE (at basic limits and limited by the MSL) divided by company subject basic limits loss and unlimited ALAE costs].
- The expected experience ratio (EER) is the complement of an expected deviation of the company's loss costs from the loss costs underlying the manual rate (here, the deviation is caused by applying the MSL).

The ER credit/debit is calculated as a credibility weighting of the AER and the EER

- An experience credit reduces premium and an experience debit increases premium.
- This plan does not have any minimums, maximums, or an off-balance correction.

Table 1: Experience Credit/Debit Calculation

(1)	Experience Components	
(a)	Reported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL	$141,500.00
(b)	Expected Unreported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL	$ 58,760.24
(c)	Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL	$200,260.24
(d)	Company Subject Basic Limit Loss and ALAE Costs	$181,365.61
(e)	Actual Experience Ratio	1.104
(2)	Expected Experience Ratio	0.888
(3)	Credibility	.044
(4)	Experience (Credit)/Debit	10.7%

(1a)= Given
(1b) Table 2
(1c)= (1a) + (1b)
(1d)= Table 2
(1e)= (1c)/(1d)
(2),(3)= Given
(4)= [((1e) - (2)) / (2)] x (3)

Table 2 shows the derivation of two elements in Table 1:
(d) company subject basic limits loss and unlimited ALAE costs and
(b) expected unreported losses and ALAE.

Table 2 - Calculation of Company Subject Loss Costs and Expected Unreported Losses

(1) Policy Period	(2) Coverage	(3) Current Company B/L Loss & ALAE Costs	(4) Detrend Factors	(5) Company Subject B/L Loss & ALAE Costs	(6) Expected Experience Ratio	(7) Expected Percentage B/L Losses & ALAE Unreported at 3/31/10	(8) Expected B/L Losses & ALAE Unreported at 3/31/10
7/1/06-07	Prem/Ops	$ 51,675.00	0.804	$ 41,546.70	0.888	0.192	$ 7,083.55
	Products	$ 18,851.00	0.839	$ 15,815.15	0.888	0.4256	$ 5,982.68
7/1/07-08	Prem/Ops	$ 51,675.00	0.849	$ 43,872.08	0.888	0.300	$ 11,687.52
	Products	$ 18,850.00	0.876	$ 16,512.60	0.888	0.545	$ 7,991.44
7/1/08-09	Prem/Ops	$ 51,675.00	.0897	$ 46,352.48	0.888	0.394	$ 16,217.43
	Products	$ 18,850.00	0.916	$ 17,266.60	0.888	0.639	$ 9,797.62
Total		$ 211,575.00		$ 181,365.61			$ 58,760.24

(4)= the reciprocal of the loss and ALAE trend factor; (5)= (3) x (4) (6),(7) = given (8)= (5) x (6) x (7)

Company subject basic limits losses and unlimited ALAE costs (column 5 above) are the product of:

- the current company basic limits loss and ALAE costs (i.e. the loss costs underlying the current manual rates) and
- the detrend factors, which bring current company basic limits loss and ALAE to the average accident date of each of the policy periods in the experience period, using the loss and ALAE trend underlying the current rates.

Detrend Factors:

The detrend factor:

- for each policy period in the experience period is the reciprocal of the loss and ALAE trend factor.
- is used to adjust the current loss costs to a historical experience period. For example:
  i. the average accident date of the prospective policy period is 1/1/2011.
  ii. for the policy period beginning 7/1/2008, the length of the detrend period is two years (the length of time between 1/1/2011 and 1/1/2009).
  iii. given a loss trend of 4.5%, the detrend factor for the 2008 policy period is the reciprocal of the trend plus 1.0, raised to the length of the detrend period [=0.916 = $(1/1.045)^2$].

Expected basic limits losses and ALAE unreported at 3/31/2010 (column 8) are the product of:

- The company subject basic limits losses and ALAE
- The expected experience ratio (EER)
- The expected percentage basic limits losses and ALAE unreported at 3/31/2010 (these %s are derived from a separate analysis).

Example ER Plan – Workers Compensation (WC)

The National Council on Compensation Insurance (NCCI) has been designated by the majority of states as the licensed rating and statistical organization of WC insurance.

- The NCCI ER Plan divides losses into primary and excess components.
- The mod formula credibility weights primary and excess losses separately:

$$M = \frac{Z_P \times A_P + (1.0 - Z_P) \times E_P + Z_e \times A_e + (1.0 - Z_e) \times E_e}{E}$$, where

M = Experience Modification Factor

A_P = Actual Primary Losses, A_e = Actual Excess Losses

E_P = Expected Primary Losses E_e = Expected Excess Losses

E = Ep + Ee

Z_P = Primary Credibility Z_e = Excess Credibility

NCCI uses an alternative (algebraically equivalent) formula by substituting some terms.

$$M = \frac{A_P + w \times A_e + (1.0 - w) \times E_e + B}{E + B}$$, where

B = Ballast Value, which is based on: Z_P = E/(E +B); w = Excess Loss Weighting Value = Ze/Zp.

How primary and excess credibility factors are expressed in NCCI's formula:

- The primary credibility factor is a function of the ballast value (B).
- The excess credibility factor is a function of both (B) and (w).
- The ballast value and weighting value:
  i. are obtained from a table based upon the policy's expected losses
  ii. both increase as expected losses increase.

WC ER Plan:

- The experience period consists of the 3 most recent complete policy years.
- Actual losses are reported losses evaluated at 18 months, 30 months, and 42 months from the beginning of the most recent, second most recent and third most recent policy years, respectively.
- Actual primary losses are capped at $5,000 per loss.
- Expected losses are the actual payroll (in hundreds) by class for the experience period multiplied by the expected loss rates by class for the prospective period.
  i. Expected loss rates reflect the losses expected to be reported at the respective evaluations of the experience period policies (18, 30, and 42 months).
  ii. Expected primary losses are the expected losses multiplied by a D-ratio (the loss elimination ratio at the primary loss limit determined using the LER techniques described in Chapter 11).

NCCI emod calculation.

- The effective date of the policy being rated is 9/1/2010
- The policy is comprised of only one class code.
- Table 1 below lists the actual losses from the last three complete policy years.
  i. The losses are separated into primary and excess components.
  ii. Primary losses are capped at $5,000; Excess losses are the portion of each individual loss above $5,000.
- Table 2 expected loss costs reflects expected losses as of policy evaluation date.
  Expected losses are separated into the primary and excess components based upon a D-ratio.

Table 1 - Actual Losses as of 3/31/10

Policy Year	Claim #	(1) Reported Losses	(2) Primary Losses	(3) Excess Losses
9/1/06-07	1	$15,000	$5,000	$10,000
	2	$100,000	$5,000	$95,000
	3	$25,000	$5,000	$20,000
9/1/07-08	1	$45,000	$5,000	$40,000
	2	$50,000	$5,000	$45,000
	3	$10,000	$5,000	$5,000
9/1/08-09	1	$20,000	$5,000	$15,000
	2	$55,000	$5,000	$50,000
Total		$320,000	$40,000	$280,000

Table 2 - Expected Losses

Policy Year	(1) Payroll	(2) Expected Loss Cost	(3) Expected Losses	(4) D-Ratio	(5) Expected Primary Losses	(6) Expected Excess Losses
9/1/06-07	$1,956,000	4.10	$80,196.00	0.24	$19,247.04	$60,948.96
9/1/07-08	$2,128,000	3.52	$74,905.60	0.24	$17,977.34	$56,928.26
9/1/08-09	$2,317,000	2.37	$54,912.90	0.24	$13,179.10	$41,733.80
Total	$6,401,000		$210,014.50		$50,403.48	$159,611.02

(3) = [(1) / $100] x (2) (5) = (3) x (4) (6) = (3) - (5)

Assuming a ballast value (B) of $30,000 and a weighting value (w) of 0.25, the ER Mod factor is

$$M = \frac{A_p + w \times A_e + (1.0 - w) \times E_e + B}{E + B},$$

$$M = \frac{40,000 + [0.25 \times \$280,000] + [(1.0 - 0.25) \times \$159,611.02] + \$30,000}{\$50,403.48 + \$159,611.02 + \$30,000} = 1.082$$

The e-mod factor of 1.082 is applied multiplicatively to policy standard premium.

Schedule Rating (SR)

SR:

- is used to modify the manual rate, in commercial lines pricing, to reflect characteristics that are:
  i. expected to have a material effect on the insured's future loss experience but that are not actually reflected in the manual rate, or
  ii. not adequately reflected in the prior experience (if ER applies).
  Example: if an insured implements a new loss control program, it is expected that losses will be lower than that indicated by the actual historical experience (hence an underwriter can use SR to reflect this).
- is applied as % credits (reductions) and debits (increases) to the manual rate.
  Characteristics can be objective (e.g. the number of years a physician has been licensed) or subjective (e.g. quality of company management).
  i. Objective characteristics are generally easier to quantify and validate.
  ii. SR requires significant underwriting judgment (and documentation is required to support application of each credit and debit).
- if used in addition to ER (e.g. a newly implemented safety program), then the latter will eventually be reflected in the loss experience, so the key for the underwriter is to avoid double-counting the risk characteristic effect in both the e-mod and SR.

Schedule credits and debits are often subject to an overall maximum modification.

SR Plan - Example

The following is a SR plan for WC and EL. In this plan:

- the underwriter has discretion in applying the credits or debits.
- there are five categories for which an insured can be eligible for a schedule credit or debit with minimums and maximums specific to each category.
- An overall maximum credit or debit also applies.

Schedule Rating Worksheet

Category	Available Range of Modification (Credit to Debit)	Credit Applied	Debit Applied	Reason / Basis
Premises - General Housekeeping - Preventative Maintenance - Workplace Design - Physical Condition	-10% to +10%			
Classification - Exposures not contemplated in class - Hazards peculiar to a classification have been eliminated - Exposure variation due to technology	-15% to +15%			
Medical Facilities - First Aid - Medical Assistance on Site	-5% to +5%			
Safety Organization - Written Safety Program - Emergency and Disaster Plans - Loss Control Programs - Ergonomics	-15% to +15%			
Employees - Pre-employment Physicals - Drug-Free Workplace - New Hire Training - Job-Specific Training	-15% to +15%			
Total				**Max = 25% (Credit) / Debit**

2 Rating Mechanisms For Large Commercial Risks 298 -309

Rating mechanisms (loss-rated composite risks, large deductible policies, and retrospective rating plans) in this section develop premium for the large commercial entities based on their experience.

1. Composite Rating

In composite rating:

- all coverages are rated using a single composite exposure base.
- an initial deposit premium is based on a composite rate and estimated composite exposures at the beginning of the policy period.
- the final premium is based on an audit of final composite exposures after the end of the policy period.

The composite rate:

- may be based on manual rates adjusted by SR and/or ER modification.
- can also be based entirely on a large insured's prior experience (a.k.a. loss-rated risks)

Example Composite Rating Plan for Loss-Rated Risks

In ISO's Composite Rating Plan, an insured is eligible for being classified as "loss-rated" if its historical reported losses and ALAE over a defined period exceed a specified aggregate dollar amount.

- the threshold varies based on coverage and limits.
- if eligible, the insured's historical experience is 100% credible for determining the composite rate.

Step 1: Compute Trended Ultimate Loss & ALAE by coverage by year =
(Reported Loss & ALAE) x (Development Factor) x (Loss & ALAE Trend Factor).
do so for each type of coverage and for each of the past five completed years of experience

Step 2: Compute Trended Composite Exposure = Composite Exposure x Exposure Trend Factor.
i. select a composite exposure base
ii. trend the composite historical exposures to the average accident date of the proposed experience period (do so for sales and payroll which are inflation-sensitive, but not for number of vehicle years used in commercial auto)

Step 3: Compute $Adjusted\ Premium = \dfrac{Trended\ Ultimate\ Loss\ \&\ ALAE}{Expected\ Loss\ \&\ ALAE\ Ratio}$

i. the expected loss and ALAE ratio is the same as the PLR discussed in Chapter 7 (1.0 minus the sum of the provisions for expenses and profit).
ii. dividing the loss and ALAE by the expected loss and ALAE ratio incorporates a provision for other expenses and profit.

Step 4: Compute $Composite\ Rate = \dfrac{Adjusted\ Premium}{Trended\ Composite\ Exposure}$ (for coverage to be written)

For loss-rated risks:

i. the composite rate is not adjusted by any ER plan (since the insured's own experience has already been reflected in the rate).
ii. SR (however) may apply.

Composite Rate Calculation Example

- Bob's Rentals sells new and used equipment, operates a repair and service shop, and offers leases and rentals on equipment it owns.
- In calculating the commercial general liability (CGL) policy premium, each of the three operations is rated separately, and the exposure base for each operation is different.
  - i. the exposure for sales on new and used equipment is receipts (in $000s) related to the latter.
  - ii. the exposure for the repair and service shop is payroll (in $00s) relating to the latter.
  - iii. the exposure for leases and rentals is receipts (in $000s) attributable only to leases and rentals.
- Bob's Rentals is large enough to meet ISO's Composite Rating Plan eligibility requirements for loss rating and desires coverage up to $250,000 per occurrence with $500,000 general aggregate.
- The last five years of reported losses and ALAE over all 3 operations, separated into BI and PD is shown below. Amounts are capped at $250,000 per occurrence.
- The selected composite exposure base is total receipts.
- Assume the following:
  * Loss and ALAE annual trend (for bodily injury and property damage) is 6%.
  * Exposure annual trend rate is 4%.
  * Expected loss & ALAE ratio is 72%.

Reported Loss & ALAE a/o 12/31/08

Policy Year	Bodily Injury	Property Damage
7/1/03-04	$1,842,705	$626,162
7/1/04-05	$1,406,353	$591,899
7/1/05-06	$1,356,511	$517,616
7/1/06-07	$1,355,545	$623,184
7/1/07-08	$1,193,012	$568,669
Total	$7,154,126	$2,927,530

Receipts

Policy Year	New/Used Equipment	Repair and Service	Lease and Rentals	Total
7/1/03-04	$56,498,756	$22,599,503	$33,899,254	$112,997,513
7/1/04-05	$58,564,822	$23,425,929	$35,138,893	$117,129,644
7/1/05-06	$61,193,878	$24,477,551	$36,716,327	$122,387,756
7/1/06-07	$63,245,228	$25,298,091	$37,947,137	$126,490,456
7/1/07-08	$65,721,869	$26,288,748	$39,433,121	$131,443,738
Total	$305,224,553	$122,089,822	$183,134,732	$610,449,107

Development Factors

Age to Ultimate	Bodily Injury	Property Damage
66-Ult	1.10	1.03
54-Ult	1.25	1.10
42-Ult	1.45	1.20
30-Ult	1.70	1.35
18-Ult	1.95	1.50

Calculate: the loss-rated composite rate for Bob's Rentals for its upcoming annual policy effective 7/1/2009.

Step 1: Develop trend factors to be applied to the loss and ALAE and the exposure base.

- The AAD of the proposed policy period is 12/31/2009, and the AAD of each policy year from the experience period is 12/31.
- Based on the assumed trend rates, the trend factors are calculated as follows:

Trend Factors

Policy Year	(1) Trend Period	(2) Annual Loss & ALAE Trend	(3) Loss & ALAE Trend Factor	(4) Annual Exposure Trend	(5) Exposure Trend Factor
7/1/03-04	6	6.00%	1.4185	4.00%	1.2653
7/1/04-05	5	6.00%	1.3382	4.00%	1.2167
7/1/05-06	4	6.00%	1.2625	4.00%	1.1699
7/1/06-07	3	6.00%	1.1910	4.00%	1.1249
7/1/07-08	2	6.00%	1.1236	4.00%	1.0816

(3) =[1.0 + (2)]^(1)   (5) =[1.0+ (4)]^(1)

Step 2: Estimate the trended ultimate loss and ALAE.

Trended Ultimate Loss & ALAE

Policy Year	(1) Incurred Loss and ALAE BI	(2) Incurred Loss and ALAE PD	(3) Development Factors BI	(4) Development Factors PD	(5) Loss & ALAE Trend Factor	(6) Trended Ultimate Loss & ALAE
7/1/03-04	1,842,705	626,162	1.10	1.03	1.4185	3,790,122
7/1/04-05	1,406,353	591,899	1.25	1.10	1.3382	3,223,764
7/1/05-06	1,356,511	517,616	1.45	1.20	1.2625	3,267,451
7/1/06-07	1,355,545	623,184	1.70	1.35	1.1910	3,746,558
7/1/07-08	1,193,012	568,669	1.95	1.50	1.1236	3,572,348
Total	7,154,126	2,927,530				17,600,243

(6) = [(1) x (3) + (2) x (4)] x (5)

Step 3: Compute trended composite exposures.

Trended Composite Exposure

Policy Year	(1) Total Receipts ($000's)	(2) Exposure Trend Factor	(3) Trended Exposure
7/1/03-04	112,998	1.2653	142,976
7/1/04-05	117,130	1.2167	142,512
7/1/05-06	122,388	1.1699	143,181
7/1/06-07	126,490	1.1249	142,289
7/1/07-08	131,444	1.0816	142,170
Total	610,449		713,127

(1) = Sum of receipts from table on prior page   (3) = (1) x (2)

Step 4: Compute the composite rate:

Composite Rate

(1) Trended Ultimate Loss & ALAE	$17,600,243
(2) Expected Loss & ALAE Ratio	72.0%
(3) Adjusted Premium	$24,444,782
(4) Trended Composite Exposure	$713,129
(5) Composite Rate	$34.28

(3) = (1) / (2) (5) = (3) / (4)

Step 5: Compute the Deposit premium:

Assuming total receipts for the proposed policy period are estimated to be $142,500, then the deposit premium is $4,884,900 (= $142,500 x 34.28).

Step 6: Final premium: Is calculated according to the audited exposure (and any difference from the deposit premium can be charged or credited to the insured).

Large (and Small) Deductible Policies

The purpose of small deductibles is for the insurer to keep premium low by avoiding expenses associated with processing and investigating small nuisance (frivolous) claims.

Under a large deductible policy, the insured is bearing significant risk (either from a large number of small claims or a small number of large claims).

Thus, the following pricing considerations must be addressed (in addition to those associated with small deductible pricing):

* **Claims handling**: Will the insured or insurer handle claims that fall within the deductible?
  i. If it is the insurer, the premium must cover the cost for all claim handling expenses (even those expenses associated with claims that do not pierce the deductible).
  ii. If it is the insured, the insurer should evaluate the insured's claim handling expertise to determine the likelihood of claims leakage above the deductible (as any increase in expected costs as a result of the insured's inexperience should be reflected in the pricing).

* **Application of the deductible**:
  i. The deductible may apply to losses or to losses and ALAE.
  ii. LER calculation should be based on data consistent with the treatment of ALAE in the policy terms.

* **Deductible processing**:
  i. When the insurer is responsible for paying the entire claim and seeks reimbursement for amounts below the deductible from the insured, the premium should reflect the cost of invoicing and monitoring deductible activity as well as a provision for the risk that the insured may become bankrupt and be unable to pay for any future deductible invoices (i.e. credit risk).
  ii. Even if collateral is received to cover potentially uncollectible deductible amounts, it is rare that this credit risk is fully collateralized.

* **Risk margin**: Since losses above a large deductible are more uncertain than losses below the deductible, the profit margin may need to be adjusted to reflect the increased risk assumed by the insurer.

With the exception of these considerations, pricing for a large deductible policy is the same as pricing a standard deductible (see Chapter 11)

Large Deductible Premium Calculation Example

Consider a large deductible CGL policy being priced based on the following provisions and assumptions:

* The deductible is $500,000 per occurrence.
* The insurer will handle all claims (including those that fall below the deductible)
* The deductible is not expected to reduce ALAE costs. ALAE costs are estimated to be 11% of total losses.
* The deductible applies to losses only.
* Total ground-up losses without recognition of a deductible are estimated to be $1,000,000.
* Fixed expenses are assumed to be $50,000.
* Variable expenses are assumed to be 13% of premium.
* The insurer will make the payments on all claims and seek reimbursement for amounts below the deductible from the insured. The cost to process deductibles is estimated to be 4% of the losses below the deductible.
* Deductible recoveries are not fully collateralized, and the credit risk is estimated to be 1% of the expected deductible payments.
* The desired UW profit for full-coverage (i.e. no deductible) premium is 2%.
* An additional risk margin of 10% of excess losses for policies with a deductible of $500,000 is charged.
* The % of total losses below the deductible (i.e. the LER) and the % of total losses above the deductible (i.e. excess ratio) are summarized below.

Loss Elimination Ratios

Loss Limit	LER	Excess Ratio [1.0-LER]
$100,000	60%	40%
$250,000	80%	20%
$500,000	95%	5%

$$Premium = \frac{Losses\ above\ Deductible + ALAE + Fixed\ Expense + Credit\ Risk + Risk\ Margin}{(1.0 - Variable\ Expense\ Provision - Profit\ Provision)}$$

Step 1: Estimate losses above the $500,000 deductible.

(1) Expected total ground-up losses	$1,000,000
(2) Excess ratio	5%
(3) Estimated losses above deductible (1) x (2)	$ 50,000

Step 2: Compute the premium as follows:

(1) Estimated Losses Above the Deductible	$50,000
(2) ALAE	$110,000
(3) Fixed Expenses	
(a) Standard	$50,000
(b) Deductible Processing	$38,000
(4) Credit Risk	$9,500
(5) Risk Margin	$5,000
(6) Variable Expenses and Profit (.13 + .02)	15%
(7) Premium	$308,824

(1) = prior table,row (3); (2) = 11% x prior table, Row (1) (3a) = Provided (3b) = 4% x prior table, Row (1) x LER
(4) = 1% x prior table, Row (1) x LER (5) = 10% x (1) (7) = [(1) + (2) + (3a) + (3b) + (4) + (5)] / [1.0 - (6)]

Retrospective Rating

A retrospective rating plan uses the insured's actual experience during the policy period to determine the premium for that same period.

- actual losses used to determine the final retrospective premium may be limited to reduce the effect of any single unusual or catastrophic event.
- total premium charged may be subject to a minimum and maximum amount, to stabilize the year-to-year cost and to protect the insured from exceeding an aggregate cost due to a large number of claims incurred in any one year.

Premium for a retro rated policy consists of an initial premium and periodic premium adjustments made after the policy period to reflect actual claims experience for a pre-determined number of adjustments or until the insurer and insured agree no more adjustments are needed.

Three ways in which initial premium and premium adjustments can be structured are as follows:

1. **Initial premium is based on total expected expenses, profit, and costs associated with any caps.**

   At the end of the policy period, the insured is billed annually for all losses incurred under the policy *after* capping rules apply.

   Annual premium adjustments continue each year for a pre-determined length of time.
2. **Initial premium is based on expenses, profit, and costs associated with any caps** (excluding LAE associated with the policy).

   Annual premium adjustments associated with reported losses during the policy period will include a provision for LAE costs (i.e. a pre-determined percentage chosen to reflect LAE costs).
3. **Initial premium is based on an estimate of the final premium under the policy** (including provision for total expected ultimate losses and expenses).

   Periodic premium adjustments are due to changes in the revised estimate of final premium based on the latest loss data.

All 3 examples above should produce the same total premium for a retro rated policy.

Retrospective Rating Plan Premium Calculation – WC

Basic Formula

The basic formula for retrospective premium is as follows:

Retro Premium = [Basic Premium + Converted Losses] x Tax Multiplier, where the retro premium is subject to a maximum and minimum.

Basic Premium = [Expense Allowance - Expense Provided Through LCF + Net Ins Charge] x Standard Premium

where:

LCF = Loss Conversion Factor

Expense Provided Through LCF = Expected Loss Ratio x (LCF -1.0)

Net Insurance Charge = [Insurance Charge - Insurance Savings] x Expected Loss Ratio x LCF.

The Basic Premium provides for:

1. The insurer's target UW profit and expenses (excluding expenses provided for by the LCF and the tax multiplier), and
2. The cost of limiting the retrospective premium (to be between the minimum and maximum premium negotiated under the policy), and

Converted Losses: Converted Losses = Reported Losses x LCF.

- Converted losses are reported losses limited by the selected limit (and then multiplied by the LCF).
- The LCF is a factor to include the ALAE and ULAE not already included in the losses.

Expenses

Are introduced into the formula through 3 components:

1. the tax multiplier (to account for the cost of premium taxes)
2. the expense allowance (to account for all other underwriting expenses).
3. the LCF (to account of expenses that varies with losses, e.g. ALAE, and is negotiated between the insurer and insured).

Standard Premium

- is the premium before consideration of the retro rated plan and any premium discount.
- is determined based on the exposure, the insurer's rates, the experience modification, and any premium charges (excluding premium discount).

Minimum/Maximum Retrospective Premium

Minimum Retro Premium = Standard Premium x Minimum Retro Premium Ratio.

Maximum Retro Premium= Standard Premium x Maximum Retro Premium Ratio.

Minimum and maximum retrospective premium ratios are negotiated between the insured and insurer.

Insurance Charge and Insurance Savings

Applying a minimum and maximum will affect the total premium collected by the insurer and therefore the cost of doing so needs to be considered as part of the final premium.

- The **insurance charge:** the cost associated with limiting the retrospective premium to be no higher than the maximum retrospective premium.
- The **insurance savings**: the savings by requiring the retrospective premium to be no lower than the minimum retrospective premium.
- The insurance charge and insurance savings:
  i. are contained in a table of values.
  ii. are expressed as a % of expected <u>unlimited</u> losses.

  Notes:

  * In the following example, the impact of the per occurrence loss limitation is incorporated into the values contained within this table;

  * There are table that represent only the effect of the maximum and minimum premiums, and the effect of the per occurrence loss limitation is computed as an additional charge.

Retro Rated Premium Calculation - Example

Assume the following:

- The 1st computation of the retrospective premium occurs 6 months after the end of the policy period and annually thereafter until the insurer and insured agree that the latest computation will be the final one.
- The policy is an annual policy and limited reported losses valued as of *18 months* are $153,000.

Retrospective premium calculation:

Note: The givens in computing the retrospective premium are shown in the first 10 rows of Table below.

(1) Minimum retrospective premium ratio (negotiated)	60.0%
(2) Maximum retrospective premium ratio (negotiated)	140.0%
(3) Loss Conversion Factor (negotiated)	1.10
(4) Per Accident Loss Limitation (negotiated)	$100,000
(5) Expense Allowance (excludes tax multiplier)	20%
(6) Expected Loss Ratio	65%
(7) Tax Multiplier	1.03
(8) Standard Premium	$769,231
(9) Insurance Charge for Maximum Premium	0.42
(10) Insurance Savings for Minimum Premium	0.03
(11) Basic Premium	*$318,346*
(12) Converted Losses	*$168,300*
(13) Preliminary Retrospective Premium	*$501,245*
(14) Minimum Retrospective Premium	*$461,539*
(15) Maximum Retrospective Premium	*$1,076,923*
(16) Retrospective Premium	**$501,245**

(11) = [(5)-(6) x [(3)-1.0]+[(9)-(10)] x (6) x (3)] x (8)
(12) = $153,000 x (3)
(13) = [(11)+(12)] x (7)
(14) = (1) x (8)
(15) = (2) x (8)
(16) = Min [Max[(13),(14)] , (15)]

3 Key Concepts 311 - 311

1. Manual rate modification plans
   a. ER
      i. Actual experience
      ii. Expected experience
      iii. Other considerations
      iv. Examples for CGL and workers compensation
   b. Schedule rating (with example plan for workers compensation and employer's liability)

2. Rating techniques for large commercial risks
   a. ISO loss-rated composite risks (with example for a CGL policy)
   b. Large deductible policies
   c. Retrospective rating plans (with example for a WC policy)

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Questions from the 1992 exam

33. (2 Points) The Acme Widget Company has a retrospectively rated workers' compensation policy with a $100,000 limitation on individual losses.

Using the information below and methods outlined in the Foundations of Casualty Actuarial Science, Chapter 3 -"Individual Risk Rating", compute Widget's retrospective premium.

Standard Premium	$100,000
Net (after discount) Premium	90,500
Incurred Losses Limited to $100,000	40,000
Retrospective Premium Development Factor	0.15
Excess Loss Premium Factor	0.12
Basic Minimum Premium Factor	0.20
Maximum Premium Factor	1.00
Loss Conversion Factor	1.10
Tax Multiplier	1.00

A. < $87,000 B ≥ $87,000 but < $89,000 C. ≥ $89,000 but < $91,000 D. ≥ 91,000 but< $93,000
E. ≥ $93,000

Questions from the 1994 exam

26. The XYZ Construction Company has a Workers Compensation policy that is rated under the National Council on Compensation Insurance (NCCI) Experience Rating Plan. Given the following information, the Experience Modification Factor for XYZ falls into which range?

Actual Primary Losses	$ 50,000
Actual Excess Losses	10,000
Expected Primary Losses	40,000
Expected Excess Losses	20,000
Weighted Loss Factor (w)	0.10
Ballast (B)	6,000

A. < 0.98 B. ≥ 0.98 but <1.02 C. ≥1.02 but < 1.06 D. ≥ 1.06 but < 1.10 E ≥ 1.10

Questions from the 1995 exam

32. (2 points) You are given:

• Workers' Compensation Manual Premium	$100,000
• Experience Modification	10.0% Credit
• Premium Discount Factor	9.0%
• Basic Premium Factor	30.0%
• Converted Losses	$80,000
• Tax Multiplier	1.05
• Minimum Retrospective Factor	80.0%
• Maximum Retrospective Factor	120.0%

According to Tiller, "Individual Risk Rating," calculate the Workers' Compensation retrospective premium.

Questions from the 1997 exam

13. According to **Werner/Modlin**, the basic premium in the NCCI retrospective rating plan provides for which of the following costs?
    1. Risk control services
    2. Premium taxes
    3. An allowance for profit and contingencies

    A. 1 B. 3 C. 1, 2 D. 1, 3 E. 1, 2, 3

36. (3 points) You are given:

	Total Reported Loss Amount	Allocated Loss Adjustment Expense
Claim 1	80,000	50,000
Claim 2	145,000	120,000
Claim 3	110,000	80,000
Claim 4	125,000	250,000

Basic Limits Earned Premium (Subject Premium)	1,500,000
Basic Loss Limit	100,000
Maximum Single Loss	200,000
Expected Loss and ALAE Ratio (Not Limited by MSL)	0.700
Expected Unreported Basic Limits Loss and ALAE (Limited by MSL)	250,000
D-Ratio	0.80
Credibility	0.50

Based on Tiller, "Individual Risk Rating," chapter 3 of Foundations of Casualty Actuarial Science,

a. (2 points) What is the actual loss ratio that will be used in calculating the experience modification?
b. (1 point) Determine the experience modification.

Questions from the 1998 exam

19. Based on Tiller, "Individual Risk Rating," chapter 3 of Foundations of Casualty Actuarial Science, calculate the NCCI experience modification factor.

Actual primary loss	$50,000
Actual excess loss	$100,000
Expected primary lose	$55,000
Expected excess loss	$25,000
Stabilizing value	$20,000
Excess loss weighting factor	0.75

32. (2 points) A commercial risk is being rated based on a one year experience period. The actual experience is as follows:

Actual basic limit loss & ALAE	$30,000
Current basic limit premium	$50,000
Loss & ALAE development factor	1.25
Credibility	.80
Detrend factor	.85
Expected loss & ALAE ratio	.70

Note: There is no maximum single loss limitation.

Based on Tiller, "'Individual Risk Rating," chapter 3 of Foundations of Casualty Actuarial Science, calculate the experience modification.

Questions from the 1999 exam:

36. (2 points) Using the ISO experience rating plan described in Tiller, "Individual Risk Rating," chapter 3 of Foundations of Casualty Actuarial Science and the information shown below, answer the following.

Loss experience for this risk:

	Loss	Allocated Loss Adjustment Expense (ALAE)
Claim #1	15,000	15,000
Claim #2	35,000	10,000

Basic limit	$25,000
Current basic limit premium	$100,000
Detrend factor	.85
Expected Percentage of Basic Limits Loss and ALAE Unreported	20%
Policy Adjustment Factor	1.00
Credibility	.80
Expected loss and ALAE ratio	.70

Assume there is no maximum single loss

a. (1 1/2points) Calculate the experience modification.

b. (1/2 point) According to Tiller, state one advantage and one disadvantage of using a one-year experience period as compared to a longer period.

Questions from the 2000 exam

28. Based on Tiller, "Individual Risk Rating," chapter 3 of Foundations of Casualty Actuarial Science, and the following information, calculate the experience modification factor following the ISO CGL Experience Rating Plan.
    - Subject Premium = $100,000
    - Adjusted Expected Loss and ALAE Ratio = 65.0%
    - Actual Loss and ALAE Ratio = 68.0%
    - Actual Losses and ALAE Limited by Basic Limits and MSL = $32,917
    - Credibility = .35

A. < 0.80 B. ≥ 0.80 but < 1.10 C. ≥ 1.10 but < 1.40 D. ≥ 1.40 but < 1.70
E. ≥ 1.70

Questions from the 2001 exam

Question 13. Based on Tiller, "Individual Risk Rating Study Note," and the following data, calculate the Adjusted Expected Loss & ALAE Ratio.

• D-ratio	0.624
• Off-balance factor	1.050
• Subject Premium	$80,000
• Total Limits Earned Premium	$100,000
• Expected Basic Limits Losses & Unlimited ALAE	$ 60,000
• Expected Total Limits Losses & Unlimited ALAE	$ 74,500

A. < 42.0% B. ≥ 42.0% but < 44.0% C. ≥ 44.0% but < 46.0% D. ≥ 46.0% but < 48.0% E. ≥ 48.0%

Questions from the 2002 exam

2. Based on Tiller, "Individual Risk Rating - Study Note," and the following data, calculate the experience modification factor using NCCI's "Revised Experience Rating Plan".

Expected total loss	210,000
Expected primary loss	50,000
Actual total loss	320,000
Actual primary Loss	40,000
Ballast factor	30,000
Excess loss weighting factor	0.25

A. < 1.070 B. ≥ 1.070 but < 1.080 C. ≥ 1.080 but < 1.090 D. ≥ 1.090 but < 1.110 E ≥ 1.110

Questions from the 2003 exam

17. Which of the following statements are true regarding individual risk rating?
    1. Schedule rating directly reflects an entity's claim experience.
    2. Experience rating is used when the past, with appropriate adjustments, is predictive of the future.
    3. Individual risk rating is appropriate when entities in a rating group are homogeneous.

    A. 1 only B. 2 only C. 3 only D. 1 and 2 only E. 2 and 3 only

42. (3 points)
    a. (1.5 points) Using the following information, calculate the final retrospective premium. Show all work.
        - Standard premium = $300,000
        - Basic premium factor = 0.18
        - Loss conversion factor = 1.20
        - Excess loss premium factor = 0.25
        - Tax multiplier = 1.04
        - Loss limit per accident = $50,000

Reported losses
$70,000
$15,000
$25,000

b. (1 point) Explain why the retrospective rating process tends to produce back-and-forth payments between the insured and insurer.
c. (0.5 point) Briefly describe a mechanism that can be used to smooth these back-and-forth payments.

Questions from the 2004 exam:

43. (3 points) Using the ISO experience rating plan for a policy with premises/operations coverage and the following information, calculate the experience debit or credit. Show all work.

Policy Period	Detrend Factors	Expected Percent of Basic Limits Loss & ALAE Unreported as of September 30, 2003
1999	0.78	15%
2000	0.85	25%
2001	0.94	40%

- Policy being rated is a January 1, 2004 - December 31, 2004 occurrence policy.
- Premises/operations premium is $240,000.
- Reported loss and ALAE for experience period as of September 30, 2003 (limited by basic limits losses and MSL) is $300,000.
- Expected experience ratio is 0.90. Expected loss and ALAE ratio is 0.62.
- Maximum single limit per occurrence is $100,000. Credibility is 0.35.
- All policies in experience period are occurrence policies.

Questions from the 2005 exam:

54. (2 points) Given the following information for an insured, determine the General Liability premium after adjustments for experience and schedule rating. Show all work.
   - Manual premium = $75,800

   Experience rating information:
   - Reported Limited Losses and ALAE = $93,500
   - Expected Unreported Limited Losses and ALAE = $25,200
   - Company Subject Basic Limits Loss and ALAE Costs = $153,900
   - Credibility = 0.35
   - Expected Experience Ratio = 0.92

   The underwriter has determined that the following schedule rating modifications are appropriate:
   - Premises - Condition, Care = +4%
   - Equipment - Type, Condition, Care = -7%
   - Classification Peculiarities = -8%
   - Employees - Selection, Training, etc. = +3%

Questions from the 2006 exam:

10. John's Car Wash is a new single-location business. It is purchasing commercial general liability insurance. Which of the following rating methods might be used in calculating the premium?

   1. Schedule Rating
   2. Experience Rating
   3. Composite Rating

A. 1 only B. 2 only C. 3 only D. 1 and 2 only E. 1 and 3 only

49. (2 points) Given the following information for a commercial general liability risk, calculate the experience (Credit)/Debit based on the ISO CGL Experience Rating Plan. Show all work.

Actual Losses in the experience period valued as of March 31, 2006:

Claim	Loss	ALAE
1	$1,000	$200
2	1,500	200
3	5,000	800
4	6,000	1,000
5	12,000	1,800
6	23,000	2,200
7	120,000	40,000

Expected Unreported Losses and ALAE @ March 31, 2006 = $45,000

Company Subject Basic Limits Loss and ALAE costs = $250,000

Basic Limit = $100,000 MSL = $150,000 Expected Experience Ratio = 0.9 Credibility = 0.6

Questions from the 2007 exam:

52. (1.5 points) Given the following information for a General Liability risk:

Company subject basic limit loss and ALAE costs:	$150,000
Expected experience ratio at MSL of $200,000:	0.9
Projected ultimate loss and ALAE limited by basic limits and MSL:	$250,000
Credibility factor (Z):	0.4
Credit/Debit limit:	+/-25%

Calculate the experience rating credit/debit using the ISO CGL experience rating plan. Show all work.

Questions from the 2008 exam:

39. (1.0 point) Identify and briefly explain two of the three types of prospective individual risk rating systems.

41. (2.0 points) You are given the following information:
- Premises/Operations Manual Premium = $200,000
- Expected Basic Limits Loss and ALAE Ratio = 70%
- Policy Adjustment Factor = .9
- Detrend Factor = .95
- Reported Loss and ALAE Limited by Basic Limits and MSL = $115,000
- Expected Unreported Loss and ALAE Limited by Basic Limits and MSL = $35,000
- Expected Experience Ratio= .85
- Credibility = 45%
- Maximum Credit or Debit = +-50%

a. Calculate the Actual Experience Ratio using the ISO Commercial GL Experience Rating Plan.
b. Calculate the Experience Credit or Debit using the ISO Commercial GL Experience Rating Plan.

Questions from the 2009 exam:

35. (3.25 points) Given the following information:

Frequency of Claims	Loss Amount per Claim
45%	$22,000
20%	$35,000
15%	$150,000
15%	$250,000
5%	$1,000,000

- Full Coverage Premium = $24,793
- Expected Ground-up Loss Ratio = 59%
- ALAE = 10% of losses (assume the deductible does not apply to ALAE)
- Incremental Fixed Expenses for processing a deductible = 4% of losses in deductible layer
- Load for uncollectible deductible payments = 1% of losses in deductible layer
- Profit = 8%
- Additional Risk Load = 5%
- Commission = 10%
- Other Variable Expenses = 5%

Calculate the final premium for a policy with a $100,000 deductible.

43. (1 point) An insurance company uses experience rating and schedule rating to calculate Commercial General Liability (CGL) premium for bowling ball manufacturers.
   - A schedule rating credit of up to 10% can be judgmentally given for loss control programs.
   - There are no caps on the experience modification factors.
   - The insured is a bowling ball manufacturer whose loss control program has reduced fosses by an estimated 5% each year for the last 10 years.

   Determine the appropriate schedule rating credit, assuming no changes to the insured's loss control program. Briefly explain your answer.

44. (1.5 points) Contrast experience rating and retrospective rating with respect to the following concepts:
   a. (0.75 point) Providing incentive to the insured to control losses during the policy period.
   b. (0.75 point) Providing stability in the premium charged to the insured.

Questions from the 2010 exam:

33. (3 points) Given the following information:

- Payrolls during the experience period were $10,920,000.
- Primary losses are capped at $10,000.
- The standard for full credibility is 1,082 claims.
- Weighting value = w = 0.36.
- The expected loss cost is 2.90 per $100 payroll.
- The D-ratio at $10,000 is 0.82.

Claim Size	Number of Claims
$4,000	32
$8,000	15
$15,000	3
$16,000	1
$23,000	2
$42,000	1

Calculate the NCCI experience modification factor.

34. (1 point) An insurer has been tracking the claims experience of a very large construction company for the three years the construction company has been insured by this insurer. The construction company will implement a new safety program starting in the upcoming year.

a. (0.5 point) Determine whether the insurer should use experience rating, schedule rating, or both to rate the construction company for the upcoming policy period. Briefly explain your answer.

b. (0.5 point) Assuming no additional changes, determine whether the insurer should use experience rating, schedule rating, or both to rate the construction company five years from now. Briefly explain your answer.

Questions from the 2011 exam:

19. (2.5 points) The owner of a parking lot is looking to purchase workers compensation insurance for herself and her employees. The insured has enough prior experience to be eligible for an NCCI experience rating modification factor. Given the following characteristics of the policy:

- The insured has a dedicated return-to-work program that makes it eligible for a 15% premium discount.
- The expense constant is $250.
- Actual primary losses in the experience period = $47,000
- Actual excess losses in the experience period = $10,000
- Expected primary losses = $75,000
- Expected excess losses = $15,000
- Primary credibility = 0.5
- Excess credibility = 0.1
- Exposures and applicable rates for the insured are as follows:

Class Code	Payroll	Rate per $100 of Payroll
8392 - Auto Parking Lot	$2,500,000	4.1
8742 - Salespersons	$500,000	0.5
8810 - Clerical Office Employees	$1,000,000	0.3

a. (1 point) Calculate the experience rating modification factor.
b. (0.75 point) Calculate the standard premium.
c. (0.75 point) Calculate the final premium for the insured.

The predecessor papers to the current syllabus reading "Basic Ratemaking" by Werner, G. and Modlin, C. were numerous. While past CAS questions were drawn from prior syllabus readings, the ones shown below remain relevant to the content covered in this chapter.

Solutions to questions from the 1992 exam

Question 33.

Retro premium = [Basic prem + Converted losses + Excess Loss prem + Retro Dev prem] * Tax Multiplier
  Basic premium = Standard Premium * Basic Premium Factor
  Converted losses = Reported limited losses at Evaluation Date * Loss conversion factor.
  Retro development premium = Standard premium * Retro Development Factor * Loss conversion factor.

Retro premium = [(100,000)*(.20) + {40,000 + (100,000)*(.12) + (100,000)*(.15)} * 1.10] * 1.00 = 93,700.

This premium is less than the maximum premium of [SP * maximum premium factor] and greater than the minimum premium of [SP * minimum premium factor] and is thus the correct premium. **Answer E.**

Solutions to questions from the 1994 exam

Question 26.

$$M = \frac{A_p + [w * A_e] + [(1-w) * E_e] + B}{E + B} = \frac{50{,}000 + .10 * 10{,}000 + .90 * 20{,}000 + 6{,}000}{(40{,}000 + 20{,}000) + 6{,}000} = 1.136.$$ **Answer E.**

Solutions to questions from the 1995 exam

Question 32.

Retro premium = [Basic prem + Converted Losses + Excess Loss prem + Retro Devel.prem] * tax multiplier

$$H \le R = (B + cL)T \le G$$

B = Basic premium = Standard premium * Basic premium factor .

cL = Converted losses = Reported limited losses at the evaluation date * Loss conversion factor

H = Minimum premium = Standard premium * Minimum premium factor.

G = Maximum premium = Standard premium * Maximum premium factor.

Standard premium = Manual premium **modified for** experience rating, loss constants, and minimum premium excluding premium discount and expense constant. SP = 100,000 * (1-.10) = 90,000.

Retro premium = [(90,000)*(.30) +80,000] * 1.05 = 112,350.

However, the retro premium calculation is subject to a maximum of
  SP * maximum premium factor = 90,000 * 1.20 = 108,000.

Solutions to questions from the 1997 exam

Question 13

13. According to Werner/Modlin, the basic premium in the NCCI retrospective rating plan provides for which of the following costs?
    1. Risk control services
    2. Premium taxes
    3. An allowance for profit and contingencies

According to Werner/Modlin, the following elements are included in the basic premium.

1. **The insurer's target UW profit and expenses (excluding expenses provided for by the LCF and the tax multiplier), and**
2. The cost of limiting the retrospective premium (to be between the minimum and maximum premium negotiated under the policy), and
3. The cost of limiting each occurrence to a negotiated loss limitation (if applicable).

Thus, 1 is False, 2 is False, and 3 is True **Answer B.**

Solutions to questions from the 1997 exam

Question 36

Write formulas to compute the

1. Actual Loss and ALAE ratio (ALR)
2. Adjusted Expected Loss and ALAE ratio (AELR) and
3. The Experience mod (M).

$$\text{ALR} = \frac{(\text{Reported L + ALAE Limited by BL \& MSL}) + E[\text{Unreported L + ALAE Limited by BL \& MSL}]}{\text{Subject Premium}}.$$

AELR = Expected Loss and ALAE ratio.

$$M = \frac{\text{ALR - AELR}}{\text{AELR}} * Z.$$

(i) Compute actual basic limits losses to be included in the experience rating calculation:

Step 1: Define basic limit losses. This is given in the problem as $100,000.

Step 2: Define and calculate actual basic limits loss and ALAE included in Mod Calculation:

Paid and O/S losses (including ALAE) with

(a) **indemnity** limited to basic per occurrence limits and

(b) (**indemnity + ALAE)** limited by the MSL (Given as 200,000).

Losses			Limited Losses +	**Actual Loss + ALAE**
Unlimited	Limited	ALAE	Unlimited ALAE	**limited by the MSL**
(1)	(2)	(3)	(4) = (2)+(3)	(5)
80,000	80,000	50,000	130,000	130,000
145,000	100,000	120,000	220,000	**200,000**
110,000	100,000	80,000	180,000	180,000
125,000	100,000	250,000	350,000	200,000
				710,000

A. Thus, the ALR = $\frac{[710{,}000 + 250{,}000]}{1{,}500{,}000}$ = .640

(ii) Compute Adjusted Expected Loss and ALAE ratio (AELR): AELR = .70 * .80 = .560.

B. Mod = $\left(\frac{.640 - .560}{.560}\right).50$ = .071.

Solutions to questions from the 1998 exam

Question 19.

$$M = \frac{A_p + [w * A_e] + [(1-w) * E_e] + B}{E + B} = \frac{50{,}000 + .75 * 100{,}000 + .25 * 25{,}000 + 20{,}000}{(80{,}000 + 20{,}000)} = 1.512.$$

Answer D.

Question 32.

Write formulas to compute the

1. Actual Loss and ALAE ratio (ALR)
2. The Experience mod (M).

$$\text{ALR}= \frac{(\text{Reported L + ALAE Limited by BL \& MSL}) + \text{E[Unreported L + ALAE Limited by BL \& MSL]}}{\text{Subject Premium}}.$$

$$= \frac{30{,}000 + \text{E[Unreported L + ALAE Limited by BL \& MSL]}}{\text{Subject Premium}}$$

ELR = Expected Loss and ALAE ratio.

$$M = 1 + \frac{\text{ALR - ELR}}{\text{ELR}} * Z.$$

Subject Premium = Current Basic Limits Premium * PAF_1 * PAF_2 * Detrend Factor

= 50,000 * 1.00 * 1.00 * .85 = 42,500

Expected Unreported Losses = Subject Premium * ELR * Expected % Unreported

$$= \text{Subject Premium} * \text{ELR} * \left(1 - \frac{1}{LDF_{ULT}}\right)$$

$$= 42{,}500 * .70 * \left(1 - \frac{1}{1.25}\right) = 5{,}950$$

Thus, ALR = $\frac{[30{,}000 + 5{,}950]}{42{,}500}$ = .846 ELR = .70

Mod = 1 + $\left(\frac{.846 - .70}{.70}\right) * .80$ = 1.17

Solutions to questions from the 1999 exam

Question 36.

Write formulas to compute the

1. Actual Loss and ALAE ratio (ALR)
2. The Experience mod (M).

$$\text{ALR}=\frac{\text{(Reported L + ALAE Limited by BL \& MSL) + E[Unreported L + ALAE Limited by BL \& MSL]}}{\text{Subject Premium}}.$$

$$=\frac{\text{30,000 + E[Unreported L + ALAE Limited by BL \& MSL]}}{\text{Subject Premium}}$$

ELR = Expected Loss and ALAE ratio.

$$M = 1 + \frac{ALR - ELR}{ELR} * Z.$$

Subject Premium = Current Basic Limits Premium * PAF_1 * PAF_2 * Detrend Factor
= 100,000 * 1.00 * 1.00 * .85 = 85,000

Expected Unreported Losses = Subject Premium * ELR * Expected % Unreported
= Subject Premium * ELR * .20
= 85,000 * .70 * .20 = 11,900

Note: Since there is no maximum single loss, loss limitation to basic limits is all that is necessary.

	Unlimited Loss	Basic Limits Loss (Limited to $25,000)	Allocated Loss Adjustment Expense (ALAE)	Basic Limits Loss + ALAE
	(1)	(2)	(3)	(4) = (2) + (3)
Claim #1	15,000	15,000	15,000	30,000
Claim #2	35,000	25,000	10,000	35,000

Thus, ALR = $\frac{[65{,}000+11{,}900]}{85{,}000}$ = .905 ELR = .70 Mod = 1 + $\left(\frac{.905-.70}{.70}\right)*.80$ = 1.234

b. advantage: more responsive. disadvantage: less stable

Solutions to questions from the 2000 exam

Question 28.

The formula for the experience modification factor is: $M = 1 + \frac{ALR - AELR}{AELR} * Z$, where

ALR = Actual Loss and ALAE ratio =.68
AELR = Adjusted Expected Loss and ALAE Ratio = 65.0%
Z = Credibility = .35

Thus, $M = 1 + \frac{.68 - .65}{.65} * .35 = 1.016$ **Answer B.**

Solutions to questions from the 2001 exam

Question 13. Calculate the Adjusted Expected Loss & ALAE Ratio.

On page 1 and 2 of the "Individual Risk Rating Study Note", Tiller states that the adjusted expected loss and ALAE ratio (AELR) is computed as follows:

$$AELR = \frac{Expected\ basic\ limits\ losses\ and (unlimited) ALAE\ *\ D-ratio}{Subject\ Premium}$$

Thus, $AELR = \frac{60,000*.624}{80,000} = .468$ **Answer D.**

Solutions to questions from the 2002 exam

Question 2. Calculate the experience modification factor using NCCI's "Revised Experience Rating Plan".

Step 1: Write an equation to compute the experience modification factor:

$$M = \frac{A_p + [w * A_e] + [(1-w) * E_e] + B}{E + B}$$

Step 2: Assign symbols to the given data in the problem and solve for any unknown terms:

Description	Amount	Symbol
Expected total loss	210,000	E
Expected primary loss	50,000	E_p
Actual total loss	320,000	A
Actual primary Loss	40,000	A_p
Ballast factor	30,000	B
Excess loss weighting factor	0.25	W

Note: $A_e = A - A_p$ = 320,000 – 40,000 = 280,000. $E_e = E - E_p$ = 210,000 – 50,000 = 160,000.

Step 3: Using the equation in Step 1, and the data from Step 2, solve for the experience modification factor.

$$M = \frac{40,000 + .25*280,000 + .75*160,000 + 30,000}{210,000 + 30,000} = 1.08333.$$ **Answer C.**

Solutions to questions from the 2003 exam

17. Which of the following statements are true regarding individual risk rating?
    1. Schedule rating directly reflects an entity's claim experience. False. Schedule rating takes into consideration characteristics that are expected to affect losses and ALAE but that are not reflected in past experience. Schedule rating is the only individual risk rating system that does not directly reflect an entity's claim experience.
    2. Experience rating is used when the past, with appropriate adjustments, is predictive of the future. **True**.
    3. Individual risk rating is appropriate when entities in a rating group are homogeneous. False. Individual risk rating is appropriate when there is a combination of non-homogeneous rating groups and entities with credible experience. **Answer: B. 2 only**

Solutions to questions from the 2003 exam

42. (3 points)

a. (1.5 points) Calculate the final retrospective premium. Show all work.

Step 1: Write an equation to determine the final retrospective premium:

$$H \le R = (B + cL)T \le G, \text{ where}$$

$R = Retro\ premium = [Basic\ prem + Converted\ Losses + Excess\ Loss\ prem + Retro\ Devel.prem] * tax\ mult$

$B = Basic\ premium = Standard\ premium * Basic\ premium\ factor$

$cL = Converted\ losses = Reported\ limited\ losses\ at\ the\ evaluation\ date * Loss\ conversion\ factor$

H = Minimum premium = Standard premium * Minimum premium factor.

G = Maximum premium = Standard premium * Maximum premium factor.

Step 2: Using the formulas in Step 1, and the data given in the problem, solve for the basic premium, converted losses, and excess losses.

a. Standard premium = Manual premium **modified for** experience rating, loss constants, and minimum premium excluding premium discount and expense constant. In this problem, SP is given as $ 300,000.

b. $B = Basic\ premium = Standard\ premium * Basic\ premium\ factor = \$300{,}000 * .18 = \$54{,}000$.

c. $cL = Converted\ losses = Reported\ limited\ losses\ at\ the\ evaluation\ date * Loss\ conversion\ factor$

= ($50,000 (limited) + $15,000 + $25,000) * 1.20 = $108,000

d. Excess Losses = SP * ELPF * LCF = $300,000 * .25 * 1.20 = $90,000

Retrospective Premium Development premium is to be ignored (since this elective option was not referenced)

Step 3: Using the equation in Step 1, the results from Step 2, and the data given in the problem, solve for the retrospective premium = [($54,000) + $108,000 + $90,000] * 1.04 = $262,080.

b. (1 point) Explain why the retrospective rating process tends to produce back-and-forth payments between the insured and insurer.

The back and forth premium payments are due to the retrospective premium adjustments that modify the premium based on loss experience incurred. The 1st adjustment (typically at 18 months after inception) is usually a return premium (i.e. a refund) because minimal loss experience is reported. Subsequent adjustments typically require additional premium from the insured, as losses develop over time.

c. (0.5 point) Briefly describe a mechanism that can be used to smooth these back-and-forth payments.

The retrospective development premium can be used to offset and smooth out some of the uneven cash flows.

Solutions to questions from the 2004 exam:

43. (3 points) Using the ISO experience rating plan for a policy with premises/operations coverage and the following information, calculate the experience debit or credit. Show all work.

Step 1: Write an equation to determine the experience modification:

$M = \frac{\text{AER - EER}}{\text{EER}} * \text{Z}$, where AER is the actual experience ratio, EER is the expected experience ratio, and Z is the credibility applied to this ratio.

Step 2: Write an equation to determine the AER

$$\text{AER}=\frac{\text{Projected Ultimate Loss and ALAE (Limited by BL and MSL)}}{\text{Company Subject Basic Limits Loss and ALAE}}$$

Projected Ultimate Losses and ALAE are comprised of the following two components:

a. Reported Losses and ALAE limited by Basic Limits and the MSL (given in the problem)
b. Expected Unreported Losses and ALAE Basic Limits and the MSL

Note: The experience used in the computation of the experience debit or credit, given in the problem is three policy periods completed at least 6 months prior to the 1/1/04 rating date.

Step 3: Using the data given in the problem, compute the values for the numerator and denominator of the equation shown in Step 2:

Policy Period	Subject Premium (1)	ELR (2)	Detrend Factor (3)	Subject Loss Cost (4)=(1)*(2)*(3)	EER (5)	% Unreported (6)	Unreported Losses (7)=(4)*(5)*(6)
1999	240,000	0.62	0.78	116,064	0.90	0.15	15,669
2000	240,000	0.62	0.85	126,480	0.90	0.25	28,458
2001	240,000	0.62	0.94	139,872	0.90	0.40	50,354
				382,416			94,481

Note: The numerator is computed as the sum of the reported loss and ALAE for experience period as of 9/30/03 (limited by basic limits losses and MSL) of $300,000 and the Unreported losses shown in col (7) above of 94,481 = 394,481. The denominator, computed in col (4) above, is 382,416

Thus, $AER = \left(\frac{394,481}{382,416}\right) = 1.0315$, and $M = \frac{1.0315 \text{ - } .90}{.90} * .35 = .051$ (experience debit)

M = +5.1% experience debit.

Solutions to questions from the 2005 exam:

54. (2 points) Given the following information for an insured, determine the General Liability premium after adjustments for experience and schedule rating. Show all work.

Step 1: Write an equation to determine the GL premium after adjusting for experience and schedule rating:

Adjusted premium = Manual premium * Experience Modification Factor * Schedule Rating factors

Note: The experience modification factor (M) = 1 + [AER – EER]/AER * Z

Step 2: Using the formula in Step 1, and the data given in the problem, solve for the adjusted premium.

I. Experience Components		
A. Reported Losses and ALAE Limited by Basic Limits and MSL		93,500
B. Expected Unreported Losses and ALAE Limited by Basic Limits and MSL	25,200	
C. Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL (A)+(B)		118,700
D. Company Subject Basic Limits Loss and ALAE Costs		153,900
E. Actual Experience Ratio (C)/(D):	AER =	.7713
II. Exposure Component: Expected Experience Ratio:	EER =	.9200
III. Credibility		.35
(M) = 1 + [AER – EER]/AER * Z	1 + [(0.7713 – 0.92)/0.92]*.35 = .943	
Cumulative additive impact of schedule	+.04 - .07 - .08 + .03 = -.08	

Adjusted premium = $75,800 * .943 * (1 - .08) = $65,761

Solutions to questions from the 2006 exam:

10. John's Car Wash is a new single-location business. It is purchasing commercial general liability insurance. Which of the following rating methods might be used in calculating the premium?

1. Schedule Rating
2. Experience Rating. ER is not appropriate to use, since this is a new business, it has no actual experience to modify application of manual rates.
3. Composite Rating. CR is not appropriate to use, since the business is small, its exposures are not complex, and it has no experience to modify application of manual rates.

A. 1 only B. 2 only C. 3 only D. 1 and 2 only E. 1 and 3 only

"Schedule rating takes into consideration characteristics that are expected to affect losses and ALAE but that are not reflected in past experience.

Experience rating uses an entity's actual experience to modify manual rates (determined by the entity's rating group).

Composite rating simplifies the premium calculation for large, complex entities and, in some instances, allows the entities' experience to affect the premium developed from manual rates or to determine the rates regardless of rating group."

Answer A:

Solutions to questions from the 2006 exam:

Question 49:

Calculate the experience (Credit)/Debit based on the ISO CGL Experience Rating Plan

Step 1: Write an equation to determine experience Credit/Debit: [AER – EER]/AER * Z, where:

AER = Actual Experience Ratio

= Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL / Company Subject BL Loss and ALAE

EER = Expected Experience Ratio and Z = Credibility.

Step 2: Using the formula in Step 1, and the data given in the problem, determine what components need to be solved for.

I. Experience Components		
A. Reported Losses and ALAE Limited by Basic Limits and MSL		?
B. Expected Unreported Losses and ALAE Limited by Basic Limits and MSL		45,000
C. Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL (A)+(B)		? +45,000
D. Company Subject Basic Limits Loss and ALAE Costs		250,000
E. Actual Experience Ratio (C)/(D):	AER =	?
II. Exposure Component: Expected Experience Ratio:	EER =	0.900
III. Credibility		0.60

Step 3: Compute the Reported Losses and ALAE Limited by Basic Limits and MSL.

Unlimited losses are first capped by the basic limit. ALAE is then added to these resulting losses, and then capped by the MSL.

Claim	Unlimited Losses	Losses Limited to 100,000	ALAE	Limited Losses and ALAE capped by the MLS
	(1)	(2)	(3)	(4)=(2)+(3)
1	1,000	1,000	200	1,200
2	1,500	1,500	200	1,700
3	5,000	5,000	800	5,800
4	6,000	6,000	1,000	7,000
5	12,000	12,000	1,800	13,800
6	23,000	23,000	2,200	25,200
7	120,000	***100,000***	40,000	140,000
Losses & ALAE Limited by Basic Limits and MSL				**194,700**

Step 4: Using the equation in Step 1, the result of Step 3 and the data given in the problem, solve for experience (Credit)/Debit

AER = (Reported + Unreported) / Company Subject BL Loss and ALAE

= (194,700 + 45,000) / 250,000 = 0.9588

EER = 0.90

Experience (Credit)/Debit = (AER – EER)/EER x Z = (0.9588 – 0.9)/0.9 x 0.6 = 0.0392

Solutions to questions from the 2007 exam:

52. (1.5 points) Calculate the experience rating credit/debit using the ISO CGL experience rating plan. Show all work.

Step 1: Write an equation to determine the experience rating credit/debit

CD = [(AER-EER)/EER](Z), subject to the CD Limit, where CD = Experience Credit or Debit, AER = Actual Experience Ratio, EER = Expected Experience Ratio and Z = Credibility.

Step 2: Compute the AER.

AER = (Projected Ult Loss and ALAE limited by BL and MSL)/(Company Subject BL Loss and ALAE)
= 250,000/150,000 = 1.6667

Step 3: Using the equation in Step 1, and the givens in the problem, solve for the experience rating credit/debit

CD = [(AER-EER)/EER](Z) =[(1.6667 - 0.90)/0.90] (0.40); CD = 0.3407

This implies a debit of +34.07%. But CD is limited by ± 25%, so min (34.07%, 25%) = 25%

Solutions to questions from the 2008 exam:

Model Solution – Question 39

1. Schedule Rating – Based on the characteristics of loss exposures of insured, underwriters assign debit or credit for the policy. Actual experience is not considered.
2. Experience Rating – Based on insured's experience, underwriters adjust the premium to be charged. Large risks that have more credible experience get more credibility towards their experience whereas small risks get less credibility towards their experience.

Model Solution – Question 41

a. Calculate the Actual Experience Ratio using the ISO Commercial GL Experience Rating Plan.

Step 1: Write an equation to determine the Actual Experience Ratio (AER)

$$AER=\left(\frac{(\text{Reported } L+ALAE \text{ Limited by } BL \ \& \ MSL) + E[\text{Unreported } L+ALAE \text{ Limited by } BL \ \& \ MSL]}{\text{Company Subject } BL \text{ Losses and } ALAE}\right)$$

Step 2: Write an equation and compute the Company Subject BL loss and ALAE

On page 166 of the 4th edition of the "Foundations of Casualty Actuarial Science", Tiller provides an example of how to compute Company Subject BL Loss and ALAE

Company Subject BL L+ALAE = Prem/Ops Manual Premium * ELR * PAF_1 * PAF_2 * Detrend Factor

= 200,000 * 0.70 * 0.90 *.95 = 119,700

Note: Although we are only given one PAF, know that

- PAF_1 adjusts current company basic limits loss and ALAE up to an occurrence level.
- PAF_2 adjusts for the experience period being CM, reflecting the CM year.

Step 3: Using the equation in Step 1, the result from Step 2 and the data given in the problem, solve for the AER.

$$AER = \left(\frac{\$115{,}000+\$35{,}000}{\$119{,}700}\right) = 1.253$$

Solutions to questions from the 2008 exam (continued):

Model Solution – Question 41 (continued):

b. Calculate the Experience Credit or Debit using the ISO Commercial GL Experience Rating Plan.

Step 1: Write an equation to determine the experience rating credit/debit

CD = [(AER-EER)/EER](Z), subject to the CD Limit, where CD = Experience Credit or Debit, AER = Actual Experience Ratio, EER = Expected Experience Ratio and Z = Credibility.

Step 2: Using the equation in Step 1, the results from part a, and the data given in the problem, solve for the experience rating credit/debit

CD = [(AER-EER)/EER](Z) =[(1.253 - 0.85)/0.85] (0.45); CD = 0.213

This implies a debit of +21.3%. But the CD is limited by ± 50%, so min (21.3%, 50%) = 21.3%

Solutions to questions from the 2009 exam:

Question 35. Calculate the final premium for a policy with a $100,000 deductible.

$$Premium = \frac{Losses\ above\ Deductible + ALAE + Fixed\ Expense + Credit\ Risk + Risk\ Margin}{(1.0 - Variable\ Expense\ Provision - Profit\ Provision)}$$

Compute the following:

$$LER(100K) = \frac{.45\ (22,000) + .20(35,000) + (.15 + .15 + .05)(100,000)}{.45\ (22,000) + .2(35,000) + .15(150,000) + .15(250,000) + .05(1,000,000)} = \frac{51,900}{126,900} = .4089$$

$$Excess\ \ ratio = 1.0 - LER_{100K} = 0.591$$

Losses = Full coverage premium * Expected ground up LER = 24,793 (.59) = **14,627.87**

Thus, Excess loss = .591 (14,627.87) = **8,645.31**, and

Losses in the deductible layer = 14,627.87 – 8,645.31= **5,982.56**

Since the problem does not state, assume ALAE is not reduced by ded: Thus, .10(14,627.87) = **1,462.787**

Incremental Fixed Expenses for processing a deductible = .04 * (5,982.56) = **239.302**

Load for Uncollected Deductible payments = .01 * (5,982.56) = **59.826**

Risk Load (assume it applies to losses from excess layer) = .05(8,645.31) = **432.27**

$$\Pr emium = \frac{8,645.31 + 1,462.787 + 239.302 + 59.826 + 432.27}{1 - .08 - .10 - .05} = \boxed{14,077.27}$$

Question: 43

No schedule rating credit should be given. The reduced loses has already been measured and would be reflected in the experience rating. If the insured were to also be given a schedule credit then there would be a double counting of credits.

Question 44

a. In retrospective rating, insurer will try to control losses incoming period because their loss experience will be used to calculate their rate. In experience rating, they have less motivation to control losses, because rate is based on past experience.

b. Experience rating is more stable because it uses experience over several periods and retrospective rating is very likely to fluctuate because it is based on loss experience during a single policy period only.

Solutions to questions from the 2010 exam:

Question 33

- The NCCI ER Plan divides losses into primary and excess components.
- The mod formula credibility weights primary and excess losses separately:

$$M = \frac{Z_P * A_P + (1.0 - Z_P) \times E_P + Z_e \times A_e + (1.0 - Z_e) \times E_e}{E}$$, where

M = Experience Modification Factor
A_P = Actual Primary Losses, A_e = Actual Excess Losses
E_P = Expected Primary Losses E_e = Expected Excess Losses
E = Ep + Ee
Z_P = Primary Credibility Z_e = Excess Credibility

- Primary losses are capped at $10,000; Excess losses are the portion of each individual loss above $10,000.
- Expected losses are separated into the primary and excess components based upon a D-ratio of .82
- Ep = Payroll/$100 * expected loss cost per $100 payroll * D-ratio
- w = Excess Loss Weighting Value = Ze/Zp.

Calculate Ap = 4,000 * 32 + 8,000 * 15 + 10,000 * (3+1+2+1) = 318,000
Calculate Ae = 15,000 * 3 + 16,000 * 1 + 23,000 * 2 + 42,000 * 1 -10,000 * (3+1+2+1) = 79,000
Calculate Ep =10,920,000/100 * 2.9 * 0.82 = 259,678
Calculate Ee = 10,920,000/100 * 2.9 * (1 – 0.82) = 57,002

There are 32 + 15 + 3 + 1 + 2 + 1 = 54 primary claims in the experience period. By the square root rule:
Zp = √(54/1082) = 0.223

Calculate Ze. Since w = Ze/Zp: Ze = Zp * w = 0.223 * .36 = 0.080
M = [Zp * Ap + (1.0 – Zp) * Ep + Ze * Ae + (1.0 – Ze) * Ee] / E
= [0.223 * 318,000 + (1 – 0.223) * 259,678 + 0.080 * 79,000 + (1 – 0.080)*57,002] / (259,678 + 57,002)
= 1.0467

34. (1 point) An insurer has been tracking the claims experience of a very large construction company for the three years the construction company has been insured by this insurer. The construction company will implement a new safety program starting in the upcoming year.

a. (0.5 point) Determine whether the insurer should use experience rating, schedule rating, or both to rate the construction company for the upcoming policy period. Briefly explain your answer.

b. (0.5 point) Assuming no additional changes, determine whether the insurer should use experience rating, schedule rating, or both to rate the construction company five years from now. Briefly explain your answer.

Question 34

A. Both. Experience rating should be used to reflect the claims experience over the previous 3 years and schedule rating to reflect the new safety program and the expected reduction in losses it will create.

B. Just experience rating. 5 years after the safety program has been implemented, the effects of the program should be seen as experience and taken into account through experience rating.

Solutions to questions from the 2011 exam:

a. (1 point) Calculate the experience rating modification factor.

b. (0.75 point) Calculate the standard premium.

c. (0.75 point) Calculate the final premium for the insured.

Initial comments

To account for differences in expense and loss levels for larger insureds, some WC insurers vary the expense component for large risks, incorporate premium discounts or loss constants, or all of these.

Standard premium is a term defined by the National Council of Compensation Insurers (NCCI). In general, it is premium **before application of premium discounts and expense constants.**

- The insured has a dedicated return-to-work program that makes it eligible for a 15% premium discount.
- The expense constant is $250.

$$M = \frac{Z_P * A_P + (1.0 - Z_P) \times E_P + Z_e \times A_e + (1.0 - Z_e) \times E_e}{E}$$, where

M = Experience Modification Factor
A_P = Actual Primary Losses, A_e = Actual Excess Losses
E_P = Expected Primary Losses E_e = Expected Excess Losses
E = Ep + Ee
Z_P = Primary Credibility Z_e = Excess Credibility

$$M = \frac{A_P + w \times A_e + (1.0 - w) \times E_e + B}{E + B}$$, where

B = Ballast Value, which is based on: Z_P = E/(E +B); w = Excess Loss Weighting Value = Ze/Zp.

Question 19 – Model Solution 1

a. M = [ZpAp + (1 - Zp)Ep + ZeAe + (1 - Ze)Ee] / (Ep + Ee)
= [0.5(47,000) + 0.5(75,000) + 0.1(10,000) + 0.9(15,000)] / (75,000 + 15,000) = 0.8388 →Mod factor

b. Manual premium = 2,500,000 / 100 * 4.1+ 500,000 / 100 * 0.5 + 1,000,000 / 100 * 0.3 = 108,000
Standard premium = 108,000 * 0.8388 = 90,590

c. Final premium = 90,590 * (1 - 0.15) + 250 = 77,252; where 0.15 = discount and 250 = exp. constant

Question 19 – Model Solution 2 – part a

a. M = [Ap + w * Ae + (1 - w)Ee + B] / (E + B) = [47 + .2(10) + .8(15) + 90] / (90 + 90) = $\boxed{.8389}$

w = Ze/Zp, • Excess credibility = 0.1; •Primary credibility = 0.5; W= .1/.5 = .2

Zp = E/(E + B)→ .5 = 90,000 / (90,000 + B) →B = 90,000
E= Ep + Ee = 75,000 + 15,000 = 90,000

1 Report Year Aggregation 312 –314

To understand how claims-made (CM) coverage and occurrence coverage differ, review the following diagram that categorizes claims by the year reported and the report lag:

Note: Report lag refers to the time between the occurrence date and report date of a claim.

Report Year Aggregation

		Report year Lag				
		0	1	2	3	4
Report Year	2010	***L(2010,0)***	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	***L(2012,2)***	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Examples:

- L(2010,0) represents a claim that occurs in 2010 and is reported in year 2010 (i.e. there is 0 time lag between when the claim occurred and when it was reported).
- L(2012,2) represents a claim that is reported in 2012 after a report lag of two years (i.e. the claim occurred in 2010).

In general, each:

- row corresponds to claims reported in a given year (i.e. the report year)
- column corresponds to claims that share the same reporting lag
- diagonal (top left to bottom right) represents claims that occurred in the same year (i.e. the same AY).

Occurrence policies

Occurrence policies cover claims that occur during the policy period regardless of when the claim is reported, and are aggregated by accident year (i.e. ***each diagonal*** in the table). Example:

- An annual occurrence policy written on 1/1/2010 covers claims incurred during the policy period and reported either during or after the policy period.
- This policy covers claims reported in 2010 with no report lag, claims reported in 2011 with a one-year report lag, claims reported in 2012 with a two-year report lag, etc.

Thus, Occurrence Policy (2010) = L(2010,0)+ L(2011,1)+ L(2012,2)+ L(2013,3)+ L(2014,4).

Given a maximum report lag of N, the occurrence policy for year Y can be written as follows:

Occurrence Policy $(Y) = \sum_{i=0}^{N} L(Y+i,i)$

Claims-Made policies

The coverage trigger for a CM policy is the report date. A CM policy is represented by the entries in a ***row***.

A CM policy written on 1/1/2010 covers all claims reported in 2010 (regardless of the report lag):

CM Policy (2010) = L(***2010***,0)+ L(***2010***,1)+ L(***2010***,2)+ L(***2010***,3)+ L(***2010***,4).

This can be written as: CM Policy $(Y) = \sum_{i-0}^{N} L(Y,i)$

Compare a 2010 CM policy (within the dotted box) to a 2010 occurrence policy (within the solid diagonal box).

Comparison of 2010 Claims-Made and Occurrence Policies

		Report Year Lag				
Report Year		0	1	2	3	4
	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2	L(2015,3)	L(2015,4)

2 Claims Made Policy Principles 314 – 317

In "Rating Claims-Made Insurance Policies" (Marker and Mohl 1980), the authors list five principles of claims-made policies that detail how pricing risk is reduced when compared to pricing occurrence policies.

1. A claims-made policy ***should always cost less than an occurrence policy*** as long as claim costs are increasing.

2. If there is a sudden, unexpected change in the underlying trends, *a claims-made policy priced based on the prior trend will be closer to the correct price than an occurrence policy* based on the prior trend.

3. If there is a sudden, unexpected shift in the reporting pattern, *the cost of a mature claims-made policy* (i.e. a policy that covers claims reported during the policy period regardless of accident date) *will be affected relatively little, if at all, relative to the occurrence policy*.

4. Claims-made policies *incur no liability for IBNR*, so the risk of reserve inadequacy is greatly reduced.

5. Investment income earned from claims-made policies *is substantially less* than under occurrence policies.

To demonstrate these principles, assume the following:

- Exposure levels are constant.
- The average loss cost for RY 2010 is $1,000 (see below).
- Loss costs increase by 5% each report year (see below).
- An equal number of incurred claims are reported each year and all claims are reported within 5 years of occurrence (i.e. 20% reported each year).
- Loss costs do not vary by report year lag. Any trends affecting settlement lag have been ignored.
- The data underlying these assumptions is shown in the table below:

Report	Loss Costs by Report Year Lag					Claims Made
Year	0	1	2	3	4	Loss Costs
2010	$200.00	$200.00	$200.00	$200.00	$200.00	**$1,000.00**
2011	$210.00	$210.00	$210.00	$210.00	$210.00	$1,050.00
2012	$220.50	$220.50	$220.50	$220.50	$220.50	$1,102.50
2013	$231.53	$231.53	$231.53	$231.53	$231.53	$1,157.65
2014	$243.10	$243.10	$243.10	$243.10	$243.10	$1,215.50
2015	$255.26	$255.26	$255.26	$255.26	$255.26	$1,276.30
2016	$268.02	$268.02	$268.02	$268.02	$268.02	$1,340.10
2017	$281.42	$281.42	$281.42	$281.42	$281.42	$1,407.10
2018	$295.49	$295.49	$295.49	$295.49	$295.49	$1,477.45

Accident Year	Occurrence Loss Costs	Using Loss Costs by Report Year Lag from above
2010	$1,105.13	=200 + 210 + 220.50 + 231.53 + 243.10
2011	$1,160.39	
2012	$1,218.41	
2013	$1,279.33	
2014	$1,343.29	

Principle 1

"A claims-made policy should always cost less than an occurrence policy as long as claim costs are increasing."

Since there is a shorter period of time between coverage trigger and settlement date for CM policies, and since short-term projections are more accurate than long-term ones, a CM policy should always cost less.

Example: An actuary pricing a 2011 CM policy only needs to project the ultimate cost of claims that will be reported in that year.

An actuary pricing a 2011 occurrence policy has to project the ultimate value of claims that occur in 2011 and may not even be reported until 2015.

Principle 2

"If there is a sudden, unpredictable change in the underlying trends, the claims-made policy priced based on the prior trend will be closer to the correct price than an occurrence policy based on the prior trend."

The following table assumes actual loss cost trend by report year is 7% instead of 5%:

Unexpected Trend

Report Year	Loss Costs by Report Year Lag 0	1	2	3	4	Claims Made Loss Costs
2010	$200.00	$200.00	$200.00	$200.00	$200.00	$1,000.00
2011	$214.00	$214.00	$214.00	$214.00	$214.00	**$1,070.00**
2012	$228.98	$228.98	$228.98	$228.98	$228.98	$1,144.90
2013	$245.01	$245.01	$245.01	$245.01	$245.01	$1,225.05
2014	$262.16	$262.16	$262.16	$262.16	$262.16	$1,310.80
2015	$280.51	$280.51	$280.51	$280.51	$280.51	$1,402.55
2016	$300.15	$300.15	$300.15	$300.15	$300.15	$1,500.75
2017	$321.16	$321.16	$321.16	$321.16	$321.16	$1,605.80
2018	$343.64	$343.64	$343.64	$343.64	$343.64	$1,718.20

Accident Year	Occurrence Loss Costs	Using Loss Costs by Report Year Lag from above
2010	$1,150.15	
2011	**$1,230.66**	=214 + 228.98 + 245.01 + 262.16 + 280.51
2012	$1,316.81	
2013	$1,408.99	
2014	$1,507.62	

- The unexpected increase in trend resulted in RY 2011 loss cost for the CM policy to be 1.9% (=$1,070.00 / $1,050.00 – 1.0) higher than the original estimate in the prior Table.
- The unexpected trend increase resulted in an AY 2011 loss cost for the occurrence policy that is 6.1% (=$1,230.66/1,160.39 -1.0) higher than the original estimate.

Since occurrence policies cover claims reported in the future and are more significantly affected by trend, an error made in the trend selection has more of an impact on occurrence policies.

Principle 3

"If there is a sudden, unexpected shift in the reporting pattern, the cost of a **mature** CM policy will be affected relatively little, if at all, relative to the occurrence policy."

Example: Assume that 5% of the claims are reported one year later than expected, but all claims are reported within five years (e.g. in 2010, $50 of the loss cost shifts from lag 0 to lag 1, $50 of the loss costs from lag 1 shift to lag 2, and so on).

Since an equal amount of loss costs are shifting in and out of lag periods 1, 2, and 3, the only impact is on the **first** and **last** lag periods.

Unexpected Reporting Shift

Report Year	Loss Costs by Report Year Lag 0	1	2	3	4	Total All Lags
2010	**$150.00**	$200.00	$200.00	$200.00	**$250.00**	**$1,000.00**
2011	**$157.50**	$210.00	$210.00	$210.00	**$262.50**	**$1,050.00**
2012	$165.38	$220.50	$220.50	$220.50	$275.63	$1,102.51
2013	$173.64	$231.53	$231.53	$231.53	$289.41	$1,157.64
2014	$182.33	$243.10	$243.10	$243.10	$303.88	$1,215.51
2015	$191.44	$255.26	$255.26	$255.26	$319.07	$1,276.29
2016	$201.02	$268.02	$268.02	$268.02	$335.03	$1,340.11
2017	$211.07	$281.42	$281.42	$281.42	$351.78	$1,407.11
2018	$221.62	$295.49	$295.49	$295.49	$369.37	$1,477.46

Accident Year	Occurrence Loss Costs	Using Loss Costs by Report Year Lag from above
2010	**$1,115.91**	=150 + 210 + 220.50 + 231.53 + 303.88
2011	**$1,171.70**	=157.50 + 220.50 + 231.53 + 243.10 + 319.07
2012	$1,230.30	
2013	$1,291.80	
2014	$1,356.40	

Conclusions:

- There is no impact on the loss cost estimates for the CM policies
- Estimates for the occurrence policies have changed (e.g. for AY 2011 loss cost estimate for the occurrence policies has changed by 1% (= ($1,171.70 / $1,160.39) – 1.0).

Principle 4

"Claims-made policies incur no liability for IBNR, so the risk of reserve inadequacy is greatly reduced."

- When pricing occurrence policies, reserves for incurred but not reported (pure IBNR) claims and incurred but not enough reported (IBNER) must be established.
- CM policies have no pure IBNR component. Only the IBNER reserve has to be determined and so the risk of reserve inadequacy is greatly reduced.

Principle 5

"The investment income earned from claims-made policies is substantially less than under occurrence policies." Insurers are required to hold unearned premium reserves, case reserves, IBNR reserves, and IBNER reserves which are invested over a period of time.

Since the CM policy has a shortened period of time between collection of premium and payment of claim, funds are invested for a shorter time and less investment income is earned relative to an occurrence policy.

This principle has pricing risk implications for CM policies (e.g. when determining the target UW profit provision, the actuary should take into account both reduced investment income as well as reduced pricing risk).

3 Determining Rates 317 - 317

Once expected loss costs are determined, rates are derived using techniques previously discussed.

4 Coordinating Policies 317 - 320

Insureds converting from one policy type to the other should be aware of coverage **overlaps** or **gaps**, since occurrence and CM policies have different coverage triggers.

- Consider an insured that had an occurrence policy in 2010 and switches to a CM policy starting in 2011.
- Notice the overlapping coverage between the occurrence policy and the claims-made policy.

Comparison of Several Claims-Made and Occurrence Policies

Report Year	Report Year Lag 0	1	2	3	4
2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = within dotted rectangle Occurrence Policy = shaded

Retroactive Date

CM policies have a retroactive date (only claims that occur on or after the retroactive date are covered).

To obtain complete coverage *without overlap*, the retroactive date should coordinate with the expiration of the last occurrence policy.

By applying the retroactive date to the table above, the results are shown in the table below.

- The insured can purchase a 1st year CM policy in 2011 with a retroactive date of 1/1/2011.
  The 1st year CM policy will only provide coverage for claims that occurred on or after 1/1/2011, and were reported in 2011 (i.e. L(2011,0)).
- A 2nd year CM policy with a retroactive date of 1/1/2011 will cover L(2012,0) and L(2012,1).
- This continues until a **mature CM** policy is issued in 2015.

Coordinating the Switch from Occurrence to Claims-Made Policy

Report Year	Report Year Lag 0	1	2	3	4
2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = within dotted rectangle Occurrence Policy = shaded

Rating CM policies includes using a step factor to recognize the growth in exposure for each successive CM policy during the transition.

- The step factor is a % of the **mature** claims-made rate.
- Computing step factors requires evaluating the expected reporting lag and factors affecting claim costs during the lag time and leads to a distribution of costs to each of the lags of a mature claims-made policy.

Example: Consider the 2015 mature claims-made policy from 2015

- Loss estimates for L(2015,0), L(2015,1), L(2015,2), L(2015,3) and L(2015,4) expressed as a ratio to the total losses for RY 2015 can be used to determine the step factors.
- The cumulative values of these ratios, by year of lag, are used to determine the step structure.
- The table below shows a potential step factor structure for a CM policy.

Claims-Made Year	Step Factor
First	40%
Second	70%
Third	85%
Fourth	95%
Fifth or More	100%

i. 40% of the of the costs of a mature CM policy come from claims that occurred and were reported during that year.

ii. 70% of the costs come from claims that occurred during that year and one year prior (and the progression continues until the mature stage is reached).

Example: An insured switching from a CM policy to an occurrence policy in 2011.

		Report Year Lag				
		0	1	2	3	4
Report Year	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,3)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = within dotted rectangle   Occurrence Policy Coverage = shaded

This causes a coverage gap, since there is no coverage for claims that occurred before 2011, but were not reported until after the expiration of the last CM policy.

Thus, insurers offer an extended reporting endorsement (or tail coverage) that covers claims that occurred but were not reported before the expiration of the last CM policy.

Switching from Claims-Made to Occurrence Policy with Tail Coverage

		Report Year Lag				
		0	1	2	3	4
Report Year	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,3)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

CM = within dotted rectangle   ***Tail Coverage = within the dotted triangle***

Occurrence Policy Coverage = shaded

A gap in coverage can also occur in the case of retirement.

- If physicians with CM policies retire, they need protection against claims that are reported after the expiration of the last CM policy.
- This protection is given by a tail policy that covers losses occurring during the period for which CM coverage was in force and that are reported after the insured's last CM policy expires.

5 Key Concepts 321 - 321

1. Rationale for claims-made coverage

2. Aggregating losses by report year and report lag

3. Coverage triggers for claims-made coverage

5. Coordinating coverage
   a. Retroactive date
   b. First- and second-year claims-made policies
   c. Mature claims-made policies
   d. Extended reporting endorsement or tail coverage

Questions from the 1988 exam

26. (1 point) According to Werner and Modlin, "Basic Ratemaking, which of the following is not one of the principles of claims-made (C-M) ratemaking?

A. Substantially less investment income is earned on C-M policies than under occurrence policies.
B. Sudden unexpected shifts in the reporting pattern will have less of an impact on the cost of mature C-M coverage than on the cost of occurrence coverage.
C. C-M policies have less risk of case reserve inadequacies than do occurrence policies.
D. A C-M policy should always cost less than an occurrence policy as long as pure premiums are increasing.
E. Whenever there is a sudden, unpredictable increase or decrease in the underlying trend, C-M policies priced on the basis of the prior trend will be closer to the correct price than occurrence policies priced the same way.

58. (a) (2 points)

An insurance company will give policyholders a choice of purchasing an occurrence policy or a claims-made policy beginning 1/1/88. From reviewing the company's experience, you know that all losses are reported within 4 years of occurrence, that the losses reported in 1986 totaled $400 and that these losses were produced in equal proportions from accidents that occurred between 1983 and 1986.

(a) (1 point) Assume that there will be no change in the reporting pattern of claims and that inflation will be 10% per year. Ignoring investment income and risk, determine the multiplier that should be applied to the adequate rate for an occurrence policy to get the rate for:
1) a first year claims-made policy.
2) a mature claims-made policy.

(b) (1 point) As a current occurrence coverage policyholder, you must decide whether to purchase the claims-made coverage policy. You plan to retire in 2 years and the company assures you that they will sell you tail coverage at that time.

Which coverage should you purchase? Assume that the conditions outlined above apply and that your decision will be based solely on the cost of the total coverage (i.e. 2 years of occurrence policies versus a first year claims made policy, a second year claims made policy, and tail coverage).

Assume all prices quoted are based on the same expected loss ratio. Explain the reasons for your decision.

59.

Using Werner and Modlin, "Basic Ratemaking," Made Insurance Policy" and given the fact that L0,0 = L1,0=L2,0 = L3,0 =L4,0 available for ratemaking (where $L_{i\,j}$ represents the pure premium for accident year lag i and report year j)

(a) (1 point) Demonstrate and identify the first principle of claims made ratemaking by pricing both occurrence and claims made policies (ignore expenses) effective at the beginning of year 1 assuming losses will increase $50 for each report year for each lag.

(b) (1 point) Demonstrate and identify the second principle of claims made ratemaking by pricing both occurrence and claims made policies (ignore expenses) effective at the beginning of year 1 assuming the increase in losses was underestimated by $15 per year per lag (i.e. losses are actually increasing at $65 per reported year).

Questions from the 1989 exam

20. From Werner and Modlin, "Basic Ratemaking", which of the following are true?

1. A claims-made policy should always cost less than an occurrence policy.
2. The investment income earned from claims-made policies is about the same as is earned from occurrence policies.
3. A sudden unexpected shift in the reporting pattern will have relatively little effect on the cost of a mature claims-made policy relative to the effect on the cost of an occurrence policy.

A. 1   B. 2   C. 3   D. 2, 3   E. 1, 2, 3.

55. (3 points)

You are acting as a consultant for a doctor beginning a private practice in an obscure specialty. The doctor wants the lowest-cost malpractice coverage available for the first two years of practice, in order to pay off a substantial loan debt. Beginning in the third year, the doctor would prefer to pay a higher cost for a policy that would cover any claims that may emerge from that year's practice.

After some thought, you explain to the doctor that at today's price levels you can recommend policies that would have a relatively low first year cost, a higher second year cost, and a much higher third year costs. Fourth and subsequent years costs would be lower than year three.

a. (1 point) What type of policies do you recommend for years 1, 2, and 3?

b. (2 points) The doctor is confused by your comment on the third year premiums. Use the report year/lag diagram approach outlined in Werner and Modlin, "Basic Ratemaking" , to illustrate your recommendations by labeling the sections corresponding to the policies you recommended in part (a). Assume that all claims would be settled by the end of the third year following their occurrence.

Questions from the 1990 exam

23. You are pricing a claims-made policy for the 1991 year using occurrence year 1990 data. Under existing conditions, you estimate that 1990 occurrence year losses will be reported in the following manner:

Report Year	1990 Occurrence Year Percentage of Losses Reported
1990	40%
1991	20%
1992	20%
1993	10%
1994	10%

If loss costs are increasing at an annual rate of 10%, what is the 1991 mature claims-made multiple of the 1991 occurrence pure premium?

A. < .88   B. $\geq$ 88 but <.92   C. $\geq$ .92 but <.96   D. $\geq$ 96 but < 1.00   E. $\geq$ 1.00

Questions from the 1990 exam

24. According to Werner and Modlin, "Basic Ratemaking", which of the following statements about the use of occurrence data to price claims-made coverage is FALSE?

A. In order to distribute the mature pure premium to lags, exponential regression is preferred to linear regression through the origin.
B. An adjustment to claim reporting patterns is needed since it is assumed that claims will be reported sooner under claims-made coverage.
C. Under claims-made coverage there are assumed to be additional incidents reported that would not have been reported under an occurrence policy.
D. Expenses should be separated into their fixed and variable portions and the final rate calculated accordingly.
E. None of the above.

Questions from the 1991 exam

For the next two questions use the techniques described by Werner and Modlin, "Basic Ratemaking" and using the following data:

		Report Year						
		1	2	3	4	5	6	7
	0	$L_{0,1}$	$L_{0,2}$	$L_{0,3}$	$L_{0,4}$	$L_{0,5}$	$L_{0,6}$	$L_{0,7}$
L	1	$L_{1,1}$	$L_{1,2}$	$L_{1,3}$	$L_{1,4}$	$L_{1,5}$	$L_{1,6}$	$L_{1,7}$
A	2	$L_{2,1}$	$L_{2,2}$	$L_{2,3}$	$L_{2,4}$	$L_{2,5}$	$L_{2,6}$	$L_{2,7}$
G	3	$L_{3,1}$	$L_{3,2}$	$L_{3,3}$	$L_{3,4}$	$L_{3,5}$	$L_{3,6}$	$L_{3,7}$
	4	$L_{4,1}$	$L_{4,2}$	$L_{4,3}$	$L_{4,4}$	$L_{4,5}$	$L_{4,6}$	$L_{4,7}$

27. Which of the following expressions defines a second-year claims made policy written at the beginning of year 4?

A. $L_{0,3} + L_{1,3}$
B. $L_{0,4} + L_{1,4}$
C. $L_{1,4} + L_{2,5} + L_{3,6} + L_{4,7}$
D. $L_{0,3} + L_{1,4} + L_{2,5} + L_{3,6} + L_{4,7}$
E. None of A, B, C, or D.

28. Which of the following expressions defines a tail policy for an insured at the end of year 3 who had previously purchased three consecutive claims-made policies, the first in year 1?

A. $L_{0,4} + L_{0,5} + L_{0,6} + L_{0,7}$
B. $L_{1,3} + L_{2,3} + L_{3,3} + L_{4,3}$
C. $L_{0,3} + L_{1,4} + L_{2,5} + L_{3,6} + L_{4,7}$
D. $L_{1,4} + L_{2,4} + L_{3,4} + L_{2,5} + L_{3,5} + L_{4,5}$
E. None of A, B, C, or D.

Questions from the 1992 exam

1. According to Werner and Modlin, "Basic Ratemaking", which of the following are true?
   1. The cost of mature claims-made coverage is less susceptible to changes in the reporting pattern than occurrence coverage.
   2. Occurrence pricing is less affected by sudden, unpredictable changes in trend than claims-made pricing.
   3. While claims costs are increasing, occurrence policies should always cost more than claims-made.

A. 1 B. 2 C. 1, 2 D. 1, 3 E. 1, 2, 3

Questions from the 1992 exam (continued):

The following information should be used to answer questions #29 and #30.
Questionable Insurance Company specializes in claims-made accountant's malpractice insurance. Questionable has been writing this line for ten years and has never experienced a claim with a report lag greater than four years. Fully developed and credible 1990 reporting and exposures show the following pure premiums:

Lag	1990 Pure Premium Per Accountant
0	$1,000
1	$2,000
2	$3,000
3	$2,000
4	$1,000

The overall trend is 10% annually.

29. Compute the pure premium for an individual accountant with a policy written 1/1/92 with a 1/1/91 retroactive date.

A. < $3,700 B. ≥ $3,700 but < $3,800 C. ≥ $3,800 but < $3,900 D. ≥ $3,900 but < $4,000 E. ≥ $4,000

30. Addem and Up is a firm of 10 accountants, each of whom has been with the firm at least five years. Compute the pure premium for Addem and Up for a mature claims-made policy written 1/1/92.

A. < $100,000 B. ≥ $100,000 but < $105,000 C. ≥ $105, 000 but <$110,000 D. ≥ $110,000 but < $115, 000
E. ≥ $115, 000

60. (2 points)
You are given the following incurred loss information evaluated at 12/31/87 and presented in a manner consistent with the Werner and Modlin, "Basic Ratemaking".

		Report Year						
		1981	1982	1983	1984	1985	1986	1987
	0	10	30	25	20	40	50	30
	1	10	10	30	25	20	40	50
L	2	5	20	15	30	25	20	40
A	3	5	10	20	14	36	30	24
G	4	5	10	20	15	0	0	0
	5	0	10	15	10	20	0	0

Create the corresponding cumulative incurred loss triangle by Accident Year and Report Period. Put your answer in the following format:

Accident Year	Reporting Period (through months) 12	24	36	48	60	72
1981						
1982						
1983						
1984						
1985						
1986						
1987						

Question from the 1993 exam

47. (3 points)
When Charlie Frye entered the actuarial profession January 1, 1962 he purchased a professional liability policy providing coverage on an occurrence basis. Charlie renewed this policy until 1989. In 1989 he switched to a "claims made policy" which he renewed until he retired at the end of 1992. His loss history is as follows:

		Report Year				
		1988	1989	1990	1991	1992
	0	2,000	2,100	2,200	2,300	2,400
L	1	950	1,000	1,050	1,100	1,150
A	2	450	475	500	525	550
G	3	215	225	238	250	263
	4	0	0	0	o	0

a. (2 points) What is Charlie's pure premium for each of his policies carried in the years 1988 through 1992?

b. (1 point) Assuming Charlie's historical reporting patterns continue, what is his anticipated pure premium for a tail policy purchased January 1, 1993, covering his entire tail exposure?

Questions from the 1994 exam

None

Question from the 1995 exam

39. Professional Services, Inc., has the following expected General Liability loss experience over seven report years:

General Liability Expected Losses

				Report Years			
Lag	1991	1992	1993	1994	1995	1996	1997
0	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000
1	$20,000	$25,000	$28,000	$35,000	$42,000	$46,000	$50,000
2	$15,000	$20,000	$25,000	$32,000	$40,000	$44,000	$48,000
3	$10,000	$15,000	$20,000	$21,000	$25,000	$28,000	$30,000
4	$0	$0	$0	$0	$0	$0	$0

Professional Services purchased an occurrence policy at the beginning of 1991 and then switched to a claims-made policy for 1992 and 1993. At the beginning of 1994 they reverted to an occurrence policy.

Using methods described in Werner and Modlin, "Basic Ratemaking".

(a) (1 point) Calculate the expected losses for the occurrence policy purchased in 1991.

(b) (1 point) Calculate the expected losses for the 1993 claims-made policy.

(c) (1 point) Calculate the expected losses for a tail policy purchased at the end of the 1993 CM policy.

(d) (1 point) Briefly explain why claims-made rates are both more accurate and more responsive to changing conditions than are rates for an occurrence policy.

Question from the 1996 exam

Question 12. You are given the following data:

General Liability Expected Pure Premiums

	Report Year						
Lag	1995	1996	19970	1998	1999	2000	2001
0	100	102	104	106	108	1101	113
1	500	600	720	864	1037	1244	1493
2	50	55	61	67	74	811	89
3	30	33	36	40	44	48	53
4	20	22	24	27	29	32	35
5	0		0	0	0	0	0

Using the approach described by Werner and Modlin, "Basic Ratemaking", calculate the difference in expected annual pure premiums between an occurrence policy purchased 1/1/96 and a mature claims-made policy purchased 1/1/96. In what range does the difference fall?

A. < \$80 B. $\geq$ \$80, but < \$100 C. $\geq$ \$100, but < \$120 D. $\geq$ \$120, but < \$140 E. $\geq$ \$140

Question from the 1997 exam

5. Based on Werner and Modlin, "Basic Ratemaking", which of the following are true?
   1. Occurrence policies have less risk of reserve inadequacy than do claims-made policies.
   2. Occurrence policies will generate more investment income than will claims-made policies.
   3. An occurrence policy should cost more than a claims-made policy, if claim costs are increasing at a rate greater than investment returns.

A. 1 B. 3 C. 1, 2 D. 2, 3 E. 1, 2, 3

33. (3 points)You are given: Medical Malpractice data

Lag	Actual 1994 Loss Costs	Estimated 1995 Loss Costs	Estimated 1996 Loss Costs	Estimated 1997 Loss Costs	Estimated 1998 Loss Costs	Estimated 1999 Loss Costs
0	1,000	1,050	1,103	1,158	1,216	1,276
1	1,000	1,050	1,103	1,158	1,216	1,276
2	1,000	1,050	1,103	1,158	1,216	1,276
3	500	525	551	579	608	638
4	0	0	0	0	0	0

Your latest rate changes for both occurrence and claims-made policies, effective 1/1/96, were based on 1994 experience and followed the methodology described by Werner and Modlin, "Basic Ratemaking". You assumed that loss costs would increase 5% annually. You have now learned that inflation in loss costs has been 10% annually, since 1994, and you expect this pattern to continue.

A. (1 point) Determine the loss cost inadequacy, as a percentage of the loss costs assumed in the rates, for a second-year claims-made policy effective 1/1/96.

B. (1 point) Determine the loss cost inadequacy, as a percentage of the loss costs assumed in the rates, for an occurrence policy effective 1/1/96.

C. (1 point) Determine the loss cost inadequacy, as a percentage of the loss costs assumed in the rates, for a claims-made tail policy effective 1/1/97 following a second-year claims-made policy. Assume that an occurrence policy was purchased 1/1/94 and that claims-made policies were purchased 1/1/95 and 1/1/96.

Questions from the 1998 exam

15. According to Werner and Modlin, "Basic Ratemaking", which of the following are true?

1. The confidence interval about the projected losses for a claims-made policy is generally narrower than for an occurrence policy priced at the same time.
2. The longer the settlement lag, the greater will be the difference in investment income between claims-made and occurrence policies.
3. A claims-made policy should always cost less than or equal to an occurrence policy.

A. 1 B. 2 C. 3 D. 1, 2 E. 2, 3

35. (2 points) You are given the following incurred loss experience for the Leaning Tower Consulting Firm.

	Report Year					
Lag	1992	1993	1994	1995	1996	1997
0	1,000	1,300	1,400	1,100	1,800	1,900
1	600	800	900	1,000	1,200	1,300
2	500	700	800	400	500	700
3	0	0	0	0	0	0

Leaning Tower Consulting purchased the following varying types of policies to cover their liability exposure:

- Up to and including 1992 they purchased occurrence policies.
- In 1993 and 1994 they purchased claims-made coverage with a
- 1/1/93 retroactive date.
- In 1995 they switched back to occurrence coverage.
- In 1995 they also bought tail coverage in the form of a single payment reporting endorsement.

Calculate the loss incurred under each of the following policies:

a. 1992 Occurrence
b. 1993 Claims-Made
c. 1994 Claims-Made
e. 1995 Tail Coverage

Questions from the 1999 exam

Question 31. (2 points) Based on Werner and Modlin, "Basic Ratemaking", and the information shown below, determine the total premium for a third-year claims-made policy.

Mature claims-made pure premium	$1,000
Commission	12%
Profit	-3%
Taxes	4%
Variable general expense	6%
Fixed general expense	$75
Unallocated loss adjustment expense	10% of loss

Annual Lag Factors	
Lag	Factor
0	.30
1	.25
2	.20
3	.15
4+	.10

Questions from the 1999 exam

Question 32. (3 points) Based on Werner and Modlin, "Basic Ratemaking", and the information shown below, determine the undiscounted pure premium for a mature claims-made policy effective 1/1/98.

- 60% of all claims are lag 0
  30% of all claims are lag 1
  10% of all claims are lag 2
- For each report year, lag 1 claims settle for twice the value of lag 0 claims, and lag 2 claims settle for three times the value of lag 1 claims.
- Report year severity is increasing 10% per year across all lags.
- An occurrence policy effective 1/1/96 has an undiscounted pure premium of $1,000.
- Claims are uniformly distributed throughout the year and frequency has been constant during the experience period.

Questions from the 2001 exam

Question 46. (2 points) Werner and Modlin, "Basic Ratemaking", discusses five principles of claims-made ratemaking. In each of the subparts of this question, one of these five principles is listed. For each of the stated principles, briefly describe why it is true.

a. (½ point) A claims-made policy should always cost less than an occurrence policy, as long as claims costs are increasing.

b. (½ point) Whenever there is a sudden, unpredictable change in underlying trend, claims-made policies priced on the basis of the prior trend will be closer to the correct price than occurrence policies priced in the same manner.

c. (½ point) Whenever there is a sudden unexpected shift in the reporting pattern, the cost of mature claims-made coverage will be affected very little, if at all, relative to occurrence coverage.

d. (½ point) The investment income earned from claims-made policies is substantially less than under occurrence policies.

Questions from the 2002 exam

43. (3 points) Based on Werner and Modlin, "Basic Ratemaking", and the following information, calculate the dollars of "pure" IBNR reserve inadequacy for a company writing occurrence policies for five years. Show all work.

Losses of $1,500 reported in the last year were produced in equal proportions from occurrences in the last five years.

Losses are forecast to increase at a rate of $10 per year.

Actual results show an unexpected shift of $5/per year/per lag towards later reportings.

Questions from the 2003 exam

22. (3 points)

   a. (1 point) Define a coverage trigger.

   b. (1 point) State how the coverage trigger for claims-made forms differs from the coverage trigger for occurrence forms.

   c. (0.5 point) A dentist begins his practice on January 1, 2003 and retires three years later. He buys the following professional liability insurance policies:

   - An occurrence policy to cover his first year of practice
   - A 1st - year claims-made policy for 2004
   - A 2nd - year claims-made policy for 2005
   - A tail policy at the end of 2005

   A loss that occurred in 2004 was not reported until 2006. State which policy, if any, covers the loss and explain why.

   d. (0.5 point) Assume that the dentist in part c. above instead purchased three occurrence policies, one for each of his first three years of practice. State which policy, if any, would cover the loss described in part c. above and explain why.

29. (3 points) Given the information below, calculate the premium for an occurrence policy written in Year 1. Show all work.

Loss Reporting Pattern

Year	Percent Reported
1	50%
2	80%
3	95%
4	100%

- Mature claims-made pure premium for Year 1 = $600
- Loss trend = 5%
- Fixed expense per policy = $150
- Commissions = 12%
- Premium taxes = 5%
- Loss adjustment expense as percent of loss = 8%
- Profit provision = 3%

Questions from the 2004 exam

12. Which of the following statements are true regarding claims-made ratemaking?

   1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies.
   2. An occurrence policy will generally cost less than a claims-made policy.
   3. Claims-made policies incur no liability for IBNR claims.

A. 1 only   B. 3 only   C. 1 and 2 only   D. 1 and 3 only   E. 2 and 3 only

Questions from the 2005 exam

15. A claim occurred in May 2001 and was reported in September 2003. Which of the following would cover this claim?
    1. A one-year occurrence policy effective January 1, 2003
    2. A second-year claims-made policy effective January 1, 2003
    3. Tail coverage effective January 1, 2003 for a physician retiring after 10 years of practice covered by claims-made coverage

    A. 2 only   B. 3 only   C. 1 and 3 only   D. 2 and 3 only   E. None of 1, 2, or 3

Questions from the 2007 exam

13. Which of the following statements are true regarding claims-made ratemaking?
    1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies.
    2. A claims-made policy should always cost less than an occurrence policy, as long as claim costs are increasing.
    3. Claims-made policies incur no liability for IBNR claims.

A. 1 only   B. 3 only   C. 1 and 2 only   D. 2 and 3 only   E. 1, 2, and 3

Questions from the 2008 exam

20. (2.0 points) Using the techniques contained in Werner and Modlin, "Basic Ratemaking", draw and label a diagram representing the following five different types of policies written in 2000 through 2004. Assume all claims are reported within four years.
    a. Occurrence policy written in year 2000
    b. 1st year claims-made policy written in 2001
    c. 2nd year claims-made policy written in 2002
    d. 3rd year claims-made policy written in 2003
    e. Tail policy written in 2004

21. (1.0 point) Explain the following terms as they pertain to a claims-made policy.
    a. Retroactive Date
    b. Extended Reporting Period

Questions from the 2009 exam

28. (2 points) An insured has purchased the following policies:

Effective Date	Policy Term	Policy Type	Retroactive Date
January 1, 2004	1 Year	Occurrence	N/A
January 1, 2005	1 Year	Occurrence	N/A
January 1, 2006	1 Year	First-Year Claims Made	January 1, 2006
January 1, 2007	1 Year	Second-Year Claims Made	January 1, 2006
January 1, 2008	1 Year	Third-Year Claims Made	January 1, 2006

A tail policy is also purchased on January 1, 2009 to cover any losses that occurred while the claims-made policies were in effect but had not been reported as of December 31, 2008.

Draw and label a diagram that shows what losses each policy covers, based on when the losses occurred and when they were reported, assuming all claims are reported within 3 years of occurrence.

Questions from the 2010 exam

22. (2 points)

a. (0.5 point) Explain the major difference between claims-made and occurrence policies.

b. (0.5 point) Explain how claims-made coverage reduces pricing risk.

c. (0.5 point) Explain how claims-made coverage reduces reserving risk.

d. (0.5 point) Explain the purpose of an extended reporting endorsement (or tail policy).

Questions from the 2012 exam

8. (2 points) A physician maintained medical malpractice coverage with occurrence policies through 2011. Effective January 1, 2012, the physician switched to claims-made coverage. The physician will retire on December 31, 2014. The last claims-made policy to be issued prior to the physician's retirement date will be effective from January 1, 2014 to December 31, 2014.

The following table contains anticipated loss costs used to evaluate pricing for the physician's policy. All claims are reported within 3 years.

	Report Year Lag			
Report Year	0	1	2	3
2011	$350	$300	$250	$100
2012	$368	$315	$263	$105
2013	$386	$331	$276	$110
2014	$405	$347	$290	$116
2015	$426	$365	$304	$122
2016	$447	$383	$319	$128
2017	$469	$402	$335	$134

a. (0.5 point) Briefly describe two advantages that claims-made coverage has over occurrence coverage for a medical malpractice insurer.

b. (1 point) Calculate the loss costs associated with a 2011 occurrence policy and the loss costs associated with a mature 2012 claims-made policy. Briefly describe the overlap in loss costs between the two and the mechanism used to prevent it.

c. (0.5 point) Identify the loss costs in the table above for which the physician would still have exposure at the time of retirement, and the coverage that the physician would need to purchase to transfer that exposure to the insurer.

Solutions to questions from the 1988 exam

Question 26.

Answer C.

Question 58.

	Report Year						
Lag /	1986	1987	1988	1989	1990	1991	1992
0	100						
1	100	100*1.1					
2	100	100*1.1	100*$(1.1)^2$				
3	100	100*1.1	100*$(1.1)^2$	100*$(1.1)^3$			
Occ. Price				464.1	510.51	561.56	617.71
Mature CM	400		400*$(1.1)^2$ = 484				

(a)
A 1st year claims made policy, purchased at the beginning of 1988, costs \$100 * $(1.10)^2$ = 121.
An occurrence policy, purchased at the beginning of 1988, costs
\$100 [$(1.1)^2$ + $(1.1)^3$ + $(1.1)^4$ + $(1.1)^5$ = \$561.56

The multiplier that should be applied to the adequate rate for an occurrence policy to get a rate for a first year claims made policy is \$121 / \$561.56= .215.
A mature claims made policy costs \$100 * 4 * $(1.10)^2$ = 484.
The multiplier that should be applied to the adequate rate for an occurrence policy to get a rate for a mature year claims made policy is 484 / 561.56 = .861.

(b)

The cost of 2 occurrence policies (after 1/1/88) = 561.56 + 617.71 = 1179.28.

The cost of a 1st year claims made, a 2nd year CM policy and tail coverage
= $100(1.1)^2 + 2*100*(1.1)^3 + 2*100*(1.1)^4 + 2*100*(1.1)^5 + 100*(1.1)^6 = 1179.28$.

Therefore, each form of coverage is equal in price.

Question 59.

See the example provided in the summary of this article.

Solutions to questions from the 1989 exam

Question 20.

1. F. The statement is true only when claims costs are rising.
2. F.
3. T.. **Answer C.**

Question 55.

a. The recommended coverage would consist of the purchase of a 1st year CM policy, a 2nd year CM policy and a combined tail policy (to cover the remaining exposure under the 1st 2 policies) and an occurrence policy, thereafter.

b.

	Report Year					
Lag /	1	2	3	4	5	6
0	$L_{0,1}$	$L_{0,2}$	$L_{0,3}$			
1		$L_{1,2}$	$L_{1,3}$	$L_{1,4}$		
2			$L_{2,3}$	$L_{2,4}$	$L_{2,5}$	
3				$L_{3,4}$	$L_{3,5}$	$L_{3,6}$
Occ. Price						
Mature CM						

$L_{0,1}$ are the losses generated by a 1st year CM policy.

$L_{0,2}$ and $L_{1,2}$ are the losses generated by a 2nd year CM policy.

The sum of the remaining cells comprise the combined tail and occurrence coverage purchased in the third year.

Fourth and subsequent years costs would be lower than year three since only occurrence coverage would be purchased.

Solutions to questions from the 1990 exam

Question 23.

Solution: Assume that the losses reported in 1990 totaled $1 and that these losses emerged according to the reporting pattern above from accidents that occurred between 1987 and 1990.

	Report Year					
Lag /	1990	1991	1992	1993	1994	1995
0	.4	$.4*(1.1)^{1}$				
1	.2	.2				
2	.2	$.2*(1.1)^{-1}$	.2			
3	.1	$.1*(1.1)^{-2}$		.1		
4	.1	$\underline{.1*(1.1)^{-3}}$			.1	
Occ. Price					1.0	**1.1**
Mature CM		**.979**				

To determine the mature claims-made multiple of the 1991 occurrence pure premium, solve for X:
X*(1.1) = .979. X = .89. **Answer B.**

Solutions to questions from the 1990 exam

Question 24.

Answer A.

Solutions to questions from the 1991 exam

Question 27.

Answer B.

Question 28.

		Report Year						
		1	2	3	4	5	6	7
	0	$L_{0,1}$	$L_{0,2}$	$L_{0,3}$	$L_{0,4}$	$L_{0,5}$	$L_{0,6}$	$L_{0,7}$
L	1	$L_{1,1}$	$L_{1,2}$	$L_{1,3}$	$L_{1,4}$	$L_{1,5}$	$L_{1,6}$	$L_{1,7}$
A	2	$L_{2,1}$	$L_{2,2}$	$L_{2,3}$	$L_{2,4}$	$L_{2,5}$	$L_{2,6}$	$L_{2,7}$
G	3	$L_{3,1}$	$L_{3,2}$	$L_{3,3}$	$L_{3,4}$	$L_{3,5}$	$L_{3,6}$	$L_{3,7}$
	4	$L_{4,1}$	$L_{4,2}$	$L_{4,3}$	$L_{4,4}$	$L_{4,5}$	$L_{4,6}$	$L_{4,7}$

Answer E. The tail policy should include $L_{1,4} + L_{2,4} + L_{3,4} + L_{2,5} + L_{3,5} + L_{4,5} + L_{3,6} + L_{4,6} + L_{4,7}$.

Solutions to questions from the 1992 exam

Question 1.

1. T.
2. F.
3. T.

Answer D.

Question 29.

The coverage required is provided by a 2nd year claims made policy.
The pure premium =$1,000*(1.1)^2 + $2,000*(1.1)^2 = 3630. **Answer A.**

Question 30.

Lag	1990 Pure Premium Per Accountant	1991 Pure Premium Per Accountant	1992 Pure Premium Per Accountant
0	$1,000	$1,000*(1.1)^1	$1,000*(1.1)^2
1	$2,000	$2,000(1.1)^1	$2,000*(1.1)^2
2	$3,000	$3,000(1.1)^1	$3,000*(1.1)^2
3	$2,000	$2,000(1.1)^1	$2,000*(1.1)^2
4	$1,000	$1,000(1.1)^1	$1,000*(1.1)^2
Mature CM (			10,890

The pure premium = 10 * 10,890 = 108,900. **Answer C.**

Solutions to questions from the 1992 exam

Question 62.

To complete the AY by RP matrix, it is important to realize that losses along the same diagonal in a report year by Lag matrix are associated with the same AY. First, complete an AY by incremental report period matrix by filling out the following grid (rows by Lag above become columns. Next, using the results of the losses by AY reported within the interval, create a cumulative loss matrix:

Losses by AY reported within the interval

Accident Year	0 - 12	13 - 24	25 - 36	36-48
1981	10	10	15	14
1982	30	30	30	36
1983	25	25	25	30
1984	20	20	20	24
1985	40	40	40	
1986	50	50		
1987	30			

Reporting Period (through months)

Accident Year	12	24	36	48	60	72
1981	10	20	35	49	49	49
1982	30	60	90	126	126	126
1983	25	50	75	105	105	
1984	20	40	60	84		
1985	40	80	120			
1986	50	100				
1987	30					

Solutions to questions from the 1993 exam

Question 47.

a.

In 1988, Charlie purchased a occurrence policy. The pure premium = 2,000+1,000+500+250+0 = 3750.

In 1989, Charlie purchased a 1st year CM policy. The pure premium = 2,100.

In 1990, Charlie purchased a 2nd year CM policy. The pure premium = 2,200 + 1050 = 3250.

In 1991, Charlie purchased a 3rd year CM policy. The pure premium = 2,300 + 1100 + 525 = 3925.

In 1992, Charlie purchased a 4th year CM policy. The pure premium = 2,400 + 1150 + 550 + 263= 4363.

b. The tail policy would cover all losses from the three AY's subsequent to the last CM policy. By extending the matrix above to account for losses reported during the next three years of tail coverage, the anticipated pure premium for a tail policy = 1200 + 575 + 600 + 275 + 288+ 300 = 3238.

Solutions to questions from the 1995 exam

Question 39.

	Report Years						
Lag	1991	1992	1993	1994	1995	1996	1997
0	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000
1	$20,000	$25,000	$28,000	$35,000	$42,000	$46,000	$50,000
2	$15,000	$20,000	$25,000	$32,000	$40,000	$44,000	$48,000
3	$10,000	$15,000	$20,000	$21,000	$25,000	$28,000	$30,000
4	$0	$0	$0	$0	$0	$0	$0
Occ Price					$96,000		

(a) Since an occurrence policy provides for all losses arising from the same AY, expected losses for AY 1991 = the sum of the losses along the AY 1991 diagonal = $96,000.

(b) Since the insured purchased CM coverage beginning in 1992, the CM policy purchased in 1993 is a 2nd year CM. The expected losses for a 2nd year 1993 CM policy are those from RY 1993, lag 0 and lag 1 = 35,000 + 28,000 = 63,000.

(c) The expected losses for a tail policy purchased at the end of the 1993 CM policy are the losses associated with LAGs 1 and 2 for RY 1994, LAGs 2 and 3 for RY 1995, LAGs 3 and 4 for RY 1996, and LAG 4 for RY 1997= 35,000 + 32,000 + 40,000 + 25,000 + 28,000 + 0 = 160,000 .

(d) CM rates are more accurate since the coverage period to which they apply are shorter in duration than the coverage period associated with an occurrence policy. Any changes in external conditions, such as changes in trend or reporting patterns, are more apparent as losses are reported. Therefore, CM rates are more responsive to changing conditions.

Solutions to questions from the 1996 exam

Question 12.

The expected annual pure premium for an occurrence policy purchased 1/1/96

= $102 + 720 + 67 + 44 + 32 = 965.

The expected annual pure premium for a mature claims made policy purchased 1/1/96

= $102 + 600 + 55 + 33 + 22 = 812.

Thus, the difference = $965 - $812 = $153. **Answer E.**

Solutions to questions from the 1997 exam

Question 5.

The answer to each of these questions can be found by reviewing the 5 principles of claims made ratemaking.

1. F. CM policies incur no liability for IBNR claims so the risk of reserve inadequacy is greatly reduced. If the claim is not reported, it is not covered. The IBNR need for a CM policy is always 0.
2. T. Investment income (II) earned from a CM policy is substantially less than under an occurrence policy.
3. T. A CM policy should always cost less than an occurrence policy, as long as claim costs are rising. **Answer D**

Solutions to questions from the 1997 exam

Question 33.

Based on an assumption of 5% loss cost inflation

Lag	Actual 1994 Loss Costs	Estimated 1995 Loss Costs	Estimated 1996 Loss Costs	Estimated 1997 Loss Costs	Estimated 1998 Loss Costs	Estimated 1999 Loss Costs
0	1,000	1,050	1,103	1,158	1,216	1,276
1	1,000	1,050	1,103	1,158	1,216	1,276
2	1,000	1,050	1,103	1,158	1,216	1,276
3	500	525	551	579	608	638
4	0	0	0	0	0	0

Based on an assumption of 10% loss cost inflation

Lag	Actual 1994 Loss Costs	Estimated 1995 Loss Costs	Estimated 1996 Loss Costs	Estimated 1997 Loss Costs	Estimated 1998 Loss Costs	Estimated 1999 Loss Costs
0	1,000	1,100	1,210	1,331	1,464	1,611
1	1,000	1,100	1,210	1,331	1,464	1,611
2	1,000	1,100	1,210	1,331	1,464	1,611
3	500	550	605	666	732	805
4	0	0	0	0	0	0

(a) Since the above RY by Lag table was constructed based on 1994 experience, a 2nd year CM policy would be based on losses associated with RY 1996.
The expected losses for a 2nd year CM policy, are from RY 1996, lag 0 and lag 1.

Expected losses, assuming 5% inflation = 1,103 + 1,103 = 2,206.

Expected losses, assuming 10% inflation = 1,210 + 1,210 = 2,420.

The loss cost inadequacy, as a percentage of the loss costs assumed in the rates, for a second-year claims-made policy effective 1/1/96 = $\left[\frac{2{,}206-2{,}420}{2{,}206}\right]$ = -9.7%.

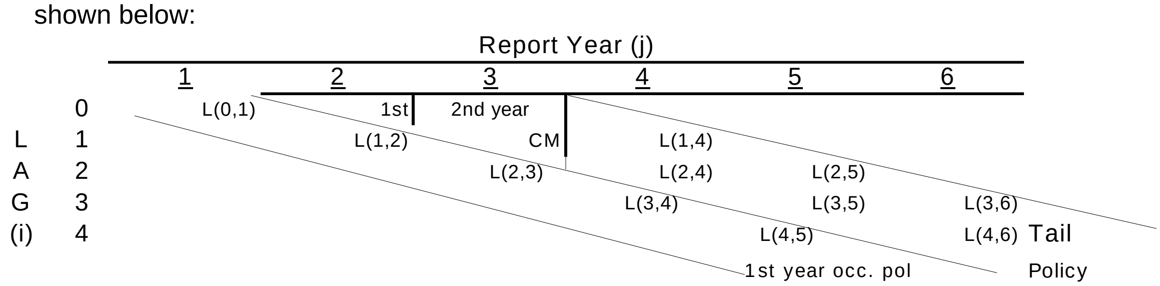
(b) Since an occurrence policy provides for all losses arising from the same AY, expected losses for AY 1996 = the sum of the losses along the AY 1996 diagonal = $L_{0,3}$ + $L_{1,4}$ + $L_{2,5}$ + $L_{3,6}$

Expected losses, assuming 5% inflation = 1,103 + 1,158 + 1,216 +638 = 4,115.

Expected losses, assuming 10% inflation = 1,210 + 1,331 + 1,464 + 805 = 4,810.

The loss cost inadequacy, as a percentage of the loss costs assumed in the rates, for an occurrence policy effective 1/1/96 = $\left[\frac{4{,}115-4{,}810}{4{,}115}\right]$ = -16.9%.

(c) The losses under a claims-made tail policy effective 1/1/97 following a second-year claims-made policy, is shown below:



Expected losses, assuming 5% inflation = 1,158 + 1,158 + 1,216 + 608 + 638 = 4,778
Expected losses, assuming 10% inflation = 1,331 + 1,331 + 1,464 + 732+ 805 = 5,663.
The loss cost inadequacy, as a percentage of the loss costs assumed in the rates, = [4,778-5,663]/4,778=-18.5%

Solutions to questions from the 1998 exam

Question 15. The answer to each question can be found by reviewing the 5 principles of CM ratemaking.

1. T.
2. F. The longer the reporting lag or the shorter the settlement lag, the greater the difference will be.
3. F. A CM policy should always cost less than an occurrence policy, as long as claim costs are rising.

Answer A

Solutions to questions from the 1998 exam

Question 35.

	Report Years					
Lag	1992	1993	1994	1995	1996	1997
0	1,000	1,300	1,400	1,100	1,800	1,900
1	600	800	900	1,000	1,200	1,300
2	500	700	800	400	500	700
3	0	0	0	0	0	0
Occ Price				2,600		

(a) Since an occurrence policy provides for all losses arising from the same AY, expected losses for AY 1992 = the sum of the losses along the AY 1992 diagonal = $1,000 + 800 + 800 + 0 = 2,600.

(b) Since the insured purchased CM coverage beginning in 1993, the CM policy purchased in 1993 is a 1st year CM. The expected losses for a 1st year 1993 CM policy are those from RY 1993, lag 0 = 1,300.

(c) Since the insured purchased CM coverage beginning in 1993, the CM policy purchased in 1994 is a 2nd year CM. The expected losses for a 2nd year 1994 CM policy are those from RY 1994, lag 0 and lag 1 = 1,400 + 900 = 2,300.

(d) The expected losses for a tail policy purchased in 1995 are the losses associated with LAGs 1 and 2 for RY 1995, LAGs 2 and 3 for RY 1996 = 1,000 + 400 + 500+ 0 +0 = 1,900 .

Solutions to questions from the 1999 exam

Question 31. We are given:

	Report Year					
Lag /	1	2	3	4	5	6
0	$L_{0,1}$	$L_{0,2}$	$\boxed{L_{0,3}}$			
1		$L_{1,2}$	$\boxed{L_{1,3}}$	$L_{1,4}$		
2			$\boxed{L_{2,3}}$	$L_{2,4}$	$L_{2,5}$	
3				$L_{3,4}$	$L_{3,5}$	$L_{3,6}$
Mature CM			1,000			

- $L_{0,3}$ and $L_{1,3}$ and $L_{2,3}$ are the losses generated by a 3rd year CM policy.
- The losses are determined by applying annual lag factors (LF) to a mature claims made premium.

Write equations for:

1. The pure premium for a 3rd year claims made policy:

   $PP_3 = PP_{MCM} * \sum_{i=0}^{2} LF_i = 1{,}000 * (.30+.25+.20) = 750$, where PP_3 and PP_{MCM} represent the pure premium for a 3rd year and mature claims made policy respectively.

2. The formula for the total premium for a third-year claims-made policy is $\frac{PP_3 + ULAE + FE}{1.0 - V - Q}$.

   V = Total variable expenses = commission + variable gen. expense + taxes + profit = .12+.06+.04=.22
   Q = Profit and Contingencies = -.03. FE = Fixed expense = $75

   Thus, the total premium for a third-year claims-made policy is $\frac{\$750 + \$750 * .10 + \$75}{1.0 - .22 - (-.03)} = 1{,}111.11$.

Solutions to questions from the 1999 exam

Question 32. We are given that:

- For each report year, lag 1 claims settle for twice the value of lag 0 claims, and lag 2 claims settle for three times the value of lag 1 claims. Let X = the severity of lag 0 claims in 1996, 2X = the severity of lag 1 claims and 3 * 2X = the severity of lag 2 claims.
- Report year severity is increasing 10% per year across all lags.

These givens can be translated diagrammatically as shown below:

	Report Year		
Lag /	1996	1997	1998
0	.6*X	.6*(1.1)X	.6*$(1.1)^2$ *X
1	.3*2X	.3(1.1)2X	.3*$(1.1)^2$ *2X
2	.1*3*2X	.1*(1.1) *3*2X	.1*$(1.1)^2$ *3*2X
Occ. Price			$1,000
Mature CM			**??**

Set up an equation to determine the premium for an occurrence policy, effective 1/1/96, with an undiscounted pure premium of $1,000, and solve for X:

.6X + .3*(1.1)*2X + .1*$(1.1)^2$ *3*2X = 1,000; .6X + .66x + .726X = 1.986X = 1,000. X = 503.52

The mature claims made pure premium for policy effective 1/1/98 is calculated as follows:

$$98\,MCM\ \Pr emium = Sev_{0,96} * \sum_{i=0}^{2} RYLF_{i,98} = 503.5*[.6*(1.1)^2 + .3*(1.1)^2*(2) + .1*(1.1)^2*(6)] = 1098$$

Solutions to questions from the 2001 exam

Question 46. For each of the stated principles, briefly describe why it is true.

a. A claims-made policy should always cost less than an occurrence policy, as long as claims costs are increasing.

Under a claims-made policy, we are always pricing next year's claims. This reduces the amount of time inflation has to impact losses. Under an occurrence policy, we must take into account claims to be reported many years in the future. This increases the amount of time inflation has to act upon losses, and thus increases the cost of occurrence policies.

b. Whenever there is a sudden, unpredictable change in underlying trend, claims-made policies priced on the basis of the prior trend will be closer to the correct price than occurrence policies priced in the same manner.

For claims-made policies, failing to incorporate the true change in the underlying trend results in a small change to the proper rate level, since the period for trending losses is shorter. However, when pricing an occurrence policy, the error in not incorporating the true change in the underlying trend is compounded over a longer period. Stated another way, the confidence interval about the projected losses for a claims-made policy is narrower than for an occurrence policy priced at the same time.

c. Whenever there is a sudden unexpected shift in the reporting pattern, the cost of mature claims-made coverage will be affected very little, if at all, relative to occurrence coverage.

Given an unexpected shift in the reporting pattern, only the first and last lags are affected since the other lags have the same dollars shifting in and out, leaving the same total dollars reported. This results in a mature claims-made policy still being correctly price.

d. The investment income earned from claims-made policies is substantially less than under occurrence policies.

Claims-made policies incur no liability for IBNR claims. Because there is no need for IBNR, the time lapsed between the collection of premium and the payment of claims is reduced. This reduces the time in which premiums may be invested to generate investment income.

Solutions to questions from the 2002 exam

Question 43. Calculate the dollars of "pure" IBNR reserve inadequacy for a company writing occurrence policies for five years.

Step 1: Recognize that the dollars of "pure" IBNR reserve inadequacy result from the difference in what actually occurs and what is estimated to occur.

Step 2: Create a table which shows the results of losses of $1500 being reported in the last year produced in equal proportions from occurrences in the last 5 years (column (1) below) and that losses are forecast to increase at a rate of $10 per year (columns (2) – (5)). This is what is estimated to occur.

		Report Year			
Lag	0	1	2	3	4
0	300	310	320	330	340
1	300	310	320	330	340
2	300	310	320	330	340
3	300	310	320	330	340
4+	300	310	320	330	340
IBNR =	**3200**				

3200 = 1240+960+660+340

Step 3: Create a table which displays actual results showing an unexpected shift of $5/per year/per lag towards later reportings.
Note: The impact of an unexpected shift of $5/per year/per lag affects the 1st and last lags differently.

Begin with Lag 0. Lag 0 shows the shift of **$5/per year** across report years 2 – 5.

For report year 2, lags 1, 2 and 3, show a **$5/per lag** shift.

Report year 2, lag 4+ shows the cumulative effect of a **$5/per year/per lag shift**.

Similar results are shown for report years 3 – 5.

Shift →	0	$5	$10	$15	$20
			Report Year		
Lag	1	2	3	4	5
0	300	305	310	$315	$320
1		$310	320	330	340
2		$310	320	330	340
3		$310	320	330	340
4+		$315	$330	$345	$360
IBNR =	**3250**				

3250 = 1245+970+675+360

Step 4: Using the information from Step 1, and the results from Steps 2 and 3, calculate the dollars of "pure" IBNR reserve inadequacy for a company writing occurrence policies for five years.
IBNR reserve inadequacy = 3,250 – 3200 = 50.

Solutions to questions from the 2003 exam

22. (3 points)

a. (1 point) Define a coverage trigger.

A coverage trigger is an event that must occur, subject to requirements in the policy, before the policy will respond to a claim.

b. (1 point) State how the coverage trigger for claims-made forms differs from the coverage trigger for occurrence forms.

For claims-made forms, coverage is triggered for a loss that is reported to the insurer during the effective period of the policy. The claim may be subject to a retroactive date. For occurrence forms, coverage is triggered when a loss occurs during the effective period of the policy.

c. (0.5 point) A dentist begins his practice on January 1, 2003 and retires three years later. He buys the following professional liability insurance policies:

- An occurrence policy to cover his first year of practice
- A 1st - year claims-made policy for 2004
- A 2nd - year claims-made policy for 2005
- A tail policy at the end of 2005

A loss that occurred in 2004 was not reported until 2006. State which policy, if any, covers the loss and explain why.

The tail policy covers the claim because the tail policy covers all claims reported 1/1/2006 and afterwards for losses that occurred between 1/1/2004 and 12/31/2005.

d. (0.5 point) Assume that the dentist in part c. above instead purchased three occurrence policies, one for each of his first three years of practice. State which policy, if any, would cover the loss described in part c. above and explain why.

The 2004 occurrence policy covers the loss because the 2004 occurrence policy covers all losses that occurred in 2004 regardless of when the loss is reported.

29. (3 points) Calculate the premium for an occurrence policy written in Year 1.

Using the loss reporting % pattern and the fact that a mature claims-made pure premium for year 1 is $600, compute 1st the RY by Lag distribution for the mature claims-made pure premium and then the year 1 occurrence pure premium.

	Report Year			
Lag	1	2	3	4
0	$300.00			
1	$180.00	$189.00		
2	$90.00		$99.22	
3	$30.00			$34.73
	$600.00			$622.95

Note: The calculations supporting the computation of the occurrence year pure premium are as follows:

300 * 1.0 = $300 $180 * (1.05) = $189 $90 * $(1.05)^2$ = $99.23 $30 * $(1.05)^3$ = $34.73

Pure premium = $300 + $189 + $99.23 + $34.73 = $622.96

To compute the premium for an occurrence policy written in year 1, the rate calculation is as follows:
R= (PP + FE)/(1.0-VE-P), where R is the rate, PP is the pure premium, P is the profit allowance and E = FE + VE is the expense, broken down into its fixed and variable components. Thus, the premium is calculated as:
Premium = [$622.96 * (1.08) + $150] / (1 – 0.12 – 0.05 – 0.03) = $1,028.50

Solutions to questions from the 2004 exam

12. Which of the following statements are true regarding claims-made ratemaking?
    1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies. True. This is principle number 5.
    2. An occurrence policy will generally cost less than a claims-made policy. **False**. This is a misstatement of principle number 1. A claims-made policy should always cost less than an occurrence policy, as lone as claim costs are increasing.
    3. Claims-made policies incur no liability for IBNR claims. True. This is principle number 4. Claims-made policies incur no liability for IBNR claims so the risk of reserve inadequacy is greatly reduced.

Answer D: 1 and 3 only

Solutions to questions from the 2005 exam

15. A claim occurred in May 2001 and was reported in September 2003. Which of the following would cover this claim?
    1. A one-year occurrence policy effective January 1, 2003. False. Occurrence policies cover claims occurring during the policy period. An accident occurring on 5/1/2001 would not be covered by a policy covering the period 1/1/2003 – 12/31/2003
    2. A second-year claims-made policy effective January 1, 2003. False. This is due to the retroactive date. The retroactive date restricts coverage to accidents occurring on or after that date. Normally, this would be the date on which an insured's first claims-made policy commences. Thus, a second-year claims-made policy effective January 1, 2003 would cover claims occurring anytime after 1/1/2002.
    3. Tail coverage effective 1/1/2003 for a physician retiring after 10 years of practice covered by claims-made coverage. True. A claims made policy covers claims reported (made) (in this example, 9/1/2003) during the policy period (i.e. 1/1/2003 – 12/31/2003), regardless of when the accident date occurred.

Answer B. 3 only

Solutions to questions from the 2007 exam

13. Which of the following statements are true regarding claims-made ratemaking?
    1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies. True. This is principle number 5.
    2. A claims-made policy should always cost less than an occurrence policy, as long as claim costs are increasing. True. This is principle number 1.
    3. Claims-made policies incur no liability for IBNR claims. True. This is principle number 4.

Answer: **E. 1, 2, and 3**

Solutions to questions from the 2008 exam

Model Solution - Question 20

	Report Year						
Lag	2000	2001	2002	2003	2004	2005	2006
0	A	B	C	D			
1		A	C	D	E		
2			A	D	E	E	
3				A	E	E	E...
4					A	E	E...
5						A	E...
6							A...

a. Occurrence policy in $2000 = All A's

b. 1st year claims made = B

c. 2nd year claims made = All C's

d. 3rd year claims made = All D's

e. 2004 tail policy = All E's

Model Solution - Question 21

a. Retroactive date is a date which activates the claims made policy. Claims occurred on or after that date and reported during the policy period will be covered by the CM policy.

b. Extended reporting period extends the periods for the claims to be reported under CM policy after the policy period ends. Claims occurred during the policy period and reported before the extended reporting period ends will be covered by CM policy.

Solutions to questions from the 2009 exam

Question#: 28

	Report Year							
LAG	2004	2005	2006	2007	2008	2009	2010	2011
0	A	B	C	D	E			
1		A	B	D	E	F		
2			A	B	E	F	F	
3				A	B	F	F	F

A: Occurrence Policy Effective 1/1/2004

B: Occurrence Policy Effective 1/1/2005

C: 1st year CM Policy 1/1/2006

D: 2nd year CM Policy Effective 1/1/2007

E: 3rd year CM Policy Effective 1/1/2008

F: Tail Policy Effective 1/1/2009

Solutions to questions from the 2010 exam

Question 22

a. Coverage Trigger

Claims made coverage is triggered when claim is first reported to the insurer, (given that it occurred on or after the retroactive date and is reported in policy period)

Occurrence coverage is triggered when the loss occurs during the policy period.

b. Claims made policies have a much shorter tail than occurrence policies, so they are not affected as severely by inflation, trend, etc. This makes pricing the future easier.

c. There is no IBNR (incurred but not reported) on a claims - made policy since all claims are reported at the end of policy period. So, it makes it easier to set reserves.

d. To provide coverage for claims that maybe reported after the claims - made policy expires

For example, a doctor may retire, so no more new claims occur, but he/she needs coverage for claims that might be reported after he/she is done practicing medicine.

Solutions to questions from the 2012 exam

8a. (0.5 point) Briefly describe two advantages that claims-made coverage has over occurrence coverage for a medical malpractice insurer.

8b. (1 point) Calculate the loss costs associated with a 2011 occurrence policy and the loss costs associated with a mature 2012 claims-made policy. Briefly describe the overlap in loss costs between the two and the mechanism used to prevent it.

8c. (0.5 point) Identify the loss costs in the table above for which the physician would still have exposure at the time of retirement, and the coverage that the physician would need to purchase to transfer that exposure to the insurer.

Question 8 – Model Solution (Exam 5A Question 8)

a. 1. Med Mal has a very long tail, so for occurrence policies it takes a very long time to develop. For claims made policies losses are known at the end of the year. No Pure IBNR component needed.

2. Since CM policies have a shorter time frame, they would be less subject to changes in trend or inflation than occurrence policies.

b. 2011 Occurrence = 350 + 315 + 276 + 116 = 1057 (sum of the loss costs along the diagonal)

2012 Mature CM = 368 + 315 +263 + 105 = 1051 (sum of the loss costs across the RY 2012 row)

Overlap would be for RY2012 Lag 1- the 315 would be covered by both. To prevent this, CM policies have retro dates which signal the beginning of coverage (losses that occurred before retro date would not be covered, only losses that occurred after). So after the occurrence policy in 2011, the CM policy in 2012 should have a retro date of 1/1/2012 + be a first year CM policy.

c. Loss costs after would be 365 + 304 + 122 + 319 +128 +134 = 1372

L(2015,1) + L(2015,2) + L(2015,3) + L(2016,2) + L(2016,3) + L(2017,3)

There would be losses that occurred while the CM policies were still in place but were reported after the physician retired. Physician would need to purchase a tail coverage to cover these losses.

Examiner's Comments

a. Many candidates received full credit on this part. Some candidates did not provide enough detail to receive credit, using statements like "less pricing risk" and "less reserving risk". Other candidates provided slightly different variations on the same item.

b. Most candidates did identify the correct loss costs. Full credit was given for identifying the overlap graphically. Some candidates lost credit for not addressing the specific overlap for this question.

c. Many candidates were able to identify the loss costs associated with the tail exposure. Some responses were not able to identify tail coverage, instead listing some combination of claims made or occurrence policies that did not match the exposure.

Since the appendices use real examples from various rate filings, some of the procedures may vary from those discussed within the actual text.

APPENDIX A: AUTO INDICATION

The following show an example of an overall rate level indication using the loss ratio approach.

- This is for the property damage liability coverage of personal automobile insurance in State XX.
- All policies are semi-annual
- The proposed effective date for the revised rates is 1/1/2017.

The individual exhibits are as follows:

- **LR Indication**: The overall indicated premium change using the LR method on 5 AYs of State XX data evaluated as of 3/31/2016.
- **Credibility**: To be applied to the experience period using the classical credibility approach and the square-root rule.
- **Current Rate Level**: The calculation of the current rate level factors using the parallelogram method.
- **Premium Trend**: Premium trend factors are computed using the two-step trending approach.
- **Loss Development**: Computation and selection of the loss development factors using the chain ladder method.
- **Loss Trend**: Selection of the loss trend factors based on the pattern of historical changes of frequency, severity, and pure premium.
- **ULAE Ratio**: Computing the ULAE factor based on the historical relationship of ULAE to losses and ALAE.
- **Expense**: Computing fixed and variable expense provisions using the premium-based projection method.

LR (LOSS RATIO) INDICATION EXHIBIT

The overall indication process:

- A projected loss and LAE ratio is selected and added to the fixed expense provision.

This ratio is compared to the variable PLR to obtain the overall indicated rate change, which is credibility-weighted with the trended present rates indication from the prior rate change analysis.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Indicated Rate Chance- Loss Ratio Method

Calendar Accident Year	(1) Earned Premium	(2) Current Rate Level Factor	(3) Premium Trend Factor	(4) Projected Earned Premium at Current Rate Level	(5) Reported Losses and Paid ALAE	(6) Loss Development Factor	(7) Loss Trend Factor	(8) ULAE Factor	(9) Projected Ultimate Losses and LAE	(10) Projected Loss and LAE Ratio
2001	$1,122,372	1.2161	1.1342	$1,548,088	$856,495	1.0000	0.9912	1.143	$970,359	62.7%
2012	$1,154,508	1.2176	1.1116	$1,562,608	$867,184	0.9799	0.9962	1.143	$967,578	61.9%
2013	$1,280,545	1.1311	1.0879	$1,575,741	$835,120	1.0003	1.0012	1.143	$955,974	60.7%
2014	$1,369,976	1.0892	1.0663	$1,591,109	$821,509	1.0282	1.0062	1.143	$971,450	61.1%
2015	$1,397,750	1.0991	1.0452	$1,605,706	$797,866	1.0966	1.0113	1.143	$1,011,357	63.0%
Total	$6,325,151			$7,883,253	$4,178,174				$4,876,718	61.9%

(2) From Current Rate Level Exhibit - 2
(3) From Premium Trend Exhibit - 3
(4) = (1)*(2)*(3)
(5) Case Incurred Losses and ALAE Evaluated As Of 03/31/2016
(6) From Loss Development Exhibit
(7) From Loss Trend Exhibit
(8) From ULAE Ration Exhibit
(9) = (5)*(6)*(7)*(8)
(10) = (9)/(4)
(12) From Expense Exhibit
(13) From Expense Exhibit
(14) Selected Profit Provision
(15) = 100% - (13) - (14)
(16)= { [(11) + (12)] / (15) } - 1.0
(17) From Credibility Exhibit
(18) From Credibility Exhibit
(19) = (16) * (17) + (18) * [1.0 - (17)]

(11) Selected Projected Loss and LAE Ratio	61.9%
(12) Fixed Expense Provision	11.3%
(13) Variable Expense Provision	17.0%
(14) UW Profit Provision	5.0%
(15) Variable Permissible Loss Ratio	78.0%
(16) Indicated Rate Change	-6.2%
(17) Credibility	100.0%
(18) Trended Present Rates Indication	6.2%
(19) Credibility- Weighted Indicated Rate Change	-6.2%
(20) Selected Rate Change	-6.2%

Noteworthy Commentary:

Projected Premium at Current Rate Level: Columns 1 – 4.

Projected ultimate loss and LAE: Columns 5 – 9.

Row 11: The (selected) 5-year average projected loss and LAE ratio

Rows 12 – 15: U/W expense and Profit items.

- Row 12 is the projected fixed expense ratio (as a % of premium).
- Rows 13 – 15: the calculation of the VPLR, where rows 13 and 14 are %s of premium

Row 15: VPLR is the % of each premium dollar that is available to pay for losses, LAE, and fixed expenses.

Row 16 is the calculation of the indicated rate change using the formula:

$$\text{Indicated Change} = \frac{\text{Loss \& LAE Ratio + Fixed Expense Ratio}}{\text{Variable Permissible Loss Ratio}} - 1.0 = \frac{[\text{Row 11 + Row 12}]}{[\text{Row 15}]} - 1.0$$

Row 17: The credibility to be applied to the indicated rate change.

Row 18: The trended present rates indication (from the prior review) and used as the complement of credibility.

Row 20 is the (selected) credibility-weighted indicated rate change.

CREDIBILITY EXHIBIT

The credibility value is calculated based on a full credibility standard of 1,082 claims,

The complement of credibility is the residual indication based on the latest rate change and indication (i.e. the "trended present rates" approach to derive complement of credibility, as discussed in Chapter 12).

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Credibility Calculations

(1) Total Number of Claims in Historical Period	3,612
(2) Number of Claims for Full Credibility	1,082
(3) Credibility	100.0%
Min { [(1)/(2)] ^ 0.5, 1.0 }	
(4) Latest Indicated Rate Change	13.2%
(5) Last Rate Change Taken	5.0%
From Current Rate Level Exhibit - 2	
(6) Residual Loss Trend	7.8%
{ [1.0 + (4)] / [1.0 + (5)] } - 1.0	
(7) Projected Loss Trend	0.5%
From Loss Trend Exhibit - 1	
(8) Projected Premium Trend	2.0%
From Premium Trend Exhibit - 1	
(9) Net Trend	-1.5%
{ [1.0 + (7)] / [1.0 + (8)] } - 1.0	
(10) Trend Period	1
From Last Rate Change Effective Date (01/01/2016) to Proposed Effective Date (01/01/2017)	
(11) Trended Present Rates Indication	6.2%
{ [1.0 + (6)] * [1.0 + (9)] ^ (10) } - 1.0	

Row 3: Since the number of claims (3,612) exceeds the number of claims needed for full credibility (1,082), the credibility is 100%.

Rows 4 – 11: Derivation of the complement of credibility.

The trended present rates indication in Row 11 and is used as the complement of credibility.

CURRENT RATE LEVEL EXHIBIT

Shows the calculation of the current rate level factors using the parallelogram method for each year.

Sheet 1 - Cumulative rate level indices for each rate level group during or after the historical period.

Columns (1) and (2): Rate change history

Columns 3 and 4: The rate factor in Column 3 and the cumulative rate level in Column 4

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Rate Change History

Rate Level Group	(1) Effective Date	(2) Rate Change	(3) Rate Level Index	(4) Cumulative Rate Level Index
A			1.0000	1.0000
B	04/01/2011	-5.0%	0.9500	0.9500
C	07/01/2012	10.0%	1.1000	1.0450
D	10/01/2013	5.0%	1.0500	1.0973
E	07/01/2014	-2.0%	0.9800	1.0753
F	10/01/2015	5.0%	1.0500	1.1291
G	01/01/2016	5.0%	1.0500	1.1855

(3) = 1.0 + (2)

(4) = Cumulative Product of (3)

Sheet 2 -Calculation of current rate level factors.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Calculation of Current Rate Level Factors

	(1a) Portion of Earned Premium Assumed in Each Rate Level Group							(2)	(3)	(4)
Calendar Year	A	B	C	D	E	F	G	Average Cumulative Rate Level	Current Rate Level Index	CRL Factor
2011	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.9750	1.1855	1.2159
2012	0.00%	75.00%	25.00%	0.00%	0.00%	0.00%	0.00%	0.9738	1.1855	1.2175
2013	0.00%	0.00%	93.75%	6.25%	0.00%	0.00%	0.00%	1.0483	1.1855	1.1309
2014	0.00%	0.00%	6.25%	68.75%	25.00%	0.00%	0.00%	1.0885	1.1855	1.0891
2015	0.00%	0.00%	0.00%	0.00%	93.75%	6.25%	0.00%	1.0787	1.1855	1.0991
(1b) Cumulative Rate Level	1.0000	0.9500	1.0450	1.0973	1.0753	1.1291	1.1855			

(1a) Portion of Each Calendar Year's Earned Premium by Rate Level Group
(1b) Cumulative Rate Level for Each Rate Level Group
(2) (1b) Weighted by (1a) Within Each Calendar Year
(4) = (3) / (2)

Column 1a %s are calculated based on the assumption that the six-month policies are written uniformly throughout the year.

Column 2 shows the average rate level for each CY (i.e. the cumulative rate level associated with each rate level group weighted by the portion of the CY premium represented by the rate level group).

Column 4 is the factor to be applied to earned premium in each CY to bring it to current rate level.

PREMIUM TREND EXHIBIT

Historical premium needs to be adjusted to account for the change in average premium level due to distributional changes in the book of business. Shown is the calculation of premium trend factors using a two-step trending approach.

Sheets 1 - 2

Sheet 1: Historical annual changes in average written premium at current rate level.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend Selection

Year Ending Quarter - X	(1) Written Premium at CRL	(2) Written Exposure	(3) Average Written Premium at CRL	(4) Annual Trend
2010 - 2	$1,314,117	12,752	$103.05	
2010 - 3	$1,323,381	12,776	$103.58	
2010 - 4	$1,333,726	12,806	$104.15	
2011 - 1	$1,343,014	12,825	$104.72	
2011 - 2	$1,354,391	12,863	$105.29	2.2%
2011 - 3	$1,364,644	12,893	$105.84	2.2%
2011 - 4	$1,374,283	12,917	$106.39	2.2%
2012 - 1	$1,384,951	12,953	$106.92	2.1%
2012 - 2	$1,393,570	12,973	$107.42	2.0%
2012 - 3	$1,403,987	13,005	$107.96	2.0%
2012 - 4	$1,415,881	13,044	$108.55	2.0%
2013 - 1	$1,428,087	13,082	$109.16	2.1%
2013 - 2	$1,438,647	13,108	$109.75	2.2%
2013 - 3	$1,448,311	13,128	$110.32	2.2%
2013 - 4	$1,458,540	13,155	$110.87	2.1%
2014 - 1	$1,468,617	13,183	$111.40	2.1%
2014 - 2	$1,479,666	13,217	$111.95	2.0%
2014 - 3	$1,492,537	13,262	$112.54	2.0%
2014 - 4	$1,503,294	13,292	$113.10	2.0%
2015 - 1	$1,514,903	13,325	$113.69	2.1%
2015 - 2	$1,524,242	13,341	$114.25	2.1%
2015 - 3	$1,536,215	13,383	$114.79	2.0%
2015 - 4	$1,547,368	13,414	$115.35	2.0%

Exponential Trend	
20 pt	2.1%
16 pt	2.1%
12 pt	2.0%
8 pt	2.0%
6 pt	2.0%
4 pt	2.0%

Selected Projected Premium Trend 2.0%

(3) = (1) / (2)
(4) Percent Change in Avg WP at CRL From Prior Year

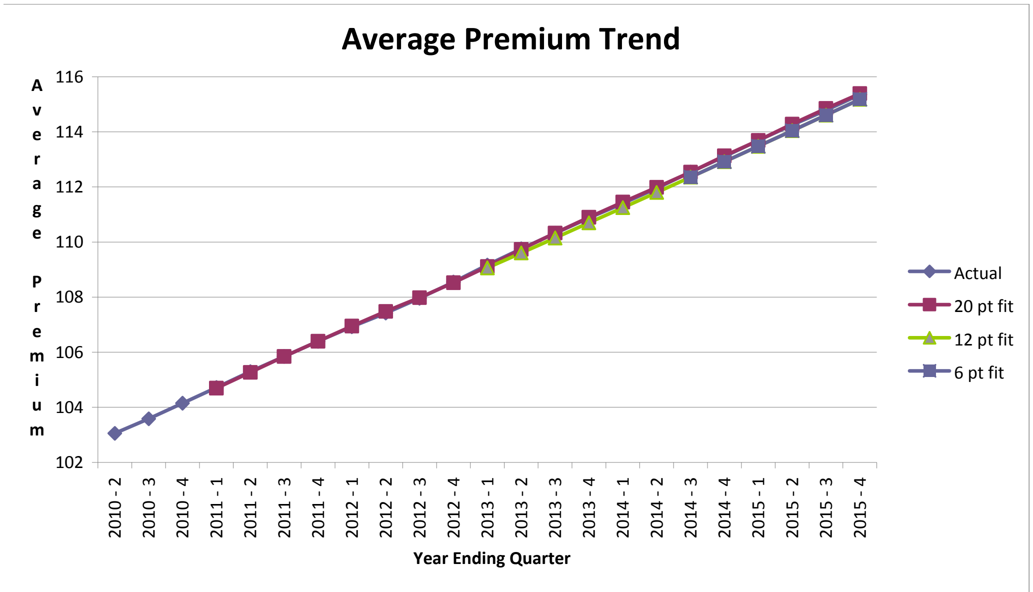
Column 3: Average written premium at current rate level for the 12-month period ending each quarter.

Average written premium at current rate level for each quarter (rather than the 12-month rolling quarter) is preferable to use, but that data was not readily available.

Column 4 calculates an annual trend of average written premium at current rate level (i.e. the percentage change from the prior year).

Sheet 2 displays Sheet 1 data in graphical format, and shows the selected projected premium trend (which is based on the more recent data because this trend is to be applied to historical premium already trended to the most recent period).

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend



Exponential Trend			Selection
20 pt	2.1%		2.0%
12 pt	2.0%		
6 pt	2.0%		

Sheet 3 - Derivation of the premium trend factors.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend Calculation

Calendar Year	(1) Earned Premium at at CRL	(2) Earned Exposure	(3) Average Earned Premium at CRL	(4) Most Recent Average Written Premium at CRL	(5) Current Trend Factor	(6) Selected Projected Premium Trend	(7) Projected Trend Period	(8) Projected Trend Factor	(9) Total Trend Factor
2011	$1,364,916.59	12,900	$105.81	115.354704	1.0902	2.0%	2.0000	1.0403	1.1342
2012	$1,405,728.94	13,020	$107.97	115.354704	1.0684	2.0%	2.0000	1.0403	1.1115
2013	$1,448,424.45	13,130	$110.31	115.354704	1.0457	2.0%	2.0000	1.0403	1.0878
2014	$1,492,177.86	13,258	$112.55	115.354704	1.0249	2.0%	2.0000	1.0403	1.0662
2015	$1,536,267.03	13,380	$114.82	115.354704	1.0047	2.0%	2.0000	1.0403	1.0452

(1) = [LR Indication Exhibit (1)] * (Current Rate Level Exhibit -1 (4)]
(3) = (1) * (2)
(4) = Average Written Premium for Year Ending 2015, Quarter 4 [From Premium Trend Exhibit -1]
(5) = (4) / (3)
(6) From Premium Trend Exhibit - 1
(7) From 06/30/2015 to 06/30/2017
(8) = [1.0 + (6)] ^ (7)
(9) = (5) * (8)

LOSS DEVELOPMENT EXHIBIT

Since historical Losses and ALAE are not fully mature, they need to be developed, and the Loss Development Exhibit shows the calculation of the LDFs using the chain ladder technique.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Development

Reported Losses and Paid ALAE Evaluated As of

Accident Year	15 Months	27 Months	39 Months	51 Months	63 Months
2009	705,088	725,592	738,686	753,027	732,239
2010	712,475	753,295	782,248	800,258	813,949
2011	714,196	763,913	855,150	874,106	856,495
2012	764,101	861,114	884,498	867,184	
2013	774,384	846,167	835,120		
2014	785,068	821,509			
2015	797,866				

Age-to-Age Factors	15-27	27-39	39-51	51-63	63-Ult
2009	1.0291	1.0180	1.0194	0.9724	
2010	1.0573	1.0384	1.0230	1.0171	
2011	1.0696	1.1194	1.0222	0.9799	
2012	1.1270	1.0272	0.9804		
2013	1.0927	0.9869			
2014	1.0464				
(1) All-Year Average	1.0703	1.0380	1.0113	0.9898	
(2) 3-Year Average	1.0887	1.0445	1.0085	0.9898	
(3) 4-Year Average	1.0839	1.0430	1.0113		
(4) Average Excluding Hi-Lo	1.0665	1.0279	1.0208	0.9799	
(5) Geometric Average	1.0699	1.0371	1.0111	0.9896	
(6) Selected Age-to-Age	1.0665	1.0279	1.0208	0.9799	1.0000
(7) Age-to-Ultimate	1.0965	1.0281	1.0002	0.9799	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Sraigtht Average Excluding Highest and Lowest Values
(5) = (Product of Age-to-Age Factors) ^ (1.0 / Number of Age-to-Age Factors)
(7) = Cumulative Product of (6)

The age-to-age factors (i.e. link ratios) are calculated for each AY by dividing the reported loss and paid ALAE at one valuation point by the value at the previous valuation point.

Rows 1 - 5 show various averages used as guides for selections.

Row 6 shows the selected age-to-age factors.

Row 7 converts the selected age-to-age factors to age-to-ultimate factors by multiplying each age-to-age factor by all of the subsequent age-to-age factors (e.g. the 39-ultimate factor is the product of the selected 39-51, 51-63, and 63-ultimate age-to-age factors).

LOSS TREND EXHIBIT

The proposed rates will be in effect in a period later than the historical period, and loss and ALAE need to be adjusted to account for expected trends in the frequency and severity of claims between the two periods.

A two-step loss trending approach is used, and regional data is used to determine appropriate trends.

Sheets 1-4

Sheet 1: Historical frequencies, severities, and pure premiums.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Trend Selections - Regional Data

Year Ending Quarter - X	(1) Earned Exposure	(2) Closed Claim Count	(3) Paid Losses	(4) Frequency	(5) Severity	(6) Pure Premium
2011 - 1	131,911	7,745	$8,220,899	0.0587	$1,061.45	$62.32
2011 - 2	132,700	7,785	$8,381,016	0.0587	$1,076.56	$63.16
2011 - 3	133,602	7,917	$8,594,389	0.0593	$1,085.56	$64.33
2011 - 4	135,079	7,928	$8,705,108	0.0587	$1,098.02	$64.44
2012 - 1	137,384	7,997	$8,816,379	0.0582	$1,102.46	$64.17
2012 - 2	138,983	8,037	$8,901,163	0.0578	$1,107.52	$64.04
2012 - 3	140,396	7,939	$8,873,491	0.0565	$1,117.71	$63.20
2012 - 4	140,997	7,831	$8,799,730	0.0555	$1,123.70	$62.41
2013 - 1	140,378	7,748	$8,736,859	0.0552	$1,127.63	$62.24
2013 - 2	139,682	7,719	$8,676,220	0.0553	$1,124.01	$62.11
2013 - 3	138,982	7730	$8,629,925	0.0556	$1,116.42	$62.09
2013 - 4	138,984	7,790	$8,642,835	0.0560	$1,109.48	$62.19
2014 - 1	139,155	7,782	$8,602,105	0.0559	$1,105.38	$61.82
2014 - 2	139,618	7,741	$8,535,327	0.0554	$1,102.61	$61.13
2014 - 3	139,996	7,720	$8,466,272	0.0551	$1,096.67	$60.48
2014 - 4	140,141	7,691	$8,412,159	0.0549	$1,093.77	$60.03
2015 - 1	140,754	7,735	$8,513,679	0.0550	$1,100.67	$60.49
2015 - 2	141,534	7,769	$8,614,224	0.0549	$1,108.79	$60.86
2015 - 3	141,800	7,755	$8,702,135	0.0547	$1,122.13	$61.37
2015 - 4	142,986	7,778	$8,761,588	0.0544	$1,126.46	$61.28

(1) Shown on a 4-Quarter Rolling Total Basis
(2) Shown on a 4-Quarter Rolling Total Basis
(3) Shown on a 4-Quarter Rolling Total Basis
(4) = (2) / (1)
(5) = (3) / (2)
(6) = (3) / (1)

Exponential Trend	Frequency	Severity	Pure Premium
20 pt	-1.7%	0.5%	-1.2%
16 pt	-1.3%	-0.1%	-1.4%
12 pt	-0.7%	-0.2%	-0.9%
8 pt	-1.3%	1.2%	-0.1%
6 pt	-0.9%	2.5%	1.6%
4 pt	-1.4%	3.3%	1.9%
Selections			
Current	-1.0%	0.5%	-0.5%
Projected	-1.0%	1.5%	0.5%

Columns 1 - 3 are the earned exposures, closed claim counts, and paid losses on a rolling 12-month basis.

- Changes in paid losses are used as the best estimate of the trend since using paid losses eliminates any distortions caused by changes in overall reserve adequacy.
- LAE are not included with the losses in the trend data, and are therefore affected by the same trend.

Exponential trends are fit to the frequency, severity, and pure premiums columns for various durations. While not displayed, actuaries may view the R-squared statistic to gauge the goodness of fit of the exponential trends.

Sheets 2 through 4: Graphical representation of the data and the selected trends.

Sheet 5: Shows the derivation of the total loss trend factor.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Trend

Accident Year	(1) Selected Current Trend	(2) Current Cost Trend Period	(3) Current Trend Factor	(4) Selected Projected Trend	(5) Projected Cost Trend Period	(6) Projected Projected Trend	(7) Loss Trend Factor
2011	-0.5%	4.00	0.9801	0.5%	2.25	1.0113	0.9912
2012	-0.5%	3.00	0.9851	0.5%	2.25	1.0113	0.9962
2013	-0.5%	2.00	0.9900	0.5%	2.25	1.0113	1.0012
2014	-0.5%	1.00	0.9950	0.5%	2.25	1.0113	1.0062
2015	-0.5%	0.00	1.0000	0.5%	2.25	1.0113	1.0113

(1) From Loss Trend Exhibit - 1
(2) From 07/01/20XX to 06/30/215
(3) = [(1.0 + (1)] ^ (2)
(4) From Loss Trend Exhibit - 1
(5) From 07/01/2015 to 09/30/2017
(6) = [(1.0 + (4)] ^ (5)
(7) = (3) * (6)

Column 2: The current cost trend period (for each AY) is the number of years between the average date of loss in the accident year (6/30/20XX) to the average date of loss for the most recent period used to select the loss trends (6/30/2015).

Column 5: The selected projected pure premium trend is used to trend losses and ALAE from 6/30/2015, to the average date of loss for the projected period.

ULAE RATIO EXHIBIT

3 CYs of countrywide data are used to determine the factor needed to adjust the State XX reported loss and paid ALAE to include ULAE.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
ULAE Ratio

Calendar Year	(1) Countrywide Paid Losses and ALAE	(2) Countrywide Paid ULAE	(3) ULAE Ratio
2013	$283,299,252	$41,170,520	14.5%
2014	$290,213,410	$41,262,210	14.2%
2015	$293,934,810	$41,959,671	14.3%
Total	$867,447,472	$124,392,401	14.3%

(3) = (2) / (1)	(4) Selected Ratio	14.3%
(5) = 1.0 + (4)	(5) ULAE Factor	1.143

CY paid information is used as it is readily available accounting data and is not susceptible to changes in reserving practices. The selection in Row 4 is based on the historical ratios.

The selected percentage is converted into a factor in Row 5 by adding 1.0.

EXPENSE EXHIBIT

U/W expense ratios are determined using the premium-based projection method.

Assume that the historical relationship between expenses and premium will continue during the projected period.

Expenses are divided into five categories: general, other acquisition, license and fees, commissions and brokerage, and taxes (calculations and selections are performed separately for each category).

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Expense Calculation

	2013	2014	2015	3-year Weighted Avg	Selected
(1) General Expenses					
a Countrywide Expenses	$29,143,368	$29,940,978	$30,763,160		
b Countrywide Earned Premium	$466,001,205	$478,971,842	$491,904,082		
c Ration [(a)/(b)]	6.3%	6.3%	6.3%	6.3%	6.3%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c)*(d)]					4.7%
f Variable Expense % [(c)*(1.0-(d))]					1.6%
(2) Other Acquisition					
a Countrywide Expenses	$40,158,296	$40,912,479	$41,652,543		
b Countrywide Earned Premium	$468,850,020	$482,345,783	$495,356,701		
c Ration [(a)/(b)]	8.6%	8.5%	8.4%	8.5%	8.5%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c)*(d)]					6.4%
f Variable Expense % [(c)*(1.0-(d))]					2.1%
(3) Licenses and Fees					
a State Expenses	$3,124	$3,190	$3,229		
b State **Written** Premium	$1,289,484	$1,380,129	$1,407,811		
c Ration [(a)/(b)]	0.2%	0.2%	0.2%	0.2%	0.2%
d % Assumed Fixed					100.0%
e Fixed Expense % [(c)*(d)]					0.2%
f Variable Expense % [(c)*(1.0-(d))]					0.0%
(4) Commission and Brokerage					
a State Expenses	$145,073	$154,235	$158,172		
b State Earned Premium	$1,289,484	$1,380,129	$1,407,811		
c Ration [(a)/(b)]	11.3%	11.2%	11.2%	11.2%	11.2%
d % Assumed Fixed					0.0%
e Fixed Expense % [(c)*(d)]					0.0%
f Variable Expense % [(c)*(1.0-(d))]					11.2%
(5) Taxes					
a State Expenses	$27,338	$27,549	$29,853		
b State **Written** Premium	$1,289,484	$1,380,129	$1,407,811		
c Ration [(a)/(b)]	2.1%	2.0%	2.1%	2.1%	2.1%
d % Assumed Fixed					0.0%
e Fixed Expense % [(c)*(d)]					0.0%
f Variable Expense % [(c)*(1.0-(d))]					2.1%
(6) Fixed Expense Provision	(1e) + (2e) + (3e) + (4e) + (5e)				11.3%
(7) Variable Expense Provision	(1f) + (2f) + (3f) + (4f) + (5f)				17.0%

Row “a” shows the expense associated with each category for each of the three years (and the expense is aggregated either at the state or countrywide level, depending on the category).

Row “b” displays the corresponding premium. The premium used in this calculation is either state or countrywide and either written or earned depending on the nature of the expense category.

Row “c” is the calculation of the expense ratio for each expense category for each year as well as the premium-weighted average of the three years; the selected percentage is displayed in the last column.

No expense trend is applied to the fixed expense ratio (assumes the expenses and premium will trend at the same rate and the ratio will remain constant).

Questions from the 2009 exam

30. (6 points) Given the following information:

- All policies have annual terms.
- Proposed effective date is October 1, 2009 and rates will be in effect for 12 months.
  - Rate change history:
  - - 4% effective July 1, 2007
- +5% effective January 1, 2009
- Selected premium trend = 1%

Calendar Accident Year	Earned Premium	Case Incurred Losses and ALAE
2007	$600,000	$250,000
2008	$650,000	$350,000

- Historical Accident Year Case Incurred Loss and ALAE Link Ratios:

Accident Year	12-24 Months	24-36 Months	36-48 Months	48-60 Months	60-72 Months
2001	1.40	1.07	1.05	1.03	1.02
2002	1.40	1.07	1.05	1.03	1.02
2003	1.40	1.07	1.05	1.03	1.02
2004	1.40	1.07	1.05	1.03	
2005	1.30	1.15	1.05		
2006	1.30	1.15			
2007	1.30				

- A tail development factor of 1.01 is needed to account for development beyond 72 months.
- Selected annual frequency trend = -2%
- Selected annual severity trend = 5%
- ULAE is consistently 4% of ultimate losses and ALAE.
- Projected fixed expense provision = 10% of premium
- Variable expense provision = 20% of premium
- Profit and contingencies provision = 3% of premium

a. (2 points) Calculate 2007 and 2008 projected calendar year earned premium at current rate level.

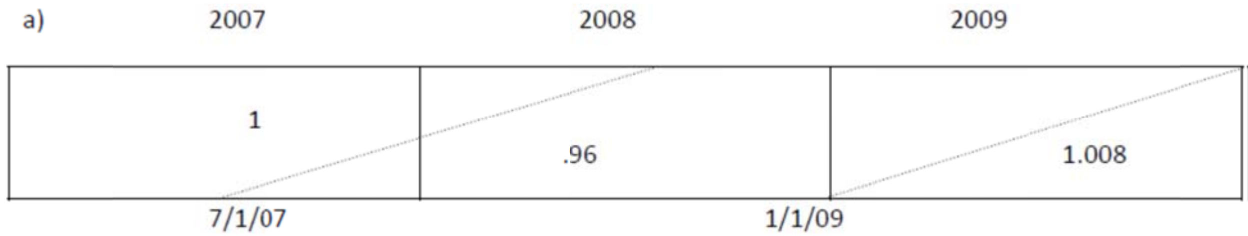
b. (1 point) Select 12-month and 24-month age to ultimate factors. Briefly explain your selection.

c. (1.5 points) Calculate the 2007 and 2008 projected calendar accident year losses and LAE.

d. (1.5 points) Calculate the indicated rate change, giving 40% weight to calendar accident year 2007 and 60% weight to calendar accident year 2008.

Solutions to questions from the 2009 exam
Question: 30

Current Level Factor = 1.0 * (1-.04) * 1.05 = 1.008



2007 on-level factor = $\dfrac{1.008}{[(.5)(.5)(.5)](.96) + (.875)(1)} = 1.0131$

2008 on-level factor = $\dfrac{1.008}{(.125)(1) + (.875)\ .96} = 1.0446$

2007 trend factor goes from 7/1/07 to 10/1/10 = 3.25 years
2008 trend factor goes from 7/1/08 to 10/1/10 = 2.25 years

2007 projected CY earned premium = $(600{,}000)(1.0131)(1.01)^{3.25}$ = $\boxed{627{,}839}$
2008 projected CY earned premium = $(650{,}000)(1.0446\ )(1.01)^{2.25}$ = $\boxed{694{,}363}$

b.

	12-24	24-3 6	36-48	48- 60	60-72
Average factors chosen	1.3	1.15	1.05	1.03	1.02

12-month age-to-ultimate =(1.3)(1.15)(1.05)(1.03)(1.02)(1.01)= $\boxed{1.6657}$
24-month age-to-ultimate = (1.15)(1.05)(1.03)(1.02)(1.01)= $\boxed{1.2813}$

There was probably a change in reserving methods underlying the abrupt changes in historical 12-24 and 24-3 6 link ratios. The new method reflecting the recent link ratios should be used.

c. 2007 AY projected loss + LAE = $(250{,}000)(1.2813)(1.04)\ [(.98\ )(1.05)]^{3.25}$ = $\boxed{365{,}573}$
2008 AY projected loss + LAE = $(350{,}000)(1.6657)(1.04)\ [(.98)(1.05)]^{2.25}$ = $\boxed{646{,}596}$

d. Weighted loss ratio= (.4)(365,573/627,839) + (.6)(646,596/ 694,363) =.7916
Indicated rate change= (.7916 + .1)/(1 - .2 - .03) - 1= $\boxed{15.8\%}$

This is an example of a homeowners (HO) rate level indication using the pure premium approach.
All policies are annual, and the proposed effective date for new rates in State XX is 1/1/2017.

The individual exhibits are as follows:

- **PP Indication**: Calculation of the overall indicated rate per exposure using the pure premium method on 5 AYs of experience as of 3/31/2016.
- **Non-Modeled Cat**: Calculation of the cat provision for non-modeled catastrophes.
- **AIY Projection**: Selection of the projected average amount of insurance years (AIY) in the effective period, used in the derivation of the non-modeled cat pure premium.
- **Reinsurance**: Projected net reinsurance cost per exposure.
- **Loss Development**: Derivation and selection of the LDFs using the chain ladder method.
- **Loss Trend**: Selection of the loss trend factors based on the historical changes of frequency, severity, and pure premium.
- **ULAE Ratio**: Computation of the ULAE factor based on the historical relationship of ULAE to losses and ALAE.
- **Expense**: Fixed and variable expense provisions using the exposure-based projection method.

PP (PURE PREMIUM) INDICATION EXHIBIT

The overall rate level indication is based on the latest 5 AYs as of 3/31/2016.

- The projected non-cat PP for State XX is credibility-weighted with a regional non-cat PP, and then added to the sum of the non-modeled cat PP and modeled cat PP.
- The total projected PP, projected fixed expense per exposure and the projected net reinsurance cost per exposure are combined and divided by the VPLR to obtain the overall indicated rate.

State XX
Wicked Good Insurance Company
Homeowners
Pure Premium Indication

Calendar Accident Year	(1) Earned Exposure	(2) Non-Cat Reported Losses and Paid ALAE	(3) Loss Development Factor	(4) Loss Trend Factor	(5) ULAE Factor	(6) Projected Ultimate Non-Cat Losses and LAE	(7) Projected Non-Cat Pure Premium
2011	12,760	$5,161,624	1.0000	1.1939	1.0118	$6,235,484	$488.67
2012	12,766	$4,820,968	1.0012	1.1705	1.0118	$5,716,355	$447.78
2013	12,805	$4,112,172	1.0054	1.1476	1.0118	$4,800,456	$374.89
2014	12,834	$5,052,052	1.0185	1.1251	1.0118	$5,857,361	$456.39
2015	13,411	$6,559,224	1.0553	1.1030	1.0118	$7,725,146	$576.03
Total	64,576	$25,706,040				$30,334,802	$469.75

(2) Reported Losses and Paid ALAE As of 03/31/2016	(8) Selected Projected Non-Cat Pure Premium	$469.75
(3) From Loss Development Exhibit	(9) Number of Claims	683
(4) From Loss Trend Exhibit - 1	(10) Claims Required for Full Credibility	1082
(5) From ULAE Ratio Exhibit	(11) Credibility	79.5%
(6) = (2) * (3) * (4) * (5)	(12) Regional Non-Cat Pure Premium	$585.75
(7) = (6) / (1)	(13) Credibility-Weighted Non-Cat Pure Premium	$493.59
(11) = Min { [(9) / (10)] ^ 0.5 , 1.0 }	(14) Non-Modeled Cat Pure Premium	$29.11
(13) = (8) * (11) + (12) * [1.0 - (11)]	(15) Modeled Cat Pure Premium	$74.57
(14) From Non-Modeled Cat Exhibit	(16) Total Pure Premium	$597.27
(15) From Hurricane Catastrophe Model	(17) Projected Net Reinsurance Cost Per Exposure	$15.68
(16) = (13) + (14) + (15)	(18) Projected Fixed Expense Per Exposure	$77.74
(17) From Cost of Reinsurance Exhibit	(19) Variable Expense Provision	13.8%
(18) From Expense Exhibit - 1	(20) Profit and Contingency Provision	5.0%
(19) From Expense Exhibit - 1	(21) Variable Permissible Loss Ratio	81.2%
(21) = 100% - (19) - (20)	(22) Indicated Rate	$850.30
(22) = [(16) + (17) + (18)] / (21)	(23) Selected Rate	$850.30

Columns 2 - 7 show the calculation of the projected non-cat pure premium (including LAE).

Rows 9 - 3 show the derivation of the credibility-weighted non-cat PP.

Row 11 full credibility standard: 1,082 claims based on the classical credibility approach; partial credibility is calculated using the square root rule.

Row 22 indicated rate per exposure: Sum of the total PP (Row 16), the projected fixed expense per exposure (Row 18), and the projected net reinsurance cost per exposure (Row 17), divided by the VPLR (Row 21).

NON-MODELED CAT EXHIBIT

This exhibit outlines the calculation of the non-modeled catastrophe provision.

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Non-Modeled Cat Loading

Calendar Year	(1) Amount of Insurance Years ($000s)	(2) Reported Cat Losses and Paid ALAE	(3) Cat-to-AIY Ratio
1996	$1,752,020	$4,412	0.003
1997	$1,911,500	$26,236	0.014
1998	$2,110,710	$155,872	0.074
1999	$2,333,580	$38,689	0.017
2000	$2,494,580	$145,490	0.058
2001	$2,545,420	$227,118	0.089
2002	$2,631,470	$222,464	0.085
2003	$2,738,710	$833,316	0.304
2004	$2,858,230	$173,649	0.061
2005	$2,927,850	$2,668,809	0.912
2006	$2,936,440	$96,981	0.033
2007	$2,923,330	$256,753	0.088
2008	$2,910,500	$54,333	0.019
2009	$2,944,090	$475,524	0.162
2010	$2,916,440	$1,230	0.000
2011	$2,665,300	$70,299	0.026
2012	$2,771,912	$485,029	0.175
2013	$2,882,788	$29,025	0.010
2014	$2,998,100	$69,868	0.023
2015	$3,208,151	$178,200	0.056

(3) = (2) / (1)	(4) All-Year Arithmetic Average	0.110
(4) = Average of (3)	(5) ULAE Factor	1.012
(5) From ULAE Ratio Exhibit	(6) Non-Modeled Cat Provision Per AIY	0.112
(6) = (4) * (5)	(7) Selected Average AIY Per Exposure	$262.20
(7) From AIY Projection Exhibit	(8) Non-Modeled Cat Pure Premium	$29.28
(8) = (6) * (7)		

Column 1:

- AIY (in $000s) represents the sum total of amount of insurance for all policies in-force during the CY.
- If the non-modeled cat provision was based on the ratio of non-modeled cat losses and ALAE to ***house years***, the ratio would increase over time due to the influence of inflation and other factors on the numerator during the twenty year period.
- Using AIY in the denominator adjust the ratio for inflation. .

AIY PROJECTION EXHIBIT

The projected average AIY is used to calculate the expected non-modeled catastrophe pure premium. The AIY Projection Exhibit details how the projected average AIY is calculated.

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Projected Average AIY

Calendar Year	(1) Amount of Insurance Years ($000s)	(2) Earned Exposure	(3) AIY-to-Earned Exposure Ratio	(4) Annual Change	(5) AIY-to-Earned Exposure Exponential Fit
2011	$2,665,300	12,760	$208.88		$209.58
2012	$2,771,912	12,766	$217.13	4.0%	$216.92
2013	$2,882,788	12,805	$225.13	3.7%	$224.52
2014	$2,998,100	12,834	$233.61	3.8%	$232.39
2015	$3,208,151	13,411	$239.22	2.4%	$240.53
2016					$248.96
2017					$257.68
2018					$266.71

(6) Projected Average AIY in Effective Period $262.20
(7) Selected AIY in Effective Period $262.20

(3) = (1) / (2)
(4) = Current Year (3) / Prior Year (3) - 1.0
(5) Exponential Fit of (3) Using Data From Calendar Years 2011 Through 2015
(6) Average of (5) For Latest 2 Years

Row 6: Average AIY for the effective period (PY 2017), or the average of Column 5 for 2017 and 2018. Row 7 shows the selected projected average AIY.

REINSURANCE EXHIBIT

The net reinsurance cost per exposure considers both the reinsurance recoveries and the cost of the reinsurance contract.

State XX
Wicked Good Insurance Company
Homeowners
Cost of Reinsurance

(1) Expected Reinsurance Recoveries	$458,672
(2) Cost of Reinsurance (Expected Ceded Premium)	$673,248
(3) Net Cost of Reinsurance	$214,576
(4) Latest Year Exposures	13,411
(5) Expected Annual Exposure Increase	1.0%
(6) Projection Period	2.0
(7) Projected Exposures	13,681
(8) Projected Net Reinsurance Cost Per Exposures	$15.68

(3) = (2) - (1)
(4) From Pure Premium Indication Exhibit
(5) Based on Company Goals
(6) From Midpoint of Latest Year to Midpoint of Reinsurance Contract [(07/01/2015) to (07/01/2017)]
(7) = (4) * [1.00 + (5)] ^ (6)
(8) = (3) / (7)

Row 1: Expected reinsurance recoveries from the reinsurance contract (obtained from the output of catastrophe models and is the expected recoveries in an “average year”).

LOSS DEVELOPMENT EXHIBIT

This is the ***same procedure used for the personal automobile example*** in Appendix A. Thus, the same comments apply.

LOSS TREND EXHIBIT

This is the same ***procedure used for the personal automobile example***, except that the d*ata is at the pure premium level rather than at the frequency and severity level*. Thus, the same comments apply.

ULAE RATIO EXHIBIT

This is the ***same procedure used for the personal automobile example***. Thus, the same comments apply.

EXPENSE EXHIBIT

The U/W expense provisions are determined using the **exposure**-based projection method.

Assumes the historical relationships of variable expenses to premium and fixed expenses to exposures are expected to continue during the projected period.

Sheet 1

Expenses are divided into: GE; Other Acq; TL&F; and Comm and brokerage.

The calculations and selections are performed for each category independently.

State XX
Wicked Good Insurance Company
Homeowners
Expense Calculation

	2013	2014	2015	3-year Weighted Avg	Selected
(1) General					
a Countrywide Expenses	$2,238,241	$2,301,402	$2,432,343		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a)*(b)]	$1,678,681	$1,726,052	$1,824,257		
d Countrywide Earned Exposures	56,884	57,452	58,027		
e Fixed Expense Per Exposure [(c)/(d)]	$29.51	$30.04	$31.44	$30.33	$31.44
f Variable Expense % [(a)*(1.0-(b))]	$559,560	$575,351	$608,086		
g Countrywide Earned Premium	$51,764,213	$53,143,516	$53,965,296		
h Variable Expense % [(f)/(g)]	1.1%	1.1%	1.1%	1.1%	1.1%
(2) Other Acquisition					
a Countrywide Expenses	$2,582,786	$2,715,731	$2,912,054		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a)*(b)]	$1,937,090	$2,036,798	$2,184,041		
d Countrywide Written Exposures	56,602	57,740	58,317		
e Fixed Expense Per Exposure [(c)/(d)]	$34.22	$35.28	$37.45	$35.65	$37.45
f Variable Expense % [(a)*(1.0-(b))]	$645,697	$678,933	$728,014		
g Countrywide Written Premium	$51,907,954	$53,554,406	$55,235,122		
h Variable Expense % [(f)/(g)]	1.2%	1.3%	1.3%	1.3%	1.3%
(3) Taxes, Licenses and Fees					
a State Expenses	$200,879	$205,363	$210,002		
b % Assumed Fixed					25.0%
c Fixed Expense $ [(a)*(b)]	$50,220	$51,341	$52,501		
d State Written Exposures	12,820	13,123	13,478		
e Fixed Expense Per Exposure [(c)/(d)]	$3.92	$3.91	$3.90	$3.91	$3.90
f Variable Expense % [(a)*(1.0-(b))]	$150,659	$154,022	$157,502		
g State Written Premium	$11,217,062	$11,810,250	$12,332,420		
h Variable Expense % [(f)/(g)]	1.3%	1.3%	1.3%	1.3%	1.3%
(4) Commission and Brokerage					
a State Expenses	$1,115,970	$1,207,693	$1,244,644		
b % Assumed Fixed					0.0%
c Fixed Expense $ [(a)*(b)]	$0	$0	$0		
d State Written Exposures	12,820	13,123	13,478		
e Fixed Expense Per Exposure [(c)/(d)]	$0.00	$0.00	$0.00	$0.00	$0.00
f Variable Expense % [(a)*(1.0-(b))]	$1,115,970	$1,207,693	$1,244,644		
g State Written Premium	$11,217,062	$11,810,250	$12,332,420		
h Variable Expense % [(f)/(g)]	9.9%	10.2%	10.1%	10.1%	10.1%

(5) Total Fixed Expenses	(1e) + (2e) + (3e) + (4e)	$72.78
(6) Fixed Expense Trend	From Expense Exhibit - 2	3.4%
(7) Trend Period	From 07/01/2015 to 07/01/2017	2.00
(8) Fixed Expense Trend Factor	[1.0 + (6)]^ (7)	1.0681
(9) Projected Fixed Expense	(5) * (8)	$77.74
(10) Variable Expense Provision	(1h) + (2h) + (3h) + (4h)	13.8%

Row “a” shows the expense associated with each category for each of the 3 CYs. The expense is either at the state or countrywide level, depending on the category.

Row “d” displays the exposure per year; the exposures are state or countrywide and written or earned depending on the expense category.

Row 7 is the length of the trend period (from the average written date of the latest year to the average written date for the time period the rates are to be in effect).

Sheet 2: Outlines the procedure for selecting the fixed expense trend.

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Annual Expense Trend

(1) Employment Cost Index - Finance, Insurance & Real Estate, excluding Sales Opportunity - (annual change over latest 2 years) U.S. Department of Labor	4.8%
(2) % of Other Acquisition and General Expense used for Salaries and Employee Relations & Welfare - Insurance Expense Exhibit, 2015	50.0%
(3) Consumer Price Index, All Items - (annual change over latest 2 years)	1.9%
(4) Annual Expense Trend - [(1) * (2)] + [(3) * { 100% - (2) }]	3.4%
Selected Annual Expense	3.4%

Questions from the 2010 exam

27. (7 points) Given the following information for a Homeowners book of business in State X:

- All policies are annual.
- Proposed effective date is January 1, 2011 and rates will be in effect for twelve months.
- Selected current loss trend is 3%.
- Selected projected loss trend is 2%.

Calendar Accident Year	Earned Exposures	Non-Cat Reported Losses and Paid ALAE	Loss Development Factor to Ultimate	ULAE Factor	Amount of Insurance Years (AIY) to Earned Exposure Exponential Fit
2005	5,400	$2,025,000	1.0000	1.050	$270.00
2006	8,600	$3,440,000	1.0500	1.050	$283.50
2007	9,600	$3,408,000	1.1000	1.050	$297.68
2008	10,000	$5,400,000	1.1500	1.050	$312.56
2009	11,000	$5,500,000	1.2000	1.050	$328.19
2010					$344.60
2011					$361.83
2012				•	$379.92

- Selected fixed expense using expense data through 2009 = $47 per exposure
- Variable expenses = 14.4% of premium
- Fixed expense trend = 3.0%
- Profit and contingency provision = 9% of premium
- State X experience is fully credible
- Modeled catastrophe pure premium = $35.15
- Arithmetic average of last 20 years' non-modeled cat to AIY ratio = 0.370
- Expected reinsurance recoveries from a reinsurance contract with coverage from June 1, 2011 to June 1, 2012 = $350,000
- Cost of reinsurance = $680,000
- Assume no projected growth in exposures

a. (3 points) Calculate the projected ultimate non-catastrophe pure premium.
b. (1 point) Calculate the projected non-modeled catastrophe pure premium.
c. (0.75 point) Calculate projected net reinsurance cost per exposure.
d. (0.75 point) Calculate the projected fixed expense per exposure.
e. (1.5 points) Calculate the indicated rate.

Solutions to questions from the 2010 exam

Question 27 Initial comments: The following is the Model CAS solution to question 27. Rather than expound upon the solution, its best for candidates to see 'exactly' what it takes to solve the problem in the most efficient manner (which this model solution does). Our notes appear in << >> below.

a. (3 points) Calculate the projected ultimate non-catastrophe pure premium.

	1	2	3	4	5	6	7
CAY	EE	Non-Cat Rept Loss +Pd ALAE	LDF	ULAE Factor	Trend Factor	Proj ult Non-Cat Loss & LAE	Proj Non-Cat PP
2005	5400	2025	1.00	1.05	1.1826	2514.503	465.65
200 6	8600	3440	1.05	↓	1.1482	4354.663	506.36
2007	9600	3408	1.10	↓	1.1147	4387.727	457.55
200 8	10000	5400	1.15	↓	1.0823	7057.137	705.71
2009	11000	5500	1.20	↓	1.0508	7282.044	662.00
	44,600					25,596.074	$\boxed{573.90}$

Notes: (1) – (4) Given; (2) & (6) in 000's
(5) '09 trended from 6/30/09 to 12/31/11 @ 2%, '08 & prior @ 3 % to'09
(6) = (2)x(3)x(4) x(5)
(7)= (6)/ (1) x 1000

<< See PP indication exhibit, Appendix B, Page 5>>

b. (1 point) Calculate the projected non-modeled catastrophe pure premium.

(1) 20 yr non - modeled CAT – to AIY Ratio	0.370
(2) ULAE Factor	1.050
(3) Aug AIY – to –EE ratio in projected period	370,875
(4) Projected non - modeled CAT PP	144.08

Notes: (1), (2) Given
(3) = avg fitted CAY 2011 & CAY 2012 Ratio
(4) = (1) x(2) x(3)

<< See Non-Modeled Cat Exhibit, Appendix B, Page 6>>

c. (0.75 point) Calculate projected net reinsurance cost per exposure.

Projected Net Reins cost per exposure = (680,000 – 350,000)/11,000 = 30

<< See Reinsurance Exhibit, Appendix B, Page 8>>

d. (0.75 point) Calculate the projected fixed expense per exposure.

Trend from 7/1/09 to 7/1/11 (Avg written date) = $47*1.03^2 = 49.86$

e. (1.5 points) Calculate the indicated rate.

(1) Non - CAT PP (part a.) =		573.90
(2) CAT PP = modeled (given) + non modeled (part b.) = 35.15+144.08 =		179.23
(3) Net Reins per EE (part c.) + fixed expense per EE (part d.)	=	79.86
(4) Permissible LR = 1.0 - .144 - .09	=	0.766
(5) Indicated Rate= [(1)+(2)+(3)]/(4)		1,087.45

Notes (4) = 1.0 – Var. Exp provision – Target & cont. provision
<<See PP indication exhibit, Appendix B, Page 5>>

The overall rate level indication for a medical malpractice (MM) insurance program using the loss ratio indication approach is shown.

- While MM insurance can be written on an occurrence or CM; the data used in this example is based on occurrence policies.
- Due to the longer-tailed nature and higher frequency of large losses, the data is more volatile and ratemaking techniques are slightly different than those used for personal automobile and homeowners.

All policies are annual and the proposed effective date of the rate change in State XX is 5/1/2016.

The individual exhibits are as follows:

- **LR Indication**: The overall indicated rate change using the loss ratio method based on 5 years of State XX calendar-accident year experience evaluated as of 9/30/2015.
- **Current Rate Level**: Calculation of the current rate level factors using the parallelogram method.
- **Loss Development**: Selected ultimate loss and ALAE using a combination of the chain ladder and Bornhuetter-Ferguson methods.
- **Net Trend**: Selection of net trend factors based on historical changes of frequency, severity, and premium.
- **Expense and ULAE Ratio**: Derives the expense provision using all ULAE and underwriting expenses.

LR (LOSS RATIO) INDICATION EXHIBIT

The overall rate level indication is calculated on the LR (Loss Ratio) Indication Exhibit.

The projected loss and ALAE ratio is calculated and compared to the permissible loss ratio to obtain the indicated statewide rate change (which is credibility-weighted with the countrywide rate indication)

Note: Certain factors in the exhibits below are displayed to a certain number of decimal places. However, certain calculations shown in these exhibits may be based on unrounded factors. Thus, these values do not match those in the corresponding exhibit in the text. However, the formulas, which are shown correctly, are what matter most when preparing for the exam.

State XX
Wicked Good Insurance Company
Medical Malpractice
Indicated Rate Change

Calendar Accident Year	(1) Earned Premium	(2) Current Rate Level Factor	(3) Earned Premium @ CRL	(4) Ultimate Loss and ALAE	(5) Net Trend Factor	(6) Projected Ultimate Loss and ALAE	(7) Projected Ultimate Loss and ALAE Ratio
2010	$14,904,664	1.2029	$17,928,820	$11,673,500	1.7902	$20,897,845	116.6%
2011	$14,494,543	1.2058	$17,476,994	$11,199,932	1.6439	$18,411,446	105.3%
2012	$14,442,449	1.2724	$18,376,646	$6,288,376	1.5095	$9,492,557	51.7%
2013	$14,834,605	1.3018	$19,312,280	$18,257,633	1.3862	$25,308,200	131.0%
2014	$18,265,093	1.2390	$22,631,001	$23,362,271	1.2729	$29,737,466	131.4%
Total	$76,941,354		$95,725,741	$70,781,712		$103,847,514	108.5%

(1) From Net Trend Exhibit - 1	(8) Selected Loss and ALAE Ratio	108.5%
(2) From Current Rate Level Exhibit - 2	(9) Expense and ULAE Ratio	34.8%
(3) = (1)*(2)	(10) Profit and Contingency Provision	-5.0%
(4) From Loss Development Exhibit - 6	(11) Permissible Loss Ratio	70.2%
(5) From Net Trend Exhibit - 3	(12) Statewide Indicated Rate Change	54.6%
(6) = (4)*(5)	(13) Number of Reported Claims	283
(7) = (6)/(3)	(14) Claims Required for Full Credibility Standard	683
(9) From Expense & ULAE Ratio Exhibit - 2	(15) Credibility	64.4%
(11) = 100% - (9) - (10)	(16) Countrywide Indicated Rate Change	18.5%
(12)= [(8)/ (15)] - 1.0	(17) Credibility - Weighted Indicated Rate Change	41.7%
(13) Derived From Net Trend Exhibit - 2	(18) Selected Rate Change	41.7%
(14) = Min { [(13) / (14)] ^ 0.5, 1.0 }		
(17) = (12) * (15) + (16) * [1.0 - (15)]		

(12)= [(8)/ (11)] - 1.0; Also

Column 4: ultimate losses and ALAE selected for each AY.

Companies cap losses at the basic limit to minimize the impact of extraordinary losses, but since basic limits losses were not available, total limit losses were used.

Row 6 selected loss and ALAE ratio is the projected loss and ALAE ratio across all accident years.

Row 10 shows the target UW profit provision.

Note that the UW profit provision is negative; Recall that the insurer's total profit is UW profit plus investment income.; II is expected to be high in this long-tailed line of business, so WU profit can be negative.

Row 12 statewide rate indication is calculated by comparing the selected projected loss and ALAE ratio (Row 8) to the permissible loss ratio (Row 11).

Rows 13 - 15 show the calculation of the credibility factor.

Row 13 shows the number of reported claims for the five most recent accident years as of 9/30/ 2015.

The number of claims for full credibility, 683, is based on a 95% probability that the observed experience will be within 7.5% of the expected experience.

Row 15, the credibility measure, is calculated using the square root rule.

The countrywide indication is displayed in Row 16. Row 17 shows the credibility-weighted rate indication of the statewide and countrywide results. A rate change is then selected in Row 18.

CURRENT RATE LEVEL EXHIBIT

These two sheets use the same parallelogram method that was used to adjust earned premium to current rate level in the personal automobile rating example.

Sheet 1: cumulative rate level indices for each rate level group during or after the historical period.

Sheet 2: current rate level factors computation.

LOSS DEVELOPMENT EXHIBIT

The calculation of ultimate loss and ALAE uses three loss development techniques, since it is common to use multiple methods in long-tailed lines of business.

The results of the three techniques are used to judgmentally select ultimate loss & ALAE by AY

Sheets 1-3

Sheets 1 and 2: Calculation and selection of age-to-ultimate LDFs using the chain ladder approach.

This is the same approach as used in the personal automobile and homeowners rating examples.

Sheet 1: The chain ladder approach applied to paid losses and paid ALAE.

Sheet 2: The chain ladder approach applied to reported losses and paid ALAE.

The losses are total limit losses; if capped losses were available, the loss development analysis would have been conducted on that basis as well.

Sheet 3: Calculation of claim count development factors based on historical reported claim counts. The resulting ultimate claim counts are used in deriving the net loss ratio trend (discussed later).

State XX
Wicked Good Insurance Company
Medical Malpractice
Claim Count Development Factors

Accident Year	Reported Losses & Paid ALAE Evaluated As of 21 Months	33 Months	45 Months	57 Months	69 Months	81 Months	93 Months	105 Months	117 Months	129 Months
2005	33	41	52	59	63	63	63	63	63	63
2006	15	33	48	48	48	48	48	48	48	
2007	26	52	74	85	85	89	93	96		
2008	37	59	70	85	85	85	85			
2009	44	81	85	107	107	107				
2010	19	44	59	67	67					
2011	15	44	63	63						
2012	48	59	67							
2013	33	56								
2014	30									

Age-to-Age Factors	21-33	33-45	45-57	57-69	69-81	81-93	93-105	105-117	117-129	129 to Ult
2005	1.2424	1.2683	1.1346	1.0678	1.0000	1.0000	1.0000	1.0000	1.0000	
2006	2.2000	1.4545	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
2007	2.0000	1.4231	1.1486	1.0000	1.0471	1.0449	1.0323			
2008	1.5946	1.1864	1.2143	1.0000	1.0000	1.0000				
2009	1.8409	1.0494	1.2588	1.0000	1.0000					
2010	2.3158	1.3409	1.1356	1.0000						
2011	2.9333	1.4318	1.0000							
2012	1.2292	1.1356								
2013	1.6970									
(1) All-Year Average	1.8948	1.2863	1.1274	1.0113	1.0094	1.0112	1.0108	1.0000	1.0000	
(2) 3-Year Average	1.9532	1.3028	1.1315	1.0000	1.0157	1.0150	1.0108	1.0000	1.0000	
(3) 4-Year Average	2.0438	1.2394	1.1522	1.0000	1.0118	1.0112	1.0108	1.0000	1.0000	
(4) Average Excluding Hi-Lo	1.8415	1.2977	1.1266	1.0000	1.0000	1.0000	1.0000			
(5) Geometric Average	1.7370	1.2542	1.1397	1.0089	1.0103	1.0140	1.0147	1.0000	1.0000	
(6) Selected Age-to-Age	1.7370	1.2542	1.1397	1.0089	1.0103	1.0140	1.0147	1.0000	1.0000	1.0000
(7) Age-to-Ultimate	2.6041	1.4992	1.1953	1.0488	1.0396	1.0289	1.0147	1.0000	1.0000	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Sraigtht Average Excluding Highest and Lowest Values
(5) = Average Weighted by Loss
(7) = Cumulative Product of (6)

Sheets 4-5

Since MM has relatively more large losses than other lines of business, the link ratio patterns are less stable, and is especially true for the more recent evaluation points; thus the reported Bornhuetter-Ferguson (BF) method (Sheets 4 and 5) is used to develop losses and ALAE to ultimate for the 3 most recent AYs.

- A two-year (2010-2011) average expected loss and ALAE ratio is calculated and adjusted to the rate and cost level of each of the three most recent years (i.e. 2012, 2013, and 2014).
- This ratio is multiplied by EP to compute expected losses and ALAE for each of the three years.
- Age-to-ultimate factors from the reported chain ladder method are used to calculate the portion of these losses that are unreported as of 9/30/2015.
- Add these estimated unreported losses to actual reported losses as of the same valuation date to derive the ultimate losses and ALAE for each year.

Sheet 4: Calculation of the two-year (2010-2011) average ultimate loss and ALAE ratio forecasted to the rate level and cost level of 2011.

Loss Development - 4

State XX
Wicked Good Insurance Company
Medical Malpractice
Bornhuetter-Ferguson Developed Losses

Accident Year	(1) Earned Premium	(2) Ultimate Loss and ALAE	(3) Ultimate Loss and ALAE Ratio	(4) Adjustment to Avg Rate Level in 2011	(5) Selected BF Net Trend	(6) Trend Length	(7) Net Trend Adjustment to 2011	(8) Ultimate Loss and ALAE Ratio as of 2011
2010	14,904,664	$11,673,500	78.3%	0.9976	13.3%	1.00	1.1330	88.9%
2011	14,494,543	$11,199,932	77.3%	1.0000	13.3%	0.00	1.0000	77.3%

(9) 2- Year Avg Ultimate Loss and ALAE Ratio (2010-2011): 83.1%

(1) From Net Trend - 1
(2) From Loss Development Exhibit - 6
(3) = (2) / (1)
(4) From (2) in Current Rate Level - 2
(5) From (14) in Net Trend - 1
(6) From 07/01/20XX to 07/01/2011
(7) = [1 + (5)] ^ (6)
(8) = (3) / (4) * (7)
(9) Straight Average of (8)

Column 2: Is a straight average of ultimate loss and ALAE from the reported and paid chain ladder methods.
Column 3: Is the ratio of Column 2 to Column 1.

Column 4: Is the ratio of the 2011 average rate level to the average rate level of each respective year.

Column 5: Is based on a review of the trend in severity and adjusted frequency from 2005-2011 (see Net Trend – 1 exhibit). As ultimate losses have not yet been derived for the most recent years, this trend analysis (for the purpose of applying the BF method) does not consider the most recent years.

Column 6: The number of years from the midpoint of each accident year (7/1/20xx) until the midpoint of AY 2011 (7/1/2011).

Sheet 5: Calculation of the ultimate loss and ALAE ratio for AY 2012-2014, using the BF method.

State XX
Wicked Good Insurance Company
Medical Malpractice
Bornhuetter-Ferguson Developed Losses

Accident Year	(1) 2- Year Avg Ultimate Loss and ALAE Ratio (2010-2011)	(2) Earned Premium	(3) Average Rate Level	(4) Rate Level 2011	(5) Average Rate Level Adjustment	(6) Selected BF Net Trend	(7) Trend Length from 2011	(8) Net Trend Adjustment	(9) Expected Losses and ALAE Ratio
2012	83.1%	14,442,449	0.9454	0.9976	0.9476	13.3%	1.00	1.1330	99.4%
2013	83.1%	14,834,605	0.9240	0.9976	0.9262	13.3%	2.00	1.2837	115.2%
2014	83.1%	18,265,093	0.9708	0.9976	0.9732	13.3%	3.00	1.4544	124.2%

(1) From Loss Development Exhibit - 4
(2) From Net Trend - 2
(3) From Current Rate Level - 2
(4) From Current Rate Level - 2
(5) = (3) / (4)
(6) From Net Trend - 1
(7) From 07/01/2011 to 07/01/20XX
(8) = [(1) + (6)] ^ (7)
(9) = (1) / (5) * (8)

(10) Expected Losses and ALAE	(11) Reported Age-to-Ult Factor	(12) Percent Unreported	(13) Reported Losses and ALAE a/0 9/30/15	(14) Expected Losses and ALAE Not Yet Reported a/o 9/30/15	(15) B-F Ultimate Losses and ALAE
14,351,088	1.9190	47.9%	$1,954,200	$6,872,518	$8,826,718
17,087,637	4.9128	79.6%	$3,873,900	$13,609,484	$17,483,384
22,687,265	36.3756	97.3%	$1,298,700	$22,063,571	$23,362,271

(10) = (2) * (9)
(11) From Loss Development Exhibit - 2
(12) = 1 - 1 / (11)
(13) From Loss Development Exhibit - 6
(14) = (10) * (12)
(15) = (13) + (14)

Sheet 6: Shows the derivation of the selected ultimate loss and ALAE for each AY.

State XX
Wicked Good Insurance Company
Medical Malpractice
Developed Loss Selection

Acident Year	(1) Paid Losses & ALAE a/o 9/30/15	(2) Reported Losses & ALAE a/o 9/30/15	(3) Paid Age-to-Ultimate Factor	(4) Reported Age-to-Ultimate Factor	(5) Ultimate Losses & ALAE Using Paid Age-to-Ultimate Factors	(6) Ultimate Losses & ALAE Using Reported Age-to-Ultimate Factors	(7) Ultimate Losses Using B-F Method	(8) Selected Losses & ALAE
2005	$5,735,000	$5,735,000	1.0000	1.0000	$5,735,000	$5,735,000		$5,735,000
2006	$2,701,000	$2,701,000	1.0000	1.0000	$2,701,000	$2,701,000		$2,701,000
2007	$4,591,700	$4,739,700	1.0000	1.0000	$4,591,700	$4,739,700		$4,739,700
2008	$8,524,800	$8,543,300	1.0040	1.0125	$8,558,831	$8,650,182		$8,604,507
2009	$7,377,800	$7,414,800	1.0426	1.0284	$7,691,841	$7,625,361		$7,658,601
2010	$7,770,000	$11,673,500	1.1596	1.0837	$9,010,050	$12,650,602		$11,673,500
2011	$7,895,800	$8,191,800	1.6452	1.1487	$12,990,063	$9,409,801		$11,199,932
2012	$1,029,200	$1,954,200	6.3690	1.9190	$6,555,025	$3,750,035	$8,826,718	$6,288,376
2013	$170,200	$3,873,900	23.6441	4.9128	$4,024,229	$19,031,882	$17,483,384	$18,257,633
2014	$873,200	$1,298,700	140.4900	36.3756	$122,675,851	$47,241,015	$23,362,271	$23,362,271

(1) From Loss Development Exhibit - 1
(2) From Loss Development Exhibit - 2
(3) From Loss Development Exhibit - 1
(4) From Loss Development Exhibit - 2
(5) = (1) * (3)
(6) = (2) * (4)
(7) From Loss Development Exhibit - 5

(8) Judgementally Selected Based On Combinations of (5), (6) and (7)
2005-2011: max [(2), average of (5) and (6)]
2012-2013: max [(2), average of (6) and (7)]
2014 uses (7) only

Because of the volatility in the more recent years:

- An average of the reported chain ladder and BF results is used for AYs 2012 and 2013
- The BF result is used for AY 2014.

For all AYs, an additional criterion is applied to the selected ultimate loss and ALAE: each year's selected ultimate loss and ALAE must be equal to or greater than that year's reported losses and paid ALAE as of 9/30/2015.

NET TREND EXHIBIT

In the personal auto: premium trend and loss trend components are analyzed and selected separately.

In MM: premium trend is considered within the loss trend.

- Adjusted frequency trend is based on ratios of ultimate claim counts to earned premium at current rate level; changes in this ratio represent the net effect of changes in frequency and average premium.
- The severity trend is based [ultimate loss and ALAE/ultimate claim counts] (both derived using the chain ladder method).
- The selected net trend is based on the combined severity trend and the adjusted frequency trend.

Due to the long-tailed nature of MM, loss trends are based on ultimate losses and ultimate claim counts rather than paid losses and reported claim counts (common in short-tailed lines).

The BF method considers trended losses in deriving ultimate loss estimates for the 3 most recent years, but the trend used within this method does not consider the 3 most recent years; thus, there are separate trends selected for the BF method and for the overall LR indication.

Sheet 1: Trend analysis conducted for the BF method.

Sheet 2: Trend analysis for the LR indication.

Sheet 1

- Severity and adjusted frequency trends are analyzed separately for AYs 2005- 2011.
- Exponential trends are fit to the data; Trend selections are made based on the results.

State XX
Wicked Good Insurance Company
Medical Malpractice
Net Trend Calculation for Borhuetter-Ferguson Method

Accident Year	(1) Selected Ultimate Loss & ALAE	(2) Reported Claim Count	(3) Reported Age-to-Ultimate Factor	(4) Developed Claim Count	(5) Severity	(6) Earned Premium	(7) Current Rate Level Factor	(8) Earned Premium at Current Rate Level	(9) Adjusted Frequency
2005	$5,735,000	63	1.0000	63	$91,032	$17,944,254	1.2029	$21,585,143	2.92
2006	$2,701,000	48	1.0000	48	$56,271	$17,942,995	1.2029	$21,583,629	2.22
2007	$4,739,700	96	1.0000	96	$49,372	$18,532,758	1.2029	$22,293,055	4.31
2008	$8,604,507	85	1.0147	86	$99,762	$18,265,093	1.2029	$21,971,080	3.93
2009	$7,658,601	107	1.0289	110	$69,562	$15,590,108	1.2029	$18,753,341	5.87
2010	$11,673,500	67	1.0396	70	$167,602	$14,904,664	1.2029	$17,928,820	3.88
2011	$11,199,932	63	1.0488	66	$169,509	$14,494,543	1.2058	$17,476,994	3.78

		Exponential Trend				Exponential Trend
(10)	2005-2011	17.0%		(11)	2005-2011	8.2%
(12)	Selected Severity Trend for BF	10.0%		(13)	Selected Adjusted Frequency Trend for BF	3.0%
				(14)	Selected Total Net Trend for BF	13.3%

(1) From Loss Development Exhibit - 6
(2) From Loss Development Exhibit - 3
(3) From Loss Development Exhibit - 3
(4) = (2) * (3)
(5) = (1) / (4)
(7) From Current Rate Level Exhibit - 2
(8) = (6) * (7)
(9) = [(4) / (8)] * 1,000,000
(10) Exponential Fit to Severity (2005-2011)
(11) Exponential Fit to Adjusted Frequency (2005-2011)
(12) Forecasted Severity Trend based on (10) and judgment, for use in BF loss development method
(13) Forecasted Adj Freq Trend based on (11) and jdgmnt in BF loss development method

Column 9: By dividing developed claim counts by premium instead of exposures, adjusted frequency reflects frequency and premium trends within one measure.

Rows 12 and 13 selected trends are made in consideration of the exponential trends and judgment with respect to the volatility of the data.

Row 14: The selected severity and adjusted frequency trends are combined to form the net trend

Sheet 2: Same format as Sheet 1 except that the most recent accident years (2012-2014) are considered.

- Exponential trends are fit to 2005-2014 and to 2010-2014.
- Row 16 selected net trend relies more heavily on the recent period.

Sheet 3: The calculation of each AYs net trend factors for use in the LR Indication.

State XX
Wicked Good Insurance Company
Medical Malpractice
Net Trend Factors

Accident Year	(1) Selected Net Trend	(2) Trend Period	(3) Net Trend Factor
2010	8.9%	6.83	1.7902
2011	8.9%	5.83	1.6439
2012	8.9%	4.83	1.5095
2013	8.9%	3.83	1.3862
2014	8.9%	2.83	1.2729

(1) From Net Trend Exhibit - 2
(2) From 07/01/20XX to 05/01/2017
(3) = [1.0 + (1)] ^ (2)

Column 2: the number of years between the midpoint of the historical period (7/1/20XX) and the average expected loss date for when the rates will be in effect (5/1/2017).

EXPENSE AND ULAE RATIO EXHIBIT

Unlike the personal automobile and homeowners, all U/W expenses are treated as variable expense and ULAE are included within this analysis.

Due to the volatility of this line of business, the expense ratios are calculated using countrywide data.

Sheet 1: Computation of the selected ULAE ratio.

State XX
Wicked Good Insurance Company
Medical Malpractice
ULAE Ratio

Calendar Year Year	(1) Countrywide Earned Premium ($000s)	(2) Countrywide Paid ULAE ($000s)	(3) ULAE Ratio
2010	$455,119	$16,310	3.6%
2011	$724,423	$34,010	4.7%
2012	$870,129	$4,799	0.6%
2013	$596,311	$10,086	1.7%
2014	$548,096	$12,573	2.3%
Total	$3,194,078	$77,778	2.4%
	(4) Selected Ratio		2.4%

(3) = (2) / (1)

Column 3 selected ULAE ratio is based on the five-year ratio in Column 3, and while it is more intuitive to study the relationship between ULAE and losses, ULAE are a small portion of the total expenses so comparing ULAE to earned premium is acceptable.

Sheet 2: Expense ratio for each category of expense using the three most recent CY of countrywide data.

State XX
Wicked Good Insurance Company
Medical Malpractice
Expense and ULAE Ratio Calculation

	2013	2014	2015	3-year Weighted Average	Selected
(1) General Expenses					
a Countrywide Expenses	$67,766	$41,658	$35,243		
b Countrywide Earned Premium	$870,129	$596,311	$548,096		
c Ratio [(a)/(b)]	7.8%	7.0%	6.4%	7.1%	6.4%
(2) Other Acquisition					
a Countrywide Expenses	$29,041	$17,853	$15,103		
b Countrywide Written Premium	$768,631	$579,383	$576,253		
c Ratio [(a)/(b)]	3.8%	3.1%	2.6%	3.2%	2.6%
(3) Taxes, Licenses, and Fees					
a Countrywide Expenses	$21,678	$14,800	$12,225		
b Countrywide Written Premium	$768,631	$579,383	$576,253		
c Ratio [(a)/(b)]	2.8%	2.6%	2.1%	2.5%	2.1%
(4) Commission and Brokerage					
a Countrywide Expenses	$159,751	$123,221	$122,211		
b Countrywide Written Premium	$768,631	$579,383	$576,253		
c Ratio [(a)/(b)]	20.8%	21.3%	21.2%	21.1%	21.2%
(5) UW Expense Ratio	(1c) + (2c) + (3c) + (4c)				32.3%
(6) ULAE Ratio	From Expense and ULAE Ratio Exhibit - 1				2.4%
(7) UW Expense and ULAE Ratio	(5) + (6)				34.7%

(1b) from Expense and ULAE Ratio - 1
(3b) from (2b)
(4b) from (2b)

Row "a" shows expenses paid for that CY and Row "b" shows premium.

- EP is used to calculate the expense ratio for GE since these expenses are incurred <u>throughout</u> the life of the policy.
- All other expense ratios use WP since these expenses are assumed to be incurred <u>at</u> policy inception (when written).

All expenses are assumed to be variable (i.e. vary by premium).

The latest year in Row "c" historical variable expense ratios (Row "c") is selected due to the downward trend exhibited.

Row 7 is not trended which assumes that expenses and premium will increase/decrease at the same rate.

The overall rate level indication using the loss ratio approach is shown.

- The example uses WC industry data to determine advisory loss costs, including LAE
- Individual WC insurers that intend to use these loss costs as a basis for rates must include their own U/W expense and profit assumptions (described later in the appendix)
- Five AYs of experience evaluated as of 12/31/2016 are used.
  Since it is industry data, the experience is more stable than that of an individual WC insurer.
  An insurer may wish to use more years of data to increase the stability of the results.
- The experience is from annual policies and the proposed effective date for the revised loss costs is 7/1/2017.

The exhibits included in this appendix are as follows:

- **Premium**: Calculates projected loss cost premium.
- **Indemnity**: Determines the indemnity loss ratio for each AY.
- **Medical**: Determines the medical loss ratio for each AY.
- **LAE**: Determines the ALAE and ULAE factors.
- **Indication**: Combines medical and indemnity loss ratios with the ALAE and ULAE ratios to develop an indicated change to advisory loss costs.
- **Company**: Computes the adjustment necessary to account for individual company UW expenses and profit (as well as deviations to expected losses).

Note: Certain factors in the exhibits below are displayed to a certain number of decimal places. However, certain calculations shown in these exhibits may be based on unrounded factors. Thus, these values do not match those in the corresponding exhibit in the text. However, the formulas, which are shown correctly, are what matter most when preparing for the exam.

PREMIUM EXHIBIT

Historical loss cost premium needs to be adjusted for current rate level, exposure trend, and expected experience modification factors.

Workers Compensation
Calculation of Projected Premium

Accident Year	(1) Industry Loss Cost Premium	(2) Annual Payroll Level Change	(3) Exposure Trend: Factor to Current Wage Level	(4) Exposure Trend: Expected Future Wage Level Change	(5) Factor to Adjust to Future Wage Level	(6) Historical Average Experience Modification	(7) Expected Average Experience Modification	(8) Projected Loss Cost Premium
2012	$3,900,972,841	2.5%	1.152	6.1%	1.222	0.991	0.970	$4,666,705,987
2013	$4,148,612,420	3.0%	1.118	6.1%	1.187	0.985	0.970	$4,847,754,029
2014	$4,334,300,493	3.7%	1.078	6.1%	1.144	0.981	0.970	$4,903,940,552
2015	$4,659,789,168	4.2%	1.035	6.1%	1.098	0.982	0.970	$5,054,547,098
2016	$4,795,461,580	3.5%	1.000	6.1%	1.061	0.957	0.970	$5,157,100,516
Total	$21,839,136,502							$24,630,048,184

(1) Industry loss costs at current rate level (assuming no company derivations and no provision for expense and profit)
(2) Determined in separate study
(3) = [1.0 + (2NextRow)] * (3NextRow)
(4) Based on 3% trend projected for 2 years
(5) = (3) * [1.0 + (4)]
(6) Determined in a separate analysis
(7) Selected
(8) = (1) * (5) * (7) / (6)

Column 1: Loss cost premium:

- represents the hypothetical portion of the premium charged by insurers assuming the current advisory loss costs and historical experience modification factors were used.
- does not reflect any company deviations from advisory loss costs or any provision for expense and profit.
- has been adjusted for subsequent changes in advisory loss costs (i.e. brought to current level) using the extension of exposures technique.

Column 2:

- The exposure base for WC insurance is payroll, which is inflation-sensitive, so premium changes as payroll changes.
- shows the historical changes in payroll by AY, assuming a constant number of workers.

Column 3: Converts the annual changes into cumulative factors such that the factor for the most recent AY period (2016) is indexed to 1.00.

Column 4: is the wage increase expected between the most recent historical period and the time the rates are to be in effect (i.e. the selected trend of 6.1% is based on an assumed trend of 3.0% for two years (= (1.03^2) -1.0).

Column 5: combines the current and projected future wage changes into a composite exposure trend factor.

Per Chapter 15, insurers use ER to modify the manual rate for larger risks based on their actual experience.
Column 6: The average e-mod factor for each historical accident year

Column 7: The e-mod expected during the projected period

INDEMNITY EXHIBITS

Sheet 1: Indemnity Loss Development

Workers Compensation
Reported Indemnity Loss Development

Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96	96 to 108	108 to 120	120 to 132	132 to 144	144 to 156	156 to 168	168 to 180	180 to 192	192 to 204	204 to 216	216 to 228	228 to 240	240 to 252	252 to 264	264 to 276	276 to 288	288 to 300	300 to 312	312 to 324
1988																				1.000	1.000	1.000	1.000	1.000	1.000	1.000
1989																			1.002	0.998	1.002	1.001	1.001	1.001	1.001	1.001
1990																		1.001	1.001	1.002	1.001	1.002	1.003	1.002	1.001	1.001
1991																	1.000	1.003	1.000	1.002	1.000	1.002	1.000	1.001	1.000	
1992																1.000	1.001	1.000	1.001	1.001	1.002	1.002	1.001	1.001		
1993															0.999	1.001	1.000	1.001	1.001	1.001	1.000	1.001	1.000			
1994														0.999	1.002	1.000	1.000	1.001	1.001	1.000	1.001	1.001				
1995													0.999	1.001	1.001	1.001	1.000	1.001	1.000	1.000	1.000					
1996												1.001	1.001	1.001	1.000	1.000	1.002	0.999	1.000	1.000						
1997											1.001	1.004	1.001	1.000	1.001	1.000	1.001	1.001	1.000							
1998										1.002	1.003	1.001	1.002	1.001	1.002	1.000	1.003	1.000								
1999									1.002	1.003	1.004	1.003	1.001	1.000	1.001	1.001	1.000									
2000								1.006	1.008	1.004	1.003	1.002	1.001	1.000	1.003	1.000										
2001							1.009	1.007	1.008	1.005	1.003	1.006	1.002	1.002	1.001											
2002						1.016	1.013	1.015	1.006	1.005	1.004	1.001	1.002	1.001												
2003					1.031	1.022	1.020	1.013	1.009	1.007	1.000	1.002	1.002													
2004				1.048	1.038	1.031	1.016	1.017	1.007	0.998	1.003	1.003														
2005			1.092	1.062	1.047	1.030	1.022	1.011	1.003	1.001	1.004															
2006		1.230	1.109	1.071	1.042	1.026	1.013	1.002	1.007	1.005																
2007	1.861	1.260	1.117	1.068	1.045	1.021	1.007	1.008	1.003																	
2008	1.910	1.291	1.118	1.068	1.034	1.014	1.011	1.006																		
2009	1.931	1.276	1.123	1.052	1.021	1.015	1.012																			
2010	1.873	1.325	1.106	1.035	1.023	1.021																				
2011	1.952	1.263	1.069	1.033	1.032																					
2012	1.782	1.187	1.069	1.055																						
2013	1.448	1.158	1.087																							
2014	1.503	1.221																								
2015	1.684																									
3-Year Average	1.545	1.189	1.075	1.041	1.025	1.017	1.010	1.005	1.004	1.001	1.002	1.002	1.002	1.001	1.002	1.000	1.001	1.000	1.000	1.000	1.000	1.001	1.000	1.001	1.001	1.001
Average xHi Lo	1.792	1.247	1.100	1.055	1.035	1.022	1.013	1.009	1.006	1.004	1.003	1.002	1.001	1.001	1.001	1.000	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001
Selected	1.792	1.247	1.100	1.055	1.035	1.022	1.013	1.009	1.006	1.004	1.003	1.002	1.001	1.001	1.001	1.000	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001
Selected Tail Factor	1.000																									
Cumulative	2.878	1.606	1.288	1.171	1.110	1.072	1.050	1.036	1.026	1.020	1.016	1.013	1.011	1.010	1.009	1.008	1.008	1.007	1.006	1.006	1.005	1.004	1.003	1.003	1.002	1.001

The selected link ratios are based on the average excluding the highest and lowest link ratios.

A tail factor, selected based on a separate study, represents the development expected beyond 348 months, and since reported losses are expected to reach their ultimate level by 348 months, the tail factor is set to 1.00.

Sheet 2: Indemnity Benefit Cost Level Factors

Indemnity loss costs are impacted by changes in the legislative benefits, changes in utilization of indemnity benefits for each AY, and inflationary pressures.

Workers Compensation
Indemnity Benefit Cost Level Factors

Accident Year	(1) Benefit Level Change	(2) Annual Impact on Benefit Due to Wage Inflation	(3) Combined Impact on Benefits	(4) Factor to Adjust Indemnity Benefits to Projected Cost Level
2012	0.0%	1.0%	1.0%	0.761
2013	0.0%	2.0%	2.0%	0.746
2014	-30.0%	2.0%	-28.6%	1.045
2015	0.0%	1.5%	1.5%	1.029
2016	0.0%	0.9%	0.9%	1.020
Projected	0.0%	2.0%	2.0%	1.000

(1) Based on average impact of legislative changes
(1 Proj) Selected
(2) Based on the weekly wages of injured workers
(2 Proj) Selected (1% annual trend)
(3) = [1.0 + (1)] * [1.0 + (2)]-1.0
(4) = [1.0 + (3NextRow)] * (4NextRow)

Column 1:

- displays the estimated average annual impact of changes in the applicable indemnity benefit levels, considering both direct and indirect effects.
- AY 2014 effect of -30% is due to a law change (the impact was calculated in a separate study).
- The last row includes any known changes in benefits that occur after the experience period.

Column 2:

- displays the annual impact of wage inflation on benefits
- %s were calculated in a separate study
- %s reflects the impact of any maximum and minimum benefit level restrictions
- last row is the expected increase in benefits due to wage increases that will occur between the historical period and the projected period; the selection is based on an estimated 1% trend for two years (i.e. from the average loss date of the latest accident year, 7/1/2016, to the average loss date of the policy projection period, 7/1/2018).
- figures in Column 2 are significantly lower than the factors used to adjust loss cost premium to future wage level (in Sheet 1) due to the impact of maximum benefit level restrictions.

Column 4: the factor needed to adjust each historical Ay's reported losses to the projected level.

Sheet 3: Indemnity Loss Ratios

Workers Compensation
Loss Ratios-Indemnity Losses Only

Year	(1) Projected Loss Cost Premium	(2) Reported Indemnity Losses	(3) Indemnity Loss Development Factor	(4) Factor to Adjust Indemnity Benefits to Projected Cost	(5) Projected Ultimate Indemnity Losses	(6) Expected Indemnity Loss Ratio
2012	$4,666,705,987	$1,678,705,592	1.110	0.761	$1,417,388,212	30.4%
2013	$4,847,754,029	$1,982,528,857	1.171	0.746	$1,732,058,164	35.7%
2014	$4,903,940,552	$1,345,482,170	1.288	1.045	$1,810,516,788	36.9%
2015	$5,054,547,098	$931,871,212	1.606	1.029	$1,540,391,665	30.5%
2016	$5,157,100,516	$668,971,913	2.878	1.020	$1,963,948,014	38.1%
Total	$24,630,048,184	$6,607,559,744			$8,464,302,843	34.4%

(1) From Premium Exhibit
(2) Input
(3) From Indemnity Sheet 1 (Development)
(4) From Indemnity Sheet 2 (Cost Change)
(5) = (2) * (3) * (4)
(6) = (5) / (1)

MEDICAL EXHIBITS

Sheet 1: Medical Loss Development

- represents the development triangle for the reported medical losses by accident year.
- *is organized in the same way as in the Indemnity Loss Development section.*
- Unlike indemnity losses, reported medical losses (in this example) are expected to develop beyond 348 months, and a tail factor greater than 1.00 is selected.

Sheet 2: Medical Benefit Cost Level Factors

Legislative and regulatory changes impact the cost of medical benefits.

- The fees for many medical services in WC are subject to a fee schedule.
- Thus, medical loss costs are impacted by changes in the medical fee schedules and changes due to general utilization and inflation.

Workers Compensation
Medical Benefit Cost Level Factors

Accident Year	(1) Medical Fee Schedule Change	(2) Annual "Other Medical" Level Change	(3) Protion of Medical Losses Subject to Fee Schedules	(4) Combined Effect	(5) Factor to Adjust Medical Benefits to Projected Cost Level
2012	0.0%	2.5%	75.0%	0.6%	0.983
2013	0.0%	2.0%	75.0%	0.5%	0.978
2014	-20.0%	4.0%	70.0%	-12.8%	1.122
2015	0.0%	4.1%	70.0%	1.2%	1.108
2016	10.0%	3.9%	70.0%	8.2%	1.025
Projected	0.0%	8.2%	70.0%	2.5%	1.000

(1) Based on evaluations of the cost impact of changes to the Fee Schedule
(1 Proj) Selected
(2) Based on medical component of the Consumer Price Index
(2 Proj) Selected (4% annual trend)
(3) Selected Based on separate study
(4) = (1) * (3) + [(2) * (1 - (3)]
(5) = [1.0 + (4NextRow)] * (5NextRow)

Column 1:

- Shows the estimated average changes in the applicable medical fee schedule (considering both direct and indirect effects).
- The medical fee schedule is not expected to change from the most recent period through the projected time period.

Column 2:

- Shows the annual average change in medical benefits not subject to the medical fee schedule.
- The %s are based on the medical component of the Consumer Price Index (CPI).
- The projected "other medical" change is based on an expected annual change of 4% for two years (and considers any expected changes between the most recent period and the projected period).

Column 5: Converts the changes in Column 4 to adjust historical accident year reported medical losses to the projected loss cost levels.

Sheet 3: Medical Loss Ratios

- Calculates expected medical loss ratios for each accident year in the experience period.
- *The calculations are the same as in the indemnity loss ratio section.*

LAE EXHIBITS

Sheet 1: ALAE Loss Development

This sheet represents the development triangle for paid ALAE by AY (organized in the same way as described in the Indemnity Loss Development section).

- The selected factors are based on the all-year average excluding the highest and lowest
- Paid ALAE are expected to develop beyond 348 months, so a tail factor greater than 1.00 is selected.

Sheet 2: ALAE Ratio: Calculates the ratio of ultimate ALAE to ultimate projected losses.

Workers Compensation
ALAE Ratio

Year	(1) Projected Ultimate Indemnity and Medical Losses	(2) Paid ALAE	(3) ALAE Development Factor	(4) Ultimate ALAE	(5) ALAE Ratio
2012	$4,339,828,939	$350,034,124	1.469	$514,051,816	11.8%
2013	$4,423,762,673	$336,178,599	1.676	$563,316,173	12.7%
2014	$4,602,457,877	$201,330,551	2.075	$417,746,386	9.1%
2015	$4,525,988,662	$155,896,057	3.102	$483,638,473	10.7%
2016	$4,711,677,739	$93,338,368	6.992	$652,596,546	13.9%
Total	$22,603,715,890	$1,136,777,699		$2,631,349,393	11.6%
			(6)	Selected Ratio	11.6%

(1) Derived from Indemnity Sheet 3 and Medical Sheet 3
(2) Input
(3) From LAE Sheet 1 (Development)
(4) = (2) * (3)
(5) = (4) / (1)
(6) Selected

Column 5 is the ratio of the ultimate ALAE to ultimate losses, and since it is expressed as a % of losses, is different from the ratios computed for indemnity and medical (which are expressed as a % of premium).

This ratio is used as ALAE are more directly related to the amount of losses than the amount of premium.

Sheet 3: ULAE Ratio

Calculates the ULAE ratio based on the historical relationship of CY paid ULAE and paid losses.

Workers Compensation
ULAE Ratio

Calendar Year	(1) Calendar Year Paid Indemnity and Medical Losses	(2) Calendar Year Paid ULAE	(3) ULAE as % of Losses
2012	$4,306,514,977	$288,536,503	6.7%
2013	$4,007,631,598	$272,518,949	6.8%
2014	$3,641,833,560	$320,481,353	8.8%
2015	$3,203,661,824	$288,329,564	9.0%
2016	$3,034,498,823	$273,104,894	9.0%
Total	$18,194,140,782	$1,442,971,263	7.9%
		(4) Selected Ratio	9.0%

(1) Input
(2) Input
(3) = (2) / (1)

Row 4 selection is based on the latest year because the actuary expects those years to be more representative of the future.

INDICATION EXHIBIT

This exhibit brings together the results from the previous exhibits and calculates the indicated loss cost premium change.

Workers Compensation
Overall Indication

Accident Year	(1) Expected Indemnity Loss Ratio	(2) Expected Medical Loss Ratio	(3) Expected ALAE Ratio	(4) Expected ULAE Ratio	(5) Expected Loss & LAE Ratio
2012	30.4%	62.6%	11.6%	9.0%	112.2%
2013	35.7%	55.5%	11.6%	9.0%	110.1%
2014	36.9%	56.9%	11.6%	9.0%	113.2%
2015	30.5%	59.1%	11.6%	9.0%	108.0%
2016	38.1%	53.3%	11.6%	9.0%	110.2%
Total	34.4%	57.4%	11.6%	9.0%	110.7%

(6) Selected	110.7%
(7) Indication	10.7%

(1) From Indemnity Sheet 3
(2) From Medical Sheet 3
(3) From LAE Sheet 2
(4) From LAE Sheet 3
(5) = [(1) + (2) [* [1.0 + (3) + (4)]
(6) Selected
(7) = (6) - 1.0

- The objective is to determine the advisory loss costs
- The premium does not include any UW expenses or profit; therefore, the target loss ratio is 100%.
- The [selected loss ratio - 1.0] produces the overall indicated *change* to the current advisory loss cost premium.
- Conduct a separate analysis to determine whether the change should be applied uniformly to all risks or whether it should vary by type of risk.

COMPANY EXHIBIT

Calculates the adjustment an individual company should make to the advisory loss costs to account for U/W expenses, profit targets, and operational differences that would affect loss cost levels.

Workers Compensation
Company Adjustment

(1) General Expenses	10.0%
(2) Other Acquisition Costs	8.0%
(3) Taxes, License and Fees	2.5%
(4) Commissions and Brokerage Fees	8.0%
(5) Target Profit Provision	1.5%
(6) Total Expense and Profit	30.0%
(7) Expense and Profit Adjustment	1.429
(8) Expected Loss Cost Difference	-5.0%
(9) Operational Adjustment	0.950
(10) Proposed Deviation	1.358
(11) Current Deviation	1.400
(12) Industry Loss Cost Change	10.7%
(13) Company Change	7.4%

(1) - (5) Inputs
(6) = (1) + (2) + (3) + (4) + (5)
(7) = 1.0 / [1.0 - (6)]
(8) Selection
(9) = 1.0 - (8) = 1.0 - .05
(13) = (10) / (11) * [1.0 + (12)] - 1.0
s/b 7.5% (rounding)

(10) = (7) * (9)
(11) Given
(12) From Indication Sheet
s/b 10.8% (rounding)

Rows 1 - 4: Expected U/W expense (for GE, Other Acq., TL&F and Com & Brkg) as a % of total premium

Row 5: Target profit as a % of total premium.

Row 7 adjustment applies multiplicatively to advisory loss costs to include a provision for U/W expenses and profit.

(Equivalently, this adjustment is expressed as the [advisory loss costs/1.0-total expense and profit percentages].)

Row 8:

- is the expected difference in loss costs due to any known operational differences between the individual company and the industry.
- an overall average adjustment of -5% was selected to reflect an expectation of lower losses attributable to the company's more stringent underwriting and claims handling practices.

Row 10: Combines the adjustment for expenses and profit with the adjustment for operational differences, and represents the deviation factor that the company should apply to the industry advisory loss costs.

Row 11 (the current company deviation factor); Row 12 (the industry loss cost change).

Row 13 (Company Change):

- assumes that the company's distribution of risks is similar to the industry distribution, and that the industry loss cost change applies uniformly to all risks.
- otherwise, the industry loss cost change may be different from the actual impact for the company.

Personal Automobile Premiums: An Asset Share Pricing Approach For Property-Casualty Insurance – Feldblum, S.

1 Introduction

General characteristics of Asset Share Pricing models:

- Used for life and health insurance premium determination.
- Examines the profitability from inception to termination (including renewals) of the policy.
- Its importance is highlighted when cash flows and reported income vary by policy year.

Predominant Property and Casualty insurance ratemaking methods: Loss Ratio and Pure Premium

Financial pricing models are used to set underwriting profit provisions.

- These models presume the contract is in effect for a single policy period.
- Most examine the duration of loss payments, and not the duration of the insurance contract.

A. Life versus Casualty Rate Making:

Factors affecting the differing rate making philosophies:

Factor	Life and Health	Property and Casualty
1. Cancellation	Few, except for non-payment of premium.	Carrier has the right to cancel at renewal and often during the term.
2. Claim Costs	Vary by duration due to: a. Policyholder age (mortality rises with age). b. Underwriting selection (but "wears off" over time).	Relationship between expected losses and duration since policy inception is less apparent.
3. Expenses	WL commission rates are high in the 1st year but low for renewals.	Commission rates do not differ over time for independent agency system.
4. Level premiums.	Much life insurance is provided by level premium contracts.	Rates may be revised each year.

B. Developments in Casualty Insurance

Attributes that motivate asset share pricing.

1. *Commissions:* Direct writers of personal lines policies charge higher commission rates in the first year than in renewal years.
2. *Cancellations:* Insurers rarely cancel or non-renew the contract, since profitability depends on the stability of the book of business.
3. *Loss costs:* Expected loss costs are greater for new business than for renewal business.

The question faced by all insurers: "Is it *profitable* to *write the insurance policy?"*

Financially strong carriers examine the stream of future profits during the original policy year and from renewal years. "Asset share pricing enables the actuary to provide quantitative estimates of long-term profitability"

2 Asset-Share Components

In property and casualty insurance, asset share pricing is not common since:

- The data needed are not always available.
- Casualty pricing techniques are still somewhat undeveloped.
- The casualty insurance policy allows great flexibility in premiums and benefit levels.
- Liability claim costs are uncertain, both in magnitude and in timing.

Factors influencing asset share pricing techniques include:

A. Premiums

Factor	Life and Health	Property and Casualty
Premiums	Premiums for whole life policies remain constant until the termination or forfeiture of the contract. Premiums for renewable term life policies are generally guaranteed for the first several years.	Fluctuate widely from year to year, for a variety of reasons.*
1. Inflation	Life insurance benefits are fixed in nominal terms.	Raises loss costs, which impact premiums.
2. Underwriting cycles	Not found in individual life insurance.	Raise and lower the premiums charged.
3. Classification	Generally is not subject to change after policy inception.	Class and or exposure may change each year (i.e. single vs. marital status in personal auto insurance).

Level premiums associated with whole life policies have lead life actuaries to place greater reliance on asset-share pricing models than P&C actuaries (which work with premiums that fluctuate widely).

B. Claims

LOB	Life and Health	Property and Casualty
	Mortality rates are stable over time and their influences (age, sex, etc.) are well documented.	Claim rates are more variable and less well understood.
Auto:		**Rural vs Urban:** Traffic density, road conditions, number of attorneys, medical treatment.
WC:		Recessions: increased filing of minor, non-disabling injuries. Prosperous times: Accidental injuries among young, inexperienced workers are more common.
O. Liability		Statutory enactments and judicial precedents affect the frequency of claims.

1. Policy Duration and Claim Frequency
    a. Policy duration has a strong influence on claim frequency, particularly in Personal Automobile.
    b. New insureds have higher average loss ratios than renewal policyholders.
    c. Older drivers have lower average claim frequencies and loss ratios.

2. Inexperience, Youth, Transience, and Vehicle Acquisition

   Factors impacting the relationship between duration of the policy and expected claim frequency:

   a. *Experience:* Good driving habits are acquired over time. Inexperienced drivers have high claim frequencies.
   b. *Youth:* Young male and female drivers have higher than average claim frequencies, even after adjusting for driving experience.

      Note: adolescent drivers living at home and insured on their parents' policies, may cause a temporary reversal in the inverse relationship of frequency with policy duration.
   c. *Transience:* Many high risk drivers (young males), are "transient" insureds (they often drop coverage with one carrier and purchase a policy from another). .

      Reasons for high (20-30%) termination rates for young male drivers:

      i. Young male drivers are more likely to voluntarily cancel their policies (move, get married, switch to their wives' insurers, drop coverage after an accident).
      ii. Company underwriters are more likely to cancel their coverage (more likely to have caused an accident or are considered too risky).
      iii. More likely to experience financial difficulties and or fail to pay premiums.
      iv. Have more incentive to shop around for cheaper coverage.
   d. *Acquisition of the Vehicle:* Policy duration is correlated with the time since acquisition. Accident frequency often decreases with time since acquisition, as the insured becomes familiar with the operation of the vehicle.

   The vehicle's age is a classification factor for physical damage coverages (the value of the car declines over time) Time since acquisition of the vehicle, **not its age**, is important for liability coverages. The two factors are the same only when the insured purchases a new vehicle.

3. Reunderwriting:
   a. Affects the relationship between loss ratios and the policy duration. D'Arcy and Doherty state that private information collected by the insurer causes declining loss ratios as the policy ages.
   b. In WC, loss engineering services and the encouragement of a safe work environment reduce claim frequency.

C. Expenses

Insurance expenses are greater when the policy is first issued than in renewal years since:

1. Underwriting and acquisition expenses are incurred predominantly at policy inception.
2. This is true for both "per policy" expenses (costs of underwriting and setting up files), and "percentage of premium" expenses (commissions and premium taxes).

   Premiums derived for Life insurance policies incorporate these expense differences by policy year.

   Premiums derived using the loss ratio and pure premium methods for P&C policies do not account for these expense differences by policy year

   a. An ELR, derived from company budgets, agency contracts, state statutes or Insurance Expense Exhibit data is compared to the experience loss ratio, after trending, development, and other adjustments to determine the indicated rate change
   b. This treatment does not recognize their actual incidence.

Policy Duration and Insurance Expenses

The **similarity** in Life insurance and P&C expense costs are that they are greater in the year of policy issuance than in renewal years.

1. Underwriting expenses incurred predominantly in the first year (salaries, policy issuance and underwriting reports costs, overhead, etc).
2. Loss control expenses incurred either at or before policy issuance (technical inspections, Landfill inspections, loss engineering services, financial analyses, building inspections). Few inspections are repeated at renewal dates.
3. Acquisition expenses for direct writers: Three types of commission schedules are used in property-casualty insurance:
   a. Independent agency companies pay level commissions (needed because the agent "owns the renewals". A lower commission in renewal years would encourage agents to move the policy to another insurer to obtain a "first year" commission). Level commission structures do not reflect actual incidence of acquisition expenses (agents spend more effort writing new policies). Thus, the independent agency system is inefficient.
   b. Direct writers pay commissions that vary by policy year: high in the first year and low renewal commissions (the insurer owns the renewals which prevents the agent from moving the policyholder to a competing carrier.
   c. Direct writers have either (i) a salaried sales force or (ii) a combined salary - commission based sales force.
4. Most "other acquisition expenses," (advertising, development costs for expanding or automating distributions systems) are expended at or before the policy inception date.

State Farm has high retention rates because:	Many independent agency co.'s have low retention rates:
1. it targets a suburban and rural insured population. 2. it offers low premium rates. 3. it provides renewal discounts.	1. because the agents can move the insured to whichever company offers the lowest rates. 2. because these carriers use little consumer advertising.

D. Persistency

Persistency rates (retention rates) are the key to asset share pricing models and vary widely by company. They are most important when the net insurance income varies by duration since policy inception.

For Long-Term Ordinary Life, persistency improves with duration since policy inception (termination rates, or “lapse rates”, decline over time).

An intuitive relationship between duration and persistency exists for both life and casualty insurance.

1. Initially, policyholders are undecided about the value of the policy and the required premiums.
2. Some feel the insurance is not worthwhile; the carrier's service is not acceptable; the premium is too high or it is unaffordable.
3. Thus, voluntary termination rates during the first year coupled with carriers' reevaluation of newly acquired risks that have had recent accidents impact persistency.

However, after several renewals, continued renewals are more likely.

Termination Rates and Probabilities of Termination

Persistency may be analyzed either by termination rates or by probabilities of termination.

1. The *termination rate* = the number of terminations ÷ [number of terminations + policies persisting].
2. The *probability of termination* = the number of terminations ÷ the number of originally issued policies in that cohort.

Example: 100 auto policies are written in 1990, 20 risks lapse the 1st year, 10 lapse the 2nd year, 5 lapse the 3rd year.

The termination rates: 20% [=20 ÷ 100] the 1st year, 12.5% [=10 ÷ 80] the 2nd year, and 7.1% [= 5 ÷ 70] the 3rd year. The probabilities of termination: 20% [=20 ÷ 100] the 1st year, 10% [=10 ÷ 100] the 2nd year, and 5% [=5 ÷100] the 3rd year.

Conclusions: Termination rates more clearly distinguish persistency patterns by classification.
Probabilities of termination, in certain analyses, better portray the insurer's profitability.

Life insurance persistency patterns are analyzed by issue age, duration, interest rates, sex, rating, policy face amount, premium payment pattern, policy form, distribution system, etc.

As described above, it is the relationship between the distribution system and persistency patterns that is particularly important for casualty insurance.

E. Discount Rates

Cash flows over the policy's lifetime for each PY are discounted to the issue date to determine PVs.

	Life and Health	**Property and Casualty**
Claim payments:	Paid soon after death. No settlement lag.	Not settled immediately due to determination of liability, claim investigations, tort system, etc.
Reserves:	Policy reserves are a known quantity.	Loss reserves are affected by inflation rates, court decisions, jury awards, and social expectations.
Discount:	The discount rate to determine the above is limited by the State's standard valuation law.	Property - Liability insurance accounting records incurred losses on an undiscounted basis, regardless of the basis (Statutory or GAAP).
Matching experience: U/W and investment	Is essential for asset share pricing.	Both Statutory and GAAP accounting do not match the experience for the same block of policies.

Methods of matching underwriting and investment experience:

1. Record undiscounted incurred claims, but include an offsetting investment income account tied to the assets supporting the unpaid losses.
2. Record cash transactions, not the accounting statement incurred losses. The asset share model looks like an expanded (multi-period) internal rate of return model.
3. Record discounted loss reserves, using market interest rates, risk-free rates, or "risk adjusted" rates.

   Feldblum uses the third method. He states that:

   a. the discount rate used to determine the present value of unpaid losses at the accident date need not equal
   b. the discount rate used to determine the present value of future earnings at the issue date.

3 Asset Share Modeling – Four Illustrations

A. *Business Expansion:* Most risks from new business have high loss and expense ratios, and although generally "unprofitable," the "loss may be offset by the future profits in a stable renewal book. Asset share modeling helps determine true profitability.

B. *Classification Relativities:* Traditional rate making methods determine classification relativities. If persistency is ignored, then rate relativities are too low for the poorly persisting classes and too high for the long-persisting classes. Thus, pricing using class relativities for young drivers is shown.

C. *Competitive Strategy:* Traditional rate making procedures ignore:

1. the future profits and losses from renewals, and
2. the effects of rate revisions on policyholder retention and new business production

Competitive pricing strategy maximizes long term income by determining the change in policyholder retention, and new business production from raising or lowering rates.

D. *Underwriting Cycles:* It is unclear whether market share gains during the soft cycle combined with profits gained during the hard cycle will lead to satisfactory long-term income. Asset share modeling helps to determine the effects of different pricing strategies on overall returns.

Rate Revisions and Rates

- Casualty pricing methods determine rate revisions and rate relativities, not actual rates.
- Asset share pricing determines rates, not rate revisions. The actuary determines an actual rate for a selected a “pivotal" classifications, and relies on interpolation and relativity analyses other (non-pivotal) classifications.

4 Illustration 1 – Business Expansion

Company expansion or contraction distorts reported financial results:

- Expansion raises the statutory combined ratio (loss reserves are held at undiscounted values and acquisition costs are written off when incurred)
- A “GAAP operating ratio” (derived after deferring acquisition expenses and adding investment income) does not resolve the problem, since the investment income received in any calendar year is not derived solely from those policies issued during that year.

Aspects of the model to circumvent the above problems:

- Use of all figures on a fully discounted basis.
- Use of a policy year model, not a calendar year model, (hence no "property-casualty type" deferred acquisition cost).

A. Growth in a New Territory

Example:

1. A Personal Automobile direct writer expands into a new geographic area in 1992
2. "Fixed" costs peculiar to the expansion (subsidies for new agents, construction costs for a new branch office, and extra advertising expenses during the **first** year), are charged to a corporate account, and not included).
3. 10,000 policies are written in 1992, 1993, and 1994. Losses of 5.6 million are incurred over this time.
4. The asset share model shows that the company is earning a 19% return on surplus.

Question: How can a 19% return on surplus be consistent with losses of $5.6 million in three years?

B. Asset Share Assumptions

1. *Premiums:* Average rate increases of 9% per annum are expected.
2. *Losses:* The fully discounted loss ratio on new business is 82% in 1992.

   Loss costs are increasing at 10% per annum, and average loss costs on any policy are expected to improve by 3% a year since policy inception, after adjusting for inflation.
3. *Expenses:* Variable expenses, (commissions and premium taxes), increase at the same rate as premium. “Fixed" expenses, (salaries and rent), increase at 5% per annum.
4. *Persistency:* The termination rates chosen begin at 15% and decline to 8% after 15 years.
5. *Present Values: The discount rate is set equal the* company’s cost of capital (12%) and is used to determine the present value of future earnings.

C. The Model: The asset share model is shown on the next page. The PV of current and future profits and premium (column 12 and 13) is $480 and $5,012 respectively. Their ratio suggests a return on sales of 9.6%, and assuming a 2 to 1 premium to surplus ratio, the return on surplus is 2 * 9.6% = 19.2%.

Exhibit 1: Asset share model for Company Growth (page 289)

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	800	656	242	0	142	0	1.000	1.000	-240	1.00	-240	800
2	872	701	0	54	0	32	0.850	0.850	72	1.12	65	662
3	950	748	0	59	0	34	0.860	0.731	80	1.25	64	554
4	1036	799	0	64	0	35	0.870	0.636	87	1.40	62	469
5	1129	853	0	70	0	37	0.880	0.560	95	1.57	60	402
6	1231	911	0	76	0	39	0.890	0.498	102	1.76	58	348
7	1342	973	0	83	0	41	0.900	0.448	110	1.97	56	305
8	1462	1039	0	91	0	43	0.900	0.403	117	2.21	53	267
9	1594	1110	0	99	0	45	0.910	0.367	125	2.48	50	236
10	1738	1186	0	108	0	47	0.910	0.334	133	2.77	48	209
11	1894	1266	0	117	0	50	0.920	0.307	142	3.11	46	187
12	2064	1352	0	128	0	52	0.920	0.283	150	3.48	43	168
13	2250	1444	0	140	0	55	0.920	0.260	159	3.90	41	150
14	2453	1542	0	152	0	57	0.920	0.239	168	4.36	38	135
15	2673	1647	0	166	0	60	0.920	0.220	176	4.89	36	120
Total:											480	5,012

Column (1) = year since policy inception. Figures in exhibit pertain to this policy only.

Column (2) = an average premium per car of $800 increasing a 9% per annum.

Column (3) is the present value at the beginning of that policy year.

Columns (4) through (7): Variable expenses are 30.2% of premium in the 1st year and 6.2% in renewal years. Fixed expenses are 17.8% of premium in the 1st year, are .038 * $800 * 1.05 in the 1st renewal year, and then increase 5% per year thereafter.

Column (8) shows the expected persistency rate.

Column (9) = the downward product of column (8).

Column (10) = Column (9) *{Column (2) - Σ of Columns (3, 4, 5, 6, and 7)}.

Column (11) uses a rate of 12% per year compounded annually.

Column (12) = column (10) ÷ column (11).

Column (13) = column (2) *** column (9)** ÷ column (11).

Accounting Results and Long-Term Profitability

The reported earnings of a negative $5.6 million for the first three policy years, even after full discounting of losses, is the result that traditional actuarial pricing techniques. Calendar year statutory financial statements use undiscounted loss reserves and write off all underwriting and acquisition expenses when incurred would show worse results.

The dependence of loss and expense ratios on the year since the policy was first issued explains the difference between the $5.6 million loss shown by traditional pricing analyses and the 19% return on surplus shown by the asset share model.

D. Federal Income Taxes

1. Federal income taxes are not considered in these illustrations.
2. The simplest way of computing income taxes is to multiply the "profit" column by the marginal tax rate (the discount rate used for losses should be pre-tax, while the discount rate used for profits should be after-tax).
3. Alternatively, if after tax premiums, losses and expenses are used, then after tax discount rates should be applied.

E. Profitability Measures

Different measures of profitability can be incorporated in an asset share model:

1. In the example, future earning are discounted at the company's cost of capital, which implies that profits should be measured using a return on equity (the examples assumes that surplus = equity).
2. Determine the "break-even" point by determining when writing policies is more profitable than investing the equity in financial securities of similar risk.
3. Combine cash transactions from the insurance operations with assumed equity flows to determine the internal rate of return to the equity providers.

5 Illustration 2 – Classification Relativities

Classification relativities are determined by comparing relative loss ratios or pure premiums among groups of insureds. For example:

Driver Category	Average losses	Class relativity
Adult (base class)	500	1.00
Young male	1500	3.00

A. Expense Flattening and Persistency

Expense flattening procedures are used to separate expenses into fixed and variable. These procedures fail to incorporate differences in persistency among insureds which impact class relativities.

1. Fixed expenses, as a % of total premium, are lower for young male drivers than for adult drivers.
2. Variable expenses, as a % of total premium, are equal for the two classes.
3. Young male drivers have higher termination rates than adult drivers and so the ratio of total expenses to total premium *over the lifetime of the policy is* greater for young male drivers.

B. Determinants of Rate Relativities

The correct relativity depends on the:

1. Classification system.
2. Average losses and persistency rates by classification, and
3. Strength of loss ratio improvement by policy year.

The following example compares young male drivers with adult drivers to determine classification relativity factors. The information listed below is needed, the 2nd and 3rd items are essential for the model.

1. The dimensions of the classification system.
2. **The relative average loss costs of these two groups of insureds.**
3. **The relative average persistency rates of these two groups of insureds.**
4. The strength of loss ratio improvement by policy year for these insureds.

C. The Classification System

Renewal discounts and age boundaries between driver classes affect future years' premium.

Example: A asset share model is being used for an 18 year old unmarried male driver.

Given that the insurer differentiates between “males aged 25 and under" and "adult drivers," then

1. The driver will spend 8 years in the "young male" classification.
2. The premium is probably too low for the next 3 or 4 years and too high for the subsequent 4 or 5 years, since average losses decline between ages 17 and 25.

3. Expected termination rates will start high but decline over the next 8 years since termination decrease with duration of the policy.
4. A renewal discount will improve persistency but reduce renewal premiums.

The results of an asset share model **should be used to design the classification system**. This is the case for the "competitive strategy" illustration (shown in the following section).

D. Coverage Mix

2 types of differences affect classification relativities:

1. Average losses for any coverage vary by classification (e.g. young male drivers have higher expected BI losses than adult drivers).
2. The coverage mix varies by classification (e.g. young male drivers are less likely to buy physical damage or excess limits for liability coverages than adult drivers).

Classification relativities and Loss cost relativities would be similar if the ratio of expenses to premium did not vary with the above mentioned items.

E. Policy Basis versus Coverage Basis Rate Relativities

The asset share pricing model can be used to develop rate relativities on either a policy or coverage basis.

1. The policy basis model compares experience for **all coverages** combined among classes of insureds, and the resultant rate relativities must be allocated to coverages.
2. The coverage basis model compares experience for **an individual coverage** among classes of insureds.
   a. “Fixed" expenses must be allocated to coverage before the asset share pricing model is used.
   b. Premiums rates are not additive and there should be a “multiple coverages" discount.

F. Policy Basis Loss Cost Relativities

3 factors account for the policy basis loss cost differences between young male and adult drivers:

1. *Young* male *driver* rate *relativities* by *coverage:* Rate relativities vary among insurers, depending on:
   a. the definition of young male drivers and
   b. the other classification dimensions(years of driving experience, past accident history).
2. *Physical damage coverage by classification: (y*oung male drivers are less likely to buy physical damage coverage, due to high premiums, the relative value of their auto, etc.).
3. *Average liability increased limits and physical damage deductibles:*

G. Persistency by Classification

Whole life policies, guaranteed issue policies, and Personal Automobile policies typically show an accounting loss during the first policy year, since either expenses or loss costs or both are higher that year. In any case, the loss turns into a profit as the policyholder persists.

Classification differences may be based on either current classification or original classification. Classification does not change in most lines with the exception of Personal Automobile, since age, geographic domicile and the value of the auto change over time.

H. Young Male Drivers

1. Traditional rate making considers **current** classification.
2. Asset share pricing models consider **original** classification and expected future changes.

Although persistency rates by duration are easily determined for current classifications (the % of young male drivers in their 5th policy year who persist into their 6th year), it is persistency rates by original classification, not current classification, that it is needed. Notice the difference: the persistency of young male drivers in their 5th policy year does not tell us the expected 5th year persistency of young male drivers.

I. Model Assumptions

Given: Adult pleasure use is the base class. Unmarried males aged 21 and 22 who drive to work will be compared.

3 differences by classification are needed to form rate relativities:

1. average loss costs,
2. average fixed expense costs, and
3. persistency rates.

Assume the following differences

1. Average liability loss costs are $400 and $1,000 per annum for adults and young male drivers respectively.
2. Average premium for all drivers is $550, average **1st year** fixed expenses (F.E.) are 17.8% of this ($98).
   a. Adult drivers are less expensive to underwrite, etc, so average fixed expenses per coverage is 10% less, or $88 per policy. 2nd year F.E = the ratio of renewal to 1st year F.E. Subsequent years F.E. increase at 5% per annum.
   b. Young male drivers are more expensive to underwrite, so average 1st year fixed expenses per coverage are 20% higher, or $117 per policy.
3. Adult drivers have higher retention rates than young male drivers.

Givens: the classification plan, average loss costs, average fixed expenses, and persistency rates.

Assume: Writing at a 2:1 premium to equity ratio and desire for a 14% return on equity.

Approach: Step 1: Use the asset share pricing model to determine a 7.0% return on premium.
Step 2: Derive the rate relativities from the resulting premiums.

For each class:

1. Select a **starting** gross premium and increase it 9% per annum, which determines the variable expenses in all future years.
2. Loss costs are discounted to the beginning of the policy year.
3. A 12% cost of capital rate is used to determine the present values of future profits and premiums at the original policy issuance date.

The Goal: Determine the original premium such that the ratio of the present value of all future profits to the present value of all future premiums is 7.0% for both classes.

Asset Share Results

1. The loss cost relativity is 2.50, or $1,000 ÷ $400.
2. The fixed expense cost relativity is 1.33, or (= $117 ÷ $88).
3. The rate relativity is 2.68, or $1,272 ÷ $475.

A premium rate relativity of 2.68 is needed to equalize the returns between these two classes.

Exhibit 3: Young Male Drivers.

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1272	1000	384	0	117	0	100%	100%	-230	1.00	-230	1,272
2	1386	1068	0	86	0	26	60%	60%	124	1.12	110	743
3	1511	1141	0	94	0	28	65%	39%	97	1.25	78	470
4	1647	1218	0	102	0	29	70%	27%	81	1.40	58	320
5	1796	1301	0	111	0	30	73%	20%	70	1.57	45	227
6	1957	1389	0	121	0	32	76%	15%	63	1.76	36	168
7	2133	1484	0	132	0	34	79%	12%	58	1.97	29	129
8	2325	1584	0	144	0	35	82%	10%	55	2.21	25	103
9	2535	1692	0	157	0	37	85%	8%	54	2.48	22	85
10	2763	1807	0	171	0	39	88%	7%	55	2.77	20	73
11	3011	1930	0	187	0	41	90%	7%	56	3.11	18	64
12	3282	2061	0	204	0	43	90%	6%	58	3.48	17	56
13	3578	2201	0	222	0	45	90%	5%	59	3.90	15	49
14	3900	2351	0	242	0	47	90%	5%	61	4.36	14	43
15	4251	2511	0	264	0	50	90%	4%	62	4.89	13	38
Total:											269	3,841

Column (1) = year since policy inception. Figures in exhibit pertain to this policy only.

Column (2) = chosen such that the PV of profits = 7.0% of the PV of premiums.

Column (3): 1st year average losses = 1,000. loss cost trend = 10% per annum. Losses decrease 3% per year.

Columns (4) through (7): Variable expenses are 30.2% of premium in the 1st year and 6.2% in renewal years. Fixed expenses are 20% higher than the average $98 per policy in the 1st year, are 550 * 1.20 * 1.05 * .038 in the 1st renewal year, and then increase 5% per year.

Column (8) shows the expected persistency rate.

Column (9) = the downward product of column (8).

Column (10) = Column (9) *{Column (2) - Σ of Columns (3, 4, 5, 6, and 7)}.

Column (11) uses a rate of 12% (cost of capital) per year compounded annually.

Column (12) = column (10) ÷ column (11).

Column (13) = column (2) *** column (9)** ÷ column (11).

6 Illustration 3 – Competitive Strategy

Example	**Given:**	**Question:**
Business expansion.	The environment.	Is the growth strategy profitable?
Classification relativities	Insured population	What prices are equitable?
Traditional ratemaking	Insured population	What are the anticipated losses and expenses that determine premiums such that economic profits are eliminated?
Competitive strategy		How can the pricing structure create a more profitable consumer base?

2 Considerations when seeking to change the insured population:

- Recognize that any strategy affects new business growth or retention rates.
- Traditional ratemaking procedures are cost-based. Premium rates and relativities impact consumer demand and the mix of insureds, which impact profitability.

Cars and Courage

	Older/Retired Drivers	**Young Drivers**
Physical limitations:	Makes them less capable of escaping dangerous situations	N/A
Awareness of the above:	Makes them more likely to avoid dangerous situations	
Exposure to road hazards:	After retirement, spend less time behind the wheel.	Drive to work. attend late parties, etc
Cost of Insurance:	Have less impetus to price shop at renewal due to lower premiums and less information about competing carriers	Have higher premiums, and are more informed about competing carrier's rates.

Considerations for the asset-share model for the pricing of a older driver

- Expected loss costs by policyholder age.
- Persistency rates by policyholder age and policy duration.
- Price elasticity of demand: (the effects of price on retention rates).

First, we will discuss the relevance of these elements to retired drivers.

A. Retired Drivers

	Older Drivers	Retired Drivers
Average loss costs:	Decrease with age. Still drives to work and is exposed to road hazards.	Drives less often than older drivers.
Price elasticity of demand:	More likely to switch carriers for a better rate.	"Consumer loyalty" is more likely.
Optimal Pricing Strategy: Requires underpricing older drivers (50's) to gain market share and eventually reap greater profits as insureds age and persist. Requires offering a discount before the data seems to justify it. This requires determination of the Age and Optimal Magnitude.		
Age:	Before any substantial decline in losses. Depends on relationship between age and persistency, discounts offered, E[loss costs].	Before retirement.
Magnitude:	Depends on price elasticity of demand and peer co. rates structure , and E[loss costs].	

B. Model Assumptions:

Determinations of the optimal age and magnitude for the retired driver discount:

1. Loss Costs by Age of Policyholder

Shown below is the loss ratio relativities by policyholder age, for new and renewal business. The relativity equals the ratio of the loss ratio in that row to the average loss ratio for all rows combined.

2. Persistency Rates for Older Drivers

Table 6: Loss Ratio Relativities by Policyholder Age

Policy holder Age	New Business LR Relativity	Renewal Business LR Relativity
20 - 49	1.02	1.03
50 - 54	1.00	0.98
55 59	0 94	0.83
60 - 64	0.84	0.72
65 - 69	0.82	0.65
70 - 74	0.98	0.76
75 & older	1.10	0.98
Total:	1.00	1.00

Retention rates improve as both the policy and the policyholder ages.

Table 7: Persistency Rates by Policyholder Age

Policyholder Age	50	54	58	62	66	70	74	78
Persistency Rate (%)	96	95	94	92	90	88	85	80

2 differences in the persistency rates shown above compared with those for adult and young male drivers:

a. Most insureds aged 50 and over represent mature renewal business.

b. Persistency drops as policyholders advance into their 70's due to death or illness.

Since persistency rates depend upon the premium discount that is offered, replace the "persistency rates" in Exhibit 9 with a set of rows, showing persistency rates with no discount, a 5% discount, a 10% discount, etc. Since these persistency rates depend on the discounts offered by other carriers, there are no "absolute" expected rates, as expected rates also depend on other carriers' discounts.

Persistency rate assumptions are subjective, but are essential for determining optimal prices.

2 sets of persistency rates for the asset share model are used:

a. One set, with lower rates, and no premium discount offered to older or retired drivers.

b. The other set, with higher rates, and a 7.5% "market" discount rate.

Table 8: Persistency Rates by Policyholder Age

Policyholder Age	50	54	58	62	66	70	74	78
Persistency: with discount	98	97	96	94	92	90	85	80
Persistency: without discount	90	85	80	75	80	80	85	80

To determine the optimal premium discount, the asset-share pricing model is run 3 times, after considering each of the following:

a. No carrier offers a retired driver discount (Exhibit 4).

b. Peer companies offer the discount, but your company does not (Exhibit 5).

c. Your company offers a 7.5% "market" discount rate (Exhibit 6).

In each case, we use a 15 year asset-share model for insureds aged 52. We assume:

a. that persistency rates depend on the premium discount offered, but
b. average loss costs do not.

Consideration	**No discounts offered.**	**Peers offer discount, but your company does not.**	**Your company offers the market discount.**
Persistency:	High quality insureds with high persistency rates exist with declining loss costs.	Persistency drops. Retention rates are lower as more insureds leave each year.	Persistency is increased as the market reacts favorably to the market discount offered.
Profitability:	Profitability is good, since the insurer has already paid the high cost of new business production and is reaping the benefits of the renewal book.	Loss and expense ratios remain unchanged, so the full profit margin is maintained. However, the impact of lower persistency reduces the PV of future profits.	Although the 7.5% discount cannot be justified on a short term basis, persistency increases to the highest level of the three scenarios and the PV of future profits has increased compared with the adjacent scenario.
	Note: A return on premium is relevant when market shares remain constant.		

Questions from the 1996 exam

Question 8. (1 point) According to Feldblum, "Personal Automobile Premium: An Asset Share Pricing Approach For Property-Casualty Insurance," which of the following are evidence that property-casualty insurance is taking on attributes that motivate asset share pricing?

1. A greater emphasis is being placed on the investment income component of rates.
2. Insurers rarely cancel or non-renew policies.
3. Expected loss costs are greater for new business than for renewal business.

A. 1 only B. 2 only C. 1, 3 only D. 2, 3 only E. 1, 2, 3

Question 38. (3 points) You are given the following for an average policy:

Policy			Variable Expense		Fixed Expense	
Year	Premium	PV Loss	Year 1	Renewal	Year 1	Renewal
1	1,000	800.00	250	0	150	0
2	1,000	776.00	0	50	0	40
3	1,000	752.72	0	50	0	40
4	1,000	730.14	0	50	0	40
5	1,000	708.23	0	50	0	40

Policy	Persistency			Discount	Present Value	
Year	Rate	Cumulative	Profit	Factor	Profit	Premium
1	1.000	1.000	(200.00)	1.000	(200.00)	1,000.00
2	0.850	0.850	113.90	1.100	103.55	772.73
3	0.850	0.723	113.63	1.210	93.91	597.11
4	0.850	0.614	110.46	1.331	82.99	461.40
5	0.850	0.522	105.33	1.464	71.94	356.56
Total					152.39	3,187.80

- PV Loss is the present value at the beginning of each policy year.
- Assume all policies are annual and have January 1 effective dates.
- The policy count at year 0 is 1,000.

Using the asset share pricing model described by Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance:"

(a) (2 points) If you increase rates 10% on January 1 of year 1 and then keep rates constant throughout the five-year period, you project a 20% policy count decrease in year 1 and all other patterns will remain the same. Calculate the revised present value 5-year aggregate profit.

(b) (1 point) If you increase rates 10% on January 1 of year 1 and then keep rates constant throughout the five-year period, what decrease in year 1 policy counts would result in the original estimated present value 5-year aggregate profit of $152,390, assuming all other patterns will remain the same?

Questions from the 1997 exam

3. According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," which of the following are true?

1. Analysis of persistency rates is a key part of asset share pricing models.
2. Agency ownership of policy renewals affects persistency rates.
3. It is preferable to review persistency rates by current driver classification rather than by the original driver classification.

A. 1 B. 2 C. 1, 2 D. 1, 3 E. 1, 2, 3

30. (4 points)
The Innovative Insurance Company is considering offering a 5% renewal discount to its Personal Auto policyholders to improve the company's retention. It has asked for a four-year study of profitability using the information below.

Year	Retention Without Discount	Retention With Discount	Commission	Fixed Expense	Premium Taxes
New	100%	100%	15%	$10	3%
2	80%	98%	3%	$5	3%
3	80%	98%	3%	$5	3%
4	80%	98%	3%	$5	3%

- First Year Average Premium : $1,000
- First Year Average Loss + LAE: $800
- Annual Cost of Capital: 10%
- Loss + LAE Trend: 5%
- Fixed Expense Trend: 4%
- Average Annual Premium Growth due to Rate Changes 6%
- Assume annual renewals
- Assume there are no new policies written
- Present Value Profit without a renewal discount over the four-year study is:$282.09

Based on Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," which alternative is more profitable (5% discount or with no discount) over the four-year study?

Questions from the 1998 exam

52. You are given the following information for a group of new business auto liability policies:

Average year 1 premium	$500
Annual rate increases	10.0%
New business loss ratio	80%
Renewal loss ratio	60%
New business commission	20%
Renewal commission	5%
Other expenses (all variable)	15%
Cost of equity capital	15%
Premium to surplus ratio	2.5

Policy year	1	2	3	4
Probability of termination	30%	30%	20%	20%

Assume all policies are annual and cancel or lapse on their anniversary.

Determine the following using the method described by Feldblum, "Personal Automobile Premium , An Asset Share Pricing Approach for Property-Casualty Insurance."

a. (1 point) The persistency rate by policy year.
b. (3 points) The four year underwriting return on premium and the four year underwriting return on surplus.

Questions from the 1999 exam

20. According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance,' which of the following are true?

1. Variability of premiums and losses in property and casualty insurance is a reason why property and casualty actuaries have not relied on asset share pricing.

2. The principal benefit to asset share pricing is the determination of profitability over the entire time a policyholder stays with the company.

3. The asset share pricing model is inappropriate to use for high risk drivers, such as young males, because they do not tend to remain with one company long enough to permit completion of a long term analysis.

A. 3 B. 1, 2 C. 1, 3 D. 2, 3 E. 1,2,3

34. (4 points) Based on Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," and the information shown below, calculate the present value of expected profits as a percentage of the present value of premium. Assume that the cost of capital is 12%.

Policy Year	Premium	Present Value of Loss*	Variable Expense	Fixed Expense	Persistency Rate
1	900	810	135	72	1.00
2	990	826	149	30	.75
3	1,089	843	163	30	.80
4	1,198	860	180	30	.85

* Present Value of Loss is the present value at the start of each respective policy year.
Assume there are no policies in policy year five.

Questions from the 2000 exam

7. T/F According to Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," the fundamental issue in asset share pricing methods is the predictability of losses.

8. T/F According to Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," asset share modeling is considered particularly valuable when differences in termination rates influence expected profits.

47. (3 points) Using the procedure described by Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance" and the following information, complete the asset share model and compute the return on premium for policies written during 1999. Use a 3-year time horizon.

- Average policy premium in 1999 = $1,000
- Loss cost trend = 8% per annum
- "Fixed" expense trend = 4% per annum
- Expected rate increases = 6% per annum
- Discounted loss ratio on new business written in 1999 = 75%
- Loss costs improve by 3% per year since policy inception, after adjusting for inflation.
- Termination rates are 10% each year after the year of policy issuance.
- Cost of capital = 9%

Acquisition and underwriting expenses for Policy Year 1999:

New Policies		Renewal Policies	
Fixed	Variable	Fixed	Variable
15%	25%	5%	10%

Questions from the 2001 exam

Question 11. Based on Feldblum, “Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance,” and the following information, calculate the termination rate for the third year.

- Number of policies originally issued = 1,000
- Number of first-year lapses = 350
- Number of second-year lapses = 200
- Number of third-year lapses = 100

A. < 12% B. ≥12% but < 16% C. ≥ 16% but < 20% D. ≥ 20% but < 24% E. ≥ 24%

Questions from the 2001 exam (continued):

Questions 12. According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," which of the following is false ?

A. Asset share pricing determines rates, not rate revisions.

B. Life insurance policy claim rates are more certain than property-casualty policy claim rates.

C. It is appropriate to assume the same pattern of persistency ratios for both direct writers and independent agency companies.

D. A level commission structure is inappropriate for the persisting and profitable risks.

E. The dominant market share of the direct writers makes asset share pricing a more appropriate model for personal automobile insurance.

23. (2 points) In his paper "Personal Automobile Premiums: An Asset Share Pricing Approach," Feldblum gives four reasons for the relationship between the duration of an auto policy and the claim frequency for that policy. State and explain these four reasons.

Questions from the 2002 exam

36. (3 points) Based on Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," and the following information, answer the questions below. Show all work.

30 policies terminate in the third year
The probability of termination in year 2 is 0.0816
The termination rate in year 2 is 0.1000
The termination rate in year 3 is 0.0750

a. (1½ points) Calculate the number of policies terminated in year 1 and year 2.
b. (1 point) Calculate the original number of policies in the cohort.
c. (½ point) Calculate the termination rate and the probability of termination in year 1.

Questions from the 2003 exam

43. (5 points)

a. (4 points) You are given the following information:

- Indicated adult class new business policy premium = $1,000
- Adult class discounted new business loss ratio = 80%
- Youthful class discounted loss cost during first policy year = $1,500
- Premiums increase 10% annually
- Losses increase 5% annually
- Variable expense ratio = 20% for all business
- All expenses are variable
- Annual adult class lapse rate = 10%
- Annual youthful class lapse rate = 25%
- The company's cost of capital is 10%
- 3-year present value of premium for adult class = $2,710
- 3-year present value of profit for adult class = $90.30
- Assume same return is earned for all classes

Using the procedure described by Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurance," calculate the indicated premium relativity for youthful drivers. Use a three year time horizon to determine your answer. Show all work.

b. (1 point) How might traditional ratemaking methods be misleading in determining classification relativities?

Questions from the 2004 exam

44. (4 points)

a. (3 points) You are given the following information about a group of policies:

- The first year average policy premium is $1,000 and increases by 12% annually.
- Premiums are collected at the beginning of each year.
- The discounted first year loss ratio is 75%.
- Loss cost trend is 10% per annum.
- Loss costs improve by 4% per year, after adjusting for loss costs trends.
- Expenses are $400 in year 1 and $100 in all subsequent years.
- 90% of first year policyholders persist into the second year.
- 90% of second year policyholders persist into the third year.
- The company's cost of capital is 15%.
- The premium to surplus ratio is 3 to 1.

Using the asset share pricing model, determine the return on equity over the three-year period. Show all work.

b. (1 point) Explain how asset share pricing models and property/casualty insurance ratemaking methods differ in their consideration of the profitability of an insurance policy.

Questions from the 2005 exam

56. (3 points)

Given the information below, use an asset share pricing approach to determine whether a company should write this business. Show all work and explain your answer.

Policy Year	Premium	Present Value of Losses	Expenses	Annual Persistency
1	$500	$415	$100	100%
2	$550	$440	$110	85%
3	$605	$460	$121	85%

- Equities of similar risk are yielding 10% per year.

Questions from the 2006 exam

50. (5.75 points) You are the actuary for an insurance company that is considering offering a 5% discount to retired drivers in order to improve retention.

Using the Asset Share Pricing approach described by Feldblum, and the information provided below, determine which alternative is more profitable for a cohort of 65 year-old existing insureds over a three-year time period. Show all work.

Year	Persistency With Discount	Persistency Without Discount	Fixed Expense
1	100%	100%	$40
2	98%	90%	42
3	95%	85%	44

- First-year average premium (with no discount) $800
- First-year average losses $500
- Average annual premium trend 5%
- Loss cost trend per annum 5%
- New Business Variable Expenses 30% of premium
- Renewal Business Variable Expenses 20% of premium
- Annual Cost of Capital 10%
- Assume there are no taxes.
- For this cohort of business, average loss costs in any policy year are 1% lower than in the preceding policy year after adjustment for loss cost trend.

Questions from the 2007 exam

28. (4.0 points) A personal automobile carrier marketing its business through direct writers is planning expansion into a new territory. You are given the following information:

First-year territory average premium	$900	
Termination rate in year 1	15%	
Termination rate in year 2	12%	
First-year average fixed expenses	$60	
Second-year average fixed expenses	$40	
First-year discounted loss ratio	75%	
Average annual premium trend	5%	
Average annual loss cost trend	7%	
Average annual fixed expense trend	5%	
New business variable expenses	27%	of premium
Renewal business variable expenses	5%	of premium
Annual cost of capital	5%	
Premium to surplus ratio	2:1	

For this cohort of business, average loss costs in any policy year are 3% lower than in the preceding policy year after adjustment for loss cost trend.

Using the Asset Share Pricing approach described by Feldblum, determine whether this opportunity exceeds the company's target return on surplus of 15% over a three-year time period. Show all work.

Questions from the 2008 exam

43. (1.0 point) Contrast the asset share pricing model to traditional techniques for calculating rate relativities.

44. (3.0 points) You are given the following information:

	Class A	Class B
Premium-First Year	$633.80	X
Loss Cost-First Year	$500	$1,000
Fixed Expense		
First Year	$90	$120
Subsequent Years	$80	$110
Variable Expense		
First Year	10%	10%
Subsequent Years	5%	5%
Persistency Rate	80%	60%

- Loss costs for renewal business are 10% lower than-for new business.
- There is no premium trend and there are no rate changes.
- There is no expense trend.
- Interest rate for discount is 10%.
- Premium-to-Surplus ratio is 2:1.
- Target pre-tax return on equity is 6%.

Calculate the indicated rate relativity for Class B as compared to the base class (Class A) using the asset share pricing model and a two-year time horizon.

Questions from the 2009 exam

45. (2.25 points)

a. (0.75 point) Define persistency rates. Briefly explain why persistency rates are important for classification ratemaking.

b. (0.75 point) For private passenger auto, identify whether a direct writer or an independent agency company is expected to have higher persistency rates. Explain your answer.

c. (0.75 point) There are two private passenger auto insurers. One targets non-standard insureds and the other targets preferred or standard insureds. Identify which insurer is likely to have higher persistency rates and explain your answer.

Questions from the 2010 exam

35. (3 points) Given the following information:

- Year 1 premium is $1000.
- Premium rates increase 10% per annum.
- Loss ratio for new business is 65%.
- Loss trend is 10% per annum.
- Loss costs improve 5% each renewal period.
- Variable expenses are 30% in Year 1 and 10% in subsequent years.
- Fixed expenses are $200 in Year 1 and $50 in subsequent years.
- Persistency is 75%.
- Cost of capital is 10%.
- Premium to surplus ratio is 2.0.
- Target return on surplus is 4%.

Determine whether this business will achieve the target return on surplus based on a two-year time horizon.

Questions from the 2011 exam

20. (3.5 points) Given the following information:

- Company cost of capital is 8%
- No premium or loss trend

	Class A	Class B
Annual premium	$800	Unknown
Present value of losses (1st year)	$550	$650
Present value of losses (2nd year)	$550	$650
Variable expense ratio (1st year)	20%	24%
Variable expense ratio (2nd year)	12%	20%
Fixed expense (1st year)	$42	$50
Fixed expense (2nd year)	$20	$30
Probability of annual termination	15%	40%

a. (0.5 point) Using a one-year period, calculate the premium for class B if the same profit loading is targeted for all classes.

b. (1.25 points) Using a two-year period, calculate the return on sales for class A.

c. (1.75 points) Using a two-year period, calculate the premium for class B that would achieve the same return on sales as calculated in part b above.

Solutions to questions from the 1996 exam

Question 8.

Comment: This question is just one of the numerous list type questions that can be asked from this paper. Answers to this question are found on page 195, Proceedings, November 1996.

Feldblum lists 3 attributes about P&C insurance that motivate the use of asset share pricing:

1. **Commissions.** Commission rates tend to be higher in the 1st year than in renewal years.
2. **Cancellations.** Insurers rarely cancel or non-renew policies, since profitability depends on the stability of the book of business.
3. **Loss costs.** Feldblum states that this phenomenon is valid for personal auto insurance as well as for other lines of business.

Therefore, 1 is False, 2 is True and 3 is True. **Answer D.**

Related topic. On page 196, Feldblum lists 4 reasons why asset share pricing is not yet common in P&C insurance.

Solutions to questions from the 1996 exam

Question 38.

(a) On page 289, Feldblum shows in Exhibit 1, an example of how to use the asset share model for company growth. The revised present value 5-year aggregate profit is calculated as follows:

5-year aggregate profit = (Policy count at time 0)*(policy count impact)*(aggregate present value profit).

The policy count at time zero, and expected policy count impact are given as 1,000 and .80 (1.0 - .20) respectively. Therefore, the only element that must be computed is 5 year aggregate present value profit.

The following is **given**:

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	**1,000**	800.00	**250**	0	150	0	1.000	1.000	-200.00	1.000	-200.00	1,000.00
2	1,000	776.00		**50**		40	0.850	0.850	113.90	1.100	103.55	772.73
3	1,000	752.72		50		40	0.850	0.723	113.63	1.210	93.91	597.11
4	1,000	730.14		50		40	0.850	0.614	110.46	1.331	82.99	461.40
5	1,000	708.23		50		40	0.850	0.522	105.33	1.464	71.94	356.54
Total											152.38	3,187.77

Only the values in bold need to be adjusted in accordance with the 10% rate increase.
This produces the following impact:

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	PV of Profit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	**1,100**	800.00	**275**	0	150	0	1.000	1.000	-125.00	1.000	-125.00
2	**1,100**	776.00		**55**		40	0.850	0.850	194.65	1.100	176.95
3	**1,100**	752.72		**55**		40	0.850	0.723	182.27	1.210	150.64
4	**1,100**	730.14		**55**		40	0.850	0.614	168.80	1.331	126.82
5	**1,100**	708.23		**55**		40	0.850	0.522	154.92	1.464	105.81
Total											435.22

Therefore, the revised present value 5-year aggregate profit = 1,000 * .80 * $435.22 = $348,176

(b) To answer this , use the same equation as shown in part (a) and solve for the policy count impact.

5-year aggregate profit = (Policy count at time 0)*(policy count impact)*(aggregate present value profit).

$152,380 = 1,000 * (1 - x) * $435.22. x = .6498.

Solutions to questions from the 1997 exam

Question 3.

1. T. Feldblum states "Persistency rates (retention rates) are the crux of asset share pricing models. They are most important when the net insurance income varies by duration since policy inception." page 207.

2. T. On page 208, Feldblum compares persistency rates among direct writers and independent agency companies:

State Farm has high retention rates because:	Many independent agency co.'s have low retention rates
(a) it targets a suburban and rural insured population.	(a) because the agents can move the insured to whichever company offers the lowest rates.
(b) it offers low premium rates.	(b) because these carriers use little consumer advertising.
(c) it provides renewal discounts.	

3. F. page 239.
   Although persistency rates by duration are easily determined for current classifications (the % of young male drivers in their 5th policy year who persist into their 6th year), **it is persistency rates by original classification**, not current classification, that it is needed.

   Notice the difference: the persistency of young male drivers in their 5th policy year does not tell us the expected 5th year persistency of young male drivers. **Answer C.**

Solutions to questions from the 1997 exam

Question 30.

On pages 292-294, Feldblum shows in Exhibits 4-6, an example of how to use the asset share model when discounts are offered.

The easiest way to solve the problem:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in italics.
3. Adjust your initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 9 through 12. These are relatively easy and apply to a number of exhibits in the article.
5. **Key. Recognize that the only computation which differs in the tables below is column 2.**

Not offering a 5% renewal discount to its Personal Auto policyholders

Policy			Variable Expense		Fixed Expense		Persistency	Cumulative		Discount	PV of
Year	Premium	Loss	Year 1	Renewal	Year 1	Renewal	Rate	Persistency	Profit	Factor	Profit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	*1,000.00*	*800.00*	180	0	*10*	0	*1.000*	1.000	10.00	1.000	10.00
2	1,060.00	840.00		63.60		*5*	*0.800*	0.800	121.12	*1.100*	110.11
3	1,123.60	882.00		67.42		*5*	*0.800*	0.640	108.28	1.210	89.49
4	1,191.02	926.10		71.46		*5*	*0.800*	0.512	96.49	1.331	72.49
Total											282.09

Column (2) = an average premium per car of $1,000, with 6% annual growth due to rate changes.
Column (3) shows the initial year Loss and LAE of $800 increased by 6% trend.
Columns (4) through (7): Variable expenses are 18% of premium in the 1st year and 6.0% in renewal years.
Fixed expenses are $10 of premium in the 1st year, and $5 in the following years.
Column (8) shows the expected persistency rate.
Column (9) = the downward product of column (8).
Column (10) = Column (9) *{Column (2) -Σ of Columns (3, 4, 5, 6, and 7)}.
Column (11) uses the 10% annual cost of capital.
Column (12) = column (10) / column (11).

Offering a 5% renewal discount to its Personal Auto policyholders

Policy			Variable Expense		Fixed Expense		Persistency	Cumulative		Discount	PV of
Year	Premium	Loss	Year 1	Renewal	Year 1	Renewal	Rate	Persistency	Profit	Factor	Profit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	*1,000.00*	*800.00*	180	0	*10*	0	*1.000*	1.000	10.00	1.000	10.00
2	**1,007.00**	840.00		60.42		*5*	***0.980***	0.980	99.55	*1.100*	90.50
3	**1,067.42**	882.00		64.05		*5*	***0.980***	0.960	111.77	1.210	92.37
4	**1,131.47**	926.10		67.89		*5*	***0.980***	0.941	124.69	1.331	93.68
Total											286.55

Column (2) = an average premium per car of $1,000, with 6% annual growth due to rate changes, times (1-.05 credit)

Solutions to questions from the 1998 exam

Question 52

a.

On page 210. Feldblum discusses the relationship among three terms: persistency rates (a.k.a. retention rates), termination rates, and the probabilities of termination.

Persistency may be computed using termination rates or probabilities of termination.

- The termination rate equals the number of terminations ÷ [number of terminations + policies persisting].
- The probability of termination equals the number of terminations ÷ the number of originally issued policies in that cohort.

Feldblum concludes that termination rates more clearly distinguish persistency patterns by classification. Thus, the persistency rate is 1.0 - termination rate.

Policy Year	Probability of Termination (1)	Number of terminations (2)	Termination Rate (3)	Persistency Rate (4) = 1.0 - (3)	Cumulative Persistency rate (5)
0	.30	30	0	1.00	1.00
1	.30	30	30/(30+70) = .30	.70	1.00 *.70 =.70
2	.20	20	30/(30+40) = .43	.57	.70* .57 = .40
3	.20	20	20/(20+20) = .50	.50	.40 * .50 = .20
Total	1.00	100			

(2) = (1)/(1 total) * 100

(5) = downward product of column (4). These values will be used in part b.

Solutions to questions from the 1998 exam

Question 52

b. On page 289, Feldblum shows in Exhibit 1, an example of how to use the asset share model under a company growth scenario.

The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in bold.
3. Adjust your initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 11 through 14. Note: columns 9 and 10 were computed in part a above. These are relatively easy to calculate and apply to a number of exhibits in the article.
5. Write formulas to compute what is asked for in the problem:

4 year underwriting return on premium = $\frac{\sum PV\ of\ profit}{\sum PV\ of\ premium}$

4 year underwriting return on surplus = $\frac{\sum PV\ of\ profit}{\sum PV\ of\ premium} * \frac{\Pr emium}{Surplus}$

Policy Year	Premium	Annual Losses Year 1	Annual Losses Renewal	Commission Expense Year 1	Commission Expense Renewal	O. Variable Expense Year 1	O. Variable Expense Renewal	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	**500.00**	400	0	100	0	75	0	**1.00**	1.00
2	550.00		330		28		83	**0.70**	0.70
3	605.00		363		30		91	**0.57**	0.40
4	665.50		399		33		100	**0.50**	0.20
Total	2,320.50								

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(11)	(12)	(13)	(14)
1	-75.00	1.000	-75.00	500.00
2	77.00	1.150	66.96	334.78
3	48.28	1.323	36.51	182.53
4	26.55	1.521	17.46	87.30
Total			45.92	1,104.61

Column (2) = an average premium per car of $500, with10% annual growth due to annual rate increases.
Column (3) is column (2) * .80 new business loss ratio. Column (4) is column (2) * .60 renewal loss ratio.
Columns (5) through (8): Commissions are 20% of premium in the 1st year and 5.0% in renewal
Variable expenses are 15% of premium in the 1st year, are 15% in the following years.
Column (9) is the persistency rate calculated in part a of the question.
Column (10) = the downward product of column (9).
Column (11) = Column (10) *{Column (2)-Σ of Columns (3, 4, 5, 6, 7 and 8)}.
Column (12) uses a rate of 15% per year compounded annually.
Column (13) = column (11) / column (12).
Column (14) = column (2) * column (10) / column (12) .

4 year underwriting return on premium = 46 / 1105 = 4.2%
4 year underwriting return on surplus = .042 * 2.5 = 10.5%

Solutions to questions from the 1999 exam

Question 20

1. T. Level premiums associated with whole life policies have lead life actuaries to place greater reliance on asset-share pricing models than P&C actuaries (which work with premiums that fluctuate widely). page 197.

2. T. It examines the profitability from inception to termination (including renewals) of the policy. page 192

3. F. Feldblum demonstrates how asset share pricing is used to determine class relativities for young drivers. page 217. **Answer B.**

Question 34.

Calculate the present value of expected profits as a percentage of the present value of premium. Assume that the cost of capital is 12%.

Policy Year	Premium (1)	Present Value of Loss (2)	Variable Expense (3)	Fixed Expense (4)	Persistency Rate (5)
1	900	810	135	72	1.00
2	990	826	149	30	.75
3	1,089	843	163	30	.80
4	1,198	860	180	30	.85

Policy Year	Cumulative Persistency (6)	Profit (7)	Discount Factor (8)	Present Value Profit (9) = (7)*(8)	Present Value Premium (10)
1	1.00	-117.00	1.00	-117.00	900
2	0.75	-11.25	$(1.12)^{-1}$ = .893	-10.04	663.05
3	0.60	31.80	$(1.12)^{-2}$ = .797	25.35	520.75
4	0.51	65.28	$(1.12)^{-3}$ = .712	46.47	435.01
				-55.22	2,518.81

(6) is the downward product of column (5)

(7) is [(1) - {(2) + (3) + (4)}] * (6)

(10) is [(1) * (6) * (8)

Solutions to questions from the 2000 exam

7. **F.** Persistency rates (the term "retention rates" are used interchangeably in this paper) are the crux (and hence the fundamental issue) of asset share pricing models. See page 207.

8. **T.** Termination rates more clearly distinguish persistency patterns by classification. Probabilities of termination, in certain analyses, provide a better portrayal of the insurer's profitability. See pages 210 - 211.

Question 47
On page 289, Feldblum shows in Exhibit 1, an example of how to use the asset share model under a company growth scenario.

The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in bold (in this case, only the premium is a given input).
3. Adjust your initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 11 through 14.
5. Write formulas to compute what is asked for in the problem:

$$\text{3 year underwriting return on premium} = \frac{\sum PV\ of\ profit}{\sum PV\ of\ premium}$$

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Fixed Expense New	Fixed Expense Renewal	Variable Expense Year 1	Variable Expense Renewal	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1999	**1,000.00**	750.00	0.00	150	0	250	0	1.00	1.00
2000	1,060.00		786.41		**52.00**		106.00	0.90	0.90
2001	1,123.60		824.58		54.08		112.36	0.90	0.81
Total	3,183.60								

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(11)	(12)	(13)	(14)
1999	-150.00	1.000	-150.00	1,000.00
2000	104.03	1.090	95.44	875.23
2001	107.39	1.188	90.39	766.03
Total			35.83	2,641.26

Column 2 is an average premium per car of 1000 with a 6% annual growth due to annual rate increases
Column (3) is column (2) * 0.75 new business loss ratio. Column (4) is column (3) * 1.049 net trend.
Column (5). First year fixed expenses are .15*1,000. Fixed renewal expenses in renewal year 1.
equal fixed renewal expenses in policy year 1 times fixed expense trend: 52 = 1,000*.05*1.04
Variable expenses are 25% of 'premium' in the 1st 'year', and 10% in the following years
Column (9) is 1.0 - termination rate of 10%
Column (10) = the downward product of column (9).
Column (11) = Column (10) *{Column (2) - Sum of Columns (3, 4, 5, 6, 7 and 8)}.
Column (12) uses a rate of 9% per year compounded annually.
Column (13) = column (11) / column (12).
Column (14) = column (2) * column (10) / column (12) .

3 year underwriting return on premium = 35.83 / 2,641.26 = 1.36%

Solutions to questions from the 2001 exam

Question 11. Calculate the termination rate for the third year.

General information:

"Persistency may be analyzed either by termination rates or by probabilities of termination.

The termination rate is the number of terminations during a given renewal period divided by the sum of terminations during that period plus policies persisting through that period.

Termination rates more clearly distinguish persistency patterns by classification."

Solution:

The termination rates by year are:

35% [= 350 ÷ 1000] the 1st year

30.79% [=200 ÷ (1,000 – 350) = 650] the 2nd year, and

22.22% [=100 ÷ (1,000 – 350 – 200) = 450] the 3rd year. **Answer D.**

See page 210.

Questions 12. Which of the following is <u>false</u> ?

A. Asset share pricing determines rates, not rate revisions. True. See page 215.

B. Life insurance policy claim rates are more certain than property-casualty policy claim rates. True. Claim rates in casualty insurance are more variable and less well understood. See page198.

C. It is appropriate to assume the same pattern of persistency ratios for both direct writers and independent agency companies. **False**. Direct writers, like Sate Farm, have <u>high</u> retention rates because they offer low premium rates and provide renewal discounts. Many independent agency companies have <u>low</u> retention rates because they can move the insured to whichever company offers the lowest rate. See page 208. **Answer C.**

D. A level commission structure is inappropriate for the persisting and profitable risks. True. A level commission structure works wells for risks that terminate quickly. It works poorly for risks that endure with the carrier. See page 206.

E. The dominant market share of the direct writers makes asset share pricing a more appropriate model for personal automobile insurance. True. In the personal lines of business, direct writers are steadily gaining market share, See page 206.

23. (2 points) 4 factors which help to explain the relationship between the duration of an auto policy and the claim frequency for that policy include:

1. Experience: Good driving habits and safety precautions exercised by experienced drivers contribute to lower claim frequency. Inexperienced drivers are more careless and tend to have high claim frequencies.
2. Youth: Young male and female drivers have relatively new policies and have higher than average claim frequencies, even after adjusting for driving experience.
3. Transience: Many high risk drivers (young males), are "transient" insureds. Young male drivers tend to cancel policies as they shop for cheaper coverage, move often, and after causing accidents, either voluntarily drop coverage or tend to be non-renewed by underwriters.
4. Acquisition of the Vehicle: Accident frequency often decreases with time since acquisition, as the insured becomes familiar with the operation of the vehicle. See pages 200 – 203.

Question 36.

30 policies terminate in the third year

The probability of termination in year 2 is 0.0816

The termination rate in year 2 is 0.1000

The termination rate in year 3 is 0.0750

a. (1½ points) Calculate the number of policies terminated in year 1 and year 2.

b. (1 point) Calculate the original number of policies in the cohort.

c. (½ point) Calculate the termination rate and the probability of termination in year 1.

Step 1: Write equations to determine the termination rate and the probability of termination.

1. $\text{The termination rate} = \dfrac{\text{the number of terminations}}{\text{number of terminations + policies persisting}}$

2. $\text{Probability of termination} = \dfrac{\text{the number of terminations}}{\text{number of policies in cohort}}$

Step 2: Set up a table similar to the one below, and enter the given data to develop a structured approach to answering questions a, b, and c.

	Year		
Number of policies	1	2	3
a. in cohort			
b. Terminating			30
c. Persisting			
Rates/Probabilities			
d. Termination rate		0.1000	0.0750
e. Prob of termination		0.0816	

Step 3: Fill in the table above by working backwards from time 3 to time 0.

$\text{The termination rate}_3 = .075 = \dfrac{30}{30\text{+ policies persisting}}$. No. of polices persisting $_{(3)} = \dfrac{30\text{-}(30^*.075)}{.075} = 370$

No. of policies persisting $_{(2)}$ = No. of polices terminating $_{(3)}$ + No. of polices persisting $_{(3)}$ = 30 + 370 = 400

$\text{The termination rate}_2 = .100 = \dfrac{\text{No of policies terminating}}{\text{No of policies terminating} + 400}$. No. of polices terminating $_{(2)} = \dfrac{.100(400)}{(1.0 - .100)} = 44$

No. of policies persisting $_{(1)}$ = No. of polices terminating $_{(2)}$ + No. of polices persisting $_{(2)}$ = 44 + 400 = 444

$\text{Probability of termination}_2 = \dfrac{\text{the number of terminations}_2}{\text{number of policies in cohort}_1}$. No. of polices in cohort $_{(1)}$ = 44 ÷ .0816 = 539

No. of policies terminating $_{(1)}$ = No. of policies in cohort - No. of polices persisting $_{(2)}$ = 539 - 444 = 95

Step 4: By examining the formulas in Step 1, recognize that the termination rate and the probability of termination in year 1 are equal.

$$\text{The termination rate}_1 = \text{Prob of termination} = \frac{95}{539} = .176$$

Answers:

a. The number of policies terminated in year 1 and 2 are 95 and 44 respectively.

b. The original number of policies in the cohort equals 539.

c. The termination rate and the probability of termination in year 1 equal .176.

Solutions to questions from the 2003 exam

Question 43.

a. Using the procedure described by Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurance," calculate the indicated premium relativity for youthful drivers. Use a three year time horizon to determine your answer. Show all work.

- Indicated adult class new business policy premium = $1,000
- Youthful class discounted loss cost during first policy year = $1,500
- Premiums increase 10% annually
- Losses increase 5% annually
- Variable expense ratio = 20% for all business
- All expenses are variable
- Annual youthful class lapse rate = 25%
- The company's cost of capital is 10%
- 3-year PV of premium for adult class = $2,710
- 3-year PV of profit for adult class = $90.30
- Assume same return is earned for all classes

Step 1: Write a generic formula to compute the indicated premium relativity for youthful drivers:

$$Premium\ Relativity_{youthful} = \frac{Youthful\ Premium_{yr1}}{Adult\ Premium_{yr1}} = \frac{?}{\$1,000}$$

Step 2: It is assumed that the same rate of return is earned for all classes. We can compute that return as the PV of the profit/PV of the premium. Since these values are only unknown for the youthful class, create a table similar to the one below to compute these values:

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Variable Expense Year 1	Variable Expense Renewal	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(7)	(8)	(9)	(10)
1	**P**	**1,500**	**0**	**.20P**	0	1.0000	1.0000
2	1.1*P		**1,575**		**.22P**	0.7500	0.7500
3	1.21*P		**1,654**		**.242P**	0.7500	0.5625

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(11)	(12)	(13)	(14)
1		1.000		
2		1.100		
3		1.210		
Total			Compute	Compute

Step 3: Compute the 3 year PV of profit and PV of premium for the youthful class:

3-year present value of profit

= [(P - 0.2P - 1,500) * 1/1] + [(1.1P - 0.22P – 1,575) * 0.75/1.10] + [(1.21P - 0.242P – 1,653.75) * 0.5625/1.21]

= [(0.8P – 1,500)] + [(0.88P – 1,575) * 0.682] + [(0.968P – 1,653.75) * 0.465]= **1.85P – 3,342.65**

3-year present value of premium = P * 1/1 + 1.1P * 0.75/1.1 + 1.21P * 0.5625/1.21 = **2.3125P**

Step 4: Equate the 3 year PV of profit and PV of premium for the adult and youthful class:

Adult return $90.30 / $2,710 = 3.33%. Thus, 3.33% = (1.85P – 3,342.65) / 2.3125P. P = 1,885 for youthful class

Therefore, the indicated premium relativity for youthful drivers = $1,885 / $1,000 = 1.885

b. How might traditional ratemaking methods be misleading in determining classification relativities?

Since traditional ratemaking methods don't take into account persistency rates, they tend to underestimate relativities for classifications with poor persistency and overestimate relativities for classifications with good persistency.

Solutions to questions from the 2004 exam

44. (4 points)

Using the asset share pricing model, determine the return on equity over the three-year period. Show all work.

Preliminary comments:

The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in bold.
3. Adjust initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 8 through 14.
5. Write formulas to compute what is asked for in the problem:

Policy		Annual Losses		Fixed Expenses		Persistency	Cumulative
Year	Premium	Year 1	subsequent	Year 1	Renewal	Rate	Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	**1,000.00**	**750**	**0**	**400.00**	0	1.0000	1.0000
2	1,120.00		793.27		**100.00**	0.9000	0.9000
3	1,254.40		839.03		**100.00**	0.9000	0.8100
	3,374.40						

Policy		Discount	Present Value of		Return on	
Year	Profit	Factor	Profit	Premium	Premium	Equity
(1)	(9)	(10)	(11)	(12)	(13)	(14)
1	-150.00	1.000	-150.00	1,000.00		
2	204.06	0.870	177.44	876.52		
3	255.45	0.756	193.15	768.29		
Total			220.60	2,644.81	8.34%	**25.02%**

Column (2) is computed based on the givens in the problem
Column (3) is col (2) * .75 (1st year loss ratio). Col (4) is col (2) * 1.10/1.04 net loss cost trend
Columns (5) - (7) are based on the givens in the problem
Column (8) = the downward product of column (7).
Column (9) = Column (8) *{Column (2) - sum of Columns (3, 4, 5, 6)}.
Column (10) uses a discount rate of 15% per year compounded annually.
Column (11) = column (9) * column (10).
Column (12) = column (2) * column (8) * column (10) .
Column (13) = column (11) $_{\text{Total}}$ / column (12) $_{\text{Total}}$
Column (14) = column (13) * Premium to Surplus ratio (given in the problem)

b. (1 point) Explain how asset share pricing models and property/casualty insurance ratemaking methods differ in their consideration of the profitability of an insurance policy.

Traditional P&C ratemaking methods consider only the profitability of the future policy period to determine whether there will be enough premium to cover losses and expenses during the forecast period.

Asset share pricing models look at profitability over the life of the policy, taking into account policyholder persistency patterns.

Solutions to questions from the 2005 exam

56. (3 points) Use an asset share pricing approach to determine whether a company should write this business. Show all work and explain your answer.

Initial comments: "Profits may be measured as the net present value of premiums minus the net present value of expenditures (losses, expenses, and taxes). Thus, Anderson, recommends that "the profit objective be defined by the criterion that the present value of the profits which will be received in the future be equal to the present value of the surplus depletion, with both present values based on a yield rate or yield rates which represent adequate return to the stockholders for the degree of risk incurred in expending surplus in the expectation of receiving future profits. That is, the present value of the entire series of profits and losses is zero."

Based on the above, setup a table similar to the one below to determine the present value of the profits.

Policy Year	Premium	PV of the Losses	Expenses	Persistency Rate	Cumulative Persistency	Discount Factor	PV of the Profits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	$500	$415	$100	100%	100.000%	1.0	-$15.00
2	$550	$440	$110	85%	85.000%	1.1^{-1}	$0.00
3	$605	$460	$121	85%	72.250%	1.1^{-2}	$14.33
	1,655.00	1,315.00					-$0.67

Column (6) = the downward product of column (5).
Column (8) = (6) *{ (2) - (3) - (4))} * (7).

Using a 10% cost of capital (the yield from equities of similar risk), this business should not be written since the present value of the profits are negative. A better return could be obtained by simply investing in the equities of similar risk that are yielding 10% per year.

See pages 265 – 266.

Solutions to questions from the 2006 exam

50. (5.75 points) Determine which alternative is more profitable for a cohort of 65 year-old existing insureds over a three-year time period. Show all work.

Preliminary comments:

The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in bold.
3. Adjust initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 8 through 13.
5. Write formulas to compute what is asked for in the problem:

Note: It is assumed that the persistency rates given are for that year only, and are not cumulative persistency rates.

Solutions to questions from the 2006 exam

Question 50

Profitability analysis for 65 year-old existing insureds - Without Offering a Discount

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Expenses Variable	Expenses Fixed	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	800.00	500	0	160.00	40.00	1.0000	1.0000
2	840.00		519.80	168.00	42.00	0.9000	0.9000
3	882.00		540.39	176.40	44.00	0.8500	0.7650
	2,522.00						

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium	Return on Premium
(1)	(9)	(10)	(11)	(12)	(13)
1	100.00	1.000	100.00	800.00	
2	99.18	0.909	90.16	687.27	
3	92.73	0.826	76.63	557.63	
Total			266.80	2,044.90	13.05%

Column (2) is computed based on the givens in the problem
Column (3) is given; Col (4) is col (2) * 1.05/1.01 net loss cost trend
Columns (5) = .20 * (2)
Columns (6) - (7) are based on the givens in the problem
Column (8) = the downward product of column (7).
Column (9) = Column (8) *{Column (2) - sum of Columns (3, 4, 5, 6)}.
Column (10) uses a discount rate of 10% per year compounded annually.
Column (11) = column (9) * column (10).
Column (12) = column (2) * column (8) * column (10) .
Column (13) = column (11) $_{\text{Total}}$ / column (12) $_{\text{Total}}$

Profitability analysis for 65 year-old existing insureds - With Offering a Discount

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Expenses Variable	Expenses Fixed	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	760.00	500	0	152.00	40.00	1.0000	1.0000
2	798.00		519.80	159.60	42.00	0.9800	0.9800
3	837.90		540.39	167.58	44.00	0.9500	0.9310
	2,395.90						

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium	Return on Premium
(1)	(9)	(10)	(11)	(12)	(13)
1	68.00	1.000	68.00	760.00	
2	75.07	0.909	68.24	710.95	
3	80.00	0.826	66.12	644.70	
Total			202.36	2,115.64	9.56%

Note: $760 = $800 * (1-.05)
The more profitable solution is to not offer a discount. For this cohort over a three-year period, the return on premium without the discount is 13.0%, and the return on premium with the discount is only 9.6%.

Solutions to questions from the 2007 exam

28. (4.0 points) Using the Asset Share Pricing approach described by Feldblum, determine whether this opportunity exceeds the company's target return on surplus of 15% over a three-year time period. Show all work.

Preliminary comments:

The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Adjust initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
3. Memorize the formulas for calculating columns 10 through 16.
4. Write formulas to compute what is asked for in the problem:

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Fixed Expenses Year 1	Fixed Expenses Renewal	Variable Expenses Year 1	Variable Expenses Renewal	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	**900.00**	675	**0**	60.00	0	243.00	0	**1.0000**	1.0000
2	945.00		701.21		40.00		47.25	**0.8500**	0.8500
3	992.25		728.45		42.00		49.61	**0.8800**	0.7480

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium	Return on Premium	Return on Equity
(1)	(11)	(12)	(13)	(14)	(15)	(16)
1	-78.00	1.0000	-78.00	900.00		
2	133.06	1.0500	126.72	765.00		
3	128.80	1.1025	116.83	673.20		
Total			165.55	2,338.20	7.08%	14.16%

Column (2) is computed based on the givens in the problem
Column (3) is col (2) * .75 (1st year loss ratio). Col (4) is col (2) * 1.07/1.03 net loss cost trend
Columns (5) and (6) are based on the givens in the problem
Columns (7) and (8) are based (2) and the givens in the problem
Column (9) is 1.0 - the given termination rates in the problem
Column (10) = the downward product of column (9).
Column (11) = Column (10) *{Column (2) - sum of Columns (3, 4, 5, 6,7,8)}.
Column (12) uses a discount rate of 5% per year compounded annually.
Column (13) = column (11) / column (12).
Column (14) = column (2) * column (10) / column (12) .
Column (15) = column (13) $_{\text{Total}}$ / column (14) $_{\text{Total}}$
Column (16) = column (15) * Premium to Surplus ratio (given in the problem)

Since the computed return on surplus does not exceed the target return on surplus, the company should not pursue this opportunity.

Solutions to questions from the 2008 exam

Model Solution - Question 43

43. (1.0 point) Contrast the asset share pricing model to traditional techniques for calculating rate relativities.

Traditional techniques only consider a single period. By doing so, they fail to consider differences in persistency amongst different risks. Persistency can have a significant impact due to loss and expense differences between new and renewal business. The asset share pricing model accounts for this by introducing multiple periods, persistency, and different assumptions for new and renewal business.

Model Solution - Question 44

Calculate the indicated rate relativity for Class B as compared to the base class (Class A) using the asset share pricing model and a two-year time horizon.

Initial comments: The easiest way to solve problems like this one is to:

1. Prepare an exhibit like the one below, without any of the numbers filled in.
2. Fill in the "givens" in the problem. These appear in bold (in this case, only the premium is a given input).
3. Adjust your initial year premiums, losses, and expenses according to the growth / trend rates given in the problem.
4. Memorize the formulas for calculating columns 10 through 16.
5. Write formulas to compute what is asked for in the problem:

Step 1: Write a generic formula to compute the indicated premium relativity for Class B:

$$Class\ B\ Premium\ Relativity = \frac{Class\ B\ Premium_{yr1}}{Class\ A\ Premium_{yr1}} = \frac{?}{\$633.80}$$

Step 2: It is assumed that the same rate of return is earned for all classes. We can compute that return as the PV of the profit/PV of the premium. Since these values are only unknown for the Class B, create a table similar to the one below to compute these values:

Policy Year (1)	Premium (2)	Annual Losses Year 1 (3)	Annual Losses subsequent (4)	Variable Expense (7)	Fixed Expense (8)	Persistency Rate (9)	Cumulative Persistency (10)
1	**X**	**1,000**	**0**	**.10X**	120	1.0000	1.0000
2	**X**		**900**	**.05X**	110	0.6000	0.6000

Policy Year (1)	Profit (11)	Discount Factor (12)	Present Value of Profit (13)	Present Value of Premium (14)	Return on Premium (15)	Return on Equity (16)
1		1.000				
2		1.100				
Total		`	**Compute**	**Compute**		**Compute**

Step 3: Compute the 2 year PV of profit and PV of premium for the Class B:

2-year present value of profit:

Year 1: [(X – 1,000 – 120 – 0.1X) * 1.0]/1.0 = (0.90X – 1,120)/1.0

Year 2: [(X – 900 – 110 – 0.05X) * 0.60]/1.1 = (0.95X – 1,010)* 0.6/1.1

Year 1 + Year 2: **1.418X – 1671**

2-year present value of premium = X + .60X/1.1= **1.545X**

Step 4: Equate the 2 year PV of profit and PV of premium for Class B to the targeted pre-tax return on equity of 6% and the given P/S ratio of 2:1, to solve for Class B year 1 premium.

PV of the profit/PV of premium = **1.418X – 1671/1.545X** = .06 * [1.0/2.0]. X = 1,218.24

Therefore, the indicated premium relativity Class B = $1,218.24/$633.8 = 1.92

Solutions to questions from the 2009 exam

Question 45

a. Persistency rates are the proportion of business that remains in force from one period to the next. They are important in classification ratemaking because certain classes may have higher persistency than others, making them more profitable to write when you consider the complete expected lifetime of the policy.

b. A direct writer is expected to have higher persistency rates since the company owns the renewals. In the independent agency systems, the agent owns the renewals and may put the insured with a different company in order to get a better rate.

c. Standard insured has higher persistency rate because non-standard insureds are high risk, which means they are either likely to shop around for cheap coverage or more likely to be cancelled by the company.

Solutions to questions from the 2010 exam

Question 35

	1	2	3	4	5	6
PY	**Prem**	**PV Loss**	**Var Exp**	**Fixed Exp**	**Persistency** Rate	**Cumulative**
1	1000	650	300	200	1	1
2	1100	680.95	110	50	.75	.75

	7	8	9	10
PY	**Profit**	**Discount**	**PV profit**	**PV Prem**
1	- 150	1	- 150	1000
2	194.29	1.1	176.63	750
			26.63	**1750**

$$\text{ROP} = \frac{26.63}{1750} = 1.522\ \%$$

ROS = Profit/Premium * Premium/Surplus = ROP *P/S = 1.522 % (2) = 3.04%

↓

Doesn't meet company's goals of 4 % ROS

(1) Use prem trend of 10 %

(2) Use 1st yr LR of 65 %
For yr 2 take 650*1.1/1.05

(3) For yr 1= 30 % (1000)
For yr 2 = 1100 (.1)

(6) is downward product of (5)

(7) = [(1) - (2) - (3) - (4)]x6

(9) = (7)/(8)

(10) = (1)x(6)/(8)

Solutions to questions from the 2011 exam

20a. (0.5 point) Using a one-year period, calculate the premium for class B if the same profit loading is targeted for all classes.

20b. (1.25 points) Using a two-year period, calculate the return on sales for class A.

20c. (1.75 points) Using a two-year period, calculate the premium for class B that would achieve the same return on sales as calculated in part b above.

Initial comments:

Year 1 Premium = PV Losses + Variable Expenses + Fixed Expenses + Profit.

Year 2 Profit = [Premium - PV Losses – Variable Expenses – Fixed Expenses]*Cumulative Persistency

Return on Sales = PV Profit/PV Premium

The probability of termination is the number of terminations during a given renewal period divided by the number of originally issued policies in that cohort. A cohort is a group of policies written in a given issue period.

Persistency may be computed using termination rates or probabilities of termination.

- The termination rate = the number of terminations ÷ [number of terminations + policies persisting].
- The probability of termination = the number of terminations ÷ the number of originally issued policies in that cohort.

Feldblum concludes that termination rates more clearly distinguish persistency patterns by classification. Thus, the persistency rate is 1.0 - termination rate.

Question 20 – Model Solution

a. Profit for class A = 800 - 550 - (800 * .2) - 42 = 48

Profit loading for class A = .06 = 48/800

Premium for class B

$.06P_B = P_B - 650 - .24P_B – 50$; $.07P_B = 700$; $P_B = 1,000$

b.

Year	Prem	PV Loss	VarExp	Fixed exp	Persis	Discount Factor	PV Prem	PV Profit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	800	550	160	42	1.0	1.0	800	48
2	800	550	96	20	.85	1.08	630	105.463
							1,430	153.463

(7) = [(1) * (5)]/(6)

(8) = {[(1) - (2) - (3) - (4)]*(5)}/(6)

Return on sales = 153.463/1,430 = .1073

c.

Year	Prem	PV Loss	VarExp	Fixed exp	Persis	Disc Factor	PV Prem	PV Profit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	P	650	.24P	50	1.0	1.0	P	.76P - 700
2	P	650	.20P	30	.60	1.08	.5556P	.444P - 377.78
							1.5556P	1.204P - 1,077.78

(7) = [(1) * (5)]/(6)

(8) = {[(1) - (2) - (3) - (4)]*(5)}/(6)

(1.204P - 1,077.78)/1.5556P = .1073

.167P = 1.204P - 1,077.78; 1.037P = 1,077.78; P = 1,039.32

1. (2 points) Given the following information for an insurance company that writes 24-month term policies:

Policy Group	Effective Date	Expiration Date	Number of Vehicles
A	January 1, 2010	December 31, 2011	50
B	July 1, 2010	June 30, 2012	100

All policies within each group have the same effective date.

a. (0.5 point) Calculate the earned car-years for calendar year 2011.

b. (0.5 point) Calculate the earned car-years for policy year 2010 evaluated as of December 31, 2010 and as of December 31, 2011.

c. (0.5 point) Assume Policy Group B cancels on January 1, 2011. Calculate the 2010 policy year written car-years evaluated as of December 31, 2010 and as of December 31, 2011 for Policy Group B.

d. (0.5 point) Assume Policy Group B cancels on July 1, 2011. Calculate the 2010 and 2011 calendar year written car-years for Policy Group B.

S13 - Exam 5 - Question #1

Preliminary comments:

- Since we are asked to compute CY and PY earned car years, and CY and PY written car years for Policy Group B that cancels its policy on different dates, it is helpful to set up a timeline to illustrate effective, expiration, and cancellation dates.
- For auto policies, one typically works with exposures (car years) written on annual policies. Since the given policies are 24-month policies, the number of car years are multiplied by two.

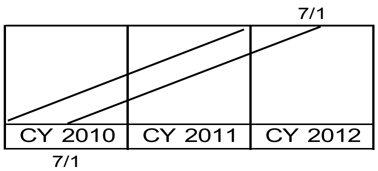
  Typically, the concepts of written and earned exposures are based on the assumption of annual policies being issued.

  Per the text "If the policy term is shorter or longer than a year, then the aggregation for each type of exposure is calculated differently. For example, if we are given six-month policies, each policy would represent one-half of a written exposure." In this problem, 24-month policies are issued; thus each policy covers twice the number of exposures (car years) that a 12 month policy would cover.

  Further, since we are given multiple vehicles on policies within a policy group, we compute earned and written exposures by multiplying by the number of vehicles within a policy group.
- **Written exposures** arise from policies issued (i.e. underwritten or written) during a specified period of time (e.g. a calendar quarter or a CY). CY 2011 written exposures are the sum of the exposures for all policies that had an effective date in 2011.

  If a policy cancels midterm, the policy will contribute a written exposure to two different CYs if the policy cancellation date is in a different CY year than the original policy effective date.

  In part d., Policy Group B is cancelled on 7/1/2011, one half way through its policy period. Each policy in policy group B will contribute 1 written exposure to CY 2010 and -(1/2)(1)=-1/2 written exposure to CY 2011.
- **Earned exposures** are the portion of written exposures for which coverage has already been provided as of a certain point in time. Note: Unlike CY earned exposure, exposure for one policy cannot be earned in two different PYs.
- Since CY captures transactions occurring on or after the first day of the year, and on or before the last day of the year, **CY** is represented graphically as a **square**
- **PY** is represented graphically using a **parallelogram** starting with a policy written on the first day of the PY and ending with a policy written on the last day of the PY.



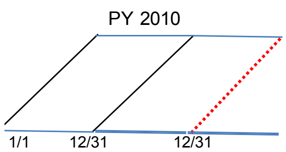
$$\text{CY ECYs} = (\text{No. of vehicles})\left(\frac{\text{mos. exposed to loss in a specific CY}}{\text{Total mos. exposed to loss over policy term}}\right)\left(\begin{matrix}\text{Policy term}\\ \text{in years}\end{matrix}\right)$$

1a. PGA CY 2011 ECYs = (50) * (12/24) * 2 = 50

1b. PGB CY 2011 ECYs = (100) * (12/24) * 2 = 100

Total CY 2011 Earned Car Years = 50 + 100 = 150

Policy Year – General Comments



For PYs, all earned exposure is assigned to the year the policy was written and increases in relation to time. By the time the policy year is complete (24 months after the beginning of the policy year for annual policies), the policy year earned and written exposures are equivalent. Unlike CY EE, exposure for one policy cannot be earned in two different PYs.

b1. Evaluated as of 12/31/2010

$$\text{PY ECYs} = (\text{No. of vehicles})\left(\frac{\text{mos. exposed to loss as of a point in time}}{\text{Total mos. exposed to loss over policy term}}\right)\left(\begin{matrix}\text{Policy term}\\ \text{in years}\end{matrix}\right)$$

PGA PY 2010 ECYs as of 12/31/2010 = (50) * (12/24) * 2 = 50

PGB PY 2010 ECYs as of 12/31/2010 = (100) * (6/24) * 2 = 50

Total earned car years = 50 + 50 = 100

b2. Evaluated as of 12/31/2011

PGA PY 2010 ECYs as of 12/31/2011 = (50) * (24/24) * 2 = 100

PGB PY 2010 ECYs as of 12/31/2011 = (100) * (18/24) * 2 = 150

Total earned car years = 100 + 150 = 250

Policy year written exposures – Policy Cancellation– General Comments

Since policy year written exposure is aggregated by policy effective dates, the original written exposure and the written exposure due to the cancellation are all booked in the same policy year.

c. Evaluated as of 12/31/2010, but cancelling on 1/1/2011

PGB PY 2010 WCYs as of 12/31/2010 = (100) * 2 = 200

Evaluated as of 12/31/2011

= PGB PY 2010 WCYs as of 12/31/2010 - PY 2010 WCY cancellations on 1/1/2011 as of 12/31/2011

= (100) * 2 – [(100) * (18/24) * 2] = 200 – 150 = 50

Calendar year written exposures – Policy Cancellation– General Comments

If a policy cancels midterm, the policy will contribute a written exposure to two different CYs if the policy cancellation date is in a different CY year than the original policy effective date.

In part d., Policy Group B is cancelled on 7/1/2011, one half way through its policy period. Each policy in policy group B will contribute 1 written exposure to CY 2010 and -(1/2)(1)=-1/2 written exposure to CY 2011.

d. PGB CY 2010 WCYs = (100) * 2 = 200
PGB CY 2011 WCYs = - (100) * (12/24) * 2 = -100

Examiner's Report

a. Most candidates answered this question correctly. A small number of candidates misread the problem and assumed that the provided vehicle counts were actually the exposures over the two year period, which caused the answer to be halved.

b. Most candidates answered this question correctly. A small number of candidates misread the problem and assumed that the provided vehicle counts were actually the exposures over the two year period, which caused the answer to be halved. A few others calculated only the earned car-years for one of the evaluation dates requested.

c. Candidates generally answered this answer correctly. A small number of candidates misread the problem and assumed that the provided vehicle counts were actually the exposures over the two year period, which caused the answer to be halved. Some candidates also provided the combined values for both Policy A & B instead of just policy B. Full credit was given to candidates that clearly identified the portion attributable to Policy B. A few others calculated only the written car-years for one of the evaluation dates requested.

d. Candidates generally answered this answer correctly. A small number of candidates misread the problem and assumed that the provided vehicle counts were actually the exposures over the two year period, which caused the answer to be halved. Some candidates also provided the combined values for both Policy A & B instead of just policy B. Full credit was given to candidates that clearly identified the portion attributable to Policy B. A few others calculated only the written car-years for one of the calendar years requested.

There were also some candidates who weren't familiar with the concept of having negative calendar year counts in cases where a multiple-year policy was cancelled in a subsequent year. These candidates often got the 2010 value correct, but would either answer the 2011 value as 0 or 100.

2. (2 points) Given the following information for an insurance company:

- Proposed effective date of the next rate change is January 1, 2014.
- Rates will be in effect for 1 year.
- All policies have 12-month terms and are written uniformly throughout the year.
- Calendar year 2012 earned premium at current rate level is $114,208,050.

12 Month Period Ending	Written Premium at Current Rate Level	Written Exposures
December 31, 2011	$104,500,000	110,000
June 30, 2012	$113,800,500	121,000
December 31, 2012	$123,916,100	133,100

a. (1 point) Utilizing one-step trending, calculate the calendar year 2012 projected earned premium at current rate level for use in calculating the rate change.

b. (0.25 point) Briefly discuss why a premium trend should be utilized in a rate level indication.

c. (0.25 point) Briefly discuss why it is inappropriate to use written premium at historical rate levels to determine premium trends.

d. (0.5 point) The insurance company decides to move all existing business with a $100 deductible to a $500 deductible upon renewal during calendar year 2013. Given this new information, discuss whether the true projected earned premium will be higher, lower, or unchanged from that in part a. above.

S13 - Exam 5 - Question #2

Preliminary comments:

Data to use for premium trend. A decision to use earned or written premium must be made.

Written premium is a leading indicator of trends that will emerge in earned premium and the trends observed in written premium are appropriate to apply to historical earned premium.

Assuming adequate data is available, the actuary will **use quarterly average written premium** at current rate levels (as opposed to annual average written premium) to make the statistic as responsive as possible.

Changes in the quarterly average WP are used to determine the amount historical premium needs to be adjusted for premium trend.

One-Step Trending

The trend factor adjusts historical premium to account for expected premium levels from distributional shifts in premium writings.

The Process: Using the changes discussed previously, the actuary selects a trend factor.

Next: Determine the trend period.

Assume: WP is used as the basis of the trend selection and EP for the overall rate level indications

Compute: The trend period as the length of time from the average written date of policies with premium earned during the historical period to the average written date for policies that will be in effect during the time the rates will be in effect. *

a. Proj CY 2012 EP @ CRL = Current CY 2012 EP @ CRL * Selected trend factor * Trend Period

Since we are given 12 month period ending data at semiannual evaluation dates, select a semiannual trend factor. Do so by first computing average written premium at current rate levels at 12/31/2011, 6/30/2012 and at 12/31/2012.

Dec 31 2011	950 ↙	-1%	104,500/110 = 950
June 30 2012	940.5 ↙	-1%	
Dec 31 2012	931		selected semiannual trend factor = -1%

Next, determine the trend period using the average written date of policies with premium earned during the historical period to the average written date for policies that will be in effect during the time the rates will be in effect. *

Trend period: 1/1/2012- 7/1/2014 based on avg. written dates.
Thus, the trend period is 2.5 years (5 half years)

Projected CY 2012 EP @ CRL = 114,208,050 $((1 - .01))^5$ =108,610,779

OR

Trend period 1/1/12 to 7/1/14 2.5 yrs. Here an annual trend will be selected and the trend period is 2.5 years.

Projected EP = CY 2012 Earned from @CRL * Trend $^{2.5}$

AVG WP @ CRL

12 mo ending	AWP at CCRL	Semi Ann Chng	
12/31/2011	950		
		-0.01	
6/30/2012	940.5		-2% annual trend
		-0.01	
12/31/2012	931		

Projected 2012 EP @ CRL = 114,208,050 * $(1-.02)^{2.5}$ = 108,583,017.3

b. It takes into account changes in exposure distributions, for what is expected to occur when rates are in effect.

OR

Premium trend accounts for the gradual shift in the book of business for things such as inflation or mix of business

c. Using historical rates would cause a double-counting effect in the trend calculation

OR

Using written premium at historical rate levels to determine premium trend would include rate changes in the selected trend number, when we don't necessarily expect those rate changes to continue into the future.

d. This change would cause premiums to go lower because fewer losses would be paid. The true projected premium is lower than that calculated above.

OR

The true projected earned premium will be lower because a higher deductible gives the insured a discount on premium.

Question 2 - Examiner's Report

a. In general candidates scored well. Some of the common errors were:

- -1% trend (not annual)
- Wrong trend period
- 8.5% or 8.9% trend (using total WP or WP over EP)
- Apply trend to WP
- Calculating EP from WP instead of projecting the given EP

b. A common error was to say the premium trend is used to bring historical premium to expected future cost level which is stating what the premium trend does but not why you'd do it. The other common mistake was to mention rate changes as part of the premium trend.

c. Candidates often compared average premium to total premium instead of historical premium to current level premium. The other common mistake was to compare written premium to earned premium instead of historical premium to current level premium.

d. Candidates scored very well on this part. When candidates missed points it was due to not responding to the actual question asked but instead describing how the issue could be addressed.

3. (2.5 points) An actuary has submitted the following analysis for a rate level indication:

Calendar/ Accident Year	Calendar Year Earned Premium	Accident Year Reported Losses and Paid ALAE	Accident Year Reported Loss and Paid ALAE Ratio
2010	$1,023,549	$703,902	68.8%
2011	$1,086,756	$773,430	71.2%
2012	$1,222,930	$749,249	61.3%

Three Year Average Reported Loss and Paid ALAE Ratio	67.1%
Fixed Expense Provision	11.0%
Variable Expense Provision	15.0%
Underwriting Profit Provision	8.0%
Variable Permissible Loss Ratio	77.0%
Indicated Rate Change	1.4%

Recommend five improvements to the analysis and briefly explain the purpose of each.

S13 - Exam 5 - Question #3

1. Adjust the earned premium to current rate level. This will avoid an indication that ignores past rate changes and provides a better projection of future loss ratios.

2. Determine a loss trend and apply to the Loss + ALAE. This will created a better projection of future losses if there is an ongoing or past change in frequency or severity of losses

3. Develop losses to ultimate. The rate must account for all losses from the policies, not just the ones that have been reported thus far. Ignoring IBNR will create an inadequate rate.

4. Include a ULAE load. The rate must provide for all costs associated with the transfer of risk so it must include adjustment expenses that are not allocated to specific claims

5. Use a volume-weighted average of loss ratios. 2012 has significantly more premium than past years and will be more responsive to changes in the book so it should be given more weight.

Question 3 - Examiner's Report

The question presented an analysis for a rate indication. The candidate was requested to provide 5 improvements for the analysis and briefly explain the purpose of each. Suggesting improvements to the company's operation did not address the question asked and did not receive credit.

The majority of candidates recommended and received full credit for at least four enhancements to the analysis. Many recommended and received full credit for five. Those that did not receive credit for all 5 recommendations didn't attempt an answer or suggested enhancements that did not improve the analysis. Additionally, some candidates confused various concepts (for example, "trend losses to ultimate"), provided a response that summarized prior enhancements, were too general in their recommended improvement, or simply identified a shortcoming in the analysis without offering an enhancement, and did not receive credit.

Candidates generally struggled to receive credit for briefly explaining the purpose of each recommendation; most candidates received less than full credit on four of the five explanations requested.

Most candidates did not provide an explanation or attempted to give further explanation of the enhancement without explaining its purpose -- these did not receive credit.

Many candidates restated a version of the original recommended improvement to the analysis in their explanation of the purpose (i.e. "Earned premium can be adjusted to the current rate level.

This makes sure that all premiums are on-level."), which did not get credit for explaining the <u>purpose</u> of the bringing the premium to current rate levels.

4. (3 points) Given the following information:

- Annual loss trend rate = +4%.
- Rate change history:
  - o +3% effective April 1, 2009.
  - o +2% effective July 1, 2010.
- All policies have annual terms.
- Calendar year 2012 earned premium = $50,000.
- Accident year 2012 reported losses at December 31, 2012 = $4,200.

Percentage of Loss Reported at:	
12 months	10%
24 months	35%
36 months	65%

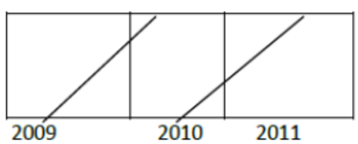
Selected Ultimate Loss Ratio	
Accident Year 2009	66%
Accident Year 2010	67%
Accident Year 2011	70%

Use the reported Bornhuetter-Ferguson technique to estimate ultimate losses for accident year 2012.

S13 - Exam 5 - Question #4

Step 1: AY 2012 BF Ultimate Losses = CY 2012 EP * AY 2012 Selected Ultimate ELR * AY 2012 % unreported at 12/31/2012 + AY reported losses at 12/31/2012

Step 2: Compute on-level factors to use in the selection of the ELR



For 2009: On- level factor: $$\frac{1.03 \times 1.02}{9/32 \times 1.03 + 23/32 \times 1} = 1.0418$$

For 2010: On-level factor: $$\frac{1.03 \times 1.02}{1/32 \times 1 + 1/8 \times 1.03 \times 1.02 + 27/32 \times 1.03} = 1.0184$$

For 2011: On- level factor: $$\frac{1.03 \times 1.02}{1/8 \times 1.03 + 7/8 \times 1.03 \times 1.02} = 1.00246$$

Step 3: Compute the selected ELR = Avg (2009 – 2011) selected ultimate loss ratio adjusted for loss trend and on-level premium factors

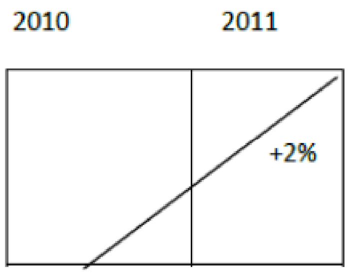
$$\frac{1}{3}\left(66\% \times \frac{1.04^2}{1.0418} + 67\% \times \frac{1.04^2}{1.0184} + 70\% \frac{1.04}{1.00246}\right) = 71.68\%$$

Step 4: AY 2012 BF Ultimate Losses = 50,000 x 71.68% x (1 – 10%) + 4,200 = 36,456

OR

BF ULT. Losses = 4,200 + [% unreported @ 12/31/12 x 2012 Selected Ult. LR x CY 2012 EP]

AY 2011 ULT loss ratio = $\frac{\text{2011 Loss + LAE}}{\text{2011 EP}}$



On level factor for 2011 EP = $\frac{1.02}{1(1/8)+1.02(7/8)} = 1.002$

AY 2011 Selected Ultimate LR adj for AY 2012 = $.7 * \frac{1.04}{1.002} = .727$

BF ULT Loss for AY 2012 = 4,200 + 0.90 * 0.727 * 50,000 = 36,915

Examiner's Report Question 4

Many candidates did not identify the need to adjust historical loss ratios for the future 2012 level.

Some did not develop on-level-factors or apply them appropriately to the historical loss ratios, while others did not apply loss trend to the historical loss ratios.

Some thought that the 2012 on-level earned premium was the only on-level adjustment needed, but this number was provided and the historical loss ratios still need adjustment for future levels.

We also frequently saw misidentified loss trend periods (2 years instead of 3, 1.5 years instead of 1, etc.).

5. (4 points) A company is reviewing the rate level adequacy. Given the following information for a book of business:
   - All policies are annual.
   - Current rates have been in effect for three years.
   - New rates will be in effect for 18 months beginning on July 1, 2013.
   - Annual premium trend = -1%.
   - Annual loss trend = +3%.
   - Loss adjustment expense provision = 2.5% of loss.
   - Historical expense ratios:
     - Fixed = 6%.
     - Variable = 30%.
   - Underwriting profit and contingencies provision = 5%.
   - Ultimate losses are estimated using the reported development technique.
   - On January 1, 2014, the company will reduce agency commissions by 3% of premium.

Calendar Year Ending	Earned Premium ($000s)
December 31, 2011	$2,163
December 31, 2012	$2,120

	Reported Losses ($000s)				
Accident Year	12 months	24 months	36 months	48 months	60 months
2008	$780	$928	$1,030	$1,083	$1,094
2009	$765	$921	$1,004	$1,053	
2010	$760	$920	$1,012		
2011	$805	$966			
2012	$890				

Calculate the indicated rate change.

S13 – Exam 5 - Question #5

$$\text{Indicated Rate Change } = \frac{LR+F}{1-V-Q_T} - 1$$

(F = 6%, v = 30%, Q = 5%, V will have to be adjusted due to the reduction in agency commissions.

Step 1: Compute Proj Ult Claims = Reported Losses * LDF to Ult * Loss Trend * LAE Loading

a. Compute volume weighted age to age factors; 60 to ultimate factor (1.0) judgmentally selected.

	12-24	24-36	36-48	48-60	60+
Selected ATAF reported Losses	1.200965	1.100036	1.050147	1.010157	1.0

$(1030+1004+1012)/(928+921+920)$

b Compute the loss trend period for AY 2011 and AY 2012

Trend Period = Average accident date during the experience period to the average accident date during the period the rates are in effect.

AAD during the experience period (AY) is 7/1/20XX.

The period the rates will be in effect is 7/1//2013 – 12/31/2014; the AWD during that period is 3/1/2014 and the AAD for a policy written on 3/1/2014 is 10/1/2014.

Trend Period for AY 2011 is 7/1/2011 – 10/1/2014 = 3.25 years, and for AY 2012 is 2.25 years

	Reported Losses	CDF-ULT	Loss Trend	LAE loading	Projected ult claims
2011 (24 mos)	966,000	1.166933	$1.03^{3.25}$	1.025	1,271,943.715
2012 (12 mos)	890,000	1.401446	$1.03^{2.25}$	1.025	1,366,387.864

=1.1200965 * 1.100036 *1.0500147*1.010157

Step 2: Compute Projected Trended Premium = EP * On-level Factor * Premium Trend Factor

$$\underbrace{\text{Avg written date of CY 20XX EP}}_{01/01/20XX} - \underbrace{\text{Avg written date of } (07/01/2013\text{-}12/31/2014 \text{ PY})}_{04/01/2014}$$

For CY Ending 12/31/2011, the trend period is 1/1/2011 – 4/1/2014 = 3.25 years

For CY Ending 12/31/2012, the trend period is 1/1/2012 – 4/1/2014 = 2.25 years

The given premium trend is -1%

	EP	On-level Factor*	Premium Trend	Projected Trended Premium
2011	2163000	1.00	$0.99^{3.25}$	2,093,490.054
2012	2120000	1.00	$0.99^{2.25}$	2,072,597.876

*Already on-level as no rate change in past 3 years

Step 3: Compute the projected LR

$$LR = \frac{1,271,943.715 + 1,366,387.864}{2,093,490.054 + 2,072,597.876} = .603328$$

Step 4: Compute V during the effective period of the rates. On 1/1/2014, V = .30-.03=.27

$$\text{V approx in forecast period } = \frac{\overbrace{07.01.2013-31.12.2013\times 0.30}^{1/3 \text{ period}} + \overbrace{01.01.2014-31.12.2014\times 0.27}^{2/3 \text{ period}}}{07.01.2013-31.12.2014}$$

= 1/3(0.3)+2/3(0.27)= 0.28

Step 5: Compute the indicated rate change

$$\text{Indicated Rate Change } = \frac{LR+F}{1-V-Q_T} - 1 = \frac{0.633288+0.06}{1-0.28-0.05} - 1 = +3.476\%$$

Question #5 (continued)

OR

Compute Trended and Developed Losses

	12-24	24-36	36-48	48-60
	Rpt	Los Dev	Δ	
08	1.19	1.11	1.05	
09	1.20	1.09	1.049	1.01
10	1.21.	1.1		
11	1.2			
Sel	1.2	1.1	1.05	1.01
To ULT	1.400	1.167	1.0605	1.01

CY	Loss	LDF	Trend Fact	LAE	Trended Dev Losses’
2011	966,000	1.167	$1.03^{3.25}$	1.025	1,272,017
2012	890,000	1.400	$1.03^{2.25}$	1.025	1,364,978
Prem		(1/1/12 – r4/1/14)			

Compute Trended EP and Trended and Developed On-Level Loss Ratios (Selection = Avg)

CY	EP	Trend	Trended Ep	LR
2011	2,163,000	$.99^{3.25}$	2,093,490	.6076
2012	2,120,000	$.99^{2.25}$	2,072,598	.6586
				Avg: .6331

Compute the Weighted Average PLR during the effective period of the rates:

PLR from 7/1/13 -1/1/13 =1.0 -.3 -.05 = .65

PLR from 1/1/14 – 12/31/14 = 1 - .27 - .05 = .68

WTD PLR = 1/3 (.65) + 2/3 (.68) = .67

Compute the Indicate Change Factor — Ind Change

$$\frac{.6331+.06}{0.67}=1.0345$$

+3.45%

Examiner’s Report - Question 5

In general, this question was completed well although there were a couple common errors on this question.

1. Most candidates recognized an adjustment needed to be made for the commission change, but the adjustment wasn’t consistently done correctly.

2. The trend period for losses and premium was often determined incorrectly. Although rates were in effect for 18 months, candidates are expected to know how to properly determine trend periods.

6. (2.5 points)

a. (0.5 point) Contrast the components of IBNR for a claims-made policy and an occurrence policy.

b. (0.5 point) Explain why a claims-made policy should cost less than an occurrence policy, provided claim costs are increasing.

c. (0.5 point) Explain why a change in underlying trends will impact the estimated premium for an occurrence policy more than for a claims-made policy.

d. (0.5 point) Briefly describe the provision that exists to eliminate coverage overlap if an insured switches from an occurrence policy to a claims-made policy, and why an overlap would exist without it.

e. (0.5 point) Explain why there would be a coverage gap if an insured switches from a claims-made policy to an occurrence policy and what an insurer can do to provide coverage.

S13 – Exam 5 - Question #6

a. Occurrence Policy has both pure IBNR + IBNER, CM policy only has IBNER

OR

CM has no pure IBNR @ report year end because all claims in the report have be reported (by def.), development is limited to IBNER. Occurrence policies will see development due to both pure IBNR + IBNER, since polices can be reported long after they occur.

b. A claims made policy has a much shorter period of time between the coverage trigger and the settlement date- it is not impacted by loss cost increases as much as an occurrence policy is impacted.

OR

Occurrence policies incur liability for claims that occur now but are reported much later so inflation/loss trend accumulates on these costs whereas CM policies incur liability for claims reported @ today's cost levels.

c. Under an occurrence policy, claims are covered that are reported much further out into the future. These loss trends will therefore have a greater impact on the losses covered by an occurrence policy - more of an impact due to inflation/loss trends

OR

An occurrence policy can have losses reported much later, trends have more leverage on future costs than on current costs → a Δ in trend affects occurrence more than CM.

d. Retroactive date means that losses are only covered by a CM policy if they occur after the retro date.

Report Year	Lag 0	Lag 1	Lag 2
10	L(10,0)	L(10,1)	L(10,2)
11	L(11,0)	L(11,1)	L(11,2)
12	L(12,0)	L(12,1)	L(12,2)

Occurrence policy in 10 would cover losses on shaded diagonal.

CM policy in 11, without a retro date would cover entire row=overlap on L(11,1)

Question #6 (continued)

OR

Apply retroactive date to the new CM policy to limit coverage to losses that occur after such a date.
A=occ. Policy covg
B= CM covg w/o adj

	LAG			
year	0	1	2	3
11	A			
12	B	A/B	B	B
13		↑	A	
"	(Over Lap)			A

(previous years as well if occ coverage was provided before 2011)

e. Use Extended reported period endorsement = provides coverage for losses that occurred when CM coverage was effective, but reported after expiration of last CM policy.

CM policy in 10 covers entire row. Occurrence policy in 11 covers diagonal = L(11,0) and L (12,1).
No coverage for L(11,1) or L(11,2) or L(12,2).

LAG

Report Year	0	1	2
10	L(10,0)	L(10,1)	L(10,2)
11	L(11,0).	L(11,1).	L(11,2)
12	L(12,0)	L(12,1)	L(12,2)

OR

Year	0	1	2	3
11	B	B	B	B
12	A			Covg
13		A		Gap
			A	

Purchase tail coverage to cover during gap

Examiner's Report Question 6

a. More than half of the candidates provided enough components of IBNR for both claims-made and occurrence to get full credit. Many candidates named only the pure IBNR component but did not state that it was the only difference between the policies. No credit was granted for candidates stating that Occurrence has IBNR and Claims-Made does not, because Claims-Made has IBNER, a component of IBNR

Other candidates named additional components of IBNR, such as claims in transit or reopened claims. No credit was granted or deducted for these additional components, unless they were assigned incorrectly.

In general the majority of candidates seemed to understand the question and what was being asked. The most common mistakes were not including both Pure IBNR and IBNER in their contrast or simply stating that Claims-made has no IBNR.

b. About half of the candidates received full credit for either some reference to Occurrence policies having claims reported further in the future at a higher cost level, or additional pricing risk associated with having to make a longer projection for Occurrence policies.

Several candidates received partial credit for showing a specific numeric example of lower costs, but without a full explanation of the cause.

Some candidates received no credit for simply stating that Claims-Made lack pure IBNR, or have no claims reported after the policy expiration, so the overall cost is less. However, these claims are balanced by claims reported from earlier accident years, such that it is the higher future cost levels (& additional pricing risk), not additional claims, that result in Claims-Made policies costing less than Occurrence policies.

Many candidates stated that Claims-Made policies have only one year of trend, or are fully settled &/or paid at the end of the year, while Occurrence policies have many years of trend. These responses received no credit, as it is the report lag that is shorter for the Claims-Made policies, not the settlement lag. Just like for Occurrence policies, inflation will act on Claims-Made policies for as long as the settlement lag lasts, which will likely be several years for a long-tailed line.

In general, a large number of candidates spent far too much time on this part. A simple statement with one or two sentences would have garnered full credit, but candidates seemed to misunderstand the intent and provided much lengthier responses – which cost them time and also increased the risk that they would misstate something resulting in only partial credit.

c. About half of the candidates received full credit for some reference to Occurrence policies having claims reported further in the future.

Several candidates received partial credit for showing a specific numeric example of the higher impact, but without a full explanation of the cause.

Many candidates stated that Claims-Made policies have only one year of trend, or are fully settled &/or paid at the end of the year, while Occurrence policies have many years of trend. These responses received no credit, as it is the report lag that is shorter for the Claims-Made policies, not the settlement lag. Just like for Occurrence policies, inflation will act on Claims-Made policies for as long as the settlement lag lasts, which will likely be several years for a long-tailed line.

Similar to part B, we found that candidates provided much lengthier responses than was necessary for full credit.

Examiner's Report Question 6

d. More than half the candidates received credit for stating any of the following for the provision: retroactive date, first-year claims-made policy (or second-year, etc.), or for describing the provision as a date restricting the mature claims-made policy to cover only claims occurring on or after that date.

Several candidates did not get credit for the provision because they incorrectly described it as the date on or after which claims must be reported for the claims-made policy, which is simply the effective date of the claims-made policy.

About half of the candidates received partial credit for the overlap description using either a written description or a diagram showing at least one occurrence & claims-made policies, and where the policies intersected as the overlap.

Several candidates did not get credit for the written overlap description because they did not mention both the reporting & occurring situation for the overlap to happen, or they did not assign them correctly.

Several candidates did not get credit for the diagram overlap description because they labeled one axis as AY with the Occurrence policy on the diagonal, which is incorrect. Other candidates did not get credit for the diagram because they did not identify the following: the axis labels, the occurrence and claims-made policies & the overlap.

In both the written response and diagram, several candidates received no credit for describing the overlap as happening when both the claims-made and occurrence policies were effective at the same time (rather than in a subsequent year), which would cause an overlap regardless of the type of policy.

Based on the responses of the candidates, it does seem that they understood the question part and formulated appropriate responses. Some candidates did spend more effort than necessary elaborating on the provision and overlap rather than 'briefly describing' them as requested.

e. Most candidates received at least partial credit for stating either of the following for the provision: tail policy or extended reporting endorsement. Similar responses were also accepted, as long as either the tail or extended reporting period for the claims-made policy was included in the response.

About half of the candidates received credit for the gap description using either a written description or a diagram showing at least one occurrence & claims-made policies, and the area between the policies where the gap would be.

Several candidates did not get credit for the written gap description because they did not mention both the reporting & occurring situation for the gap to happen, or they did not assign them correctly.

Several candidates did not get credit for the diagram gap description because they labeled one axis as AY with the Occurrence policy on the diagonal, which is incorrect. Other candidates did not get credit for the diagram because they did not identify the following: the axis labels, the occurrence and claims-made policies & the gap (or alternatively, the area where the tail coverage would fill in).

In both the written response and diagram, several candidates received no credit for describing the gap as happening when both the claims-made and occurrence policies were effective at the same time, rather than in a subsequent year.

As with part D, candidates did demonstrate a strong understanding of what was being asked, but some provided responses that were more involved than needed.

7. (3 points) An actuary is reviewing workers compensation indemnity loss experience for a rate level indication analysis. Given the following information:

- A benefit change having an impact of +5.0% applies to all indemnity losses for accidents occurring after July 1, 2011.
- A benefit change having an impact of +2.0% applies to indemnity losses on policies written after October 1, 2012.
- No other benefit changes are expected within the next few years.
- The annual impact on benefits due to wage inflation has been +2.0% and is expected to continue.
- The proposed effective date for revised loss costs is July 1, 2013.
- Policies are annual.
- Revised loss costs would be in effect for one year.
- Losses occur uniformly throughout the year.

Accident Year	Estimated Ultimate Losses at Pre-July 1, 2011 Benefit Levels ($000s)
2010	$1,875
2011	$1,875
2012	$2,000

Calculate the 2010, 2011, and 2012 accident year projected ultimate losses to be used in the rate level indication.

S13 – Exam 5 - Question #7

Since the proposed effective date is 7/1/2013, and since annual pols will be issued and in effect for 1 year, trend losses to the avg loss date of 7/1/2014.

AY	ULT Loss (000s)	Trend	Benefit Changes*	ULT Losses (000s)
2010	1,875	$(1.02)^4$	(1.05)(1.02) = 1.071	2,173.7
2011	1,875	$(1.02)^3$	(1.05)(1.02)	2,131.0
2012	2,000	$(1.02)^2$	(1.05)(1.02)	2,228.5

*since all losses are reported at pre July 2011 benefit levels, all years need both the 2% and 5% adjustment.

Examiner's Report

This question was a straightforward calculation. The most challenging part for candidates was the part of the question where it stated that losses given were prior to the 7/1/11 benefit change, and that all accident years needed to adjusted by the both benefit changes (the full amounts) for full credit.

The majority of candidates missed this subtlety and approached the question by adjusting each accident year by a different amount. A common mistake among these candidates was to treat the 7/1/11 benefit change as applying to policies written on or after 7/1/11 (question stated that it applied to losses on or after) and/or treat the 10/1/12 benefit change as applying to losses on or after 10/1/12 (question stated that it was applied to policies written on or after).

Several candidates correctly calculated the average benefit level for losses in each of the given accident years, but then multiplied the given losses by the average benefit level (rather than using the average benefit level to calculate a benefit level adjustment factor before applying).

8. (3 points) Given the following information:

- All policies are annual and written on January 1.
- Rate change effective date is January 1, 2013.
- Rate level is reviewed annually.
- Underwriting guidelines were revised on January 1, 2011, substantially changing the composition of the book of business.

Accident Year	Reported Loss & ALAE as of June 30, 2012
2010	$10,000,000
2011	$6,000,000
2012	$1,500,000

Selected Reported Loss & ALAE Age-to-Ultimate Factors										
Month	6	12	18	24	30	36	42	48	54	60
Factor	6.50	2.00	1.55	1.20	1.12	1.08	1.05	1.02	1.01	1.00

Calendar Year Ending	Reported Loss & ALAE		
	Frequency	Severity	Pure Premium
Sep 2009	0.058	$20,355	$1,181
Dec 2009	0.059	$20,125	$1,187
Mar 2010	0.062	$20,500	$1,271
Jun 2010	0.063	$21,575	$1,359
Sep 2010	0.063	$21,388	$1,347
Dec 2010	0.065	$19,903	$1,294
Mar 2011	0.078	$19,567	$1,526
Jun 2011	0.078	$19,238	$1,501
Sep 2011	0.079	$19,538	$1,543
Dec 2011	0.082	$20,063	$1,645
Mar 2012	0.081	$20,050	$1,624
Jun 2012	0.082	$19,950	$1,636

# of Points	Annual Frequency Exponential Fit	Annual Severity Exponential Fit	Annual Pure Premium Exponential Fit
12	15.9%	-1.7%	13.9%
8	16.0%	-1.7%	14.0%
6	4.7%	2.9%	7.7%
4	4.1%	2.5%	6.7%

Calculate the 2010 accident year trended ultimate loss & ALAE to be used in a rate change analysis. Justify any trend selections.

S13 – Exam 5 - Question #8

Preliminary comments

"In some circumstances, the actuary may choose to undertake a two-step trending process. This technique is beneficial when the actuary believes that the loss trend in the historical experience period and the expected trend for the forecast period are not identical." This is the case in this problem since underwriting guidelines were revised on January 1, 2011, substantially changing the composition of the book of business.

While we believe the point of this problem was for candidates to recognize that two trending periods were necessary to use due to the u/w guidelines change on 1/1/11, we do not believe that the 4/1/2012 ending date of the 1st step trend period is the only date that can be used. We believe examiners were testing candidates' ability to recognize that two step trending was appropriate and then looking for judgment needed to determine the ending date of the 1st step trend period.

First, the losses in the experience period are trended from the average accident date in the experience period to the average accident date of the last data point in the trend data. For example, the average loss occurrence date of Calendar-Accident Year 2010 (the "trend from" date) is assumed to be July 1, 2010.

Note the assumption being made here:

Assume that 6-month reporting periods for trend period selection is appropriate

Since the last data point in the loss trend data is the 6 months ending second quarter 2012, the average accident date of that period (the "trend to" date) is March 31, 2012.

Second, these trended losses are projected from the average accident date of the latest data point (the "project from" date of April 1, 2012) to the average loss occurrence date for the forecast period (assuming annual policies, the "project to" date of July 1, 2013). Note that the problem states that all policies are annual and are written on 1/1, and thus the AAD is 7/1. This differs from the AAD if the problem stated that all policies are uniformly written over the year.

Historical vs. Projected Trending Periods

Historical Period:

Use 2-part trend since historical trend is different due to changing book of business.

# of Points	Annual Frequency Exponential Fit	Annual Severity Exponential Fit	Annual Pure Premium Exponential Fit
12	15.9%	-1.7%	13.9%
8	16.0%	-1.7%	14.0%
6	4.7%	2.9%	7.7%
4	4.1%	2.5%	6.7%

Assume 6-month reporting periods for trend period selection.

Historical trend period = 7/1/2010 - 4/1/1012 = 1.75

Projected trend period = 4/1/2012 - 7/1/2013 = 1.25

Historical trend selection: freq = 16% sev = -1.7%

Use 8 point trends tor both frequency and severity; this will account for the change in the book of business.

Projection Period:

"Underwriting guidelines were revised on January 1, 2011, substantially changing the composition of the book of business."

Use 4 point trends for frequency and severity since this includes the period after the mix of business changed and should be indicative of future patterns.

Future trend selection: freq = 4.1% sev = 2.5%

2010 AY trended Ult Loss + ALAE

= AY 2010 Reported Loss & ALAE as of 6/30/2012 * 30-Ult LDF * (Hist Freq * Sev)^Hist Trend Period * (Future Freq * Sev)^Projected Trend Period

= $10,000,000 \times 1.12 \times (1.16 \times .983)^{1.75} \times (1.041 \times 1.025)^{1.25}$ = $15,282,922

Loss Development

Used the 30 month CDF-ULT factor of 1.12 since AY 2010 is 30 months old when evaluated at 6/30/2012.

Examiner's Report Question 8

Only a very small number of candidates received the full credit.

One of the most popular mistakes is the incorrect trending periods. Very few candidates got it right.

A significant portion of candidates missed the assumption that "All policies are annual and written on January 1" and therefore calculated the total trending period as incorrect 3.5 years.

Another common mistake is the application of one step trending without any adjustment.

Most candidates did not use two step trending or one step trending plus onetime adjustment to account for the underwriting guidelines change. Regarding the loss development part, most candidates got it correct.

A small percentage of candidates misread the ultimate LDFs provided in the question as age-to-age factors. Almost all candidates understood the correct trend factor calculation (freq*sev) ^ trend period.

They also understood that projected ultimate loss is calculated by multiply the incurred loss by the loss development factor to ultimate and trend factor.

About 10% of all candidates did not attempt the question (having a blank or almost blank answer sheet).

9. (2 points) An actuary develops an overall indicated rate increase of 4.5% using the following assumptions:

- All expenses are variable.
- Total permissible loss ratio = 65%.
- Profit and contingency provision = 5%.

The actuary's manager asks that the expenses be split into fixed and variable components as follows:

- Fixed = 75% of total expenses.
- Variable = 25% of total expenses.

a. (1.25 points) Calculate the revised overall rate indication with the new expense split suggested by the actuary's manager.

b. (0.25 point) Briefly explain why splitting the expenses as described above results in a different indication.

c. (0.5 point) Identify two reasons an actuary may want to split expenses into fixed and variable components.

S13 – Exam 5 - Question #9

a. Since the PLR = .65 =1 – V – Q, and Q = .05, then V = .3 represents total current expenses

When splitting expenses into fixed and variable, the respective %'s are:

Fixed % = .75(.3) = .225

Variable % = .25 (.3) = .075

To compute the revised overall rate indication, one needs to determine the experience period loss ratio in in initial rate indication:

$1.045=\dfrac{\text{Loss Ratio}}{.65}$, therefore, the experience period loss ratio =.67925

Revised Indication = $\dfrac{.67925+.225}{1-.075-.05}=1.0334$, which is a 3.34% Increase

b. Splitting expenses into fixed + variable accounts for the fact that certain expenses are a set amount for each risk, regardless of premium size. Depending on ratio of fixed vs. variable, indication will differ due to fixed included on top off equation added to loss ratio.

OR

Allows fixed expenses to be added in with the loss of ratio and the revised permissible loss ratio to be higher which lowers indication.

OR

Because fixed expenses are not changing with premium they are a set in stone percentage. That's why we add them to the LR rather than include it in the permissible ratio.

c.

1. Assuming all variable expenses when some are truly fixed will over charge high premium risks and under charge low premium risks.
2. Fixed expenses may be affected by trend, so separating allows us to apply trend factors to get more accurate expense load.

OR

1. including fixed and variable expenses together could distort your indication
2. Including them together could cause you to undercharge small premium policies and overcharge large premium policies.

OR

1. because some expenses do not vary with premium and in order to correctly account for it, it should be fixed.
2. Also it helps better track expenses and understand expenses

Examiner's Report

a. Many candidates received full credit for this question. When there was an error committed, candidates either used the permissible loss ratio as the experience loss ratio or flipped the variable and fixed expense percentages.

b. Many candidates had trouble with this question. The answer was a verbalization of part a of this question. Many didn't realize this and tried to define fixed and variable expenses rather than stating how reflecting fixed expenses impacted the indication.

c. The most common mistakes on this part was providing the similar responses twice, only defining fixed and variable expenses.

10. (2.25 points) Given the following information for a policy:

- Annual earned premium = $1,000.
- New business expected loss ratio = 60%.
- Losses expected to decrease $25 per year.
- New business expenses = $420.
- Renewal business expenses = $350.
- Probability of first renewal = 85%.
- Probability of second renewal = 90%.
- Probability of third renewal = 0%.
- Assume an annual discount rate of 3%.

a. (1.75 points) Calculate the lifetime value of the expected total profit as a percentage of premium.

b. (0.5 point) Identify two considerations used in the analysis in part a. above that differ from standard actuarial ratemaking techniques.

S13 – Exam 5 - Question #10

a.

Duration	(1)	(2)	(3)	(4)	(5)	(6)	7)=[(1) - (2) -(3)] x (5) / (6)	PV of Premium
	Premium	Loss	Expense	Persistency	Cumulative Persistency	Discount Factor	PV of Profit	
1	$1,000	$600	420	100%	100%	1.000	-20	1,000
2	1,000	575	350	85%	85%	1.030	61.89	825.24
3	1,000	550	350	90%	76.5%	1.0609	72.11	721.09
							114	2,546.33

Profit/premium = $114/$2,546.33 = 4.477%

b.

i. Standard actuarial ratemaking techniques typically do not consider persistency, the likelihood of and insured renewing his policy.

ii. Standard actuarial ratemaking techniques only consider premium and losses for the period in which rates will be in effect, not over the lifetime of the insured with the insurer.

Examiner's Report

Generally speaking, the candidate pool did very well on both parts of this question.

a. When candidates did make mistakes, the most common ones were:

1. Only calculated the lifetime value of the expected total profit but did not calculate the expected premium (the denominator for the final ratio)
2. Didn't apply cumulative persistency to the expected premium
3. Incorrect discounting (for example, multiplying by 0.97 in year 2 instead of dividing by 1.03)
4. Mathematical error (with credit given for the remainder of Part A in situations where the correct answer would have been calculated without the math error)

b. Candidates scored well on this part too, with credit was typically given for the following themes:

1. The use of multiple policy years (i.e. "lifetime" of the policy)
2. The use of persistency (i.e. "retention")
3. Reflection of discounting
4. Differences in expenses/losses for new business versus renewal business

11. (3.5 points) An insurance company is researching three new rating variables to include in its homeowners risk classification system. The insurer has determined the following information about the existing book of business:

Credit	Exposures	Pure Premium	Competitor's Rating Plan Factor	Base Class
Excellent	1,500	$116.67	0.85	No
Good	2,500	$128.00	1	Yes
Fair	1,000	$155.00	1.3	No
Total	5,000	$130.00		

Age of Homeowner	Exposures	Pure Premium	Competitor's Rating Plan Factor	Base Class
Under 30 years	800	$150.00	0.7	No
30 to 40 years	1,200	$116.67	1	Yes
Over 40 years	3,000	$130.00	1.2	No
Total	5,000	$130.00		

Loss Prevention	Exposures	Pure Premium	Competitor's Rating Plan Factor	Base Class
Fire extinguisher	100	$100.00	0.9	No
Smoke detector	4,700	$128.72	1	Yes
None	200	$175.00	1.5	No
Total	5,000	$130.00		

- Credit is determined using the credit score for the primary homeowner.
- Age of homeowner is determined using the age of the primary homeowner.
- A homeowner with both a fire extinguisher and smoke detector would be classified with a smoke detector.
- Full credibility claim standard = 400.
- The square root rule is used to determine partial credibility.
- A competitor's rating relativities are used as the credibility complement.
- Frequency for every risk classification = 10%.
- Assume that the insurer can implement only one new rating variable at this time.
- Assume that each variable is independent.

a. (1.5 points) For each potential rating variable, briefly describe two possible concerns of adding it to a risk classification system.

b. (0.75 point) Without performing any calculations, recommend and justify which rating variable the insurer should implement within a risk classification system.

c. (1.25 points) Develop the indicated credibility weighted rating factors for the variable recommended in part b. above.

S13 – Exam 5 - Question #11

Credit: -Lacks causality as is correlated with loss exposure; however, difficult to show causality
-Invades privacy of insureds

Age: -Lacks controllability since insured can't control their age
-The indicated relativities from the insurer's data differ significantly from competitor relativities. (e.g. Ind Under 30 Rel > 1.00)

Loss Prevention:
-Difficult and expensive to verify as it is subject to manipulation from the insureds
-Non-sensical definition. Why would someone with both a fire extinguisher and a smoke detector be rated higher than someone with just a fire extinguisher

b. I would recommend credit score as score as a variable.
-significant loss cost differentiation
-objective definition
-Easy and inexpensive to verify and administer
-Social concerns are not sufficient to prevent using this variable (assuming it is legal to do so)

c. (1.25 points) Develop the indicated credibility weighted rating factors for the variable recommended in part b. above.

Credibility
- Full credibility claim standard = 400.
- The square root rule is used to determine partial credibility.

Credit	PP (1)	PP Ind Rel (2)=(1)/Tot(1)	Comp Rel /1.015 (3)	Z (4)	Z-wtd Rel (5)	Z-wtd Rel/Base (=good) (6)
Excellent	116.67	0.8975	0.8374	61.237%	0.8741949	**0.8877**
Good-Base	128.00	0.9846	0.9852	79.057%	0.9847424	**1.0000**
Fair	155.00	1.1923	1.2808	50.000%	1.2365479	**1.2557**
Total	130.00	1.0000	1.0000			

(3): 1.015 = 5075/5000 = Sum[Comp Rel * Exposures]/Sum[Exposures]
(4) = Sqrt [(Exposures * Freq)/Full Cred Standard]
(5) = $\dfrac{(2)\times(4)+(3)\times[1-(4)]}{(2)\times(4)+3\times[1-(4)]}$

Examiner's Report Question 11

a. Candidates needed to provide a brief description along with the characteristic they listed.

Most candidates lost points for either no, or an insufficient, description of the characteristic listed. For example, a common insufficient answer is that "credit is discriminatory". Such an answer is not quite accurate, since all classification plan factors discriminate among insureds. Thus, a clarification of the nature of discrimination that causes concern is warranted.

Some candidates mentioned concern that the age of homeowners relativities curve does not trend monotonically.

Candidates who received credit typically mentioned lack of credibility in the youngest age group or the dissimilar direction compared to competitor relativities. However, the lack of monotonic relationship in and of itself was not accepted as a valid concern.

b. Many candidates did not provide a description commensurate with the point value assigned.
In order to receive full credit, candidates needed to briefly describe at least three reasons to support their choice.
Some candidates provided reasons for choosing a variable that contradicted the concerns listed in Part A, which lost them points.
Often, candidates described reasons why they wouldn't choose other variables.
Points were awarded when the reason a variable wasn't selected for one variable was a valid reason to select the chosen variable.
For example, if the candidate didn't select loss prevention because it is difficult to verify and they were choosing credit score (which is not difficult to verify), points were awarded. However, if a candidate said they didn't select age of homeowner because of lack of credibility and they chose loss prevention (which has an issue with credibility), points were not awarded.
Many candidates who chose credit score lost points for saying the levels were "fully credible", as opposed to "good credibility" which leads to a different discussion and also lead to candidates losing points in Part C.

c. To receive full credit, candidates needed to correctly calculate:

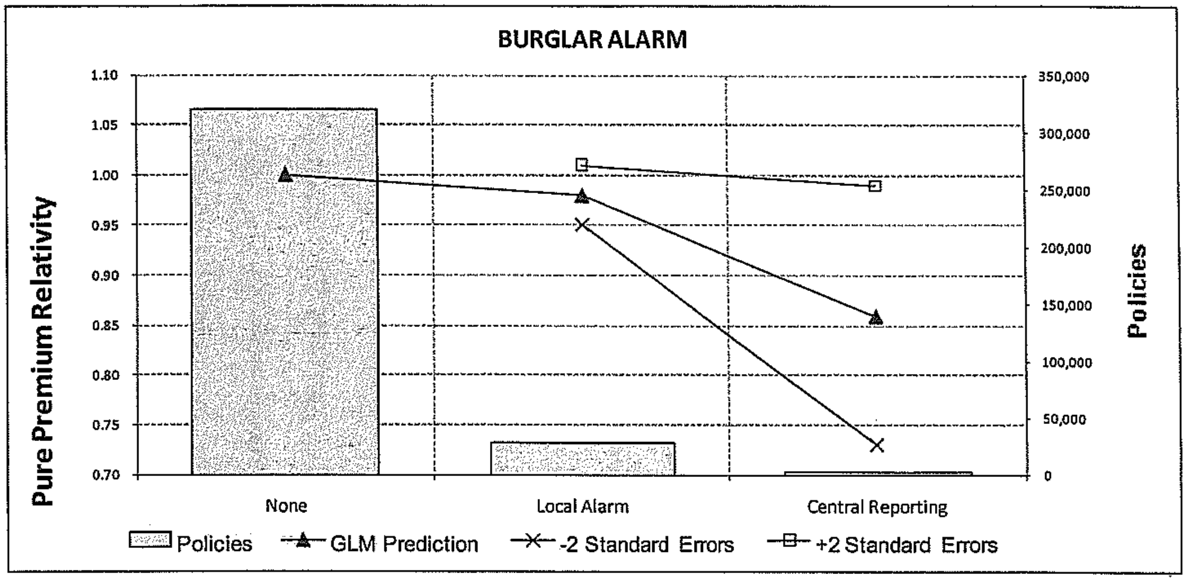
- the full credibility standard,
- the credibility using the square root rule,
- the company indicated relativities,
- credibility weight the company relativities with the competitor relativities, and finally
- re-base the credibility weighted relativities.

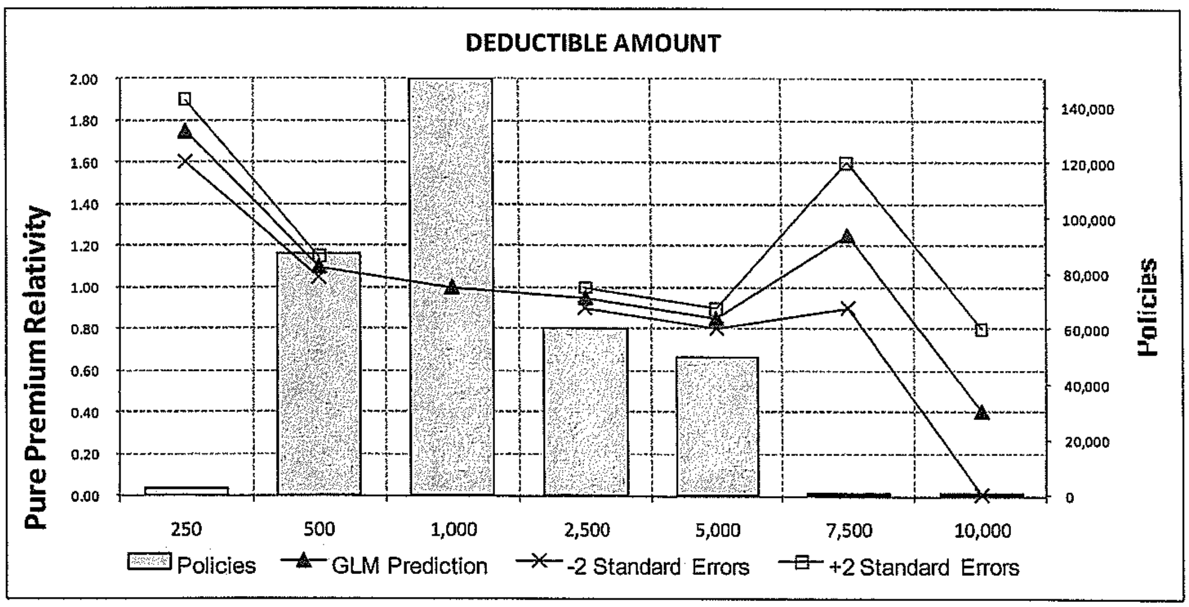
The most common mistake here was claiming full credibility, not recognizing that the 400 full credibility standard refers to claim count and not exposure.

For candidates who calculated the indicated company relativities relative to the total pure premium, a common mistake was not calculating the revenue neutral competitor relativities as well.

Additionally, some candidates missed the instruction to use the competitor's relativities as the complement of credibility.

12. (3 points) An insurer is planning to revise burglar alarm and deductible rating plan factors for its Homeowners program. Given the following generalized linear model output:





12 (continued)

Burglar Alarm	GLM Prediction	-2 Standard Errors	+2 Standard Errors	Policies
None	1.00			320,000
Local Alarm	0.98	0.950	1.010	27,500
Central Reporting	0.86	0.730	0.990	2,500

Deductible	GLM Prediction	-2 Standard Errors	+2 Standard Errors	Policies
$250	1.75	1.60	1.90	2,700
$500	1.10	1.05	1.15	87,000
$1,000	1.00			150,000
$2,500	0.95	0.90	1.00	60,000
$5,000	0.85	0.80	0.90	50,100
$7,500	1.25	0.90	1.60	150
$10,000	0.40	0.00	0.80	50

Propose revised burglar alarm and deductible rating plan factors. Document the relevant analysis and rationale to support the proposal.

S13 – Exam 5 - Question #12

Burglar Alarm: Relatively low volume and wide confidence interval for both Local Alarm and Central Reporting groups.

The Local Alarm std errors suggest it's not significantly different than the None category (the confidence interval encompass the relativity for none).

Central reporting has very for few exposures and large standard errors. I would recommend this variable not be used (1.00 factor for all groups.

Deductible:

250	500	2500	5000	7500	10000
1.50	1.000	0.95	0.85	0.75	0.65

1. 250 not enough data
2. 500, 1000, 2500, and 2000: fit very well and sufficient data factor directionally also make sense. Use indicated factors.
3. 7500: reversal should be lower than 5,000

   10,000: indicated factors are too small, may be due to sparse data judgmentally select 0.65.

   7500: Select the average factors of 5,000 (.85) and 10,000 (.65)

Examiner's Report Question 12

In general, the response to this question was poor. Many candidates recognized the small data volume but incorrectly went about combining alarm types or deductibles into one category. This was often accompanied by a calculation of a proposed factor by weighted the GLM output. Time was unnecessarily lost by this calculation. Another common error was candidate's often recognized unintuitive output that seemed to be the result of sparse data but yet still proposed to select the predicted factor.

13. (2 points) Given the following for a large deductible commercial general liability policy:

Per occurrence deductible	$250,000
Loss elimination ratio for a $250,000 deductible	80%
ALAE/ground up loss ratio	10%
Ground up loss estimate	$2,000,000
Fixed expenses	$100,000
Variable expenses as % of premium	12%
Underwriting profit as a % of premium	3%
Deductible processing cost as a % of losses below the deductible	5%
Credit risk as a % of losses below the deductible	2%
Additional risk margin as a % of excess losses	8%

- The insurer will handle all claims, including those that fall below the deductible.
- The insurer will make the payments on all claims and will seek reimbursement for amounts below the deductible from the insured.
- The deductible is for loss only.
- All ALAE is paid by the insurer.

Calculate the premium for the large deductible policy.

S13 – Exam 5 - Question #13

Write an equation to compute the premium for a large deductible policy. Assign symbols to the given data, compute values for various terms used in the equation and written.

LER =. 80 ALAE = .10 L = 2M

ALAE$ = .1 x (2,000,000) = 200,000; Loss = (1 - .8) x (2,000,000) =400,000

Fee for handling the ded: 80 x (2,000,000) x .05 = 80,000

Credit Risk = .8 x (2,000,000) x .02 = 32,000

Risk Margin = (1 - .8) (2,000,000) (.08) =32,000

$$\frac{L + E_L + Ded\ Fee + Credit\ Risk + Risk\ Margin + F}{1 - V - Q}$$

$$\frac{400,000 + 200,000 + 80,000 + 32,000 + 100,000}{1 - .12 - .03} = 992,941.176$$

Examiner's Report

Many candidates received full credit on this question. Some common mistakes that were made on this problem:

- Forgetting fixed expense is in the numerator.
- Treating the loss elimination ratio as the excess loss ratio. If the candidate used the incorrect LER "correctly" (applied the deductible processing and credit risk loads to the losses under the deductible, the excess risk margin to the losses above the deductible, and used the losses above the deductible in the numerator) candidates still received some partial credit.
- Applying the ALAE % to excess losses.

14. (1.25 points) An insurer proposes to increase rates by 6.0% where many individual policy impacts will be above 10%. The insurer proposes a capping rule that will restrict premium changes at the policy level to plus or minus 10.0%.

a. (0.5 point) Identify two problems that a capping rule may cause for an insurer.

b. (0.75 point) Explain why an insurer would propose a capping rule in light of the problems identified in part a. above.

S13 – Exam 5 - Question #14

a. 1. Insurer will not be charging what they should be to keep the fundamental insurance equation in balance and earn their target underwriting profit.

2. Systems limitations-need to program this rule into computer systems. Can get complicated as to what gets capped and what doesn't and how this changes the rating algorithm

OR

1. May cause need for premium transition
2. Insurer may not get all the rate needed

OR

1. Can cause rates to be inadequate
2. Can be subject to adverse selection

b. May have a concern that they will not retain policyholders if they raise rates substantially at renewal-may cause insureds to shop- Also might be regulation reasons-restrictions on the amount of rate increase a policyholders can see at each renewal

OR

Keep customers from getting shocked at renewal and shopping.

OR

An insurer would propose a capping rule in light of the problems in (a) to maximize the retention. An insurer might be able to get an increase in rate in the future which will make rates adequate again. The more profitable business they retain the more profits they will enjoy in the long run.

Examiner's Report

a. Candidates not receiving partial credit on often restated the same item twice or two sides of the same item. To receive full credit, 2 separate ideas were necessary.

b. On part b, very few candidates only received partial credit. Examples of full credit statements include:

- "An insurer's retention may decline if a rate cap is not adopted."
- "State laws may require a maximum rate change be followed for all policies."

15. (2.5 points) An employer negotiated a workers compensation retrospective policy with an insurer, effective from January 1, 2011 to December 31, 2011. The first adjustment of the retrospective premium occurs six months after the end of the policy period and annually thereafter until the tenth adjustment.

The reported losses during the policy period evaluated as of June 30, 2012 are as follows:

Claim	Reported Losses
#1	$300,000
#2	$200,000
#3	$100,000

The provisions for this retrospective rating plan are as follows:

Minimum retrospective premium ratio	50%
Maximum retrospective premium ratio	150%
Loss Conversion Factor	1.2
Per Accident Loss Limitation	$150,000
Expense Allowance Excluding Tax Multiplier	25%
Expected Loss Ratio	60%
Tax Multiplier	1.05
Net Insurance Charge	44.6%
Standard Premium	$540,000

a. (2 points) Calculate the retrospective premium as of June 30, 2012.

b. (0.5 point) Discuss what could cause the retrospective premium in part a. above to change for the insured between June 30, 2012 and the tenth adjustment.

S13 – Exam 5 - Question #15

a. Basic Premium = [e - (c – 1.0)(E)+ cl] *SP

Basic Premium = [0.25 - (1.2 – 1.0)(0.60)+ 0.446] * 540,000 = 311,040

Retro Premium = [Basic Premium + Converted Losses] x Tax Multiplier, where the retro premium is subject to a maximum and minimum.

Limited Reported Losses = 100,000 + Min(200,000,150,000) + Min(300,000,150,000) = 400,000

Retro Premium = [311,040 + 400,000(1.2)]1.05 = 830,592 before min/max

Maximum Retro Premium= Standard Premium x Maximum Retro Premium Ratio.

Max Retro Premium is 1.5(590,000) = 810,000

So the final retrospective premium is 810,000

b. The retro premium could decrease from the max cap if reports losses develop downward or if claims are closed with no payment.

Examiner's Report Question 15

This question was answered poorly with few candidates receiving full credit.

a. To get full credit, candidates would need to calculate the basic premium and retrospective premium correctly, and calculate and apply the maximum/ minimum premium. The common errors included:

- incorrectly calculating the capped losses
- when calculating the basic premium, applying factors to adjust the net insurance charge that was provided in the question
- incorrect basic premium formula
- not applying the max/ min premium

b. Candidates did better on this part. The most common error was to provide reasons that the premium could increase, as it was already at the maximum level. However, if candidates incorrectly calculated the retrospective premium in part a, and produced a number that was in between the min and max, we did award them full credit in part b if they stated that premium could rise or fall.

16. (1.75 points) Given the following information:

Accident Half-Year	Cumulative Closed Claim Counts 6 Months	12 Months	18 Months	24 Months	30 Months	36 Months
2010-1	4,898	7,349	7,571	7,647	7,647	7,647
2010-2	5,576	6,786	7,487	7,569	7,569	
2011-1	6,580	10,215	10,618	10,724		
2011-2	7,514	9,564	10,953			
2012-1	8,894	13,807				
2012-2	10,265					

Accident Half-Year	Age-to-Age factors 6-12	12-18	18-24	24-30	30-36
2010-1	1.500	1.030	1.010	1.000	1.000
2010-2	1.217	1.103	1.011	1.000	
2011-1	1.552	1.039	1.010		
2011-2	1.273	1.145			
2012-1	1.552				

Assume no closed claim count development after 36 months.

a. (1.25 point) Estimate the ultimate claim count for accident year 2012.

b. (0.5 point) Briefly discuss two advantages for analyzing this data using accident half-years as opposed to full accident years.

S13 – Exam 5 - Question #16

a. There appears to be a seasonal pattern in the age-to-age factors that causes differences between XXXX-1 and XXXX-2 half years.

I would select a separate pattern for each half year (-1 and -2) using simple all year averages.

	6-12	12-18	18-24	24-30	30-36	36-ult
Sel (-1)	1.535	1.035	1.010	1.000	1.000	1.000
Sel (-2)	1.245	1.124	1.011	1.000	1.000	1.000

ULT count for AY 2012 = 13,807(1.035)(1.01) + 10,265(1.245)(1.124)(1.011)= 28,956

b. Allows for recognition of seasonal patterns in claims development

Allow for better recognition of growing portfolio as average accident date shifts.

OR

ADV 1: Since there is a pretty clear seasonality effect based on the ATA values that vary significantly by period, using this type of analysis captures these differences to produce a more accurate development projection.

ADV 2: Using shorter time frames such as half year can help the accuracy of projection during times of greatly increasing exposure (due to higher granularity). This could be useful here, since the claims closed down the 6 and 12 month columns are increasing noticeably, which may be due in part to an exposure increase.

OR

1. Because of the developmental seasonality it helps to pick different patterns for the different half years'
2. The counts appear to be increasing at a decent rate. When counts are increasing like this it could mean an increase in exposures. Splitting the years into half-years better deals with the changing average date of loss that accompanies rapidly increasing exposures.

Examiner's Report

a. Most candidates were able to properly apply development factors, while not everyone reflected the seasonality in the data. Some of the common mistakes were as follows:

- Developing the 6 month closed claims for the first half of the year instead of the 12 month closed claims.
- Failing to reflect seasonality.
- Applying 1st half factors to the 2nd half closed claims and vice-versa
- Only calculating the ultimate claims for one half of the year

b. Most candidates were able to recognize the seasonality. A significant number also recognized the exposure growth and shifting of average accident date. A common mistake was to misinterpret the question as referring to development age (6, 12, 18, etc vs 12, 24, 36, etc). This resulted in many responses along the lines of making the LDFs less leveraged.

17. (1.25 points) The following information is available for a self-insured entity:

Accident Year	Case Outstanding	Industry Reported CDF to Ultimate	Industry Paid CDF to Ultimate
2010	$30	1.005	1.105
2011	$60	1.035	1.235
2012	$110	1.120	1.560

a. (0.5 point) Using a case outstanding development technique, estimate the unpaid claims for accident year 2012 as of December 31, 2012.

b. (0.5 point) Identify two limitations to the technique used in part a. above.

c. (0.25 point) Briefly describe a situation when this technique is particularly useful.

S13 – Exam 5 - Question #17

Preliminary Information

Chapter 12 - Case Outstanding Development Technique Exhibit III
Self-Insurer Case Outstanding Only - General Liability
Development of Unpaid Claim Ratio ($000)

Accident Year	Case Outstanding at 12/31/08	CDF to Ultimate Reported	CDF to Ultimate Paid	CDF to Ultimate Case Outstanding	Unpaid Claim Estimate
(1)	(2)	(3)	(4)	(5)	(6)
1998	500,000	1.015	1.046	1.506	753,065
1999	650,000	1.020	1.067	1.454	945,128
2000	800,000	1.030	1.109	1.421	1,136,911
2001	850,000	1.051	1.187	1.445	1,228,356
2002	975,000	1.077	1.306	1.439	1,403,157
2003	1,000,000	1.131	1.489	1.545	1,544,858
Total	4,775,000				7,011,474

Column Notes:
(2) Based on data from Self-Insurer Case Outstanding Only.
(3) and (4) From Exhibit I, Sheet 2 in Chapter 8.
(5) = { [(3) - (1) * (4)]/ ((4) -(3))} +1
(6) = [(2) * (5)].

The following formula is used to develop the case O/S development factor:

$$\frac{(\text{Reported CDF to Ultimate - 1.00}) \text{ x } (\text{Paid CDF to Ultimate})}{(\text{Paid CDF to Ultimate - Reported CDF to Ultimate})} + 1.00$$

The case development factor includes provisions for case O/S and IBNR (the broad definition of IBNR, which includes development on known claims). The estimated unpaid claims are shown in Column (6) and equal the current estimate of case O/S * the derived case O/S CDF to ultimate.

S13 – Exam 5 - Question #17

17a. (0.5 point) Using a case outstanding development technique, estimate the unpaid claims for accident year 2012 as of December 31, 2012.

17b. (0.5 point) Identify two limitations to the technique used in part a. above.

17c. (0.25 point) Briefly describe a situation when this technique is particularly useful.

Problem Specific Solutions

a. Case O/S development factors for AY 2012 $= \frac{(1.12-1)\times 1.56}{1.56-1.12} + 1 = 1.425$

AY 2012 unpaid claims as of 12/31/2012 = 110 x 1.425 = 156.75

b. 1. Industry benchmark CDF often prove to be inaccurate for a particular insurer
2. Analysis can be distorted by large losses in case outstanding

OR

- Industry benchmarks aren't accurate or don't apply to this self-insured entity
- Paid CDFs might be highly leveraged→ subject to inaccurate estimates

c. This technique is useful when no other technique is available because the only information the self-insured has is case O/S.

Examiner's Report

a. About ½ the candidates received full credit on this question. The most common error was providing IBNR instead of total unpaid claims.

b. Many candidates got partial credit on this question for only listing the "industry development/mix might not be like carrier development/mix" limitation. The other two limitations (large loss and leveraged) were not very common. There were several common limitations that did not receive credit, such as "this method only produces unpaid claims" or answers that made reference to the other case outstanding method (references to claims made policies).

c. Many candidates got this question completely correct. A wide variety of answers were accepted, but did not give credit for candidates who said that the insurer had "limited" or "thin" data. Credit was not given for candidates that referenced the other case outstanding method (references to claims made policies).

18. (2 points)

a. (0.25 point) Briefly explain the key assumption of the Bornhuetter-Ferguson method.

b. (0.5 point) Briefly explain how the Bornhuetter-Ferguson method can be considered a credibility-weighted method and how the credibility is calculated.

c. (0.25 point) Briefly describe one situation where the credibility-weighted assumption underlying the Bornhuetter-Ferguson method may not apply.

d. (0.5 point) Explain whether the paid or reported Bornhuetter-Ferguson method is more responsive in a situation where claim ratios are increasing.

e. (0.5 point) Compare and contrast the Cape Cod method and Bornhuetter-Ferguson method by providing one similarity and one difference.

S13 – Exam 5 - Question #18

a. Key assumption: Losses reported (paid) to date do not tell you anything about the losses that are yet to be reported (paid)

(Unpaid) Unreported losses are better estimated based on an a priori initial expected ultimate.

OR

Assumes the actuary's a priori estimate is a better indicator of unpaid/unreported claims than experience to date

b. The method is considered a cred weighted method of the Development Method and Initial Expected.

Z (Dev Method) + (1-Z) Initial Expected Ultimate

Z = $\text{The percent reported to date} = \dfrac{1}{\begin{array}{l}\text{cumulative dev. factor}\\ \text{from development method}\end{array}} = \dfrac{1}{\text{CDF}}$

OR

Cred weighting of Development and Expected Claim techniques,

The weight is based on % paid (or % reptd.), i.e. B-F Ult = % paid * Dev Ult + (1 - % paid) x Exp Clm. Ult

c. On a pattern that goes above 100% reported or paid, you'll see this on lines with salvage + subrogation or short tailed lines with strong case reserves. The % reported amount (2) cannot go above 1 in credibility theory. Therefore, in this situation, in theory, the method shouldn't be used.

OR

Would not apply if % paid is greater than 100% (violates credibility definition)

d. The reported method would be more responsive because the development method is responsive to increasing claim ratios, and the reported BF method will give more weight to the development method early on since % Rpt is often greater than % paid.

OR

Reptd is more responsive, since % reptd is usually greater than % paid, thereby putting more weight on the developed emerging exp. And less on the a priori estimate

S13 – Exam 5 - Question #18

e. Similarity: CC (Cape Cod) and BF methods both assume the unreported amount should be based off of another estimate and not developed as in the development technique. In other words, they both assume that experience to date in an AY doesn't tell you everything about future development.

Difference: The two methods calculated the "initial expected" ultimate differently. The BF method relies on an a priori selected loss ratio and the CC method calculates the LR (or PP) using the losses to date divided by the "used up" premium. Therefore the CC method is more responsive.

OR

Both methods are cred weighting of Dev &Exp Claims but B-F initial exp loss ratio is an a priori estimate, while Cape Cod determines IELR using reported losses & used-up premium

Examiner's Report

a. The majority of candidates received full credit. Those that didn't receive full credit typically lost points because they didn't differentiate between total claim versus unreported/unpaid claim.

b. The majority of candidates received full credit. Those that didn't receive full credit were often mentioning the credibility calculation but were not mentioning to which method this factor would apply.

Another common mistake was to weight Z with [Actual loss / reported/ paid] instead of [Development Method Ultimate Loss/ reported / paid]

c. The majority of candidates did not receive full credit. A common mistake for candidates was that they were mentioning situation where BF method was not appropriate instead of referring to a situation where credibility weighting assumption itself of BF method was not appropriate.

d. The majority of candidates did not receive full credit. Most of the candidate identified the right method, but only a few had a clear explanation on why the reported method was more appropriate.

e. Most candidates received full credit on this part.

19. (3.25 points) Given the following information:

Accident Year	Reported as of December 31, 2012 Claim Counts	Seventies	Payroll ($000)
2010	1,549	$22,418	$63,438
2011	1,455	$18,730	$62,893
2012	1,023	$12,501	$67,005

As of Month	Reporting Patterns (Reported %) Claim Count	Seventies
12	85.0%	43.0%
24	95.0%	67.0%
36	98.0%	83.0%

- The reported claim counts for accident year 2012 are unusually low due to a temporary slowdown of claims being opened.
- Annual frequency trend = -2%.
- Annual severity trend = +5%.
- Annual payroll trend = +4%.

Use an appropriate frequency-severity technique to estimate the IBNR for accident year 2012 at December 31, 2012 and justify all selections.

S13 – Exam 5 - Question #19

AY 2012 ULT Losses = Sel PP x payroll ($100)

Sel PP = Trended and Developed Claim Counts * Trended and Developed Severity/Trended Exposures

AY 2010 IBNR = AY 2012 ULT Losses – AY 2012 Reported Losses

= AY 2012 ULT Losses – AY 2012 (Reported Claim Counts * Reported Severities)

Because 2012 frequency is off, severity is probably also impacted (smaller claims open faster), so 2012 will not be used in the calculation.

As of 12/31/2012, AY

	Counts	CDF	Trend	Trend + Dev counts (a)
2010	1,549	1/.98	$.98^2$	1518.02
2011	1,455	1/.95	.98	1500.95

	Sev	CDF	Trend	Trend + Dev sev (b)
2010	22,418	1/.83	1.05^2	29778.13
2011	18,730	1/.67	1.05	29352.99

	Exposure	Trend	Trended Exp (c)
2010	63,438	1.04^2	= 68,614.54
2011	62,893	1.04	= 65,408.72

$\text{Trended PP} = \frac{(a)\bullet(b)}{(c)}$; 2010 = 658.81; 2011 = 673.57; Sel = Avg = 666.19

AY 2012 ULT Losses = Sel PP x payroll($100) = 666.19 x 67,005=44,638,060.95

AY 2010 IBNR = AY 2012 ULT Losses – AY 2012 Reported Losses

= AY 2012 ULT Losses – AY 2012 (Reported Claim Counts * Reported Severities)

= 44,638,060.95 – (1023) x 12501 = $31,849,537.95

OR

AY 2012 ULT Losses = Ultimate Trended Frequency * Ultimate and Trended Severity * payroll ($100)

ULT and Trended Frequency = Trended Ultimate Counts/Trended Payroll

ULT Trended Severity = Reported Severity Cumulative Reported Severity % * Severity Trend

AY 2010 IBNR = AY 2012 ULT Losses – AY 2012 Reported Losses

= AY 2012 ULT Losses – AY 2012 (Reported Claim Counts * Reported Severities)

Because 2012 frequency is off, severity is probably also impacted (smaller claims open faster), so

ULT claims	Claim Trend	Trended Ult Claims		Trended Payroll = Payroll * Payroll Trend
1549/0.98	1.0192^2	= 1,642		63,438 x 1.04^2 = 68,615
1455/0.95	1.0192^1	= 1,561		62,893 x 1.04^1 = 65,409
1023/0.85	1.0192^0	= 1,204		67,005 x 1.04^0 = 67,005

Freq trend = Claim Trend / Payroll Trend = 0.98 = Claim Trend/1.04; Claim Trend = 1.0192

ULT and Trended Frequency = Trended Ultimate Counts / Trended Payroll

2010 Freq = 1,642/68,615= 0.0239

2011 Freq= 1,561/65,409 = 0.0239

→ Selected frequency trend = 0.0239

ULT Trended Severity = Reported Severity / Cumulative Reported Severity % * Severity Trend

22,418/0.83 x 1.05^2 = 29,778

18,730/0.67 x 1.05 = 29,353

12,501/0.43 x 1.00 = 29,072

→All Average Sel= 29,401

AY 2012 Ultimate = 0.0239 x $29,401 x $67,005 = $47,083,335

AY 2012 IBNR = $47,803,335 – 1,023 x $12,501 = $34,294,812

Selected Frequency based on 2010 + 2011 because 2012 had a slowdown in claim counts, making it project an inaccurately low ULT claim count.

Severity is still reliable because it is an average number i.e. average is based on counts and dollars. Used an all years average for stability.

S13 – Exam 5 - Question #19
OR

	Ultimate Claims	Trended Exposure	Frequency
2010	1,549 /.98 = 1580	63,438 x 1.04^2	2.30%
2011	1,455 /.95 = 1532	62,893 x 1.04	2.34%

Trended Frequencies
2010 .023 $(.98)^2$ = .0221
2011 .0234(.98) = .0229
Selected Frequency = Simple Average = .0225

	Ultimate Severity	Trended Ultimate Severity
2010	$\frac{22,418}{.83} = 27,010$	29,779
2011	$\frac{18,730}{.47} = 27,955$	29,353
2012	$\frac{12,501}{.43} = 29,072$	29,072

Selected Severity = Simple Average = 29,401

Ultimate Claims= 29,401 x .0225 x 67,005 = 44,325,315
IBNR= 44,325,315 - 1,023 x 12,501= 31, 536,792

Since AY 2012 claim counts were subject to a temporary slowdown they were removed from the calculation of the ultimate frequency because using the current report patterns would severely underestimate ultimate freq. for that year.

Severity was assumed to be unaffected since there was no mention of a change in claim department methodology, just a slowdown in opening all claims.

Examiner's Report

Candidates generally performed well on the calculation portion of this question.

Some candidates did not calculate frequency (claim counts / payroll) and simply multiplied the average of 2010 and 2011 claim counts by a severity selection to determine 2012 ultimate claims. This does not account for the 2012 exposure levels and was not awarded full credit.

Some candidates calculated the ultimate loss indication correctly and subsequently lost points by failing to calculate the indicated IBNR associated with the ultimate loss. A small portion of candidates calculated the IBNR for all 3 accident years rather than just 2012.

Some candidates did not justify their selections, as specified in the question. Additionally, a portion of candidates simply wrote out their selection in words; for example, writing "select average of 2010 and 2011" does not constitute a justification and did not receive credit.

There were some candidates that spent time converting the percentage reported factors to loss development factors and subsequently multiplying by the claim counts and severities. The mathematical equivalent of dividing by the percentage reported could have saved the candidates time. A smaller portion of candidates used the percentage reported figures to create triangles of counts and severities that were unnecessary and subsequently not used in their solution.

Common mistakes included:

- Not using trend factors
- Not using loss development factors
- Applying loss development factors or trend factors to the incorrect year (for example, applying the 36-month factor to 2012 rather than 2010)
- Assuming that the inverse of the given percentage reported factors were age-to-age factors rather than age-to-ultimate factors

20. (3 points) Given the following information for a line of business:

- Assume no reported claims development past 36 months.
- Annual claim severity trend = +5%.
- Paid claim development method ultimate loss for accident year 2012 = $10,275,000.
- Reported claim development method ultimate loss for accident year 2012 = $9,650,000,

Cumulative Paid Claims ($000s)			
Accident Year	12 Months	24 Months	36 Months
2010	$2,100	$6,410	$8,300
2011	$2,210	$7,000	
2012	$2,550		

Cumulative Closed Claim Count			
Accident Year	12 Months	24 Months	36 Months
2010	35	75	99
2011	35	80	
2012	40		

Cumulative Reported Claims ($000s)			
Accident Year	12 Months	24 Months	36 Months
2010	$5,300	$7,810	$8,500
2011	$5,500	$8,130	
2012	$6,000		

Cumulative Reported Claim Count			
Accident Year	12 Months	24 Months	36 Months
2010	80	98	100
2011	79	97	
2012	82		

Outstanding Claims ($000s)			
Accident Year	12 Months	24 Months	36 Months
2010	$3,200	$1,400	$200
2011	$3,290	$1,130	
2012	$3,450		

Outstanding Claim Count			
Accident Year	12 Months	24 Months	36 Months
2010	45	23	1
2011	44	17	
2012	42		

Fully discuss the considerations in deciding between using the paid or the reported claim development method to estimate ultimate claims for this line of business, and recommend an ultimate loss estimate for accident year 2012.

S13 – Exam 5 - Question #20

Based on the given data, one should create triangles of various claim averages (i.e. avg. paid severities, avg. case o/s, avg. closed to reported counts, avg. reported severities) and analyze each for anomalies or trends in the data.

Check avg. paid severities:

AY		12		24	36
10		60		85.47	83.84
	1.05		1.024		
11		63.14		87.5	
	1.01				
12		63.75			=7,000/80

Avg paid severities appears to be trending at rate less than 5% for most recent AY.

This could indicate a change in settlement practices; Insurer could be closing more small claims.

Check Avg Case Outstanding: **Avg Case out =** $\dfrac{\text{O/S \$Claim}}{(\text{O/S Claim Count})}$

AY		12		24	36
10		71.11		60.87	200
	1.05		1.09		
11		74.77		66.47	
	1.02				
12		76.19			

Avg. case outstanding increased by less than 5% per year at 12 months and greater than 5% per year at 24 months. This could indicate a change in type of claim being closed at the pd.

Look at closed to reported ratios: Closed Ct / Rep Ct

AY	12	24	36	
10	.4375	.7653	.99	
11	.4430	.8247		=99/100
12	.4878			

Closed to report count ratio appears to be increasingly, indicating a speed up in claim settlement.

Since there is a speed up in settlement and avg. paid severity is trending at rate lower than 5%, it appears the insurer is closing more small claims quickly.

Look at avg rep clm

AY		12		24	36
10		66.25		79.69	85
	1.05		1.05		
11		69.62		83.81	
	1.05				
12		73.17			

Avg. Rep. CLM increasing at steady rate of 5%.

Due to the diagnostics and explanations above, I would select the reported dev method ultimate of $9.65 mil.

Examiner's Report Question 20

Candidates were supposed to evaluate Average Paid (and/or Outstanding) and Average Reported trends and compare them to the known severity of 5%.

They should have noticed the increase in paid settlement and that reported trends matched the 5% severity.

From there they were to conclude to use the reported method and not the paid. This conclusion should have been reached by evaluating changes (or lack of change) in both case adequacy and settlement rates.

Many candidates calculated Average Paid and Average Case severities, but did not calculate the Average Reported severities. Most candidates did calculate trend from year to year.

Many of those lost credit by not making any statement on the stability or instability of the resulting trends.

Also, comparisons of the observed paid severity to the outstanding severity, or the observed severities along the diagonal rather than down the columns of the triangle did not receive full credit.

Many candidates that only looked at average paid and case and decided the change in trend of the case outstanding disproved using the reported method.

But case alone is inconclusive in determining reported stability.

Many of those candidates did not test for settlement rate changes, likely with the thought that they had identified the relevant piece of information to make their choice.

Some candidates further went on to test the settlement rate but did not see how an apparent case adequacy change is influenced by a real settlement rate change.

Those that did calculate Average Reported often noticed that the year to year trend was stable and some of those mentioned that the trend was consistent with the 5% severity.

A large number of candidates went off onto a Berquist-Sherman technique or an "adjusted" reported methodology which was incorrect as the reported method without adjustment is the preferred method.

Full credit for the selection of the reported method was given if the correct choice was made or even if the words "select the reported method" and no numerical choice was made.

If the candidate mistook the reported ultimate for incurred and then applied an LDF, or created their own LDF instead of using the ultimate given, full credit was still awarded.

If they adjusted the reported triangle using a BS or other methodology and then developed to ultimate, no credit was given for selecting the reported method.

The question asked the candidates to choose between the paid and reported methods.

Some candidates choose an average of them and got a number "Between." Since the reported was accurate and the paid was not candidates did not receive full credit.

21. (2 points) Given the following information as of the December 31, 2011 actuarial valuation:

Accident Year	Ultimate Claims	Reported Claims	Paid Claims
2010	\$1,200	\$280	\$125
2011	\$1,300	\$125	\$75
Total	**\$2,500**	**\$405**	**\$200**

Age in Months	Cumulative Percent Reported	Cumulative Percent Paid
36	40%	12%
24	25%	10%
12	10%	5%

Given the following information as of December 31, 2012:

Accident Year	Reported Claims	Paid Claims
2010	\$470	\$200
2011	\$320	\$175
Total	**\$790**	**\$375**

a. (0.5 point) Based on the 2011 actuarial valuation, calculate expected paid claims for each accident year during calendar year 2012.

b. (0.5 point) Based on the 2011 actuarial valuation, calculate expected reported claims for each accident year during calendar year 2012.

c. (0.5 point) Discuss a scenario that explains any differences between actual and expected paid and reported claims as of December 31, 2012.

d. (0.5 point) Using the scenario discussed in part c. above, justify the selection of a reserving technique for estimating ultimate claims as of December 31, 2012.

S13 – Exam 5 - Question #21

Expected paid during CY 2012 = (Ult – Paid) / % Unpaid × (% Paid at 2012 - % Paid at 2011)

a.	Ultimate-Paid	% unpaid	developed in CY 2012
2010	1075	90%	$(1075/.9)*(12\%-10\%)=23.89$
2011	1225	95%	$\left(\frac{1225}{.95}\right)*(.1-.05)=64.47$

OR

Expected paid during CY 2012 = Ultimate Paid * x (% Paid at 2012 - % Paid at 2011)

Yr	Ult Paid	% pd	%pd age+12	% pd in age	Exp paid in 2012
	(1)	(2)	(3)	(4)=(3)-(2)	(1)*(4)
2010	1200	.10	.12	.02	24
2011	1300	.05	.10	.05	65
					89

S13 – Exam 5 - Question #21

OR

Exp. Emergence ($) = Paid Claims x [Age to Age factor - 1.0]

Expected paid claims in CY 2012= Paid Claims x [Age to Ult x+12/ Age to Ult x – 1.0]

- AY 2010 = $125\left(\frac{1}{.10} \div \frac{1}{.12} - 1\right) = 25$
- AY 2011 = $75\left(\frac{1}{.05} \div \frac{1}{.1} - 1\right) = 75$

b.

Expected reported during CY2012= (Ult – Rptd) / % Unrptd × (% Rptd at 2012 - % Rptd at 2011)

	Ultimate-Reported	% unreported	
2010	920	.75	$\left(\frac{920}{.75}\right)(.4 - .25) = 184$
2011	1175	.9	$\left(\frac{1175}{.9}\right)(.25 - .1) = 195.83$

OR

Expected reported during CY2012 = Ultimate Reported * x (% Paid at 2012 - % Paid at 2011)

Yr	Ult Reported	% rptd	%rptd age+12	% rptd in age	Exp reported in 2012
	(1)	(2)	(3)	(4)=(3) – (2)	(5)=(1)*(4)
2010	1200	.25	.4	.15	180
2011	1300	.1	.25	.15	195
					375

OR

Exp. Emergence ($) = Reported Claims x [Age to Age factor - 1.0]

Expected reported claims in CY 2012= Reported Claims x [Age to Ult x+12/ Age to Ult x – 1.0]

- AY 2010 = $280\left(\frac{1}{.25} \div \frac{1}{.1} - 1\right) = 168$
- AY 2011 = $125\left(\frac{1}{.1} \div \frac{1}{.25} - 1\right) = 187.5$

Question 21 - continued

c. Using reported and paid claims as of 12/31/2011 and using the expected reported and expected paid from solution 1:

Reported at 12/31/2011 + Expected Reported	Paid at 12/31/2011 + Expected Paid
2010: 280 + 184 = 464	125 + 23.89 = 148.89
2011: 125 +195.83 = 320.83	75 + 64.47 = 139.47

Actual Reported as of 12/31/2012	Actual Paid as of 12/31/2012
2010 = $470	2010 = $200
2011 = $320	2011 = $175
Expected reported is close to actual	Expected paid is much less than actual

The higher actual paid can be a result of speed up in the claim settlement.

OR

Increase in rate of claim settlement. The reported losses tracked quite close to expected, while the paid losses were much larger than expected.

OR

Reported claims expected are less than actual, so are paid claims. They could be understated due to change in the mix of business towards business with worse claim experience.

d. The actuary can use the reported development technique because the projected vs. actual development was very close, and it is not affected by the speed up in claim settlement as the paid claim dev. method.

OR

I would use a reported dev. technique as it is not affected by decrease in settlement lag.

OR

I would suggest using the expected claims technique because you can judgmentally adjust the expected claims ration up due to the shift.

Examiner' Report

a. Most candidates performed well , either applying the formula from the Friedland text or another reasonable estimation technique of expected loss emergence.

b. Most candidates performed well , either applying the formula from the Friedland text or another reasonable estimation technique of expected loss emergence.

c. Many candidates skipped this part. Some candidates focused on explaining the relatively minor difference in emerging reported losses while overlooking the more drastic difference in paid loss emergence. Other candidates described a scenario that would only partially explain the results derived in part a. and part b. Other candidates described scenarios that would result in the opposite results from those seen in part a. and part b., reversing the actual and expected losses. These responses generally received partial credit.

d. Many candidates skipped part d. No credit was given for simply stating a reserve technique, as the question required the candidate to justify the technique. Some responses failed to link the response back to the scenario described in part c. as the question required.

22. (3 points) An actuary is assisting a manufacturing company in reserving its self-insured workers compensation program as of December 31, 2012. The program began on January 1, 1998 and has undergone the following changes in recent years:

- On January 1, 2007, the per-occurrence retention was increased from $300,000 to $750,000.
- On January 1, 2010, the company automated some of its production process. As a result, the company replaced a significant portion of its assembly-line staff with sales staff.

The actuary would like to use the following methods and data to estimate ultimate claims as of December 31, 2012:

- Development method using company-specific claim development triangles.
- Expected claims method using payroll as exposure base and the average of the reported and paid claim development projections as initial estimates of ultimate claims.
- Frequency-severity method using company-specific claim count development triangles.

a. (1 point) Discuss necessary adjustments the actuary should make to the company-specific data to use the development method.

b. (1 point) Briefly describe four adjustments the actuary should consider making to historical claims and exposures to put them on current levels in the expected claims method.

c. (1 point) Describe two diagnostic tests the actuary should perform before using the frequency-severity method.

S13 – Exam 5 - Question #22

a. If possible, the actuary should restate the historical triangles to a $300k retention (one triangle) and to a $750K retention (a separate triangle) in order to remove the distortion that the change in retention would otherwise create. The actuary should then review these triangles separately and select LDFs to be applied to the appropriate retention by year.

OR

The actuary should adjust the claims data to be used in development method since the retention was increased from $300,000 to $750,000. The increase in retention will increase the claims reported and paid. Therefore, claims data before 2007 should be adjusted to current level before applying the development method. In addition, the change from assembly-line to sales will have an impact to the claims. Less injury will be expected when the company automated some of its production process. Hence, claims data before 2010 should be adjusted.

b. -Adjust the losses so they are on the 750,000 retention level by using ILFS.

-Adjust losses to account for the change in workers. Sales staff will have fewer losses (injuries) than assembly staff

-Adjust the exposures to account for inflation.

-Adjust the losses to account for benefit changes related to inflation. As the workers get raises, the losses will increase.

OR

1. Cap the historical claims, select large loss load
2. Apply loss trend
3. Apply benefit level change adjustment
4. Apply exposure trend

S13 – Exam 5 - Question #22

22c. (1 point) Describe two diagnostic tests the actuary should perform before using the frequency-severity method.

c. Look at the avg severity amount → claims/closed counts. The change in per occurrence retention could have an effect on severity.

Look at frequency triangle → claims/exposures. Change in production could have significant increases on frequency.

OR

1. Paid to reported claim counts to determine if there were any changes in claim settlement rate.
2. Average case outstanding per open claim to see if there were any changes in case outstanding adequacy.

Examiner's Comment

a. Many candidates did not include a detailed discussion of how the changes in retention and/ or risk profile would affect the data.

Some candidates did not recognize that the actuary was working for a self-insured client and not an insurance company; in these cases, some candidates said premium should be adjusted to current rate level, but the actuary would not have premium to use as an exposure base for the self-insured layer.

b. Again, some candidates said premium should be adjusted to current rate level; however the actuary in the question would not have access to premium information for the self-insured layer.

c. Some candidates discussed the need to review the data for changes in frequency and severity, but failed to identify diagnostics that could be used to test for changes.

23. (2 points) Given the following information:

Unadjusted Case Outstanding Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2010	$10,300	$21,300	$37,500
2011	$11,400	$29,400	
2012	$15,600		

Open Claim Counts

Accident Year	12 Months	24 Months	36 Months
2010	1,030	1,420	1,500
2011	1,140	1,470	
2012	1,200		

Unadjusted Cumulative Paid Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2010	$2,575	$15,975	$30,000
2011	$2,850	$18,200	
2012	$3,900		

Selected annual severity trend = +5%

a. (1.5 points) Calculate the adjusted cumulative reported claim triangle using the Berquist-Sherman case outstanding adjustment technique.

b. (0.5 point) Discuss whether IBNR estimated using the Berquist-Sherman case outstanding adjustment technique should be higher or lower than IBNR estimated using an unadjusted reported claim development technique.

S13 – Exam 5 - Question #23

($000) Adj Rept = (Adj Avg Case x open) + Paid

a. Avg case = Case/Open Example AY 2011 at 12 mos = 13/1.05=12.38

Adj Avg Case ($000)

	12	24	36
2010	11.791	19.048	25
2011	12.381	20	
2012	13(=15.6/1.2)		

($000) Adj Rept = (Adj Avg Case x open) + Paid

	12	24	36
2010	14,720.12	43,022.62	67,500
2011	16,964.29	47,600	
2012	19,500		

b. Original Avg Case

	12	24	36
2010	10	15	25
2011	10	20	
2012	13		

Adj Avg Case amounts are higher than original avg case amounts so adjusted case will result in higher reported amounts in earlier years, and lower LDFS, thus less IBNR.

Unadjusted reported claim development technique would overstate IBNR so adjusted technique will produce lower IBNR than the unadjusted technique.

OR

Whether the B/S case OS method produces higher or lower IBNR depends on how the trend in case reserves relates to the selected severity trends.

If the case trend is higher, the adjusted amount will be higher in the B/S than development method. This will lead to lower CDFs, and lower IBNR amounts.

Vice Versa if the trend in case OS is lower than the select severity trend.

Examiner's Report

a. A majority of the candidates received full credit on this part. When there were errors, the most common was calculation errors in the Acc Year 2010 at 24 months despite correct answers elsewhere in the final triangle.

b. Many candidate provided answers that were factually correct but did not fully explain the issue at hand and/or the mechanics of the adjustment.

24. (2.5 points) Given the following information:

Paid Claims Gross of Salvage & Subrogation

Accident Year	12 Months	24 Months	36 Months	48 Months
2009	$2,000	$2,400	$2,500	$2,500
2010	$2,100	$2,300	$2,400	
2011	$2,100	$2,400		
2012	$2,500			

Paid Salvage & Subrogation

Accident Year	12 Months	24 Months	36 Months	48 Months
2009	$98	$166	$250	$250
2010	$105	$163	$240	
2011	$107	$170		
2012	$75			

- Assume no development after age 48.
- Ultimate claims for accident year 2012 = $2,985.

a. (0.75 point) Using a development approach, estimate the ultimate salvage and subrogation for accident year 2012.

b. (1.5 points) Using a ratio approach, estimate the ultimate salvage and subrogation for accident year 2012.

c. (0.25 points) Briefly discuss which approach, the development or ratio approach, to select in recommending an ultimate salvage and subrogation estimate for accident year 2012.

S13 – Exam 5 - Question #24

a. Compute Paid S&S ATA factors

Select all year weighted avg.

12-24	24-36	36-48	48-ULT
1.6097	1.4894	1.000	1.000

e.g. 1.6097 = (166 + 163 + 170)/(98 + 105 + 107)

AY 2012 Ult S&S = AY 2012 Paid S&S * 12-Ult LDF = (75) (1.6097) (1.4894) = 179.81

b. Compute the ratio of paid S&S/ to paid claims

	12	24	36	48	ULT ratio (using the selected all year avg ratios)
09	0.049	0.069	0.1	0.1	0.10 = .10 * 1.0
10	0.05	0.07	0.1		0.10= .10 * 1.0
11	0.051	0.071			0.071(1.429)(1.0) = 0.10
12	0.03				0.03(1.4701)(1.429)= 0.06; however selected = .10

Select all yr weighted avg of ratios:

12-24	24-36	36-48
1.407	1.429	1.0

AY 2012 S&S Ult = AY 2012 Ultimate Claims * Selected Ult Ratio of S&S/Paid Claims = (2,985)(0.1)=298.5

c. Ratio approach provides more stability, less subject to leveraging at early maturities

S13 – Exam 5 - Question #24

Examiner's Report

a. Most candidates received full credit. In limited cases, there were mathematical errors or no final calculation of the ultimate paid S&S.

b. Most candidates received high partial credit. Very few candidates selected an ultimate ratio for accident year 2012 that considered ultimate ratios from prior years.

c. Many candidates received full credit. Some of the common mistakes were not selecting a method by saying it does not matter and therefore not having a reason, or not giving a valid reason.

25. (2.25 points) Given the following information for a portfolio written on claims-made policy form:

Calendar Year	Paid ULAE	Paid Claims	Year-End Outstanding Case Reserve	Year-End Outstanding IBNR
2009	$409	$3,625	$7,575	$6,250
2010	$476	$5,875	$10,450	$7,500
2011	$614	$7,950	$13,750	$8,750
2012	$761	$10,375	$16,500	$10,625

Claim amounts include ALAE.

a. (1.5 points) Calculate a ULAE provision as of December 31, 2012 using the Kittel adjustment.

b. (0.5 point) Explain the purpose of the Kittel adjustment.

c. (0.25 point) Briefly explain a shortcoming of the classical method that is not addressed by the Kittel adjustment.

S13 – Exam 5 - Question #25

a.

Kittel ULAE Ratio = (CY paid ULAE)/ ½ ×(CY paid + CY reported)

ULAE = Ratio * [(.50) * (case o/s + IBNR)]

Note the ULAE provision is being made for a portfolio written on <u>claims-made</u> forms

CY	PD ULAE	Pd claims	Reported claims	Ratio
	(1)	(2)	(3)	(4)=(1)/[(2)+(3)]
09	409	3,625	17,450	.0388
10	476	5,875	23,825	.0320
11	614	7,950	30,450	.0320
12	761	10,375	37,500	.0318
	2,260	27,825	109,225	.0330
			Selected CY 09-12 Avg =	.0330

(3) = Pd claims + case ols +IBNER

(assuming "year-end O/S IBNR" = IBNER)

(4) = Pd ULAE/Avg (Pd claims and reported claims)

Unpaid ULAE= .0330 * [50% * (16,500 +10,625)] = 447.6

Note: This provision is for a portfolio of claims made policies and thus CY 2012 Case O/S and Year End IBNR O/S only is used.

S13 – Exam 5 - Question #25

OR

ULAE Reserve = Paid to Paid Ratio * % at closing * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves)

Paid to Paid ratio = paid ULAE/(paid loss + % at opening (change in total reserves))

Change in reserves = (Case o/s at 2010 - Case o/s at 2009) + (IBNR at 2010 – IBNR at 2009)

09	Pd ULAE	Pd	Reported = Paid + Δ case + Δ IBNR
10	476	5,875	10,000 = 5,875+(10,450 – 7,575) + (7,500 – 6,250)
11	614	7,950	12,500
12	761	10,375	15,000

	ULAE / Avg(paid, reported)	
10	476/((5,875+10,000)/2)	=.05997
11		=.06000
12		=.06000

Selected ratio (.600) is based on a straight average of the ratios above

ULAE Reserves = .50 * Paid to Paid Ratio * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves)

.06 x .5 x 16,500 + .06 x 10,625 = 1,132.5

b. It accounts for ULAE on reported but not yet paid claims. It is a adjustment to the classical technique. It is useful for cases like this where there is growing business + it is not steady state.

c. A short coming of the classical method is the assumption that 50% of the ULAE is incurred when claims are opened and 50% of the ULAE is closed. This is not addressed by the Kittel method.

The problem is that the 50%-50% assumption is inflexible and doesn't distinguish between the cost of closing a claim and maintaining a claim.

OR

When inflation affects paid ULAE and claims differently

OR

Both assume 50% of ULAE is paid on opening and 50% on closing. This assumption is not always true.

Examiner's Report

a. Candidates generally did not score well on this part.

Many candidates received partial credit for:

- using the average of paid and incurred losses in the denominator of the ULAE ratio
- selecting a ULAE ratio that was appropriate given the ratios calculated by year
- calculating the ULAE provision

Most candidates failed to properly calculate incurred losses as the sum of paid losses, the change in case reserves, and the change in IBNR.

Errors made in the incurred loss calculation included simply adding paid losses to the year-end reserve values or not including IBNR.

Some candidates did not properly use the average of paid and incurred losses in the denominator of the ratio.

Additionally, many candidates calculated a ULAE ratio based on the sum of all years (a weighted average) instead of calculating the ratio by year to identify potential trends.

Some candidates determined a ULAE ratio but did not calculate the ULAE provision.

Finally, of candidates that did calculate the ULAE provision, almost all candidates failed to properly calculate the ULAE provision.

The most common errors in this final step of the calculation included applying the ratio to the sum of year-end case reserves and IBNR for all years, or applying the ratio to 50% of case reserves and 100% of IBNR, despite the question clearly identifying the policy as being claims-made.

b. Most candidates received either no credit or partial credit on this part. Many candidates failed to describe the purpose of the Kittel adjustment, and simply mentioned that the adjustment used the average of paid and reported losses in the denominator of the ratio. Candidates receiving partial credit failed to mention that the adjustment is intended to improve upon the classical method in the case of growing lines of business.

c. The majority of candidates who attempted this part provided an acceptable response.

26. (2 points) An actuary is conducting a reserve review for a line of business and calculates the following:

	Claims as of December 31, 2012		Projected Ultimate Claims					
			Development Method		BF Method		Frequency-Severity	
Accident Year	Reported	Paid	Reported	Paid	Reported	Paid	Claim Count and Severity Technique	Disposal Rate Technique
2009	$76,700	$75,800	$77,501	$77,483	$77,758	$78,022	$77,474	$77,817
2010	$104,000	$98,100	$113,782	$113,828	$113,374	$113,165	$112,669	$106,363
2011	$107,200	$55,100	$130,379	$94,770	$127,393	$102,646	$132,743	$107,447
2012	$58,100	$20,400	$120,014	$89,600	$121,397	$115,159	$123,383	$93,012

a. (1.5 points) Suggest a reason for the disparity between the estimates of ultimate claims for accident year 2011 and propose diagnostic tests that would verify the assumption.

b. (0.5 point) Determine what steps the actuary should take to determine the most appropriate methodology to project ultimate claims for accident year 2011.

S13 – Exam 5 - Question #26

a. Perhaps case outstanding adequacy was strengthened for AY 2011, with no change in payment pattern. Thus the DFM (reported) is applying too-high DFs to reported losses and coming up with too high estimate of ultimate. If severity in the F-S technique includes reported losses' severity, then this will similarly produce a high result.

To verify produce triangles of average paid and average case OS. Look for a jump between 2010 and 2011 at 24 months that is larger than the average increase in pd avg down the columns.

OR

A slowdown in the settlement pattern could have caused the differences as it would have applied the historic CDF's to a lower paid amount at early maturities.

-This could be tested by looking at the paid-to-reported claims ratios and the closed count-to reported count if these ratios decrease for a given maturity for new accident years, this would support the reason.

b. Discuss these questions with claims dept manager, and examine payment patterns to make sure they are consistent. If so, use a paid DFM or BF.

OR

The actuary should confirm there was a change to the settlement pattern and check if there were changes to the case strength. If there were changes the data could be adjusted using the Berquist Sherman technique the actuary should talk to the claims department to get insight into the process.

S13 – Exam 5 - Question #26

Examiner's Report

a. There were many potential causes to the discrepancy in the data – the most common responses were case reserve strengthening, claim payment slowdown, and the presence of an unpaid large loss. Credit was given to any explanation that made sense given the data.

In addition to stating a reason for the discrepancy between paid and reported methods, candidates received credit for explaining how the ultimates for some of the methods were impacted instead of merely stating the result of reported method is overstated or paid method is understated.

A more complete answer would be giving case reserve strengthening as a reason and explaining how the same historical cdfs are applied to higher reported losses resulting in a possible overestimate.

The question asked the candidate to propose "diagnostic tests" to verify the assumption. In order to receive full credit, candidates had to provide more than one test (some candidates only provided one test). In addition, some indication of how the diagnostic tests would be used to verify the assumption was required for full credit. Candidates did not receive full credit for simply listing tests without further explanation.

Other errors:

- Candidates assume a speed up in claim settlement when it should be a slowdown (candidates were able to receive points on the rest of the question with this answer).
- Merely stating there was a change in claim settlement

b. Some candidates listed diagnostic tests in part b but not in part a. For these candidates, credit was given in part a. for diagnostic tests listed in part b.

Many of the students gave only half the answer. They either explained what they would do to confirm their reason for the discrepancy without following-up with a solution or they would only give a solution.

Full credit was awarded if the candidate indicated how their findings or confirmation steps will lead to a solution.

END OF EXAM

Actuarial Notes for

Spring 2014 CAS Exam5

Syllabus Section B

Estimating Claim Liabilities

Volume 2

Table of Contents
Exam 5– Volume 2: Estimating Unpaid Claims Liabilities

This volume (including C11 Exhibits that can be downloaded from our website) includes numerous sample and past CAS questions and solutions associated with the following articles that are no longer on the syllabus but were used extensively by Friedland in authoring of her paper.

Adler, M.; and Kline, C.D. Jr., "Evaluating Bodily Injury Liabilities Using a Claims Closure Model"

Berquist, J.R.; and Sherman, R.E., "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach"

Bornhuetter, R.L.; and Ferguson, R.E., "The Actuary and IBNR"

Fisher, W.H.; and Lange, J.T., "Loss Reserve Testing: A Report Year Approach"

Fisher, W.H.; and Lester, E.P., "Loss Reserve Testing in a Changing Environment"

Wiser, R.F.; Cockley, J.E; and Gardner A., "Loss Reserving," Foundations of CAS (Fourth Edition)

1 Importance of Accurately Estimating Unpaid Claims 1 - 5

Accurately estimating unpaid claims is critical to an insurer since it must report financial results on a regular basis. However, an insurer may not be able to quantify the exact costs of covered claims for years due to lengthy settlement periods.

Three viewpoints of the importance of accurately estimating unpaid:

1. Internal management; 2. Investors; 3. Regulators

1. Internal Management

Accurately estimating unpaid claims is essential for pricing, underwriting, strategic, and financial decisions.

It is very important in pricing since inaccurate estimates could ruin an insurer's financial condition.

Scenario 1: An inadequate estimate of unpaid claims could cause an insurer to reduce its rates not realizing that the estimated unpaid claims were insufficient to cover historical claims.

a. the new lower rates would be insufficient to pay the claims arising from the new policies.

b. if the insurer gains market share as a result of the lower rates, the premiums collected would prove to be inadequate to cover future claims, and could lead to a situation where the future solvency of the insurer is at risk.

Scenario 2: An excessive estimate of unpaid claims could cause the insurer to increase rates unnecessarily, resulting in a loss of market share and a loss of premium revenue to the insurer, negatively impacting the insurer's financial strength.

Scenario 3: An inaccurate estimate of unpaid claims could lead to poor underwriting, strategic, and financial decisions, because financial results influence an insurer decisions (e.g. where to increase business and whether to exit an underperforming market).

An inaccurate estimate can have a negative impact on the insurer's decisions regarding its reinsurance needs and claims management procedures and policies.

Unpaid claims estimates impact financial decision-making such as capital management (i.e. which lines of business get a larger proportion of allocated capital).

2. Investors

Inaccurate reserves may lead to misstated balance sheets and income statements and misleading key financial metrics used by investors.

Investor decisions about an insurer could be affected by an insurer with:

- insufficient reserves presenting itself in a stronger position than it truly is, and
- excessive reserves showing itself in a weaker position than its true state.

3. Regulators

Regulators rely on accurate financial statements to perform supervisory duties (e.g. assisting insurers that mask their true financial position because of inadequate reserves to regain strength).

2 Further Requirements for Accurate Reserves 5 - 7

1. State Law

Accurate estimation of unpaid claims is required by law, and many jurisdictions tie legal requirements to do so to the actuary (e.g. the role of the Appointed Actuary has been created by insurance legislation in countries around the world).

2. National Association of Insurance Commissioners (NAIC)

In 1990, the NAIC required that most P&C insurers in the U.S. obtain a Statement of Actuarial Opinion signed by a qualified actuary regarding the reasonableness of the carried statutory loss and loss adjustment expense (LAE) reserves as shown in the statutory annual statement.

In 1993, qualified actuaries signing statements of opinion used the title of Appointed Actuary because the NAIC required that they be appointed by the Board of Directors.

3. Other U.S.-Regulated Entities

Many state insurance departments require opinions for captive insurers, self-insurers, self-insurance pools and some underwriting pools and associations.

4. Canada

The Insurance Companies Act requires federally regulated insurers to have an Appointed Actuary to value the actuarial and other policy liabilities of the company at their financial year end.

The Appointed Actuary's:

- valuation must be in accordance with the rules and the standards set by the Canadian Institute of Actuaries (CIA).
- responsibilities are set forth by the Office of the Superintendent of Financial Institutions Canada (OSFI).

Most provinces have adopted similar legislation defining the responsibilities of the Appointed Actuary.

5. Other Examples — Australia and Slovenia

Australia: Insurance legislation requires insurance companies to have an Appointed Actuary. The signed actuary's report must contain a statement of the actuary's opinion about each of the following:

* The adequacy of all or part of the amount specified in the general insurer's accounts in respect of its liabilities, and the amount that the actuary considers would be adequate in the circumstances
* The accuracy of any relevant valuations made by the actuary
* The assumptions used by the actuary in making those valuations
* The relevance, appropriateness, and accuracy of the information on which those valuations were based

Slovenia: Every company with insurance operations is obliged to appoint a certified actuary. The insurance legislation defines the tasks of the certified actuary as follows:

A certified actuary shall be obliged to examine whether premiums are calculated and technical provisions set aside in accordance with the regulations, and whether they are calculated or set aside so as to ensure the long-term meeting of all the insurance under writing's obligations arising from the insurance contracts. ...

A certified actuary shall be obliged to submit to the supervisory boards and boards of directors, together with the opinion on the annual report, a report on the findings of the certified actuary with regard to the supervision carried out in the preceding year pursuant to the first paragraph hereunder.

The said report must, in particular, include the reasons for issuing a favorable opinion, an opinion with a reservation or an unfavorable opinion of a certified actuary on the annual statements.

3 Organization of This Book 7 -10

This text focuses on estimating unpaid claims for P&C insurers, reinsurers, and self-insured entities.

Actuaries wanting to expand their knowledge beyond the scope of this text should look to:

* Casualty Actuarial Society (CAS) seminars (e.g. the Reserve Variability Limited Attendance Seminar and the Casualty Loss Reserve Seminar)
* CAS publications (including the Proceedings of the CAS(PCAS), Forum, Discussion Paper Program, and Variance)
* International actuarial organizations (e.g. The Institute of Actuaries of Australia and The Institute of Actuaries / The Faculty of Actuaries (UK))

Organization of the book:

* Part 1 — Introduction
* Part 2 — Information Gathering
* Part 3 — Basic Techniques for Estimating Unpaid Claims
* Part 4 — Estimating Unpaid Claim Adjustment Expenses

Part 1: Estimating unpaid claims from the perspective of the claims department.

A claim is traced from its first report to the insurer, to the establishment of an initial case outstanding (case O/S), to partial payments and changes in the case O/S, to ultimate claim settlement.

Part 2: Information gathering; Types of data to analyze; and Development triangles.

Information gathering includes:

- summarizing historical claims and exposure experience
- understanding the insurer's internal and external environment, which involves:
  conducting meetings with those involved in the claims and underwriting processes and obtaining detailed information the actuary should seek from such meetings.

Types of data actuaries use and methods for organizing the data are discussed.

Since the development triangle is used to evaluate the performance of an insurer and to determine estimates of unpaid claims, Part 2, Chapter 5, describes how to create and use development triangles.

Part 3: A review of basic techniques for estimating unpaid claims.

- Examples of actual experience of U.S. and Canadian insurers are shown
- Similar portfolios of insurance in successive chapters allow a comparison of the results from different techniques.
- Detailed examples of the impact of various changes (e.g. an increase in claim ratios, a shift in the strength of case outstanding, and a change in product mix) on each method for estimating unpaid claims is demonstrated.
- An evaluation of all the methods presented is given as well as a discussion of on-going monitoring of unpaid claim estimates.

Part 4: Techniques to estimate unpaid claim adjustment expenses.

Claim adjustment expenses:

- are the costs of administering, determining coverage for, settling, or defending claims
- may be small (e.g. when a claim is a house fire that is settled with only a few phone calls).
- may be large (e.g. when an asbestos claim involving complex legal and medical issues, results in high defense costs and expert fees and thus, very high expenses)
- in some cases (e.g. asbestos claims) may be significantly greater than the indemnity payment.

Claim adjustment expenses are categorized as allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE).

- ALAE are costs the insurer is able to assign/allocate to a claim (e.g. legal and expert witness expenses)
- ULAE are costs not easily allocated to a specific claim (e.g. payroll, rent, and computer expenses for the claims department).

In Canada, actuaries still separate claim adjustment expenses into ALAE and ULAE

In 1998, the NAIC promulgated two new categories of adjustment expenses for U.S. insurers reporting on Schedule P of the P&C Annual Statement: defense and cost containment (DCC) and adjusting and other (A&O).

- DCC expenses include defense litigation and medical cost containment expenses regardless of whether internal or external to the insurer;
- A&O expenses include all claims adjusting expenses, whether internal or external to the insurer.

The Actuarial Standards Board (ASB) is a U.S. actuarial organization associated with the Academy that promulgates the standards of practice for the U.S. actuarial profession.

- CAS members are required to observe the Academy's standard if they practice in the U.S.
- CAS members who do not practice in the U.S are required to observe the standards set by other recognized actuarial organization for the jurisdiction in which they practice (e.g. the CIA in Canada or the Institute/Faculty of Actuaries in the United Kingdom).
- These organizations provide standards of practice, educational notes, statements of principles, and other professional guidelines.
- Selected CAS and Academy documents related to the estimating unpaid claims are in the appendices.

4 Ranges of Unpaid Claim Estimates 10

This text focuses on obtaining point estimates for unpaid claims.

- However, several methods applied to the same line of business produce different unpaid claims estimates.
- Since each method produces a different value of the unpaid claim estimate, we recognize that we are dealing with the estimation of the mean of a stochastic process, since actual unpaid claims almost always differ from the estimate.

While a range of estimates of the unpaid and a statement of confidence that the actual unpaid claims is valuable to management, regulators, policyholders, investors, and the public, the insurer's balance sheet requires the insurer to record a point estimate of the unpaid claims.

Actuarial Standard of Practice No. 43 (ASOP 43) defines the actuarial central estimate as an expected value over the range of reasonably possible outcomes.
This text does not address ranges of unpaid claim estimates.

5 Background Regarding the Examples 10 - 12

1. Differences in Coverages and Lines of Business Around the World

Differences in the types of P&C insurance offered and in the names used for similar coverages include:

- in the U.S. and Canada, insurers use the name "automobile insurance" to refer to the P&C coverage for automobiles and trucks;
- in the U.K., coverage is called "motor insurance";
- in India, coverage is called "car insurance";
- in the U.S., coverage protecting personal homes and possessions is "homeowners insurance"
- in Canada, "home insurance"
- in South Africa, some insurers differentiate between "household content" and "household building" insurance.

Some major coverages for U.S. P&C insurers (e.g. workers compensation (WC) or medical malpractice (MM), may not exist at all in other countries.

In Canada, WC insurance is not categorized as a P&C insurance coverage and is not sold by insurers (it is provided by monopolistic provincial funds; pension and life (not P&C) actuaries typically provide actuarial services to the provincial WC funds).

The authors relied on claim development data from *Best's Aggregates & Averages Property/Casualty United States & Canada — 2008 Edition* for many of the examples presented (as well as their actuarial colleagues at Canadian insurers who volunteered data from their organizations).

2. Description of Coverages Referred to in This Book

To assist the reader in understanding types of coverage, a brief description of each P&C coverage is given.

- **Accident benefits** - Canadian no-fault automobile (Auto) coverage that provides numerous benefits following a covered accident including: medical and rehabilitation expenses, funeral benefits, death benefits, and loss of income benefits

  Since this is a no-fault coverage, it is payable by the insured's insurer regardless of fault for the accident
- **Auto property damage** - A sub-coverage of auto liability insurance

  Provides protection to the insured against a claim or suit for damage to the property of a third-party arising from the operation of an auto
- **Collision** - A sub-coverage of auto physical damage coverage providing protection against claims resulting from any damages to the insured's vehicle caused by collision with another vehicle or object

  It's a first-party coverage and responds to the claims of the insured when he or she is at fault.
- **Commercial auto liability** - A coverage that provides protection from the liability that can arise from the business use of owned, hired, or borrowed autos or from the operation of an employee's autos on behalf of the business
- **Crime insurance** - Protects individuals and organizations from loss of money, securities, or inventory resulting from crime

  Including but not limited to: employee dishonesty, embezzlement, forgery, robbery, safe burglary, computer fraud, wire transfer fraud, and counterfeiting
- **Direct compensation** – A Canadian auto coverage that provides for damage to, or loss of use of, an auto or its contents, to the extent that the driver of another vehicle was at fault for the accident

  It is called direct compensation because, even though someone else caused the damage, the insured person collects from his or her insurer instead of from the person who caused the accident
- **General liability** (GL) – In the U.S. and Canada covers a wide array of insurance products

  The principal exposures covered by GL insurance are: premises liability, operations liability, products liability, completed operations liability, and professional (i.e., errors and omissions) liability
- **Medical malpractice** – (medical professional liability insurance)
  * is often separated into hospital professional and physician/surgeon professional liability insurance
  * responds to the unique GL exposures present for insureds (both individuals and organizations) offering medical care and related professional services
  * an example from "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach" by James R. Berquist and Richard E. Sherman (PCAS, 1977) is used by the authors (see chapter 13)

  While the data for the MM example is very dated, the methodology, approach, and conclusions remain applicable today
- **Personal auto insurance** – (private passenger auto insurance)

  Auto insurance (either personal or commercial) provide a variety of coverages, including first-party and third-party coverages, and are dependent upon the jurisdiction in which the insurance is written
- **Primary insurance** - Refers to the first layer of insurance coverage

  It pays compensation in the event of claims arising out of an insured event ahead (first) of any other insurance coverage that the policyholder may have
- **Private passenger auto liability** – Provides third-party liability protection to the insured against a claim or suit for bodily injury or property damage arising out of the operation of a private passenger auto
- **Private passenger auto physical damage** - A personal lines coverage providing protection against damage to or theft of a covered private passenger auto

- **Property insurance** - Provides protection against most risks to property, such as fire, theft, and some weather damages

  Specialized forms of property insurance include fire insurance, flood insurance, earthquake insurance, home insurance, and boiler and machinery insurance
- **Umbrella and excess insurance** - Refers to liability types of coverage available to individuals and companies protecting them against claims above and beyond the amounts covered by primary insurance policies or in some circumstances for claims not covered by the primary policies
- **U.S. workers compensation** - Provides coverage for the benefits the insured (i.e. the employer) becomes legally responsible for due to workplace injury, illness, and/or disease

  The complete name for this U.S. coverage - workers compensation and employers liability insurance

  U.S. WC also covers the cost to defend against, and pay, liability claims made against the employer (i.e. the insured) on account of bodily injury to an employee.

6 Key Terminology 12 - 16

Definitions from the Standards of Practice and Statements of Principles are used.

Insurer: any risk bearer for P&C exposures, whether an insurance company, self-insured entity, or other.

A. Reserves

U.S. and Canada financial statements contain different types of reserves including:

1. case reserves,
2. loss reserves, bulk and IBNR reserves, case LAE reserves,
3. unearned premium reserves,
4. reserves for bad debts,
5. reserves for rate credits and retrospective adjustments,
6. general and contingency reserves, and
7. earthquake reserves.

The focus of the text is estimating unpaid claims and claim adjustment expenses.

ASOP 43 limits the term reserve to its strict definition as an amount booked in a financial statement. It defines the term unpaid claim estimate to be the actuary's estimate for future payment resulting from claims due to past events.

This text uses terminology consistent with ASOP 43.

Unpaid claim estimate vs. carried reserve for unpaid claims:

1. The unpaid claim estimate results from an estimation technique.

   For the same line of business and the same experience period:
   - different estimation techniques will often produce different unpaid claim estimates.
   - unpaid claims estimate will often change from one valuation date to another (for the same portfolio).

2. The carried reserve is the amount reported in an external/internal statement of financial condition.

Key: The unpaid claims estimate includes 5 components:

1. case outstanding on known claims,
2. provision for future development on known claims,
3. estimate for reopened claims,
4. provision for claims incurred but not reported, and
5. provision for claims in transit (i.e., claims reported but not recorded).

Terminology:

- Case O/S or unpaid case refers to estimates of unpaid claims set by the claims department, third-party adjusters, or independent adjusters for known and reported claims only (it does not include future development on reported claims).
- The sum of the remaining 4 components is a broad definition of incurred but not reported (IBNR).

IBNR claims are often separated into 2 components:

1. Incurred but not yet reported claims (pure IBNR or narrow definition of IBNR)
2. Incurred but not enough reported (IBNER, a.k.a. development on known claims)

An important reason for separating IBNR into its components is to test the adequacy of case O/S over time, since it can be a useful when determining which methods are most appropriate for estimating unpaid claims.

In Chapter 3, a discussion of the different types of data provided for estimating unpaid claims is provided (e.g. does the data include or exclude: IBNR, estimates of unpaid claim adjustment expenses, recoverables from salvage and/or subrogation, reinsurance recoveries, and policyholder deductibles?).

B. Claims, Losses, and Claim Counts

"Claims" and "losses" are used interchangeably.

- Claims rather than losses are used more frequently in the U.S. and Canadian actuarial organizations
- Claims are more frequently used for financial reporting purposes of insurers.
- While "losses" often used to refer to ultimate losses, expected losses, loss ratios, and LAE, the authors have chosen to select the term "claims".

  Thus, ultimate claims, expected claims, claim ratios, and claim adjustment expenses are used.

Note: Claims (dollar values) and **Claim Counts** (or number of claims) are differentiated.

C. Reported Claims

"Reported claims" instead of incurred claims (or incurred losses) are used.

- Incurred losses can be misunderstood as to whether or not it includes IBNR.
- Actuaries use the labels <u>case incurred</u> or incurred on reported claims to specifically note that the losses do not include IBNR.
- Reported claims refer to the sum of cumulative paid claims and case outstanding estimates at a particular point in time.

D. Ultimate Claims

Ultimate claims are at their total dollar value after they are settled and closed.

- For short-tail lines of insurance (e.g. property insurance and automobile physical damage), ultimate claims are known within a short time period (e.g. 1-2 years after the end of the accident period).
- For long-tail lines of insurance (e.g. GL and WC) it may take many years before the value of ultimate claims are known.

Projecting ultimate claims:

- allows calculating the estimate of unpaid claims for IBNR and the total unpaid claim estimate (i.e. the sum of IBNR and case outstanding).
- is valuable for evaluating and selecting the final unpaid claim estimate and for determining the accuracy of the prior estimate of unpaid claims.

Evaluation of numerous estimation techniques are discussed in chapter 15.

E. Claim-Related Expenses

Claim adjustment expenses and claim-related expenses refer to total claim adjustment expenses (i.e. the sum of ALAE and ULAE, or the sum of DCC and A&O).

Because the terms ALAE and ULAE are widely used and accepted, claims include ALAE and exclude ULAE in the examples in the text.

F. Experience Period

Refers to the years included in a specific technique for estimating unpaid claims.

F. Emergence

- Refers to the reporting or development of claims and claim counts over time.
- in Canada, it refers to the rate of payment of ultimate claims, particularly when calculating estimates of discounted claim liabilities.

Sample Questions:

1. Friedland differentiates between “Carried Reserves” and “Unpaid Claim Estimates.” Define each.

2. Friedland discusses terminology surrounding “Reserves” and prefers the term “Unpaid Claim Estimate.” One component of the Unpaid Claims Estimate is the “Case Outstanding” which is made up of the estimated future dollar amounts that the claims/adjusting departments predict will be required to settle/close existing claims (that are known and reported).

   There are four other components that are often grouped together under the broad definition of IBNR.

   a. Identify the four components that are included under the broad definition of IBNR.
   b. Friedland also notes two subdivisions of this broad definition: Pure IBNR and IBNER. Describe each, and note what Friedland generally uses in the text as IBNR.

1994 Exam Questions (modified):

3. True/False: Accident year approaches to reserve estimation produce reserve indications consistent with the broad definition of IBNR

1995 Exam Questions (modified):

37. (1 point) The CAS Statement of Principles on Loss Reserving lists five elements that comprise the total loss reserve. Which of these may be alternatively classified as either reported reserves <u>or</u> IBNR?

Solutions to Sample Questions:

1. Friedland differentiates between "Carried Reserves" and "Unpaid Claim Estimates." Define each.

   An actuary may come up with several "Unpaid Claim Estimates" using different methods (as discussed in Friedland Chapter 7 – 13 for example). The "Carried Reserve" is the amount the company actually selects and reports in its published financial statements. Both reflect amounts to represent the case outstanding and IBNR, broadly defined.

2. Friedland discusses terminology surrounding "Reserves" and prefers the term "Unpaid Claim Estimate." One component of the Unpaid Claims Estimate is the "Case Outstanding" which is made up of the estimated future dollar amounts that the claims/adjusting departments predict will be required to settle/close existing claims (that are known and reported). There are four other components that are often grouped together under the broad definition of IBNR.
   a. Identify the four components that are included under the broad definition of IBNR.
      1) Provision for claims incurred but not reported ("pure" IBNR)
      2) Provision for future development on known claims
      3) Reopened claims reserve
      4) Provision for claims in transit (incurred and reported, but not recorded).
   b. Friedland also notes two subdivisions of this broad definition: Pure IBNR and IBNER. Describe each, and note what Friedland generally uses in the text as IBNR.
      Pure IBNR is for claims which are exactly that: "incurred, but <u>not reported</u>" (1 above)
      IBNER is "incurred, but NOT ENOUGH reported" (2,3 and 4 above)
      Friedland uses the broad definition of IBNR (including pure and IBNER).
      Note: See Conger for more discussion of IBNR.

Solutions to 1994 Exam Questions (modified):

3. True/False: Accident year approaches to reserve estimation produce reserve indications consistent with the broad definition of IBNR.
   True.

Solutions to 1995 Exam Questions (modified):

37. The CAS Statement of Principles on Loss Reserving lists five elements that comprise the total loss reserve. Which of these may be alternatively classified as either reported reserves <u>or</u> IBNR?
    The five elements:
    1) Case reserves (for known/reported claims)
    2) Provision for future development on known claims
    3) Reopened claims reserve
    4) Provision for claims incurred but not reported ("pure" IBNR)
    5) Provision for claims in transit (incurred and reported, but not recorded).
    The following elements can be categorized as either reported or IBNR losses:
    2) Provision for future development on known claims
    3) Reopened claims reserve
    5) Provision for claims in transit (incurred and reported, but not recorded).

1 Overview 17

5 elements comprise the total unpaid claim estimate:

1. Case O/S
2. Provision for future development on known claims
3. Provision for reopened claims
4. Provision for claims incurred but not reported (IBNR)
5. Provision for claims in transit (incurred and reported but not recorded)

Claims professionals estimate case O/S on claims (a.k.a. "unpaid case" or "case estimates")

- According U.S. insurance industry data, unpaid case (net for reinsurance) represents less than 50% of total unpaid claims and claim expenses.
- Unpaid case to total unpaid claims ratio varies greatly by type of business and insurer

Actuaries estimate the other four components of total unpaid claims.

Chapter 2 focuses on how claims professionals estimate the unpaid claim.

It is important for the actuary to understand why the estimated value of a reported claim varies over time and how changes in case O/S are processed by insurers.

2 Claims Professionals 17 - 18

The claims professional (a.k.a. claims examiner or claims adjuster) can be an employee of the insurer or an employee of an outside organization.

- Large commercial insurers have internal claim adjusters
- Small to mid-sized commercial insurers hire claim administrators (TPAs) outside the company

Outside claim administrators (TPAs)

- handle a specific book of claims.
- handle claims from the initial report to the final payment.
- report details of the claims to insurers on a predetermined basis (e.g. monthly or quarterly).
- manage all the claims of an insurer, largely in an unsupervised manner.
- compensation is based on work done for the entire book as a whole (not on a claim by claim basis).

An insurer may hire an independent adjuster (IA) paid on a fee per claim basis to handle:

- an individual claim or a group of claims.
- a specific type of claim or a claim in a region of unknown expertise
- large volume of claims after a natural disaster such as a tornado or hurricane.

3 A Claim is Reported 18 – 19

The estimation process for unpaid claims begins when an insured first reports a claim to the insurer and a claims professional then reviews the report.

A claims adjuster must decide whether or not the reported claim is covered under the terms of a policy. Claims professionals review the following to determine if the incident represents a covered claim and to establish a case O/S estimate:

* Effective dates of the policy
* Date of occurrence
* Terms and conditions of the policy
* Policy exclusions
* Policy endorsements
* Policy limits
* Deductibles
* Reinsurance or excess coverage
* Reporting requirements
* Mitigation of loss requirements
* Extent of injury and damages
* Extent of fault
* Potential other parties at fault
* Potential other sources of recovery

If a liability exists for a covered incident, the claims professional establishes an initial case O/S.

- Insurers use a formula or tabular value as the basis of the initial case O/S (e.g. an insurer may initially set all automobile physical damage glass claims at $500)

  Note: Tabular estimates are set based on predetermined formula, which takes into account characteristics of the injured party and the insurance benefits.
- For WC claims, an insurer may use a tabular system where injury type dictates the initial case O/S value.

Case O/S is estimated based on the information known at that time, and the value of a claim changes as more information is uncovered.

Approaches used by insurers to set case O/S:

Example: A claim is reported under a medical malpractice policy with a policy limit of $1 million.

Approach 1: Establish case O/S based on the best estimate of the ultimate settlement value of such a claim including inflation.

Approach 2: Set case O/S equal to the maximum value (i.e. the $1 million policy limit)

Approach 3: Seek the advice of legal counsel.

Assume that legal counsel estimates that there is an 80% chance that the claim will settle without payment and a 20% chance of a full policy limit claim.

1. Set the case O/S based on the mode ($0 in this case).
2. Set the case O/S based on the expected value calculation or $200,000 = [(80% x $0) + (20% x $1 million)].

Approach 4: Establish case O/S for the estimated claim amount only.

Approach 5: Establish case O/S for the estimated claim amount and all claim-related expenses.

Approach 6: Establish case O/S for ALAE (or DCC) only, Establish case O/S for ULAE (or A&O) only.

Practices for the establishing case O/S for salvage and subrogation recoveries include:

- setting case O/S based on an estimate of the salvage or subrogation recovery that the insurer expects to receive (i.e. case O/S is net of expected salvage and subrogation recoveries).
- not setting case O/S but tracking actual salvage and subrogation recoveries as they arise.

Case O/S for reinsurance recoveries is easily determined:

- for proportional (i.e. quota share) reinsurance, ceded case O/S is based on the reinsurers share of the total case O/S.
- for excess of loss reinsurance, ceded case O/S for a claim that exceeds the insurer's retention is the total case O/S estimate less the insurer's retention.

4 The Life of a Claim 19 - 24

A single insurance claim may extend over a number of years.

Example: An automobile insurer issues a 1 year policy effective 12/1/2007 – 11/30/2008.

- An accident occurred on 11/15/2008, but the insurer does not receive notice of the claim until 2/20/2009.
- On 2/20/2009 (the report date of the claim), a claims professional records a number of transactions related to this claim which could include:

* Establishment of the initial case O/S estimate
* Notification to the reinsurer if the claim is expected to exceed the insurer's retention
* A partial claim payment to injured party
* Expense payment for independent adjuster
* Change in case O/S estimate
* Claim payment (assumed to be final payment)
* Takedown of case O/S and closure of claim
* Re-opening of the claim and establishment of a new case O/S estimate
* Partial payment for defense litigation
* Final claim payment
* Final payment for defense litigation
* Closure of claim

The transactions details for a sample claim are shown in the following table.

Date	Transaction	Reported Value of Claim to Date	Cumulative Paid to Date	Case O/S
February 20, 2009	Case 0/S of $15,000 established for claim only	$15,000	$0	$15,000
April 1, 2009	Claim payment of $1,500 - case 0/S reduced to $13,500 (case 0/S change of -$1,500)	$15,000	$1,500	$13,500
May 1, 2009	Expense payment to IA of $500; no change in case O/S	$15,500	$2,000	$13,500
September 1, 2009	Case 0/S for claim increased to $30,000 (case 0/S change of +$16,500)	$32,000	$2,000	$30,000
March 1, 2010	Claim thought to be settled with additional payment of $24,000 – case 0/S reduced to $0 and claim closed (case 0/S change of -$30,000)	$26,000	$26,000	0
January 25, 2011	Claim reopened with case 0/S of $10,000 for claim and $10,000 for defense costs	$46,000	$26,000	$20,000
April 15, 2011	Partial payment of $5,000 for defense litigation and case 0/S for defense costs reduced to $5,000 – no change in case 0/S for claim	$46,000	$31,000	$15,000
September 1, 2011	Final claim payment for an additional $12,000 case 0/S for claim reduced to $0 (case 0/S change of -$10,000)	$48,000	$43,000	$5,000
March 1, 2012	Final defense cost payment for an additional $6,000 – case 0/S for defense costs reduced to $0 and claim closed (case 0/S change of -$5,000)	$49,000	$49,000	$0

Key characteristics of insured claims found in the above example:

- Claim activity extends over time (i.e. 3 years for this claim)
- Its estimated value is not ultimately established until the claim finally closes; changes over time (e.g. the claim is closed on 3/1/2010, but then reopens on 1/25/2011, with an increase to the case O/S)
- The estimated case O/S value is reasonable at the time of the claim professionals estimate but can later turn out to be too high or low
- An insured claim can have many different *types of payments* associated with it

  Example - the insurer makes an initial claim payment to the injured party on 4/1/2009.

  This claim payment provides for out-of-pocket medical expenses reported by the claimant.
  - Since the insurer questioned the validity of the claim, they hired an IA; as a result, there was a payment of $500 for the IA's services on 5/1/2009 (in the U.S. it would be classified as A&O; in Canada would be categorized as ALAE.)
  - On 3/1/2010, the insurer makes another payment of $24,000 to the claimant for lost wages and additional medical expenses.
  - Roughly one year later, a claims professional reopens the claim.
  - Over the course of the following year, the insurer makes further payments for defense litigation, additional lost wages, and medical expenses.
- There are many dates associated with each claim:
  - *Policy effective date* is the date the insurer issues the policy (12/1/2007)
  - *Accident date*, or date of loss, is the date the covered injury occurs (11/15/2008)
  - *Report date* is the date the insurer receives notice of the claim (2/20/2009)
  - *Transaction date* is the date on which either a case O/S transaction takes place or a payment is made (see all the dates in the preceding table)
  - *Closing dates* are the dates the claim is initially closed (3/1/2010) and finally closed (3/1/2012)
  - *Reopening date* is the date the insurer reopens the claim (1/25/2011)

This example does not cover every combination of transactions possible. Some claims open and close on the same day with a single payment (one transaction and no case O/S value).

As an insurer makes a specific payment, it may:

- reduce the case O/S more than the payment
- reduce the case O/S less than the payment
- not reduce the case O/S at all
- increase the case O/S

When referring to paid claims, it is important to know whether the claims are cumulative or incremental

- Cumulative paid claims are sum of all claim payments through the valuation date.
- Incremental paid claims are the sum of all claim payments made during a specific period of time

In the above example, the cumulative paid claims including claim-related expenses are:

* $1,500 at April 1, 2009
* $2,000 at May 1, 2009
* $26,000 at March 1, 2010
* $31,000 at April 15, 2011
* $43,000 at September 1, 2011
* $49,000 at March 1, 2012

The incremental paid claims from

- 1/1/2009 to 12/31/2009 are $2,000
- 2010, 2011, and 2012 are $24,000, $17,000, and $6,000, respectively

The case O/S is the estimated amount of future payments on a specific claim at any given point in time.
Example: The initial case O/S on the report date of the claim is $15,000.

- just before the claim initially closes in March 2010, the case O/S is $30,000.
- when the claim is reopened on 1/25/2011 a new case O/S is established for both claim amount and defense costs.
- it settles for a greater amount than the case O/S for both claim amount and defense costs.

“Reported claims" (or case incurred) are the sum of cumulative claim payments and the case O/S at the same point in time. Using the example above, the reported claims are:

* $15,000 at the time of first report (i.e. 2/20/2009)
* $15,500 at 5/1/2009 after a payment of $500 to an IA
* $32,000 at 9/1/2009, when the insurer increases the case O/S to $30,000 ($2,000 cumulative paid claims + $30,000 case O/S)
* $26,000 upon initial closing on 3/1/2010 ($26,000 cumulative paid claims + $0 case O/S)
* $46,000 upon reopening on 1/25/2011 ($26,000 cumulative paid claims + $10,000 claims and $10,000 defense costs case O/S)
* $48,000 at 9/1/2011 after final claim payment ($43,000 cumulative paid claims and LAE + $5,000 case O/S for defense costs)
* $49,000 at 3/1/2012 after final defense costs payment ($49,000 cumulative paid claims and LAE + $0 case O/S)

Calculate reported claims over a given period of time as:

- reported claims at the end of the period minus the reported claims at the beginning of the period, or
- incremental paid claims + ending case O/S minus beginning case O/S.

Example: Reported claims for the period 1/1/2009 - 12/31/2009 are $32,000.

- As of 1/1/2009, the claim was not yet reported and thus there are $0 reported claims for the claim.
- Incremental claim payments during 2009 are $2,000 and the change in case O/S is $30,000 ($30,000 ending case O/S minus $0 beginning case O/S).
- Reported claims over the period 1/1/2010 to 12/31/2010 are -$6,000.
- Incremental claim payments in 2010 are $24,000 and the change in case O/S is -$30,000 (ending case O/S of $0 minus beginning case O/S of $30,000).

The term "reported claims" are used under two contexts: incremental and cumulative and time periods involved to differentiate them between these two contexts.

- Reported claims equal the sum of cumulative paid claims through a specific date and case O/S as of that same date (for a given claim or an aggregate of a group of claims).
- Reported claims can refer to claim activity over an interval of time (e.g. the insurer's income statement).

Thus, the formulae for reported claims over a given period of time are as follows:

- Reported claims = (reported claims at end of period) **–** (reported claims at beginning of period)
- Reported claims = paid claims during period **+** case O/S at end of period **-** case O/S at beginning of period

5 Further Claim Examples 24 - 25

Table 2 shows additional examples of how claim transactions can affect reported claims.

Table 2 - Examples of Changes in Reported Values

	At December 31, 2007			Transactions During 2008			At December 31, 2008		
Example Number	Cumulative Paid Claims	Case O/S	Reported Claims	Paid Claims	Change in Case O/S	Reported Claims	Cumulative Paid Claims	Case O/S	Reported Claims
‘(1)	‘(2)	‘(3)	‘(4)	‘(5)	‘(6)	‘(7)	‘(8)	‘(9)	‘(10)
1				100		100	100		100
2	200		200	50		50	250		250
(Making payments where there had been no previous case outstanding increases reported claim.)									
3					1000	1000		1000	1000
(Establishing a case outstanding increases reported claim by the amount of the case outstanding.)									
4		1000	1000	100	(100)		100	900	1000
(Payment with offsetting case outstanding reduction has no effect on reported claim.)									
5	500	5,000	5,500	200	(1,000)	(800)	700	4,000	4,700
(If case O/S is reduced by a larger amount than the claim payment, the impact is a reduction to reported claim.)									
6	5,000	10,000	15,000	12,000	(10,000)	2,000	17,000		17,000
(If payment on closing exceeds case outstanding, reported claim transaction is positive.)									
7	5,000	10,000	15,000	6000,	(10,000)	(4,000)	11,000		11,000
(If payment on closing is less than case outstanding estimate, reported claim transaction is negative)									
8	5,000	15,000	20,000	4,500		4,500	9,500	15,000	24,500
(Claim payment with no change in case outstanding increases the reported claim.)									
9	3,000	10,000	13,000		(4,000)	(4,000)	3,000	6,000	9,000
(No payment and decrease in case outstanding decreases the reported claim.)									
10	2,000	10,000	12,000	1,000	5,000	6,000	3,000	15,000	18,000
(Payment and increase in case outstanding result in increase in reported claim.)									

- Columns (4) and (10) show reported claims as of year-end 2007 and 2008, respectively.
- Reported claims at a point in time (i.e. year-end 2007 and 2008) equal to the cumulative claim payments plus the case outstanding at that point in time.
- Reported claims shown in Column (7) represent the incremental reported value during the period of time running from 1/1/2008 to 12/31/2008.
- Reported claims over the year are equal to sum of the payments during the year (Column (5)) and the changes in case outstanding (Column (6)).

The transactions shown in Table 2 vary with respect to their impact on total reported claims.

- There are payments in the first two examples made in 2008 on claims where there was no prior existing case O/S at 12/31/2007; thus total reported claims for both of these claims increase.

  These payments could occur when the insurer reopens a claim.
- Ex. 4 – There is no change to reported claims if the payment made equals the reduction in case O/S.
- Ex. 8 – Reported claims increase when the payment made is larger than the reduction in case O/S.
- Ex. 5 and 7 – Reported claims decrease when the payment is smaller than the reduction in case O/S.
- Ex. 3 and 9 - A change in case O/S without any associated payment impacts reported claims.

1 Sources of Data 28 - 29

Actuaries rely on data from an insurer's management information systems to generate claims and exposure data for the unpaid claims' estimation.

The Need for External Data:

- Smaller insurers may have less internal data because of a limited volume of business written or because the organizations' system does not provide such data. Thus, actuaries must turn to external sources of data.
- Large insurers who have entered a new line of insurance or have focused on a new geographical region may also need external sources of information when developing estimates of unpaid claims.

Available external data varies (by jurisdiction and by product) in the:

United States

- Insurance Services Office, Inc. (ISO)
- National Council on Compensation Insurance (NCCI)
- Reinsurance Association of America (RAA)
- The Surety & Fidelity Association of America (SFAA)
- A.M. Best Company (Best)
- NAIC Annual Statement data

Canada

- Best
- General Insurance Statistical Agency (GISA)
- Insurance Bureau of Canada (IBC)
- Reinsurance Research Council (RRC)
- Market-Security Analysis & Research Inc. (MSA)

Insurers use internally generated data and external industry benchmarks.
External information is needed for selecting:

- tail development factors
- trend rates
- expected claim ratios (i.e., expected loss ratios).

External information is beneficial when an actuary evaluates or resolves the results of different estimations and makes final selections of claims and unpaid claim estimates.

Shortcomings of External Data:

The International Actuarial Association (IAA) feels that entity-specific data is far better than external data. External data may be misleading/irrelevant due to differences relating to:

- insurance products,
- case outstanding and settlement practices,
- insurers' operations,
- coding,
- geographic areas, and
- mix of business and product types

2 Homogeneity and Credibility of Data 29 - 31

Different lines of insurance have different claim behaviors.

- Even though the insurance coverages may be identical, claims from personal insurance policies differ from those generated from business insurance.
- Claims for umbrella and excess insurance differ from claims for primary insurance. Sub-coverages under a single line of insurance differ greatly.
- Property damage claims for automobile liability policies are reported and paid quickly and have a low severity (i.e. settlement value).
- Claims from auto accidents involving catastrophic spinal injuries can take years to settle and cost millions of dollars.

Estimating unpaid claims can be made more accurate by subdividing experience into groups exhibiting similar characteristics, such as

- comparable claim experience patterns,
- settlement patterns,
- size of claim distributions.

When separating data into groups for analyzing unpaid claims, actuaries focus on key characteristics:

* Consistency of coverage triggered by the claims in the group (i.e. group claims subject to the same or similar laws, policy terms, claims handling, etc.)
* Volume of claim counts
* Length of time to report the claim once an insured event has occurred (i.e. reporting patterns)
* Ability to develop a case outstanding estimate from earliest report through the life of the claim
* Length of time to settle the claim (i.e. settlement, or payment, patterns)
* Likelihood of claim to reopen once it is settled
* Average settlement value (i.e. severity)

Claims are grouped by lines and sublines of business with similar traits based on the characteristics listed above or by policy limits to achieve similar claims attributes within a block of business.

The goal: Divide data into homogeneous groupings without dividing the data into small groups which do not provide enough information to the actuaries.

Credibility is:

- the predictive value given to a group of data
- increased by increasing the homogeneity of the data or by increasing the amount of data in the group.

Changes in the portfolio also need to be considered when grouping data. Despite different claims development, it may be appropriate to combine personal automobile and commercial automobile data.

- Groupings do not work as well if the volume of business is changing between these two lines of insurance.
- As described in Part 3, in a portfolio where the volume of personal automobile is increasing at 5% per year while the commercial automobile volume is increasing at 30%, the changing proportion on the different estimation techniques can be significant.

3 Types of Data Used by Actuaries 31 - 38

1. Claims and Claim Count Data

Common types of data used by actuaries to establish and test unpaid claim estimates include:

* Incremental paid claims
* Cumulative paid claims
* Paid claims on closed claims
* Paid claims on open claims
* Case outstanding
* Reported claims (i.e., sum of cumulative paid claims plus case outstanding)
* Incremental reported claims
* Reported claim counts
* Claim counts on closed with payment
* Claim counts on closed with no payment
* Open claim counts
* Reopened claim counts

The data types can be used for claims only (i.e. losses only), claim-related expenses, or claims and claim-related expenses combined.

2. Claim-Related Expenses

The actuary uses claim data based on how the insurer handles expenses.

- If the claim data and policy limits include claim adjustment expenses, combine ALAE experience and historical claims when determining unpaid claims (here, *claims* refers to both claims and ALAE combined).
- If the claim analysis includes only ALAE and not ULAE, a separate analysis is used to evaluate the unpaid ULAE estimate.

Claim-related expenses can be classified many ways.

Insurers categorize LAE by the function of the expenses as either defense and cost containment (DCC) or as adjusting and other (A&O).

A&O includes all claim adjuster costs regardless of whether or not they are attributable to:

i. internal adjusters (viewed as overhead and difficult to attribute to an individual claim) or

ii. external independent adjusters (which are easily attributable to an individual claim).

Reporting requirements and insurer claim management processes determine how insurers categorize claims expenses.

An actuary must determine which claim expenses are included in the data and how expenses are defined.

Example: Different people working for the same insurer may define the term ALAE based on:

- financial reporting systems (to meet external reporting requirements) or
- meeting internal claim management needs.

3. Multiple Currencies

If claims data exist in information systems in different currencies, an adjustment needs to be made to the data prior to analysis. Separate the data, translate the currencies using exchange rates to single currency, and then combine the resulting amount.

Example: If the claims data are in Euros, pounds sterling, and U.S. dollars, and a final unpaid claim estimate is needed in Euros, convert all amounts to Euros using the current exchange rates.

4. Large Claims

Large claims in the data distorts the results from traditional methods used for estimating unpaid claims. To circumvent the problem,

- exclude large claims from the initial projection, and then
- add a case specific provision for the reported portion of large claims, and then
- add a smoothed provision for the IBNR portion of large claims.

The size criterion of a large claim varies by:

- line of business
- geographic region

It may even vary between analyses of unpaid claims.

Actuaries consider the following when establishing a large claim threshold:

* Size of claim relative to policy limits
* Size of claim relative to reinsurance limits
* Number of claims over the threshold each year
* Credibility of internal data regarding large claims
* Availability of relevant external data

Actuaries look at large claims reports from an insurer's claims departments that track individual experience of claims exceeding a certain threshold.

5. Recoveries

Numerous types of recoveries affect an insurer's net claims experience.

Deductibles are common.

- For auto physical damage, deductibles reduce claim payments to policyholders, and the insurer applies the deductible before issuing payment to the insured.
- For general liability, the injured party is not the insured party and the insurer usually makes claim payments to the injured party first, and then seeks a recovery of the deductible from the insured.

Insurers differ on how they set case outstanding given that a deductible exists:

- Some set case outstanding net of the deductible.
- Others do not consider the deductible when setting case outstanding.

Salvage and Subrogation:

When an insurer pays an insured for a claim considered to be a total loss, the insurer acquires the rights to the damaged property.

- Salvage is what the insurer collects from the sale of such damaged property.
- Subrogation is the insurer's right to recover the amount of claim payment to a covered insured from a third-party responsible for the injury or damage.

An actuary must know whether or not the insurer records paid claims as net or gross of these recoveries.

Questions to ask include:

* are salvage and subrogation recoveries tracked separately from claim payments?
* are claim payments only recorded net of salvage or subrogation recoveries?
* is data for salvage and subrogation recoveries available to the actuary?

6. Reinsurance

When conducting an analysis of ceded or net unpaid claims, it is important to understand the reinsurance program of the insurer and the affect of reinsurance on claims.

Because current and previous reinsurance plans and retentions affect an insurer's estimates of unpaid claims, actuaries analyze claims both gross and net of reinsurance recoveries.

Some actuaries:

- separately analyze gross claims and ceded claims (claims ceded to reinsurers), and then
- determine the estimate of net (estimated gross unpaid claims minus estimated ceded unpaid claims)

Other actuaries:

- separately analyze gross claims and net claims (gross claims minus ceded claims), and then
- determine the estimate of ceded unpaid claims (estimated gross unpaid claims minus estimated net unpaid claims)

The implied net or ceded unpaid claim estimate is reviewed for reasonableness.

3 possible treatments of ALAE in excess of loss reinsurance which the actuaries must focus on are:

1. Included with the claim amount in determining excess of loss coverage (most common)
2. Not included in the coverage
3. Included on a pro rata basis; the ratio of the excess portion of the claim to the total claim amount times the ALAE amount determines coverage for ALAE

How ALAE is treated will have an effect on data requirements and possibly the method selected for estimating unpaid claims.

7. Exposure Data

Some methods for estimating unpaid claims require a measure of the insurer's exposure to claims.

- Earned premium is the most common type of exposure and is used for estimation by insurers and reinsurers.
- Other types of exposures used by insurers include:
  - written premium
  - policies in force
  - policy limits by region (the early estimation of unpaid claims related to a catastrophe)
  - the number of vehicles insured (personal automobile insurance)
  - payroll (workers compensation).

Actuaries often adjust historical premiums to current rate levels (on-level premiums).

2 ways in which this is done include:

1. A re-rating of historical exposures at current rates (very computer-intensive and does not work in all situations)
2. Computing rate level changes over the experience period and adjusting the premiums in the aggregate for historical rate changes.

Note: The actuary might not always be able to collect accurate rate changes data (therefore use premium data from insurer on unadjusted basis)

Self-insurers and insurers collect premiums in different ways.

Actuaries working with self-insurers use other observable/available exposure bases that are more closely related to the risk and therefore claims potential.

The following table summarizes, by line of business, types of exposures used for analyzing self-insurers' unpaid claims.

Table 1 - Examples of Exposures for Self-Insurers

Line of Insurance	**Exposure**
U.S. workers compensation	Payroll
Automobile liability	Number of vehicles or miles driven
General liability for public entities	Population or operating expenditures
General liability for corporations	Sales or square footage
Hospital professional liability	Average occupied beds and outpatient visits
Property	Property values
Crime	Number of employees

Exposures are important:

- as input to certain techniques for estimating unpaid claims.
- for evaluating and reconciling the results of the various techniques.

8. Insurer Reporting and Understanding the Data

It is important to know what types of claims data are contained in the insurer's claims reports and information systems, since different insurers, TPAs, IAs, and different departments in an organization may have different definitions for the same terms.

"Incurred loss" is a term with a universal meaning but actually means different things to different people. For:

- the finance department, it means transactional losses incurred during a defined period (e.g. a calendar (or fiscal) quarter or year.)

  Incurred loss = sum of payments made + the change in total unpaid claims + IBNR.
- the actuary working on an incurred claim development triangle, incurred losses = cumulative claim payments through a valuation date + case outstanding at the same valuation date (a.k.a case incurred or incurred on reported claims).
- TPA loss reporting, incurred losses refer to case outstanding only.

The authors use the term "reported claims" to refer to case incurred losses.

"Unpaid claims" and "reserves" are terms that also have many different meanings.

In a report from:

- the finance department, unpaid claims (or reserves) means the estimate of total unpaid claims including both case outstanding and IBNR.
- the claims department, unpaid claims (or reserves) refers to case outstanding only.
- a TPA, unpaid claims (or reserves) represent the total reported value of the claims (cumulative payments + current case outstanding estimates).

The actuary subtracts cumulative paid claims from the reserves to determine unpaid claims.

The actuary must know whether unpaid claims is net or gross of deductibles or other types of recoveries, including:

- salvage,
- subrogation,
- and reinsurance recoveries (also where in the claims process those recoveries are included).

The actuary needs to know whether or not case outstanding include claim-related expenses.

- Some insurers record case outstanding and payments for claim-related expenses separately from claim only case outstanding and payments.
- Other insurers record expense payments separately (from claim payments) but do not carry case outstanding for expense.

"Reserves" can be used differently in the actuarial and accounting professions in South Africa and the U.K.

- South African and British accountants distinguish between provisions (unpaid claim estimates) and reserves.
- Actuaries use "reserves" to refer to unpaid claim estimates and do not distinguish between different types of reserves.

Paid claims can be:

- cumulative or incremental, including or excluding claim-related expenses (and based on what kind of claims expenses)
- net or gross of recoveries.

Actuaries need to know how the insurer's system tracks claim counts, which are critical to diagnostic analyses (after analyzing unpaid claims) as well as being an important data piece for several estimation techniques for unpaid claims.

Actuaries use claim counts to evaluate and select a final value for the unpaid claim estimate.

Actuaries should be able to answer questions such as:

- Does the insurer counts an automobile accident with payments for multiple coverages (bodily injury liability and physical damage) or to multiple parties (claimants) as one claim or multiple claims?
- How are reopened claims (especially in U.S. WC and accident benefits coverages) treated and are they considered a new claim?

For a proper estimate of unpaid claims, actuaries must:

- identify the specific data that exists and
- identify the data they are requesting from the insurer
- understand the data that they receive

9. Verification of the Data

Actuaries must have ways to review data other than relying on a formal audit of the data.

The data review may include the following components:

* *Consistency with financial statement data* – Can the actuary reconcile the data with financial statement data (that may be subject to some form of external audit)?
* *Consistency with prior data* – Is the current data consistent with data used in the prior analysis? If not, why?
* *Data reasonableness* – Are there certain values that appear questionable (e.g. large negative paid claims or apparent inconsistencies between data elements? Questionable values are not always incorrect values, but the actuary should investigate them anyway).
* *Data definitions* – Does the actuary know how each of the data items is defined? An actuary should determine the proper definition of a data piece instead of just assuming the definition (similar labels do not always imply similar definitions).

Proper documentation of the verification process, findings, and data verification are essential to any actuarial analysis which include:

- discussions with external auditors, and
- reliance on their work regarding data verification.

4 Organizing Data 38 - 43

1. Key Dates

Several key dates for organizing claim data include:

* Policy effective dates
* Accident date
* Report date
* Accounting date
* Valuation date

1. *Policy effective dates are* the beginning and ending dates of the policy term (i.e. the period for which the policy triggered by the claim was effective).

   Some systems only capture the policy year (the year that the policy became effective).

   Reinsurers refer to it as the underwriting date (or year).

2. *The accident date is*
   - the date that the accident or event occurred that triggered the potential policy coverage.

   Some systems only capture the accident year (the year that the triggering event occurred).

   For claims-made policies, the accident date:
   - is the date the claim was reported (date of the event that triggered coverage)
   - may be defined as the date that an injury occurred with the injury not covered by the policy unless the resulting claim was reported during the policy period.

3. *The report* date
   - is the date when the claim was reported to the insurer and recorded in its claims system.

   Some databases split the report date into:
   - report date, and
   - record date, and
   - (possibly) a notification date (the date the insurer is put on notice that an event occurred that may result in a claim).

   Example: An insured motorist notifies their insurer that they got in an accident (not filing a claim); this is the notification date.
   - A week later, the insurer receives claim from the other party in the accident - this is the report date (the date on which the claim was reported).
   - The following day, the claims department records the claim into their system - this is the record date.
   - Notification dates are not commonly used in many actuarial analyses.

4. *The accounting date*
   - is the date that defines the group of claims for which liability may exist (i.e. all insured claims incurred on or before the accounting date).
   - may be any date selected for a statistical or financial reporting purpose.
   - must follow a date for which the history is frozen in time (e.g. month, quarter, or year-end with quarter, and year-end dates as the most common).

   Claims Activities and Accounting Dates Example:
   - Given an accounting date for an occurrence-based policy of 12/31/2008, the total unpaid claim estimate as of this accounting date must provide for all incurred claims, whether reported or not, as of 12/31/2008.
   - An insured loss that occurred on 12/31/2008, for a policy written on 12/15/2008, would be included in the estimate of unpaid claims for the accounting date 12/31/2008, regardless of when the claim is reported to the insurer.
   - An insured loss that occurred on 1/5/2009, for the same policy that was written on 12/31/2008, would not be included in the unpaid claim estimate for the accounting date 12/31/2008, because this accident occurred after the accounting date.

5. The *valuation date*
   - is the date through which transactions are included in the database used in the evaluation of the liability.
   - does not depend on when the actuary does his/her analysis.
   - may happen before, coincident with, or after the accounting date.
   - may be at month-end, quarter-end, half-year-end, or year-end.

Example: To determine total unpaid claims at 12/31/2008, actuaries use data valued as of 12/31/2008.

- Here, the valuation date and the accounting date are the same.
- In some situations, the actuary does not have time to wait for the 12/31/2008 data to be available because of internal financial reporting requirements at year-end for some insurers.
- Actuaries often use data at an earlier valuation date to estimate the requirement for unpaid claims at the accounting date of 12/31/2008 will be.
- Some insurers use data as of 9/30/2008 to estimate unpaid claims as of 12/31/2008; in this situation the valuation date is 9/30/2008 and the accounting date is 12/31/2008.

The valuation date can be later than the accounting date.

Example – If the actuary wants to re-estimate what claim liabilities were at 12/31/2006, he takes into account the actual experience of 2007 and 2008.

- The actuary can use a 12/31/2008 valuation date and thus include actual paid and reported claims experience through 2007 and 2008.
- The estimation of unpaid claims at 12/31/2008 (the accounting date) is the valuation date (the projected ultimate claims that he or she derives using data through 12/31/2008) minus the actual payments at 12/31/2006.

Aggregation by Calendar Year (CY)

Calendar year data is transactional data.

Examples:

- CY 2008 paid claims are claim payments made by the insurer between 1/1/2008 and 12/31/2008
- CY 2008 reported claims = CY 2008 paid claims + case O/S at 12/31/2008 – case O/S at 1/1/2008
- CY 2008 reported claim counts claim counts reported from 1/1/2008 to 12/31/2008
- Closed claim counts are the number of claims closed during the year.

CY data is used for:

- aggregation of exposures and
- diagnostic testing when analyzing AY claims data.

CY 2008 written premium (WP) is the sum of all written premium reported/recorded in the accounting systems during 2008.

CY earned premium (EP) is:

WP + Beginning Unearned Premium Reserve (UEPR) - Ending UEPR

Advantages of using CY data:

- no future development as the value remains fixed as time goes unlike claims and exposures aggregated based on accident year, policy year, and even report year bases.
- readily available because most insurers conduct financial reporting on a CY basis.

Disadvantage to using CY data:

- it cannot be used for loss development purposes.
- very few techniques for estimating unpaid claims are based on CY claims.

Note: CY exposures and AY claims are frequently used in estimation techniques.

Aggregation by Accident Year (AY)

Aggregation by AY:

- is the most common grouping of claims data for an actuarial analysis of unpaid claims.
- groups claims according to the date of occurrence (the accident date or coverage triggering event).
  Example: AY 2008 consists of all claims with an occurrence date in 2008.

Self-insurers' AY data may have their fiscal year ends that do not coincide with calendar year-end.

Example - AY 2008 may coincide with a self-insurer's 8/1/2007 to 7/31/2008 fiscal year or include claims occurring during the 1/1/2008 to 12/31/2008 CY period.

Insurers compile claims data according to a variety of accident periods including accident month, accident quarter, accident half-year and accident year.

Financial reporting schedules and statistical organizations for insurers in the U.S. and Canada require claim information by AY. In some areas (e.g. Lloyds of London), financial reporting by underwriting year is more common than AY.

Actuaries use CY exposures with accident year claims.

- CY EP match the claims that occur during the year with the insurance premiums earned by an insurer during the year.
- Claims and exposures aggregated by policy year (PY) provide an exact match.
- For self insurers, CY exposures represent an exact match with AY claims.

Advantages to using AY Aggregation

- AY aggregation is the norm for P&C insurers in the U.S. and Canada.
- AY grouping is easy to achieve and easy to understand
- Since AY includes claims occurring over a shorter time frame than for PY or underwriting (U/W) year aggregation, ultimate AY claims should be reliably estimable sooner than those for PY or U/W year.
- Many industry benchmarks are based on AY experience.
- Tracking claims by AY is valuable when there is change due to economic or regulatory forces (e.g. inflation or law amendments) or major claim events (e.g. atypical weather or a major catastrophe) which can influence claims experience.

Aggregation by Policy Year (PY) or Underwriting Year (U/W Y)

Aggregation by PY:

- Claims are grouped according to the year in which the policy was written.
- Matches the premiums and claims arising from a group of policies.

  U/W Y data is often used by reinsurers and refers to claims grouped by the year in which the reinsurance policy became effective.

Claims arising from a PY or U/W Y can extend over 24 calendar months if the policy term is 12 months.

Example: PY 2010 refers to policies with effective dates between 1/1/2010 – 12/31/2010.

Claims for annual policies effective 12/31/2010 will have occurrence dates between 12/31/2010 – 12/31/2011

Advantages of PY Aggregation:

The key advantage is the true matching of claims and premiums.

- PY experience is very important when underwriting or pricing changes occur (e.g. a shift from full coverage to large deductible policies, a change in emphasis on certain classes of business, or an increase/decrease in the price charged leading to a change in expected claim ratios and possibly a change in the type of insured).
- PY aggregation is useful for self-insureds, who often issue a single policy.

Disadvantages of PY Aggregation

- The primary disadvantage is the extended time to gather complete data (i.e. it can take up to 24 months to gather all reported claims) and to reliably estimate ultimate claims.
- PY data can make it difficult to understand and isolate the affect of a single large event (e.g. a major catastrophe or court ruling), which changes how insurance contracts are interpreted.

Aggregation by Report Year (RY)

RY data is used for lines of insurance in which coverage depends on the date the claims is reported (i.e. claims made (CM) coverage).

CM coverage is often used for medical malpractice, products liability, errors and omission, and directors' and officers' liability.

For these lines of business, RY data is used for developing estimates of unpaid claims.

RY aggregation groups claims by the date they are reported to the insurer, regardless of the claim's accident date. Aggregating claims by RY can be used to test the adequacy of case O/S on known claims over time.

Note: If CM policies have extended reporting endorsements that are not coded as a new policy, development beyond 12 months may be possible even for annual policies.

Advantages of Report Year Aggregation

The number of claims is fixed at the close of the year (other than for claims reported but not recorded). The RY approach substitutes a known quantity (i.e. the number of reported claim counts) for an estimate.

Thus, a RY approach will often result in more stable data and more readily determinable development patterns than an AY approach, since the number of AY claims is subject to change at each successive valuation.

Disadvantage of Report Year Aggregation

RY estimation techniques only measure development on known claims (and not pure IBNR)

Sample Questions:

1. List and describe 5 key dates regarding data organization for loss reserving, per Friedland Ch 3.

2. Which of the following statements is/are true?
   ❶ The valuation date can be on, after, or before the accounting date.
   ❷ Case Outstanding represents estimated settlement values assigned to specific known claims.
   ❸ A liability provision for reopened claims is generally needed only for the medical malpractice line of business.

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

3. Friedland discusses how techniques to estimate unpaid losses may be used with data arranged into different time intervals. List the 6 groupings discussed (See Chapters 5 and 9).

For the next three questions, assume data is organized and analyzed by Accident Year:

4. Assume you have applied one of the techniques, on paid claims, described in Friedland to estimate unpaid claims of $X. Let paid claims at the evaluation date = P and case outstanding estimates = C.
   a. Define the Ultimate Claims in terms of X, P, and C.
   b. Define the IBNR (broad definition) in terms of X, P, and C.
   c. Define the Total Unpaid Claims (Total Reserves) in terms of X, P, and C.
   d. Define Reported Claims in terms of X, P and C.

5. Assume you have applied one of the techniques, on reported claims, described in Friedland to estimate IBNR of $Y. Let paid claims at the evaluation date = P and case outstanding estimates = C.
   a. Define the Ultimate Claims in terms of Y, P, and C.
   b. Define the IBNR (broad definition) in terms of Y, P, and C.
   c. Define the Total Unpaid Claims (Total Reserves) in terms of Y, P, and C.

6. Throughout the Study Manual we see that most often past questions have provided reported claims data, and asked us to solve for IBNR. However, some questions will ask for total unpaid claims or ultimate claims.
   a. What do we need to add to “IBNR” (broadly defined) to get total unpaid claims?
   b. What do we need to add to the “paid” claims to get ultimate claims?
   c. What do we need to add to the “reported” claims to get ultimate claims?

7. The previous three questions apply to Accident Year data (by far, the most common).
   a. What is the key fact about development, when working with Calendar Year data?
   b. What is the key fact about development, when working with Report Year data?

1995 Exam Questions (modified):

1. True/False. According to the CAS Statement of Principles on Reserves, policy effective date is one of the key dates in the organization of a reserving database.

1997 Exam Questions (modified):

48. You are given the following information:

Cumulative Report Year Claims ($000's) at:

Report Year Ending	12 mos.	24 mos.	36 mos.	48 mos.	Estimated Ultimate ($000's)	Required Reserve ($000's)
12/31/93	60	66	69	69	69	0
12/31/94	50	55	58		58	3
12/31/95	70	77			81	11
12/31/96	80				92	0
					Total:	14
Selected Age-to-Age:	1.10	1.05	1.00	1.00		
Cumulative CDF:	1.16	1.05	1.00	1.00		

"Required reserve" = Estimated ultimate claims - Reported Claims = $14,000 for all insured claims incurred on or before 12/31/95 (for financial reporting purposes).

a. (0.25 point) What is the accounting date of the evaluation of the required reserve (unpaid claims estimate)?

b. (0.25 point) What is the valuation date of the evaluation of the required reserve (unpaid claims estimate)?

c. (0.5 point) Which of the following components of a total loss reserve (unpaid claims estimate) are considered in the "required reserve" for this report year analysis? Explain your answer.

Case outstanding estimates at 12/31/06

Future development on known claims

Incurred but not reported claims

53. You have recently been hired as the chief actuary of a small multi-line property and casualty company. The company has the following written premium by line during the past three years:

Line of Business	1994	1995	1996
Commercial Auto Bodily Injury Liability	$100,000	$150,000	$225,000
Personal Auto Bodily Injury Liability	200,000	220,000	242,000
Commercial Auto Property Damage Liability	20,000	30,000	45,000
Personal Auto Property Damage Liability	40,000	44,000	48,400
Commercial Multi-Peril	250,000	275,000	300,000
Workers Compensation	5,000	5,000	5,000

a. (1 point) Your first task as chief actuary is to determine how the data will be segregated by line for reserving purposes. Based on the discussion in Friedland, list three considerations you would use in making this decision.

b. (2 points) Based on your answers from (a), list the different lines of business that you would combine for reserving purposes, explaining your rationale for each grouping.

2011 Exam Questions:

21. (2 points) A large insurer is considering combining data from a long-tailed, low-frequency line of business with data from a short-tailed, high-frequency line of business to estimate unpaid claims.

Identify and briefly discuss four characteristics of the data that should be considered before combining these lines of business.

2012 Exam Questions:

16. (2 points) Below are four independent scenarios for estimating ultimate losses as of December 31, 2011. For each, briefly explain why the actuary should not use the data described and identify a more appropriate alternative.

    a. (0.5 point) Prior to 2010, all policies for a property insurer had a $1,000 deductible. Effective January 1, 2010, all policies were written with a $5,000 deductible. The actuary intends to use accident year data.

    b. (0.5 point) The insurer writes general liability coverage in one state only. The average severity of litigated claims reported after January 1, 2010 is twice the value of claims reported prior to January 1, 2010. The actuary intends to use accident year data.

    c. (0.5 point) A general liability claim with both bodily injury and property damage case estimates would have counted as one claim count prior to 2010 and is now recorded as two. The actuary intends to use claim counts as an exposure base.

    d. (0.5 point) The rate of growth of earned exposures has increased dramatically over the past two years, which has changed the average accident date significantly. The actuary intends to use accident year data.

Solutions to Sample Questions:

1. List and describe five key dates regarding data organization for loss reserving, per Friedland Ch 3.
   Policy Effective Date, Accident Date, Report Date, Accounting Date, Valuation Date

2. Which of the following statements is/are true?
   ❶ The valuation date can be on, after, or before the accounting date True.
   ❷ Case Outstanding represents estimated settlement values assigned to known claims. True.
   ❸ A liability provision for reopened claims is generally needed only for the medical malpractice line of business
   False. Generally only for the workers compensation line of business
   1. ❶ 2. ❷ **3. ❶, ❷** 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

3. Friedland discusses how techniques to estimate unpaid losses may be used with data arranged into different time intervals. List the 6 groupings discussed (See also Chapters 5 and 9).
   Accident Year, Policy Year, Treaty Year, Underwriting Year, Report Year, Fiscal Year

For the next three questions, assume data is organized and analyzed by Accident Year:

4. Assume you have applied one of the techniques, on paid claims, described in Friedland to estimate unpaid claims of \$X. Let paid claims at the evaluation date = P and case outstanding estimates = C.
   a. Ultimate Claims = Paid Claims + Unpaid Claims = P + X
   b. IBNR = Total Unpaid Claims – Case Outstanding = X - C
   c. Total Unpaid Claims = Total Reserve = Case Outstanding “C” + IBNR = X
   d. Reported Claims = Paid Claims + Case Outstanding = P + C
   Note: Friedland comments that actuaries often use “case incurred” or even just “incurred” losses to describe “reported” claims. Also note, it generally refers to a cumulative total amount.

5. Assume you have applied one of the techniques, on reported claims, described in Friedland to estimate IBNR of \$Y. Let paid claims at the evaluation date = P and case outstanding estimates = C.
   a. Ultimate Claims = Paid Claims + Case Outstanding + IBNR (broadly defined) = P + C + Y
   b. IBNR = Y
   c. Total Unpaid Claims = Total Reserve = Case Outstanding “C” + IBNR = C + Y

6. Throughout the Study Manual we see that most often past questions have provided reported claims data, and asked us to solve for IBNR. However, some questions will ask for total unpaid claims or ultimate claims.
   a. We need to add <u>Case Reserves</u> to “IBNR” (broadly defined) to get total unpaid claims.
   b. We need to add <u>Total Unpaid Claims (Reserves)</u> to the “paid” claims to get ultimate claims.
   c. We need to add <u>IBNR</u> (broadly defined) to the “reported” claims to get ultimate claims.

7. The previous three questions apply to Accident Year data (by far, the most common).
   a. On Calendar Year data, there is no future development.
   b. On Report Year, Friedland comments: “Estimation techniques based on claims aggregated by report year only measure development on known claims and not pure IBNR …”

Solutions to 1995 Exam Questions (modified):

1. True/False. According to the CAS Statement of Principles on Reserves, policy effective date is one of the key dates in the organization of a reserving database.

   False, their key dates are: accident date, report date, recorded date, accounting date, and valuation date.

   Friedland, however, does discuss Policy Effective date.

Solutions to 1997 Exam Questions (modified):

48. (0.25 point) NOTICE REPORT YEAR (NOT ACCIDENT YEAR) Friedland comments: “Estimation techniques based on claims aggregated by report year only measure development on known claims and not pure IBNR …”

    a. (0.25 point) What is the accounting date of the evaluation of the required reserve?

       Accounting date = 12/31/95; this is the date at which we are interested in estimating our liability for financial reporting purposes.

    b. (0.25 point) What is the valuation date of the evaluation of the required reserve?

       Valuation date = 12/31/96; this is the date through which actual claims transactions are included in the data we are using for the analysis.

    c. (0.5 point) Which of the following components of a total loss reserve (unpaid claims estimate) are considered in the “required reserve” for this report year analysis? Explain your answer.

       Case reserves: <u>Not included</u> since they’re a part of incurred loss as of December 31, 1995

       Future development on known claims: <u>Included</u>

       Incurred but not reported claims: Claims that are truly incurred but not reported are <u>excluded</u> from the analysis because the data is accumulated on a report year basis. Claims that have been reported but not yet recorded would be included.

53. a. (1 point) Your first task as chief actuary is to determine how the data will be segregated by line for reserving purposes. Based on the discussion in Friedland, list three considerations you would use in making this decision.

    Segregate data for reserving purposes based on expected differences in

    - Volume of data needed for credibility
    - Homogeneity of data (loss ratios and development patterns)
    - Growth rates/change in exposure levels

    Friedland comments in Chapter 3: “It is often possible to improve the accuracy of estimating unpaid claims by subdividing experience into groups exhibiting similar characteristics, such as comparable claim experience patterns, settlement patterns, or size of claim distributions.”

Solutions to 1997 Exam Questions (modified - continued):

b. (2 points) Based on your answers from (a), list the different lines of business that you would combine for reserving purposes, explaining your rationale for each grouping.

- Combine commercial auto liability BI and PD because:
  1. Mix of business is constant:

	1994	1995	1996
Commercial Auto, Total	$120,000	$180,000	$270,000
% BI	83.3%	83.3%	83.3%
% PD	16.7%	16.7%	16.7%

  2. Development characteristics are comparable (both 3rd party commercial liability lines)

- Combine commercial auto liability BI and PD because:
  1. Mix of business is constant:

	1994	1995	1996
Personal Auto, Total	240,000	264,000	290,400
% BI	83.3%	83.3%	83.3%
% PD	16.7%	16.7%	16.7%

  2. Development characteristics are comparable (both 3rd party personal liability lines)

- Keep commercial multi-peril and workers compensation separate because: different development characteristics and different growth rates of these lines of business. Find another source of data to supplement the limited available workers compensation data.

Solutions to 2011 Exam Questions

21. Identify and briefly discuss four characteristics of the data that should be considered before combining these lines of business.

Question 21 – Model Solution

1. Credibility of the Data

   Consider if each line has a large volume of data to be credible. If not, combining the data may be the alternative.

2. Severity (average claim size)

   Average claim size for each line should be considered since using combined data can distort the results from various estimation techniques, causing the unpaid claim estimate to be inaccurate. Usually, long-tailed-low-frequency lines have higher severity (e.g. medmal) than short-tailed high frequency (e.g. Auto PD)

3. Case reserve adequacy

   Review the case reserving philosophy used on each line of business. Different reserving practices may affect the results of estimated unpaid claims.

4. Claim settling rate

   Consider the differences between the claim settlement rates of the lines being reviewed. This is crucial because long-tailed low frequency lines usually have longer reporting patterns. Applying the resulting development factors from this data to the combined data may distort the true unpaid claim estimate.

Solutions to 2012 Exam Questions

16. (2 points) Below are four independent scenarios for estimating ultimate losses as of December 31, 2011. For each, briefly explain why the actuary should not use the data described and identify a more appropriate alternative.

    a. (0.5 point) Prior to 2010, all policies for a property insurer had a $1,000 deductible. Effective January 1, 2010, all policies were written with a $5,000 deductible. The actuary intends to use accident year data.

    b. (0.5 point) The insurer writes general liability coverage in one state only. The average severity of litigated claims reported after January 1, 2010 is twice the value of claims reported prior to January 1, 2010. The actuary intends to use accident year data.

    c. (0.5 point) A general liability claim with both bodily injury and property damage case estimates would have counted as one claim count prior to 2010 and is now recorded as two. The actuary intends to use claim counts as an exposure base.

    d. (0.5 point) The rate of growth of earned exposures has increased dramatically over the past two years, which has changed the average accident date significantly. The actuary intends to use accident year data.

Question 16 – Model Solution 1 (Exam 5B Question 1)

a. Using AY data is not appropriate because of the shift in the mix of business (changing deductibles). An analysis using Policy year data is more appropriate.
b. Use of Report year data is better than AY data because of the shift in severity. The change in severity will likely cause the occurrence data to better be correlated with the report data so RY data is best.
c. Using earned exposure instead of the claim counts would be better to use because of the change in the definition of a claim count. Using claim counts would distort the analysis because of the changed)
d. Use of accident quarter would be better used then AY data because of the shift in growth over the past two years. AY data will be distorted because of the growth distribution change.

Question 16 – Model Solution 2 (Exam 5B Question 1)

a. Because there is a change in deductible, policy year data should be used.
b. Average severity is more correlated to when the claim was reported so report year data would be more appropriate.
c. There is a change in claim count definition so the actuary should use earned exposures instead.
d. Because the average accident data has changed, the actuary should use accident quarter data.

Examiner's comments

Overall, the candidates did well on this question. Many candidates have no problem stating the alternative to use.

Some had trouble explaining the inappropriateness of using accident year data (for 3 of the 4 parts in the question).

Sometimes candidates provided explanation that either would have rendered accident year data inappropriate even before the change, or would have continued to be a problem even with their suggested alternative.

Candidates with the better answers were able to point out the essence of the change described in the question and explain how accident year data/claim count fails to continue to be appropriate.

1 Understanding the Environment 44 - 45

Before developing estimates of unpaid claims, the actuary must first understand:

- circumstances within the insurer's organization as well as
- the economic, social, legal, and regulatory environments that affect the insurer’s liabilities.

A sound understanding of the insurer’s internal and external environment is needed to correctly interpret patterns and changes in the data.

Claims reporting and payment patterns, frequency, and severity can be altered by changes in:

* Classes of business written or geographical writings
* Policy provisions (e.g. policy limits and deductibles)
* Reinsurance arrangements (including limits and attachment points)
* Claims management philosophy that often occur when managerial changes occur
* Claims processing lags (e.g. when a new technology is implemented) or when department staffing is disrupted (e.g. in the event of a merger or a major catastrophe) overwhelming the claim department's capacity
* Legal and social environment (e.g. introduction of no-fault auto insurance, court system back-logs, new court rulings, and implementation of tort reform)

  Note: Tort reform is legislation designed to reduce liability costs through limits on various kinds of damages and/or through modification of liability rules.
* Economic environment (e.g. an increase in the inflation rate or a decrease in the interest rate).

Information gathering requires a great deal of back-and-forth dialogue between the actuary and management.

To collect data and information, the process must include both a review of quantitative data and discussions with members of the insurer's claim and underwriting departments.

Based on the Berquist/ Sherman paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach”, the appendix contains a list of possible interview questions for the various departments of an insurer.

By asking such questions, the actuary gains a better understanding of the specific circumstances of particular books of business, and thus guides the actuary to choose the most appropriate methods for determining unpaid claim estimates.

The following questions are presented from the perspective of a consultant interviewing insurance company management.

2 Sample Questions for Department Executives 45 - 49

A. Questions for a Claims Executive

1. What specific objectives and guidelines does the department have in setting unpaid case?

   Are unpaid case established on what it would cost today to settle the case, or has a provision for inflation between now and the time of settlement been included in the case outstanding?
2. Have there been any significant changes in setting and reviewing unpaid case during the last 5 years?
3. Have there been any changes in the definitions of or rules for setting bulk or formula reserves for reported claims in the last 5 years?
4. Are any special procedures or guidelines used in the reserving of large or catastrophic claims?
5. Has the adjuster's caseload size changed significantly in the past several years?
6. When is a claim file established?
7. Are claims files setup for each claimant or for each accident? What procedures are used when there are multiple claimants from the same accident? Is a claim file setup for each coverage or for all coverages combined?
8. What procedures are used in recording reopened claims? Are such claims coded to the report date of the original claim or to the date of reopening? How will the reopening of a claim affect aggregate data for paid, open or reported claims and paid, outstanding or incurred losses?
9. Have there been shifts in the reporting or non-reporting of small/trivial claims? In the procedures for the recording of such?
10. Has there been any shift in emphasis in settling large versus small claims? In the relative % of such claims? In attitudes in adjusting such claims?
11. Have there been any changes in the guidelines on when to close a claim?

    For example, is a P.D. (property damage) claim kept open until the associated B.I. (bodily injury) claim is closed, or only until the P.D. portion is settled?
12. Have there been changes in the rate of settlement of claims recently?
13. Has there been any shift from the use of company adjusters to independent adjusters? Or vice versa? If so, how has this affected the operations of the claims department?
14. Has there been any change in the timing of the payment of ALAE? Are such payments made as the expenses are accrued (or incurred) or when the claim is closed?
15. Has there been any change in the definition and limit for one-shot or fast-track claims in recent years? What is that limit?
16. What safeguards against fraudulent claims are used? Are any special procedures followed in the event of the filing of questionable or non-meritorious claims? Have these safeguards changed in recent years?
17. Have there been any shifts toward (or away from) more vigorous defense of suits in recent years?
18. Could you provide copies of all bulletins to the field issued in the last 5 years in which details of the changes in claims procedures are provided?
19. Could you provide copies of recent claim audits?
20. For WC, what mortality table was used (year and general population or disabled lives table) to set the unpaid case for permanently disabled claimants?
21. For large open claims, has there been any revision in the reserve since the latest evaluation date of the claims experience?
22. Are unpaid cases set at an expected level, the most likely settlement amount, or the minimum possible amount (or some other standard)?

B. Questions for an Underwriting Executive

1. What changes have occurred in your company's book of business and mix of business in the past 5-7 years? How are the risks insured today different from those of the past?
2. Do you underwrite any large risks which are not characteristic of your general book of business?
3. Have any significant changes occurred in your underwriting guidelines in recent years?
4. Has the proportion of business attributable to excess coverages for self-insurers changed in recent years? Can a distribution of such business be obtained by line, retention limit, class, etc.?

   Is a record of self-insured losses and claims available?
5. How many different programs or types of risk are premium and claims experience tracked and compiled into claim ratio runs?
6. Are any details of excess policies (e.g. attachment points, exclusions, per occurrence, sunset clauses, aggregate caps, etc.) available?
7. How frequent are experience summaries run? How far back are these available?
8. How are new programs priced? If you are relying on another insurer's filings, how similar are the underlying books of business?

C. Questions for a Data Processing or Accounting Executive

1. Has there been any date change as to when books are closed for the quarter? The year?
2. How are claim payments handled for claims which have already been paid, but which have not yet been processed to the point where they can be allocated to accident quarter? Are they excluded from the loss history until they are allocated to accident quarter or are they loaded into an arbitrary quarter?
3. Have new data processing systems been implemented in recent years? Have they had a significant impact on the *rate of processing claims* or on the *length of time required from the reporting to the recording of a claim*?
4. Are data sources crosschecked and audited for accuracy and for balancing to overall company statistics? Comment on the degree of accuracy with which each kind of statistic has been properly allocated to accident quarter, to line of business, to size of loss, etc.
5. Have there been any changes in coding procedures which would affect the data supplied?
6. Can partial payments exceed the case outstanding on a claim? If so, what adjustments are made? Are unpaid case taken down by the amount of partial payments?
7. How far back can the claims data be actively re-compiled by various key criteria?
8. What data elements are available for each claim? For each risk?
9. By what key criteria could the historical claims data be freshly compiled? Examples of criteria: size of loss breakdowns, type of claim breakdowns (e.g., liability vs. property for commercial multi-peril or homeowner multi-peril), separate compilations by policy limit, or deductible, or type of claim, or state.
10. Can data be compiled either by claimant or occurrence, if multiple claims are set for one occurrence?

D. Questions for Actuaries Specializing in Ratemaking

1. Have there been any changes in company operations or procedures which have caused you to depart from standard ratemaking procedures? If so, please describe those changes and how they were treated.
2. What data used for ratemaking purposes could also be used in testing unpaid claims?
3. Has there been any significant shifts in the business by type of risk or type of claim within the past several years?

D. Questions for Actuaries Specializing in Ratemaking (continued):

4. Do you have any of the following sources of information which may be of value in reserve testing:
   a. External economic indices,
   b. Combined claims data for several companies (e.g., data obtainable from bureau rate filings),
   c. Special rating bureau studies,
   d. Changes in state laws or regulations, and
   e. Size of loss or cause of loss studies?
5. Could we obtain copies of recent rate filings?
6. Were there any changes in statues, court decisions, extent of coverage that necessitated some reflection in the rate analysis?
7. How are new programs priced? If you are relying on another insurer's filing, how similar are the underlying books of business?

E. Questions for In-House Actuaries

1. Could we obtain copies of any and all actuarial studies done by consultants, auditors or internal actuaries?
2. What areas of disagreement are there between these different studies?
3. What specific background information did you take into account in making your selections?

3 Additional Questions 49 - 50

The authors recommend the following questions be added for meetings with senior management of the insurer.

F. Questions for Those Managing Reinsurance

* Please provide details of reinsurance treaties for both assumed and ceded business.
* Please provide details of all reinsurance ceded treaties including:
  i. Retention level or Q.S. %
  ii. Reinsurers involved (including participation)
  iii. Details of any sliding scale premium, commission, or profit commission (including currently booked amounts)
  iv. Any problems or delays encountered in collecting reinsurance

* Please provide details of any internal or sister company reinsurance agreements (cover notes, relevant amounts, and by-line breakdowns).
* Have the reinsurance programs for next year been secured? If so, under what terms?

G. Questions for Senior Management

Please provide a brief description of the company's operations including:

* An organization chart (with recent changes highlighted)
* Details of ownership
* Description of types of business written (including all special programs)
* Description of marketing (i.e., direct writer, independent agent, etc.)

INTRODUCTION

A development triangle shows changes in the value of various cohorts (groups of claims) over time.

The table below shows how cumulative paid claims by insurers arising out of auto accidents that occurred during 2006, 2007, and 2008 (the cohorts) increased from year-end 2006 to year-end 2007 to year-end 2008

Table 1 - Paid Claims and Expenses ($US Billions)
by Year End Accounting Date

Accident Year	Year-end 2006	Year-end 2007	Year-end 2008
2006	100	150	170
2007		110	161
2008			115

Development for any of these AY cohorts is the change in the value for the cohort over time.
Paid claims and expense for AY 2006 experienced development of $50 billion (due to the change from $100 billion to $150 billion)

It is easier to observe development by looking at the age (or maturity) of the cohort rather than the accounting date for the cohort.

The above triangle reformatted to reflect this approach is shown below:

Table 2 – Paid Claims and Expenses ($US Billions)
by Age

Accident Year	12 Months	24 Months	36 Months
2006	100	150	170
2007	110	161	
2008	115		

Age (or maturity) is measured from the start of the cohort period. For example, the:

- age of AY 2006 (valued at year-end 2006) is 12 months from the start of the AY.
- age of AY 2006 (valued at year-end 2007) is 24 months from the start of the AY.

Both approaches result in data in a triangle shape (hence the term development triangle).

However, in the second triangle it is easier to see how the:

- volume (or scale) of the AY cohort changes from one AY to the next (vertically) and
- value of cumulative paid claims for an AY changes from age to age (horizontally).

Development can be positive or negative. For example:

- the number of claims occurring in an AY will increase from one valuation point to another until all claims are reported. The number of claims decreases at successive valuations.

  however, the number of claims can decrease from one valuation point to another (see Chapter 11, private passenger auto collision coverage)
- reported claim development can show downward patterns if the insurer:
  i. settles claims for a lower value than the case O/S estimate or
  ii. includes recoveries with the claims data.

Development patterns are critical inputs to many techniques used to estimate unpaid claims.

In this chapter, we demonstrate:

- how to build development triangles for paid claims, case O/S, reported claims, and reported claim counts.
- the use of payment and case O/S for a sample of 15 claims over a 4-year time horizon.

1 Rows, Diagonals, and Columns 52 - 54

There are three important dimensions in a development triangle:

1. Rows 2. Diagonals 3. Columns

Table 3 — Reported Claim Triangle

Accident	**Reported Claims as of (months)**			
Year	12	24	36	48
2005	1,500	2,420	2,720	3,020
2006	1,150	1,840	2,070	
2007	1,650	2,640		
2008	1,740			

Each row in the triangle represents one AY.

Data organized by AY groups claims according to the date of occurrence (i.e. the accident date), and each row consists of a fixed group of claims.

Rows:

The first row of the triangle contains claims occurring in 2005; the second row, claims occurring in 2006; the third row, claims occurring in 2007; and the final row, claims occurring in 2008.

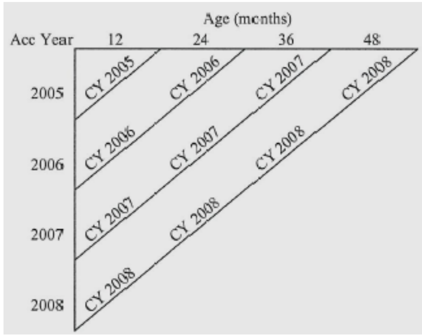
Diagonals:

Each diagonal represents a successive valuation date.

* The first diagonal (a single point) is the 12/31/2005 valuation
* The next diagonal is the 12/31/2006 valuation for AYs 2005 and 2006
* The next diagonal is the 12/31/2007 valuation for AYs 2005 through 2007
* The last diagonal is the 12/31/2008 valuation for AYs 2005 through 2008

The diagonals and corresponding valuation dates are shown below.

CY in the diagram below refers to calendar year.



The first diagonal (in the upper left corner of the triangle) is at the 12/31/2005 valuation date and represents AY 2005 at 12 months of maturity.

AY 2005 begins on 1/1/2005 and is 12 months old at 12/31/2005.

The second diagonal at the 12/31/2006 valuation date and consists of AY 2005 ay 24 months old and AY 2006 at 12 months old.

The last diagonal of the triangle at a valuation date of 12/31/2008 represent claims for:

* AY 2005 as of 48 months (counting from the start of the AY, 1/1/ 2005, to the valuation date of 12/31/2008)
* AY 2006 as of 36 months (counting from 1/1/2006 to 12/31/2008)
* AY 2007 as of 24 months
* AY 2008 as of 12 months

Column:

Each column represents an age (or maturity) related to the combination of AY and valuation date used to create the triangle.

The data is AY using annual valuations, and thus the ages in the columns are 12 months, 24 months, 36 months, and 48 months.

Different valuations can be used (e.g. 6 months, 12 months, 18 months, etc.).

2 Alternative Format of Development Triangles 54

Development triangles with the rows corresponding to the experience period (e.g. AY in the prior example) and the columns representing the maturity ages are the most common presentation of development triangles.

Some insurers reverse this orientation and present AYs (or policy or underwriting years) as the columns and the maturity ages as the rows.

3 Detailed Example of Claim Development Triangles 54 - 60

Understanding the Data

To better understand how to create a claim development triangle, individual claims data underlying the reported claim triangle shown in Table 3 is used.

How claims amounts in the claims listing below are integrated into the cells of a claim development triangle is shown below. Case O/S means case outstanding.

Table 5 – Detailed Example – Claims Transaction Data

			2005 Transactions		2006 Transactions		2007 Transactions		2008 Transactions	
Claim ID	Accident Date	Report Date	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S
1	Jan-5-05	Feb-1-05	400	200	220	0	0	0	0	0
2	May-4-05	May-15-05	200	300	200	0	0	0	0	0
3	Aug-20-05	Dec-15-05	0	400	200	200	300	0	0	0
4	Oct-28-05	May-15-06			0	1,000	0	1,200	300	1,200
5	Mar-3-06	Jul-1-06			260	190	190	0	0	0
6	Sep-18-06	Oct-2-06			200	500	0	500	230	270
7	Dec-1-06	Feb-15-07					270	420	0	650
8	Mar-1-07	Apr-1-07					200	200	200	0
9	Jun-15-07	Sep-9-07					460	390	0	390
10	Sep-30-07	Oct-20-07					0	400	400	400
11	Dec-I2-07	Mar-10-08							60	530
12	Apr-12-08	Jun-18-08							400	200
13	May-28-08	Jul-23-08							300	300
14	Nov-12-08	Dec-5-08							0	540
15	Oct-15-08	Feb-2-09								

The table above contains detailed information for 15 claims that occurred in AYs 2005 - 2008.

The first column shows the claim ID number; the next two columns are the accident date and the report date.

The accident date is needed to determine the appropriate row of the triangle.

The report date determines when the claim first enters the triangle.

The table includes claim payments made in the year and the ending case O/S value.

Claim payments are not cumulative paid values, but are transactional payments made during the year.

The case O/S values are the *ending* case O/S values.

Step-by-Step Example

A step by step demonstration on how to create the paid claims, case O/S, reported claims, and reported claim count triangles will be given.

To build the cumulative paid triangle, begin with incremental paid claim development triangle (see Table 6 below, an excerpt of Table 5, which shows payment transactions).

Using the data below, an incremental payments triangle showing the amounts paid in each 12-month calendar period for the fixed group of claims will be constructed.

Table 6 - Detailed Example – Claims Transaction Paid Claims Data

Claim ID	Accident Date	Report Date	Incremental Payments in Calendar Year 2005	2006	2007	2008
1	Jan-5-05	Feb-1-05	400	220	0	0
2	May-4-05	May-15-05	200	200	0	0
3	Aug-20-05	Dec-15-05	0	200	300	0
4	Oct-28-05	May-15-06		0	0	300
5	Mar-3-06	Jul-1-06		260	190	0
6	Sep-18-06	Oct-2-06		200	0	230
7	Dec-1-06	Feb-15-07			270	0
8	Mar-1-07	Apr-1-07			200	200
9	Jun-15-07	Sep-9-07			460	0
10	Sep-30-07	Oct-20-07			0	400
11	Dec-12-07	Mar-10-08				60
12	Apr-12-08	Jun-18-08				400
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				0
15	Oct-15-08	Feb-2-09				

For claims that occurred during 2005, the insurer paid a total of:

- $600 (400 +200) during the first 12-month period (2005),
- $620 (220+200+200) during the second 12-month period (2006), and
- $300 in each of the following two 12-month periods (2007 and 2008).

For claims that occurred during 2006, the insurer paid

- $460 (260+200) during 2006,
- $460 (190+270) during 2007 and
- $230 during 2008.

Use the same approach for each AY grouping of claims to derive the following triangle of *__incremental__* paid claims.

Table 7 — Incremental Paid Claim Triangle

Accident Year	Incremental Paid Claims as of (months) 12	24	36	48
2005	600	620	300	300
2006	460	460	230	
2007	660	660		
2008	700			

The incremental paid claim triangle is used for diagnostic purposes and for some frequency-severity techniques.

Actuaries use cumulative paid claim triangles more often, created using the incremental paid claim triangle.

1. The first column in the incremental and cumulative triangles at age 12 months is the same (i.e. incremental paid claims equal cumulative paid claims at the first maturity age).
2. The second column of the cumulative paid claim triangle equals the second column (i.e. age 24 months) of the incremental paid claim triangle added to the first column of either triangle.
3. The third column of the cumulative paid claims at 36 months is equal to the cumulative paid claims at 24 months plus the incremental paid claims at 36 months.

Table 8 — Cumulative Paid Claim Triangle

Accident	Cumulative Paid Claims as of (months)			
Year	**12**	**24**	**36**	**48**
2005	600	1,220	1,520	1,820
2006	460	920	1,150	
2007	660	1,320		
2008	700			

An alternative way to computing the cumulative claim triangle rather than simply cumulating the incremental paid triangle follows:

The first cell of the cumulative paid claim development triangle is AY 2005 at a valuation date of 12/31/2005 (a.k.a. AY 2005 at 12 months).

4 claims occurred in 2005 (Claim IDs 1, 2, 3, and 4).

- The first 3 claims occurred <u>and</u> were reported to the insurer during 2005.
- Claim ID 4 was not yet reported as of the 12/31/2005 valuation date.
- Claim ID 3 did not have any payments as of 12/31/2005.

Thus, the \$600 paid claims appearing in the first cell of the triangle are the payments for Claim IDs 1 and 2 during the year 2005.

Constructing the second diagonal of the cumulative paid claim triangle (i.e. the 12/31/2006 valuation).

It contains two points: AY 2005 at 24 months and AY 2006 at 12 months.

- First calculate the value of paid claims at 24 months for AY 2005.

  Total payments made during 2006 for Claim IDs 1, 2, 3, and 4 are \$620 (\$220 + \$200 + \$200 + \$0). Cumulative claim payments for AY 2005 through 12/31/2006 equal the sum of the payments made during 2005 and the payments made during 2006 = 600+ 620 = \$1,220.
- Next calculate the payments for AY 2006 at 12 months.

  Claim IDs 5 and 6 were reported in 2006, and Claim ID 7 is not included in the calculation for the 12/31/2006 valuation since it was not reported as of the 12/31/2006 valuation.

  Thus, paid claims for AY 2006 as of 12/31/2006 equal to the sum of claim payments (\$260 + \$200) for Claim IDs 5 and 6.

Constructing the third and fourth diagonals of the cumulative paid claim triangle (i.e. the 2007 and 2008 diagonals).

The third diagonal consists of three points:

* AY 2005 at 36 months; * AY 2006 at 24 months; * AY 2007 at 12 months

The fourth diagonal consists of AY 2005 at 48 months, AY 2006 at 36 months, AY 2007 at 24 months and AY 2008 at 12 months.

A similar procedure to the example above is used in cumulating claim payments made through 12/31/2007 and 12/31/2008.

Case O/S Triangle

Table 9 is an excerpt from Table 5 presented earlier in the chapter.

Table 9 – Detailed Example – Claims Transaction Ending Case Outstanding Data

			Ending Case Outstanding			
Claim ID	**Accident** Date	**Report** Date	2005	2006	2007	2008
1	Jan-5-05	Feb-1-05	200	0	0	0
2	May-4-05	May-15-05	300	0	0	0
3	Aug-20-05	Dec-15-05	400	200	0	0
4	Oct-28-05	May-15-06		1,000	1,200	1,200
5	Mar-3-06	Jul-1-06		190	0	0
6	Sep-18-06	Oct-2-06		500	500	270
7	Dec-1-06	Feb-15-07			420	650
8	Mar-1-07	Apr-1-07			200	0
9	Jun-15-07	Sep-9-07			390	390
10	Sep-30-07	Oct-20-07			400	400
11	Dec-12-07	Mar-10-08				530
12	Apr-12-08	Jun-18-08				200
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				540
15	Oct-15-08	Feb-2-09				

Use the table above to create the case O/S development triangle below.

Table 10 – Case Outstanding Triangle

Accident	Case Outstanding as of (months)			
Year	12	24	36	48
2005	900	1,200	1,200	1,200
2006	690	920	920	
2007	990	1,320		
2008	1,040			

Case O/S for AY 2005 at 12 months is computed by adding the ending case O/S values for Claim IDs 1, 2, and 3 (200+300+400) to derive the case O/S value of $900.

Claim ID 4 case O/S is not included since it is not reported until 5/15/2006.

Case O/S for AY 2005 at 24 months equal case O/S values for Claim IDs 3 and 4 or $1,200 ($200 + $1,000).

Note that case O/S for Claim IDs 1 and 2 are both $0 at December 31, 2006.

Case O/S for AY 2005 at 36 months and 48 months equal the ending case O/S for Claim ID 4 of $1,200.

Case O/S for AY 2006 at 12 months (i.e., valuation date December 31, 2006) equals $690 which is equal to the sum of the ending case O/S for Claim IDs 5 and 6 ($190 + $500).

Case O/S at 24 months equals the sum of case O/S on all three AY 2006 claims ($0 + $500 + 420).

Case O/S for AY 2006 at 36 months equals $920 which is equal to the case O/S for Claim IDs 6 and 7

Continue in a similar manner to build the remainder of the case O/S development triangle.

<u>Reported Claim Development Triangle</u>

Definition: Reported claims equal cumulative paid claims plus case O/S at the valuation date.

Thus, reported claim development triangle equal cumulative paid claim triangle plus the case O/S triangle.

Table 11 — Reported Claim Development Triangle

Accident	**Reported Claims as of (months)**			
Year	12	24	36	48
2005	1,500	2,420	2,720	3,020
2006	1,150	1,840	2,070	
2007	1,650	2,640		
2008	1,740			

Commentary: What happened to AY 2005 claims over time?

Claim ID 1 occurred and was reported 2005.

- By 12/31/2005 (the first year of development), there were $400 in payments and case O/S of $200.
- During 2006, a claim payment of $220 ($20 more than the case O/S) and the case O/S was reduced to $0.
- There was no further activity on this claim through year-end 2008.

Claim ID 2 occurred and was reported in 2005

- By 12/31/2006, there was a claim payment of $200 and case O/S of $300
- During 2006, the claims was settled $200 ($100 less than the $300 case O/S).

Claim ID 3 occurred and was reported in 2005.

- By 12/31/2005 an initial case O/S of $400 as set.
- During 2006, a $200 payment was made and case O/S was reduced to $200.
- During 2007, a final payment was made for $300, causing the final incurred value to be $500 ($100 more than the reported claim estimates at year-ends 2005 and 2006).

Claim ID 4 occurred in 2005 and was reported 2006.

- By 12/31/2006, the case O/S was $1,000 for this claim.
- By 12/31/2007, the case O/S had increased to $1,200.
- There were no payments in either 2006 or 2007.
- In 2008, claim payments were $300 but there was no change in the ending case O/S.
  Thus, the reported claim increased by $300 during 2008 from
  $1,200 (cumulative claim payments through 12/31/2007 of $0 plus ending unpaid case of $1,200) to
  $1,500 (cumulative claim payments through 12/31/2008 of $300 plus ending unpaid case of $1,200).

Reported Claim Count Development Triangle

The data in Table 5 can be used to build a reported claim count triangle. A description of how to build the claim count development triangle by using AYs 2005 and 2008 follows.

Table 12 — Reported Claim Count Development Triangle

Accident	**Reported Claim Counts as of (months)**			
Year	**12**	**24**	**36**	**48**
2005	3	4	4	4
2006	2	3	3	
2007	3	4		
2008	3			

There are 4 claims for 2005, but only 3 of them were reported as of 12/31/2005.

Thus, the first cell in the reported claim count triangle which represents AY2005 as of 12/31/2005 shows 3 claims reported.

By 12/31/2006, all 4 claims were reported.

No further claims were reported for AY 2005, and thus the number of reported claims remains unchanged at 4 for ages 36 months and 48 months.

There are 4 claims for AY2008, but as of 12 months, only 3 claims were reported for AY 2008 (claim ID 15 was not reported until 2009 and thus is not included in the triangle).

4 Other Types of Development Triangles 60 - 62

Actuaries use a wide variety of data when creating development triangles.

First, determine the time interval (i.e. the rows of the triangles) data will be organizing into.

Other that AY, common intervals include:

* Report year
* Underwriting year
* Treaty year (i.e. a period of 12 months covered by a reinsurance contract or treaty)
* Policy year
* Fiscal year

AY is most common used by actuaries in the U.S. and Canada use when creating development triangles.

RY is used for analyzing claims-made coverages (e.g. medical malpractice and errors and omissions liability).

U/W year is used by reinsurers and PY is a similar to underwriting year.

For self-insurers:

- PY, FY, and AY are often the same. For example, a self-insured public entity may:

  have a *FY* 4/1 to 3/31, and

  issue documents of coverage to departments and agencies with an 4/1 to 3/31 coverage period; and arrange excess insurance with a *PY* of 4/1 to 3/31.
- Finally, this public entity may aggregate development triangles using *AY* periods of 4/1 to 3/31.

Time intervals (for organizing claims) other than annual intervals:

- include monthly, quarterly, and semi-annual data for developing estimates of unpaid claims.
- are selected after considering the credibility of the experience or the stability of development or both.

Types of claims data commonly appearing in development triangles include:

* Reported claims
* Case O/S
* Cumulative total paid claims
* Cumulative paid claims on closed claim counts
* Incremental paid claims Reported claim counts
* Claim counts on closed with payment
* Claim counts on closed with no payment
* Total closed claim counts
* O/S claim counts

Actuaries use the data types previously listed to create triangles of ratios and average claim values, which include:

* Ratio of paid-to-reported claims
* Ratio of total closed claim counts-to-reported claim counts
* Ratio of claim counts on closed ***with*** payment-to-total closed claim counts
* Ratio of claim counts on closed ***without*** payment-to-total closed claim counts
* Average case O/S (case O/S divided by O/S claim counts)
* Average paid on closed claims (cumulative paid claims on closed claims divided by claim counts closed with payment)

  Cumulative paid claims on closed claim counts may be difficult to obtain; Actuaries may determine that interim or pre-closing payments are immaterial enough to justify the inexact match from including all payments, even those from open claims/closed claim counts.
* Average paid (cumulative total paid claims divided by total closed claim counts)
* Average reported (reported claims divided by reported claim counts)

Triangles of ratios and average values provide useful insight into the relationships between the various types of data at different points in time during the experience period (see Chapter 6 as to how actuaries use these types of triangles as diagnostic tools).

LAE data may be analyzed independently of claims only. The actuary may create development triangles with:

- ratios of paid LAE-to-paid claims only and
- ratios of reported LAE-to-reported claims only.

How many development periods are needed to be evaluated?

- Should development be analyzed through the 3rd, 5th, 10th or the 20th maturity year?

  The actuary should analyze development out to the point at which the development ceases (i.e., until the selected development factors = 1.000).
- The number of development periods required varies by line, jurisdiction, and by data type. For example:

  Paid claims often require more development periods than reported claims.

  Reported claims often require more development periods than reported claim counts.

  Auto physical damage claims settle more quickly than general liability claims, and thus an analysis of unpaid claims for auto physical damage requires fewer development periods than for general liability.

In the following chapters, the development triangle is used as a diagnostic tool for numerous estimation techniques for unpaid claims.

5 Naming Convention for Examples 62

Naming conventions include the terms:

* "reported claims" to refer to cumulative reported claims and
* "paid claims" to refer to cumulative paid claims.
* "reported claim counts" and "closed claim counts" to refer to cumulative reported and closed claim counts.

For some examples in Chapters 11 - 13, *incremental* claims and claim counts are used

Questions from the 2010 Exam:

10. (1.75 points) Given the following information:

Cumulative Paid Loss ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	75,000	212,500	288,000	337,000
2007	50,000	165,000	310,000	
2008	115,000	238,000		
2009	85,000			

Case Outstanding ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	188,000	115,000	74,000	35,000
2007	175,000	94,000	45,000	
2008	115,000	238,000		
2009	208,000			

a. (0.25 point) Calculate reported claims for accident year 2007 as of December 31, 2009.
b. (0.5 point) Calculate paid claims for calendar year 2009.
c. (0.5 point) Calculate the change in case reserves for calendar year 2009.
d. (0.5 point) Briefly describe two benefits of organizing data for reserving on an accident year basis.

15. (1.75 points) Given the following claim detail ($000):

Claim	Accident Date	Paid During 2007	Case Reserve at 12/31/07	Paid During 2008	Case Reserve at 12/31/08	Paid During 2009	Case Reserve at 12/31/09
1	January 1, 2007	75	250	50	250	300	0
2	July 1, 2007	25	250	50	200	200	0
3	January 1, 2008			0	500	50	600
4	July 1, 2008			100	50	100	0
5	January 1, 2009					105	645

a. (0.5 point) Construct an accident year cumulative paid loss triangle.
b. (0.5 point) Construct an accident year cumulative reported loss triangle.
c. (0.75 point) Perform a diagnostic test to determine whether the data suggests a speed-up in claim payments.

Questions from the 2011 Exam:

22. (2.25 points) Given the following claim detail (000s):

Claim	Accident Date	Paid During 2008	Case Reserve at Year End 2008	Paid During 2009	Case Reserve at Year End 2009	Paid During 2010	Case Reserve at Year End 2010
1	March 3, 2008	$225	$190	$250	$0	$0	$0
2	July 18, 2008	$150	$500	$0	$500	$230	$270
3	December 1, 2008			$105	$75	$75	$25
4	March 1, 2009			$200	$200	$150	$100
5	October 3, 2009			$320	$280	$200	$0
6	November 3, 2009			$0	$100	$50	$100
7	April 12, 2010					$45	$55
8	June 28, 2010					$500	$500

a. (1.25 points) Construct the cumulative accident year reported loss development triangle as of December 31, 2010.

b. (0.5 point) Describe a situation in which it is preferable to use accident year data for estimating unpaid claims rather than report year data.

c. (0.5 point) Describe a situation in which it is preferable to use report year data for estimating unpaid claims rather than policy year data.

Solutions to questions from the 2010 Exam

10a. (0.25 point) Calculate reported claims for accident year 2007 as of December 31, 2009.

10b. (0.5 point) Calculate paid claims for calendar year 2009.

10c. (0.5 point) Calculate the change in case reserves for calendar year 2009.

10d. (0.5 point) Briefly describe two benefits of organizing data for reserving on an accident year basis.

Initial comments

AY Reported Claims = Cumulative AY Paid claims (as of a given evaluation date)
+ Latest AY case reserves (as of a given evaluation date)

CY Paid Claims = Sum (of the diagonal for a given evaluation date) of Cumulative Paid
- Sum (of the diagonal 1 year prior to the given evaluation date) of Cumulative Paid

CY Chg in Case Res = Sum (of the diagonal for a given evaluation date) of Case Reserves
- Sum (of the diagonal 1 year prior to the given evaluation date) of Case Reserves

For AY reported claims data, cumulative paid claims (for a given AY) + latest case reserves (for the same AY) are needed.

For CY paid claims data, cumulative paid claims (for all AYs as of a given evaluation date) + cumulative paid claims (for AYs 1 year prior to a given evaluation date) are needed.

Question 10 – Model Solution 1

a. AY 2007 reported claims at 12/31/2009 = $310M + $45M = $355M.

b. ($337M + $310M + $238M + $85M) - $288M - $165M - $115M = $402M

c. ($35M + $45M + $238M + $208M) - $74M - $94M - $115M = $243M

d. Numerous benchmarks are tracked by accident year. Tracking claims by accident year can be very useful when economic/regulatory changes have recently occurred, or if a significant large loss has occurred.

Question 10 – Model Solution 2

a. AY 2007 Reported Claims = Cumulative Paid + Cumulative Outstanding = $310,000 + $45,000 = $355,000.

b. Paid claims in 2009 = $85,000 + ($238,000 - $115,000) + ($310,000 - $165,000) + ($337,000 - $288,000)
= $402,000

c. 2008 case outstanding = $115,000 + $94,000 + $74,000 = $283,000.
2009 case outstanding = $208,000 + $238,000 + $45,000 + $35,000 = $526,000.
Change in case = $526,000 - $283,000 = $243,000.

d. It’s easier to understand. It’s a shorter time period than policy year.

Solutions to questions from the 2010 Exam

Question 15 – Model Solution 1

15a. (0.5 point) Construct an accident year cumulative paid loss triangle.

15b. (0.5 point) Construct an accident year cumulative reported loss triangle.

15c. (0.75 point) Perform a diagnostic test to determine whether the data suggests a speed-up in claim payments.

a. Cumulative Paid Triangle

	12	24	36
2007	100	200	700=75+25+50+50+300+200
2008	100	250=0+100+50+100	
2009	105		

b. Cumulative Reported = Cumulative Paid + Outstanding Case at Valuation

	12	24	36
2007	600	650	700=700+0
2008	650	850=250+600	
2009	750=105+645		

c. Cumulative Paid/Cumulative Reported

	12	24	36
2007	0.167	0.308	1.000
2008	0.154	0.294=250/850	
2009	0.14=105/750		

There seems to be a decrease in the paid/reported ratio at 12 months. This could be caused by either a slow-down in claim payments or increase in reserve adequacy. However, it is difficult to draw conclusions with this small amount of data. There is little credibility.

Question 15 - Model Solution 2 – Part c

a. Cumulative Paid Triangle (same as Model Solution 1)

b. Cumulative Reported (same as Model Solution 1)

c. Closed Claim Count/Reported Claim Count

	12	24	36
2007	0%	0%	100%=2closed/2reported
2008	0%	50%=1closed/2reported	
2009	0%		

It seems that we closed the claim in the 12-24 period faster for AY 2008 than for AY 2007. However, the experience is too thin, so it might be just random change but not intentional speeding up.

Question 15 - Model Solution 3 – Part c

Average Cumulative Payment

	12	24	36
2007	50	100	350=700/2
2008	50	125=250/2	
2009	105=105/1		

Again, it seems that we increase the average cumulative payment over years, but experience is too thin to draw meaningful conclusions.

Solutions to questions from the 2011 Exam

Question 22 – Model Solution 1

22a. (1.25 points) Construct the cumulative accident year reported loss development triangle as of 12/31/2010.

22b. (0.5 point) Describe a situation in which it is preferable to use accident year data for estimating unpaid claims rather than report year data.

22c. (0.5 point) Describe a situation in which it is preferable to use report year data for estimating unpaid claims rather than policy year data.

Incremental Paid Loss (as of months)

AY	12	24	36
8	375	355	305=230+75
9	520	400=150+200+50	
10	545=45+500		

Case reserve (as of months)

AY	12	24	36
8	690	575	295=270+25
9	580	200=100+100	
10	555=55+500		

Cumulative Rpt Loss (as of mths) = Cum. Paid loss + Case reserve

AY	12	24	36
8	1065	1305	1330 = 375+355+305+295
9	1100	1120=520+400+200	
10	1100=545+555		

b. AY data is widely used to estimate unpaid claims so there are many industry benchmarks and data based on AY aggregation. When the actuary wants to use such benchmarks or industry data, then it is preferable to use internal AY data as well.

c. When there is a severe change in legal or social climate that the average severity tracks more with the report date rather than the occurrence/accident date of the policy.

Question 22 – Model Solution 2

Initial comment on part a. The cumulative AY reported loss development triangle as of 12/31/2010 is correct, but no supporting calculations were given in this model solution. As a general rule, it's important to shown CAS examiners some of the calculations you performed to arrive at a triangle of values shown below.

a.

AY	*12*	*24*	*36*
2008	*1065*	*1305*	*1330*
2009	*1100*	*1120*	
2010	*1100*		

b. When you want to estimate IBNR – this is impossible (or at least very difficult) with report year data, since unpaid claims for a report year are IBNER, not pure IBNR.

c. When you are modeling claims made policies, it makes sense to use report year, since CM policies operate on report years and have no IBNR at year end.

1 Introduction 63

The main topics discussed in previous chapters:

- Chapter 3 described types of data and how data is organized.
- Chapter 4 discussed the importance of meeting with “management” and understanding the insurer’s internal and external environments.
- Chapter 5 demonstrated the construction of development triangles.

In this chapter, development triangles are used to better understand how changes in an insurer's operations and the external environment can influence the claims data.

2 Detailed Example – Background Information 63 – 64

Company: XYZ Insurer

Experience: Private passenger automobile bodily injury liability experience in a single state over the 2002 to 2008 experience period.

Purpose: To demonstrate how to use development triangles for diagnostic review.

Goal: To teach you how to look at relationships and how to develop your own observations and questions.

Management Disclosures:

- The strength of current case outstanding is much greater than in prior years.
- New information systems have been implemented in the past three years for the purpose of speeding up the claims reporting and settlement processes.
- Significant changes to the automobile insurance product in this geographic region.
    1. Major tort reforms were implemented in 2006 resulting in caps on awards as well as pricing restrictions and mandated rate level changes for all insurers operating in the region.
    2. Management decided to reduce its presence in this market as a result.

Review Goals and Expectations:

- To determine if the effect of the changes implemented by management in the claims data can be observed.
- Expect that the review will lead to further questions and discussions with management.

To determine what types of data and which techniques will be most appropriate to estimate unpaid claims for XYZ Insurer.

3 Premium History 64 – 65

Given: XYZ Insurer provided the earned premium and rate level changes by year.
Compute: Cumulative average rate level and annual change in exposures from year to year.

Table 1 – Summary of Earned Premium and Rate Changes

Calendar Year	Earned Premiums ($000)	Rate Changes	Cumulative Average Rate Level	Annual Exposure Change
2002	61,183		0.00%	
2003	69,175	5.00%	5.00%	7.70%
2004	99,322	7.50%	***12.90%***	33.60%
2005	138,151	15.00%	29.80%	21.00%
2006	107,578	10.00%	42.80%	-29.20%
2007	62,438	-20.00%	14.20%	-27.50%
2008	47,797	-20.00%	-8.60%	***-4.30%***

The average rate level is calculated by successive multiplication of annual rate changes.
For 2004, the cumulative average rate level is **12.9%** = {[(1.00 + 5.0%) x (1.00 + 7.5%)] – 1.001

The annual exposure change is equal to the annual change in earned premiums divided by the rate change in the year.
For 2008, the annual exposure change is **-4.3%** = {[(47,797 / 62,438) / (1 –20.0%)] – 1.001

Assume that the rate changes in the above table represent the average earned rate level for the year.

Table 2 - Reported Claim Development Triangle

Accident	Reported Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169
2003	9,651	16,995	30,354	40,594	44,231	44,373	
2004	16,995	40,180	58,866	71,707	70,288		
2005	28,674	47,432	70,340	70,655			
2006	27,066	46,783	48,804				
2007	19,477	31,732					
2008	18,632						

Table 3 - Paid Claim Development Triangle

Accident	Paid Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437
2003	1,743	6,240	12,683	22,892	34,505	39,320	
2004	2,221	9,898	25,950	43,439	52,811		
2005	3,043	12,219	27,073	40,026			
2006	3,531	11,778	22,819				
2007	3,529	11,865					
2008	3,409						

Analysis:

- Look down the columns at the experience of different AYs at the same age of development.
- In a stable environment, one will see stability in the claim experience down each column.

Two diagnostic triangles:

1. The ratio of reported claims to earned premium (a.k.a. the reported claim ratio) and

2. The ratio of reported claims to on-level earned premium.

   Calculate the on-level premium using the average rate level changes by year and restating the earned premium for each year as if it was written at the 2008 rate level.

Table 4 - Ratio of Reported Claims to Earned Premium

Accident Year	Ratio of Reported Claims to Earned Premium as of (months) 12	24	36	48	60	72	84
200	0.20	0.33	0.43	0.61	0.72	0.79	0.78
200	0.14	0.24	0.43	0.58	0.63	0.64	
200	0.17	0.40	0.59	0.72	0.70		
200	0.20	0.34	0.50	0.51			
200	0.25	0.43	0.45				
200	0.31	0.50					
200	0.39						

Table 5 - Ratio of Reported Claims to On-Level Earned Premium

Accident Year	Ratio of Reported Claims to On-Level Earned Premium as of (months) 12	24	36	48	60	72	84
200	0.22	0.36	0.47	0.67	0.79	0.87	0.86
200	0.16	0.28	0.50	0.67	0.73	0.73	
200	0.21	0.50	0.73	0.89	0.87		
200	0.29	0.48	0.72	0.72			
200	0.39	0.67	0.70				
200	0.39	0.63					
200	0.39						

Questions/Observations:

1a. For AY 2003, why are reported claims so low after 12 and 24 months of development?

- Per Table 1, the insurer had a 5% higher rate level in 2003 than 2002.
- It ***appears*** that the insurer experienced an exposure growth of approximately 8% in 2003 ([(($69,175 / 1.05) / $61,183) - 1.00]).
- ***Knowing*** the insurer actually increased its exposure base, a 25% drop in reported claims for 2003 after 12 months is surprising.

1b. What led to the lower level of reported claims for the first 24 months?

Was there a change in systems?

Were paid claims or case outstanding driving the decrease in reported claims?

The paid claim triangle for AY 2003 shows that paid claims are also down at 12 and 24 months of development (roughly of the same magnitude as for the reported claims).

2. What happened in AY 2004, at and after the 24-month valuation?

- While EP are up 44% over 2002 and 34% over 2003 (after adjustment for rate changes), reported claims for 2004 after 24 months of development are up by 97% [($40,180 / $20,370) - 1.00] over 2002 and 136% [($40,180 / $16,995) - 1.00] over 2003.
- Are large claims or more claim counts or both driving the increase?
- Was there a change in case outstanding adequacy that had an effect on the 12/31/05 valuation?

Questions/Observations (continued):

3. What happened in AYs 2005 and 2006 to drive reported claims up so much at 12 months of development?
   - One possible answer: Higher EP volume for these two years
   - However at the 12-month valuation, reported claims are again increasing at a rate that is greater than the increase in exposures and our knowledge of the inflationary environment.

   Compare reported claims between AYs 2004 and 2005:

   [(AY_{2005} / AY_{2004}) - 1.00] = [($28,674 / $16,995) - 1.00] = 69% (greater than the increase in exposures between these years, which is 21%)

   Compare reported claims between accident years 2004 and 2006:

   [(AY_{2006}/ AY_{2004}) - 1.00] = [($27,066 / $16,995) - 1.00] = 59% (is greater than the change in exposures between these years, which is actually a decrease of 14%).

4. Looking down the 24-month column, there are:
   - Large volumes of reported claims for AYs 2004 - 2006 and larger volumes of paid claims for 2004, 2005 and 2006.
   - At 24 months, AY 2007 reported claims are lower than the preceding three accident years.

   Could the lower claims in 2007 be a result of the tort reforms introduced during 2006?

5. For AY 2006, the insurer experienced a significant reduction in exposures during the year.
   - EP dropped from $138,151 in 2005 to $107,578 even with a 10% rate increase (indicating a drop in exposures of almost 30%). However, reported claims:
   - After 12 months of development differ from 2005 by less than 6% [($27,066 / $28,674) — 1.00] and
   - At 24 months of development by less than 2% [($46,783 / $47,432) — 1.00].

6. For AYs 2007 and 2008, reported claims are significantly lower than for 2005 and 2006 though the claim ratios are not.

   Determine the change in exposures based on the given premium information:
   - While exposures were reduced 30% during 2007 (from 2006), the change in earned premiums between 2007 and 2008 was primarily due to the rate change and not due to changes in exposure volume.
   - Reported claim volume at 12 months for AYs 2007 and 2008 is consistent with EP.

At this point, analyze additional development triangles to look for answers to some of the questions raised in this initial review of the claims data.

5 The Ratio of Paid to Reported Claims 68 - 69

Often, reported and paid claim development triangles are the only triangles available to the actuary.

- The ratio of paid to reported helps determine whether there might have been changes in case outstanding adequacy or in settlement patterns.
- Determine whether there are changes in paid claims (i.e. the numerator) occurring or whether changes in case outstanding, which impact reported claims (i.e. the denominator), taking place

  Note: Changes in the ratio of paid-to-reported claims may be taking place, but cannot be observed, because offsetting changes in both claim settlement practices and the adequacy of case outstanding can result in no change to the ratio of paid-to-reported claims.

Recall that claims management believes that:

- New claims settlement practices resulted in a speed-up in claims closure.

  Thus, expect paid claims to be increasing along the latest diagonals relative to prior years.
- New policies related to case outstanding are resulting in stronger unpaid case than in prior years.

Thus, reported claims should also be increasing along the latest diagonals of the triangle.

Therefore, the ratio of paid-to-reported claims may be unchanged along the latest diagonals when compared with prior years' diagonals.

Table 6 - Ratio of Paid Claims-to-Reported Claims

Accident	Ratio of Paid Claims-to-Reported Claims as of (months)						
Year	12	24	36	48	60	72	84
2002	0.181	0.389	0.519	0.587	0.719	0.834	0.923
2003	0.181	0.367	0.418	0.564	0.780	0.886	
2004	0.131	0.246	0.441	0.606	0.751		
2005	0.106	0.258	0.385	0.567			
2006	0.130	0.252	0.468				
2007	0.181	0.374					
2008	0.183						

Look down each column to compare the experience from AY to AY.

- It is difficult to discern changes in this ratio.
- Recall that a downward trend in the ratio of paid-to-reported claims could be the result of decreasing paid claims or of increasing case outstanding adequacy.

However, management states that the rate of claims settlement has increased. Thus:

- Is the change in case outstanding adequacy masking the changes in the settlement process?
- Is the type of claims being reported changing (since different types of claims have different settlement and reporting characteristics, and this could affect on both paid and reported claims)?

6 The Ratio of Paid Claims to On-Level Earned Premiums 69

This diagnostic triangle can help to determine whether there was a speedup in claims payment or possibly deterioration in underwriting results.

Table 7 - Ratio of Cumulative Paid Claims to On-Level Earned Premium

Accident	Ratio of Cumulative Paid Claims to On-Level Earned Premium as of (months)						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.041	0.142	0.247	0.395	0.571	0.727	0.795
2003	0.029	0.104	0.211	0.38	0.573	0.653	
2004	0.028	0.123	0.323	0.54	0.657		
2005	0.031	0.126	0.278	0.412			
2006	0.051	0.171	0.331				
2007	0.071	0.238					
2008	0.071						

Observations/Questions:

- There seems to be evidence of a possible speed-up in payments, particularly at 12 and 24 months.
- Has there been a shift in the type of claim settled at each age?

Additional data (reported and closed claim counts development diagnostic triangles) are needed for further review.

7 Claim Count Triangles 69 - 71

Reported and Closed claim counts triangles are reviewed next.

Table 8--Reported Claim Count Development Triangle

Accident	Reported Claim Counts as of						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	1,342	1,514	1,548	1,557	1,549	1,552	1,554
2003	1,373	1,616	1,630	1,626	1,629	1,629	
2004	1,932	2,168	2,234	2,249	2,258		
2005	2,067	2,293	2,367	2,390			
2006	1,473	1,645	1,657				
2007	1,192	1,264					
2008	1,036						

Table 9 — Closed Claim Count Development Triangle

Accident	Closed Claim Counts as of						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	203	607	841	1,089	1,327	1,464	1,523
2003	181	614	941	1,263	1,507	1,568	
2004	235	848	1,442	1,852	2,029		
2005	295	1,119	1,664	1,946			
2006	307	906	1,201				
2007	329	791					
2008	276						

The importance in understanding claim <u>count</u> development triangles (i.e. what types of data are contained in such triangles?).

1. How does the insurer treat reopened claims?

   Are they coded as a <u>new</u> claim or is a previously closed claim <u>re-opened</u>?

   If treated as a reopened claim, there could potentially be a decrease across a row in the closed claim count development triangle.
2. Does the insurer include claims closed with no payment (CNP) in the reported and closed claim count triangles?
3. How are claims classified that have only expense payments and no claim payment?

XYZ Insurer indicated that:

- Closed claim count development data excludes CNP claim counts.
- Reported claim count development triangles also excludes CNP counts.

Observations and Questions:

1. At 12 months:
   - Reported claim counts experienced an increase of 40% [(1,932/1,373) - 1.00] and
   - Closed claim counts had an increase of 30% [(235/181) - 1.00] between AYs 2003 and 2004.
   - However, a 76% increase in reported claims is observed.

   At 24 months for AY 2005, increase in claim counts [(2,293/2,168) - 1.00 = 5.8%] are not as significant as the increases in reported claims [($47,432/$40,180) - 1.00 = 18.0%].

   Why are claims increasing so much more than the number of claims?

   Could large claims be driving the increases?

2. Reported claim counts for AYs 2004 and 2005 area at the highest values at all ages (and this is consistent with the experience shown in the reported claim triangle).

   However, we do not observe a similar increase in the closed claim count triangle where 2006 and 2007 are highest at 12 months.

   At 24 months, the highest closed claim count values are for AY 2005 and 2006. Are the higher closed claim counts due to the new systems implemented at the insurer?

3. The decrease in reported claim counts for 2006 and 2007 is consistent with the decrease in exposures for these years.

   However, there is not a similar decrease in closed claim counts. Is this due to the speed-up in claims settlement processes that management discussed?

4. Finally, for AY 2008, reported and closed claim counts are lower than we would expect given reported claims, paid claims, and the steady-state of exposures between 2007 and 2008.

   Therefore, why are the number of claims down for the latest year?

8 The Ratio of Closed to Reported Claim Counts 71 - 72

If changes in the settlement rate of claims are suspected, reviewing the ratio of paid-to-reported claims, is an important diagnostic tool to use.

Factors affecting the reporting and closing of claims include:

* A change in guidelines on how claims are established
* A decrease in the statute of limitations duration (from a major tort reform action)
* Delegating higher claim settlement limits to a TPA
* Restructuring of the claim field offices (e.g. merging or adding of new offices).
* Introducing a new claim call center
  - A change resulting in a temporary increase in closing patterns occurs when a claim department makes an extra effort to get the backlog as low as possible before making a transition to a new system.
  - A speed-up due to faster processing occurs when the new system leads to a slowdown in closing, due to a learning curve necessary before the new system is fully operational.

Management at XYZ Insurer stated that claims are now settling much more quickly, and the new system is having an affect on the entire portfolio of outstanding claims (not just claims from the latest AY).

As a result, we would then expect to see greater closed-to-reported claim counts ratios for the latest diagonals than for prior years.

Table 10 - Ratio of Closed-to-Reported Claim Counts

Accident	Ratio of Closed-to-Reported Claim Counts as of					
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.151	0.401	0.543	0.699	0.857	0.943	0.98
2003	0.132	0.38	0.577	0.777	0.925	0.963	
2004	0.122	0.391	0.645	0.823	0.899		
2005	0.143	0.488	0.703	0.814			
2006	0.208	0.551	0.725				
2007	0.276	0.626					
2008	0.266						

Change is clearly evident in this diagnostic triangle.

- For 2002 - 2005 at 12 months of development, closed-to-reported claim counts was roughly 0.14.
- For 2006 – 2008 at 12 months, the ratio is in excess of 0.20; and for the latest year it is 0.266.
- The same type of increases for the 24-month through 48-month development periods are evident.

The experience of closed and reported claim counts is consistent with management's emphasis on settling claims faster.

Now, the actuary must consider the consequences of such a change.

- Less complicated and less expensive claims close the quickest. More complicated claims (involving litigation and expert witnesses), take longer to close.
- If emphasis is on closing small claims quickly, there will likely be a shift in the type of claims closed or open at any particular age in the claim development triangle.

This is discussed in the next section on average claims.

9 Average Claims 72 - 76

Reported and paid claim development triangles as well as the reported and closed claim count triangles are used to calculate various average values.

Table 11 - Definitions of Average Values

Average Value	Definition
Average reported claim	Reported claim triangle / reported claim count triangle
Average paid claim	Paid claim triangle / closed claim count triangle
Average case outstanding	$\dfrac{\text{Reported claim triangle - paid claim triangle}}{\text{Reported claim count triangle - closed claim count triangle}}$

Two important issues related to average values:

1. Have a clear understanding of the definition of closed and reported claim counts.

   Some insurers include claims with no payment (CNP) in the definition of closed claim counts and some include claims with no case outstanding and no payments in the definition of reported claim counts.

   Including CNPs in closed claim count statistics or claims with no case outstanding or payments in reported claim counts produces a much lower average value.

   A change in the definition of claim counts can impact the results of diagnostic analyses using claim counts and on estimation techniques that rely on the number of claims.

2. Large claims. Both the presence and absence of such claims can distort average claims. Methods to deal with large claims include:

   a. Removing large claims from the database before conducting both ratio and average value calculations and handling the unpaid large claim estimate separately.

   b. Use development triangles using limited claims (e.g. claims can be limited to $500,000 or $1 million per occurrence in the reported and paid claim development triangles). See previous discussion of determining a large claims threshold in Chapter 3.

Two other aspects affecting average values are policy deductibles and retentions.

For XYZ Insurer:

- Closed claim counts exclude claims closed without any payment.
- Reported claim counts exclude claims in which there are no case outstanding and no payments.
- Paid claims include partial payments as well as payments on closed claims. Thus, the average paid claim triangle will be a combination of payments on settled claims as well as payments on claims that are still open.

The average reported claim triangle is often used to detect changes in case outstanding adequacy.

It is not quite as valuable as the average case outstanding triangle since reported claims include both paid claims and unpaid case reserves, and changes in paid claims can mask changes in case outstanding adequacy.

The average reported claim triangle may be all that is available for diagnostic purposes.

We expect to see changes down the columns limited to inflationary forces only, however the changes observed below are greater than the annual inflation (assumed to be 5% for this region's auto BI liability).

Are the increases are due to greater levels of payments or stronger case outstanding?

Table 12 - Average Reported Claim Development Triangle

Accident	Average Reported Claims as of (months)						
Year	12	24	36	48	60	72	84
2002	9,546	13,455	17,219	24,192	28,673	31,379	30,997
2003	7,029	10,517	18,622	24,966	27,152	27,239	
2004	8,796	18,533	26,350	31,884	31,129		
2005	13,872	20,686	29,717	29,563			
2006	18,375	28,440	29,453				
2007	16,340	25,104					
2008	17,985						

The average paid claim triangle:

A mismatch exists in the average paid claim triangle since the numerator (cumulative paid claims) includes partial claim payments and the denominator (closed claim counts) represents only claims with final settlement. Consider this limitation when drawing any conclusions from this particular diagnostic triangle.

Notice that in the average paid triangle below, the average values along the latest diagonal are generally the highest value in each column (particularly at 12 to 36 months). The average paid claim triangle appears relatively stable for ages 48 and older.

The next important question to ask is whether or not there has been a change in the type of claim that is being closed at these particular ages (since this can affect the actuary's selection of estimation techniques and claim projection factors).

Table 13 - Average Paid Claim Development Triangle

Accident	Average Paid Claims as of						
Year	12	24	36	48	60	72	84
2002	11,417	13,067	16,436	20,290	24,073	27,752	29,178
2003	9,631	10,163	13,478	18,125	22,896	25,077	
2004	9,452	11,673	17,996	23,455	26,028		
2005	10,315	10,920	16,270	20,569			
2006	11,502	13,000	19,000				
2007	10,726	15,000					
2008	12,351						

The change in average paid claims only at 12, 24, and 36 months is consistent with insurers having the greatest control on closure rates of the less complicated and less expensive claims.

Finally, we review the average case outstanding (a.k.a. average open claim amount) triangle, since it is one of the most important diagnostic tools for testing changes in case outstanding adequacy.

A decreasing pattern down the column is an indicator of potential weakening in the case outstanding,

An increasing pattern down the column is an indicator of possible strengthening in the case outstanding.

Questions regarding case outstanding adequacy:

- Has there been a change in case outstanding practices, policies, philosophy, staff, or senior management of the claims department?
- Has there been changes in the mix of business in the portfolio that have nothing to do with changes in case outstanding strength?

Looking down the columns, we see that the average case outstanding is generally increasing by more than the 5% inflation we expect.

Table 14 — Average Case Outstanding Development Triangle

Accident Year	Average Case Outstanding as of (months) 12	24	36	48	60	72	84
2002	9,213	13,714	18,151	33,273	56,167	91,729	120,366
2003	6,634	10,733	25,647	48,766	79,718	82,826	
2004	8,706	22,941	41,561	71,204	76,320		
2005	14,464	29,994	61,547	68,983			
2006	20,185	47,368	56,984				
2007	18,480	42,002					
2008	20,031						

For 2002 through 2004, the average case outstanding at 12 months of development was less than $10,000. For 2006 and 2008 at 12 months, the average case outstanding is greater than $20,000.

We see similar increases at 24 and 36 months.

We also observe increasing values of average case outstanding at 48 and 60 months.

We know that management increasing case outstanding strength is a priority, and a review of the average case outstanding shows increasing average values for outstanding claims.

However, what affect, if any, is the change in claims settlement having on the average case outstanding?

- If smaller claims are settling more quickly, only the more complex/expensive claims are left.
- This, in and of itself, would lead to an increase down the columns in the average case outstanding.

Thus, it is very important for the actuary to determine how much of the increase in the average case outstanding is truly due to a:

- systemic change in the overall level of case outstanding adequacy
- different mix of claims.

10 Summary Comments for XYZ Insurer 76

Every claim development diagnostic that was reviewed shows evidence of the changes noted by management.

Now the actuary must determine how to incorporate all this information in the development of an unpaid claim estimate to be carried on XYZ Insurer's financial statements.

The changing environment will have an effect on the actuary's choice of estimation techniques, types of data, and actuarial factors within the techniques.

11 Conclusion 76 - 77

The development triangle is an excellent tool for exploring the data. It is important for the actuary to take the information obtained during meetings with management and then seek confirmation in the actual claims experience behavior.

Discussions the actuary has with those involved with the insurer's operations (especially claims operations) must be ongoing, since understand data is a complex process that requires input of many people.

Questions from the 2009 Exam

8. (2 points) Given the following information for a single line of business for an insurance carrier:

		Cumulative Paid Loss		
Accident Year	12 Months	24 Months	36 Months	48 Months
2005	$4,531,950	5,919,356	6,511,844	6,768,106
2006	4,871,246	6,312,582	6,894,515	
2007	5,294,951	6,962,001		
2008	6,675,164			

Accident Year	Premium (On-Level)	Exposures	Average Premium
2005	$11,641,265	18,384	$633
2006	12,726,119	19,333	658
2007	13,538,710	20,871	649
2008	14,905,384	22,391	666

Using statistics drawn from the above data, discuss one reason why it is not appropriate to use the paid development method to estimate the ultimate losses for accident year 2008.

Questions from the 2011 Exam

23. (1 point) Given the following data as of December 31, 2010:

		Reported Claims (000s)		
Accident Year	12 Months	24 Months	36 Months	48 Months
2007	$500	$554	$586	$592
2008	$448	$470	$512	
2009	$312	$346		
2010	$426			

		Paid Claims (000s)		
Accident Year	12 Months	24 Months	36 Months	48 Months
2007	$85	$200	$500	$570
2008	$81	$225	$472	
2009	$59	$175		
2010	$85			

Fully discuss whether the data indicates a speed-up in claim closure.

Questions from the 2012 Exam

17. (1.5 points) Given the following:

Age in Months	Incremental % Paid Claims	Incremental % Reported Claims
0-12	50.0%	40.0%
12-24	25.0%	30.0%
24-36	15.0%	20.0%
36-48	2.5%	10.0%

- Assume all outstanding claims are reported and paid by the 60th month.

a. (1 point) Calculate the paid age-to-age factors for ages 12-24, 24-36, 36-48, and 48-60.
b. (0.5 point) Provide two observations that may indicate a problem with the data.

23. (1.5 points) An insurance company faces the following scenarios:

- For property claims, a new claims processing system is implemented that will result in claims closing faster.
- For liability claims, a tort reform change is passed that will reduce the statute of limitations on reporting a claim.

a. (1 point) For each scenario above, explain the effect on the average case outstanding triangle.
b. (0.5 point) Briefly describe two additional scenarios that could cause a change in the ratio of closed to reported claim counts.

Solutions to questions from the 2009 Exam

8. Using statistics drawn from the above data, discuss one reason why it is not appropriate to use the paid development method to estimate the ultimate losses for accident year 2008.

Question 8 - Model Solution 1

Ratio of Cumulative Paid Loss to On-level Premium:

AY	12	24
2005	0.3893	0.5085
2006	0.3828	0.496
2007	0.3911	0.514
2008	0.4478	

.4478 / .3911 = +14.5%

When we look at the ratio of cumulative paid claims to on-level premium at 12 months of development, we see that there is a large increase (+14.5%) in the ratio from 2007 to 2008.

This may be caused by a speed-up in the settlement of the claims and thus, the paid development method will overstate the ultimate losses for AY 2008 because it will overstate the LDF.

Paid claim development method assumes that past development is indicative of the future development and this will not be the case because there is an increase in the settlement rate from 2007 to 2008.

Question 8 - Model Solution 2

Exposure	Trend	Paid @ 12 mth	
18,384		4,531,950	
19,333	5.16%	4,871,246	7.5%
20,871	8%	5,294,951	8.7%
22,391	7.3%	6,675,164	26%

We can see that in AY 2008, paid claim increased tremendously (26%) compared to the exposure growth increase of (7.3%). We also know that the Avg prem doesn't change a lot, so the big paid increase is caused by settlement rate speed up.

If we use LDFs derived from past years and applied it to the most recent year (AY 2008 paid losses are too high relative to past paid losses at 12 months), this will overestimate AY 2008 ultimate losses.

Solutions to questions from the 2011 Exam

23. Fully discuss whether the data indicates a speed-up in claim closure.

Question 23 – Model Solution

Look at disposal rate or ratio of paid to reported.

Cumulative paid losses /cumulative reported losses.

AY	12	24	36	48
07	0.170	0.361	0.853	0.963
08	0.181	0.479	0.922	
09	0.189	0.506		
10	0.200			

Looking down each column, the ratios indicate that there may be a speed up in claims closure rate, however the increasing ratio may also be due to a decrease in case reserving adequacy.

Solutions to questions from the 2012 Exam

17a. (1 point) Calculate the paid age-to-age factors for ages 12-24, 24-36, 36-48, and 48-60.
17b. (0.5 point) Provide two observations that may indicate a problem with the data.

Question 17 – Model Solution 1 (Exam 5B Question 2)

Age	Cum. Paid %	Cum. Reported %
0-12	50%	40%
12-24	75%	70%
24-36	90%	90%
36-48	92.5%	100%
48-60	100%	100%

Example: 92.5% = 50% + 25% + 15% + 2.5%

			Incr. paid	
Age	paid CDF	Reported CDF	LDF	LDF
12-ult.	2	2.5	1.5	1.749
24-ult.	1.333	1.429	1.1998	1.286
36-ult.	1.111	1.111	1.028	1.111
48-ult.	1.081	1	1.081	1
60-ult.	1	1	1	1

2 = 1 / 0.5 ; 1.5 = 2/1.333

b) (i) Reported CDFs are usually less than paid CDF. Here, at ages 12 and 24, Reported CDF are higher.
(ii) There should be a smooth decrease of incremental LDF across dev. period.
Here, paid LDF 36-48 is 1.028 and 48-60 is 1.081.

Question 17 – Model Solution 2 (Exam 5B Question 2)

Age	% paid	1 /% paid = CDF
12	50%	2
24	75%	1.333
36	90%	1.111
48	92.5%	1.081
60	100%	1.000

Age to Age	Age to Age factors
12-24	2/1.333=1.5
24-36	1.333/1.111=1.2
36-48	1.111/1.081=1.028
48-60	1.081/1.00=1.081

60-ult= 1.00

b. 1. After 1 year we see that half of claims are paid, but only 40% are reported. This implies negative case outstanding, which doesn't make much sense.
2. The 48-60 age-to-age factor is larger than the 36-48 age-to-age factor. Generally, age-to-age factors should steadily decrease as the experience matures.

Examiner's Comments

a. Most candidates received full credit on this part.

b. Most candidates were able to identify one observation but not both. Some candidates restated the same observation in a slightly different manner.

Solutions to questions from the 2012 Exam

23a. (1 point) For each scenario above, explain the effect on the average case outstanding triangle.

23b. (0.5 point) Briefly describe two additional scenarios that could cause a change in the ratio of closed to reported claim counts.

Question 23 – Model Solution 1 (Exam 5B Question 7)

a. Property- We will likely see an increase in average case outstanding. Often an increase in settlement rate means small claims are being closed quicker. A higher percentage of open claims will likely be large claims.

Liability- This will result in a speed up in reporting rate as people need to file claims sooner. Its effect on average case is difficult to tell. It could lower average case at early maturities if we see a lot of claims filed that we believe will result in no payment. When statute of limitations decreases, we may see more filing claim first ask questions later behavior.

b. 1. Change in claims department strategy to fight more claims in court will result is a decrease of closed to reported claim counts.

2. Increase in average case load per claims adjuster due to staff cuts could also result in decrease of closed to reported ratio.

Question 23 – Model Solution 2 (Exam 5B Question 7)

a. Claims closing faster: both case reserves and open counts should be lower at each age, since as payments are made, claims close and case is reduced. As such it is unclear how the ratio of these two will react to the denominator and numerator changing. For example, if it is small claims being closed more quickly, then average case will go up, and vice versa.

Tort Reform: we would see an influx of claims reported as people try to get their claims in before the new cap on reporting date. This would increase open counts and case O/S. If these new claims have higher severity than the old average claim, we would see average case rise as the reserves put up would outpace the number of new open counts in the denominator.

b1. CAT hits an insurer creating a backlog of reported claims -> ratio goes down

b2. Focus on closing small claims quickly -> ratio goes up.

Examiner's Comments

a. Any reasonable explanation was accepted, including explanations of an increase, decrease, or no change to average case outstanding for either scenario.

Many candidates did not "explain" the effect to average case outstanding, and instead limited their answer to either stating an effect or only explaining what would happen to case outstanding (not average case outstanding). These candidates received no credit.

Candidates often confused tort reform vs. statue of limitations and assumed there would be a reduction in severity rather than the claim reporting impact due to the change in statute of limitations.

b. Most candidates offered reasonable scenarios which were accepted for full credit. Explanations were not required for full credit.

Common mistakes not receiving credit include: stating "changes in settlement rates" without identifying a scenario, offering scenarios that affect "case reserve adequacy" instead of claim reporting or settlement rates, and identifying the same scenario from Part a) and not offering a new scenario.

1 Introduction 84

In this chapter, estimates of ultimate claims and unpaid claims based on the reported and paid claim development methods (a.k.a. the chain ladder technique) are developed.

2 Key Assumptions 84

The underlying assumption in the development technique is that:

- claims recorded to date will continue to develop in a similar manner in the future (i.e. the past is indicative of the future).
- the relative change in a given year's claims from one evaluation point to the next is similar to the relative change in prior years' claims at similar evaluation points.

Other key assumptions of the development method include:

- consistent claim processing,
- a stable mix of types of claims,
- stable policy limits, and
- stable reinsurance (or excess insurance) retention limits throughout the experience period.

3 Common Uses of the Development Technique 84 - 85

The development technique can be applied to:

- paid and reported claims as well as number of claims.
- all lines of insurance including short-tail lines and long-tail lines.

To use the development method, data is organized into different time intervals, including:

* Accident year; * Policy year; * Underwriting year; * Report year;

* Fiscal year (e.g. for a self-insured public entity with a fiscal year ending March 31, the actuary will likely organize the claim development data by April 1 to March 31 fiscal year).

This technique can be applied to monthly, quarterly, and semiannual and annual data.

4 Mechanics of the Development Technique 85 - 92

The development method consists of seven steps:

Step 1 — Compile claims data in a development triangle
Step 2 — Calculate age-to-age factors
Step 3 — Calculate averages of the age-to-age factors
Step 4 — Select claim development factors
Step 5 — Select tail factor
Step 6 — Calculate cumulative claim development factors
Step 7 — Project ultimate claims

To demonstrate the seven steps, industry-aggregated accident year claim development data for U.S. private passenger automobile insurance (labeled "U.S. Industry Auto") is used.

Step 1 — Compile Claims Data in a Development Triangle

Exhibit I, Sheets 1 and 2: consists of:

- cumulative reported and paid claim development triangles, respectively.
  Part 1 of each exhibit is the data triangle for AYs 1998 - 2007.
  The 10 diagonals in each triangle have annual valuation dates of 12/31/1998 – 12/31/2007
- data net of reinsurance and includes the defense cost portion of claim adjustment expenses (a.k.a. DCC for U.S. statutory accounting).

U.S. Industry Auto
Reported Claims($000)

Exhibit I
Sheet 1

PART 1 - Data Triangle

Accident	Reported Claims as of (months)									
Year	12	24	36	48	60	72	84	96	108	120
1998	37,017,487	43,169,009	45,568,919	46,784,558	47,337,318	47,533,264	47,634,419	47,689,655	47,724,678	47,742,304
1999	38,954,484	46,045,718	48,882,924	50,219,672	50,729,292	50,926,779	51,069,285	51,163,540	51,185,767	
2000	41,155,776	49,371,478	52,358,476	53,780,322	54,303,086	54,582,950	54,742,188	54,837,929		
2001	42,394,069	50,584,112	53,704,296	55,150,118	55,895,583	56,156,727	56,299,562			
2002	44,755,243	52,971,643	56,102,312	57,703,851	58,363,564	58,592,712				
2003	45,163,102	52,497,731	55,468,551	57,015,411	57,565,344					
2004	45,417,309	52,640,322	55,553,673	56,976,657						
2005	46,360,869	53,790,061	56,786,410							
2006	46,582,684	54,641,339								
2007	48,853,563									

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors									
Year	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1998	***1.166***	1.056	1.027	1.012	1.004	1.002	1.001	1.001	1.000	
1999	1.182	1.062	1.027	1.010	1.004	1.003	1.002	1.000		
2000	1.200	1.061	1.027	1.010	1.005	1.003	1.002			
2001	1.193	1.062	1.027	1.014	1.005	1.003				
2002	1.184	1.059	***1.029***	1.011	1.004					

Step 2 — Calculate Age-to-Age Factors (a.k.a. report-to-report factors or link ratios)

To calculate the age-to-age factors for the 12-month-to-24-month period, divide the claims as of 24 months by the claims as of 12 months.

Using the reported claims presented in Exhibit I, Sheet 1, calculate the following:

12-24 factor for accident year 1998:

$$\frac{\text{reported claims at 24 months for accident year 1998}}{\text{reported claims at 12 months for accident year 1998}} = \frac{\$43,169,009}{\$37,017,487} = 1.166$$

36-48 factor for accident year 2002

$$\frac{\text{reported claims at 48 months for accident year 2002}}{\text{reported claims at 36 months for accident year 2002}} = \frac{\$57,703,581}{\$56,102,312} = 1.029$$

Continue in the same manner down the columns and across the rows of the triangles.

Step 3 — Calculate Averages of the Age-to-Age Factors

The most common averages include:

* Simple (or arithmetic) average
* Medial average (average excluding high and low values)
* Volume-weighted average
* Geometric average (the nth root of the product of n historical age-to-age factors)

Shown In Part 3 of Exhibit I, Sheets 1 and 2, are:

* Simple averages for the latest five years and the latest three years
* Medial average for the latest five years excluding one high and one low value (medial latest 5x1)
* Volume-weighted averages for the latest five years and the latest three years
* Geometric average for the latest four years

PART 3 - Average Age-to-Age Factors

	Averages									
	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Simple Average										
Latest 5	1.168	1.058	1.027	1.011	1.004	1.003	1.002	1.001	1.000	
Latest 3	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	
Medial Average.										
Latest 5x1	1.165	1.057	1.027	1.010	1.004	1.003	1.002	1.001	1.000	
Volume-weighted Average										
Latest 5	1.168	1.058	1.027	1.011	1.004	1.003	1.002	1.001	1.000	
Latest 3	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	
Geometric Average										
Latest 4	1.164	1.057	1.027	1.011	1.004	1.003	1.002	1.001	1.000	

Examples (**simple average and medial average**):

For reported claims, the 12-24 month simple average of the latest five factors is based on the average of the 12-24 month factors for AYs 2002 – 2006 = 1.168 = (1.184 + 1.162 + 1.159 + 1.160 + 1.173) / 5.

To calculate the 24-36 month medial average development factor of the latest 5x1, consider the 24-36 month factors for AYs 2001 - 2005; we exclude the highest value (1.062 for accident year 2001) and the lowest value (1.055 for accident year 2004) and take an average of the remaining three values.

The 24-36 month medial average of the latest 5x1 = 1.057 = (1.059 + 1.057 + 1.056) / 3).

Examples (**volume weighted and geometric**):

The formula for this type of average uses the sum of the claims for the specific number of years divided by the sum of the claims for the same years at the previous age.

The 36-48 month volume-weighted average of the latest three years = the sum of the reported claims for AYs 2002 - 2004 at 48 months ($57,703,851 + $57,015,411 + $56,976,657 = $171,695,919) divided by the sum of the reported claims for AYs 2002 - 2004 as of 36 months ($56,102,312 + $55,468,551 + $55,553,673 = $167,124,536), or 1.027.

The geometric average (a.k.a. geometric mean) for the latest four years is equal to the fourth root of the product of the last four age-to-age factors.

The geometric average for the latest four years at 12-24 months = $(1.162 \times 1.159 \times 1.160 \times 1.173)^{.25} = 1.164$.

The geometric average for the latest four years at 48-60 months = $(1.010 \times 1.014 \times 1.011 \times 1.010)^{.25} = 1.011$.

Actuaries often rely on the most recent experience as this data reflects the effect of the latest changes in the insurer's internal and external environments.

There is often a trade-off between stability (the number of experience periods included in the average values) and responsiveness (where only the most recent experience periods are considered).

Step 4 — Select Claim Development Factors

The selected age-to-age factor (a.k.a. claim development factor or loss development factor) represents the growth anticipated in the subsequent development interval.

Selections are based on a review of the historical claim development data, the age-to-age factors, the various averages of the age-to-age factors, and a review of the prior year's claim development factor selections.

Benchmarks:

When the credibility of the insurer's historical experience is limited, there may be a need to supplement the experience with benchmark data. Possible benchmark includes:

- experience from similar lines with similar claims handling practices within the insurer.
- claim development patterns from the insurance industry when comparable.

When using benchmarks, there may be significant differences between the line of business being analyzed and the benchmark with regard to claims practices, policy coverages, underwriting, geographic mix, claim coding, policyholder deductibles and/or limits, legal precedents, etc.

When selecting claim development factors, consider the following characteristics:

1. *Smooth progression of individual age-to-age factors and average factors across development periods.*

   A steadily decreasing incremental development from valuation to valuation
2. *Stability of age-to-age factors for the same development period.*

   A relatively small range of factors (small variance) within each development interval (i.e. down the columns).
3. *Credibility of the experience*.

   Credibility is based on the volume and the homogeneity of the experience for a given AY and age.

   Benchmark development factors from the insurance industry may be needed when credibility is lacking.
4. *Changes in patterns*.

   May suggest changes in the internal operations or external environment.
5. *Applicability of the historical experience*.

   Has the insurer’s book of business and insurer operations changed over time?

   Have the effects of changes in external factors manifested themselves in the reported claims experience?

In Part 4 of Exhibit I, Sheets 1 and 2:

Actuarial judgment is used to choose selected factors after reviewing all of the age-to-age factors, the various averages, and the prior year's selected factors.

The term "To Ult" (i.e. To Ultimate) is used to designate the tail factor (e.g. 120 months-to-ultimate).

Selections of development factors are subjective, differ from one actuary to another, and there is more than one reasonable selection of age-to-age and tail factors.

Table 1 - Selected Age-to-Age Factors

	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-ultimate
Reported	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	1.000
Paid	1.702	1.186	1.091	1.044	1.019	1.009	1.005	1.002	1.002	1.002

Step 5 — Select Tail Factor

If data is available, analyze development out to the point at which the development ceases (i.e. until the selected development factors are equal to 1.000).

When development factors for the most mature development periods are still greater than 1.000, a tail factor is needed to bring the claims from the latest observable development period to an ultimate value.

The tail factor is crucial as it:

- influences the unpaid claim estimate for all accident years (in the experience period) and
- can create a disproportionate leverage on the total estimated unpaid claims.

Approaches to select the tail factor:

1. Use industry benchmark development factors
2. Fit a curve to the selected or observed development factors to extrapolate the tail factors (exponential decay is a common for curve fitting).
3. For paid development, when reported development is at ultimate, use reported-to-paid ratios at the latest observed paid development period.

Step 6 – Calculate Cumulative Claim Development Factors (CDF)

Cumulative claim development factors (a.k.a. age-to-ultimate factors and claim development factors to ultimate):

- are calculated by successive multiplications beginning with the tail factor and the oldest age-to-age factor.
- projects the total growth over the remaining valuations.

Using the selected age-to-age factors from Step 4 and the tail factor in Step 5, calculate the following:

Reported CDF at 120 months = selected tail (120-ultimate) factor = 1.000

Reported CDF at 108 months = (selected tail factor) x (selected development factor 108-120 months)
= 1.000 x 1.000 = 1.000

Reported CDF at 96 months = (selected tail factor) x (selected development factor 108-120 months) x (selected development factor 96-108 months)
= (CDF at 108 months) x (selected development factor 96-108 months) = 1.000 x 1.001 = 1.001

Continue in this manner until computing the Reported CDF at 12 months
= (CDF at 24 months) x (selected development factor 12-24 months) = 1.110 x 1.164 = 1.292

Table 2 summarizes the cumulative claim development factors based on the selected age-to-age factors, from Exhibit I, Sheets 1 and 2.

Table 2 — Cumulative Claim Development Factors

	12	24	36	48	60	72	84	96	108	120
Reported	1.292	1.11	1.051	1.023	1.011	1.006	1.003	1.001	1.000	1.000
Paid	2.39	1.404	1.184	1.085	1.04	1.02	1.011	1.006	1.004	1.002

Step 7 — Project Ultimate Claims

Ultimate claims equal the product of the latest valuation of claims (the amounts on the last diagonal of the claim triangles) and the cumulative claim development factors.

Calculations are shown in Exhibit I, Sheet 3, an excerpt of which is shown below:

- Column (3) is the last diagonal of the reported claim development triangle in Exhibit I, Sheet 1, and Column (4) is the last diagonal of the paid claim development triangle in Exhibit I, Sheet 2.
- Columns (5) and (6) are the cumulative claim development factors that are calculated in Step 5.
- Each cumulative claim development factor refers to a specific age.

Chapter 7 - Development Technique — Exhibit I
U.S. Industry Auto — Sheet 3
Projection of Ultimate Claims Using Reported and Paid Claims($000)

Accident Year	Age of Year	Claims at 12/31/07 Reported	Paid	CDF to Ultimate Reported	Paid	Projected Ultimate Claims Using Dev. Method with Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)= [(3) x (5)]	(8)= [(4) x (6)]
1998	120	47,742,304	47,644,187	1.000	1.002	47,742,304	47,739,475
2007	12	48,853,563	27,229,969	1.292	2.390	63,118,803	65,079,626

Projected ultimate claims for accident year 1998
= (reported claims for 1998 as of 12/31/07) x (reported CDF at 120 months) = $47,742,304 x 1.000 = $47,742,304

Projected ultimate claims for accident year 2007
= (reported claims for 2007 as of 12/31/07) x (reported CDF at 12 months) = $48,853,563 x 1.292 = $63,118,803

Perform similar calculations for the projection of ultimate claims using the paid claim development technique.

Projected ultimate claims for accident year 2007
= (paid claims for 2007 as of 12/31/07) x (paid CDF at 12 months) = $27,229,969 x 2.390 = $65,079,626

5 Unpaid Claim Estimate Based on the Development Technique 92 - 93

Using the development technique, unpaid claim estimates = projected ultimate claims - actual paid claims.

- Because AY data is used, the unpaid claim estimate includes both case outstanding and the broad definition of IBNR.
- To compute estimated IBNR based on the development technique:
  i. IBNR = projected ultimate claims - reported claims
  ii. IBNR = estimated total unpaid claims - case O/S

Exhibit I, Sheet 4, summarizes the calculations for the unpaid claim estimate based for U.S. Industry Auto.

Columns (2) and (3) contain reported and paid claims data as of 12/31/2007 (the latest diagonals in our claim development triangles).

Columns (4) and (5) are the projected ultimate claims (developed in Exhibit I, Sheet 3).

The equations to compute Columns (6) – (10) are shown below in the excerpt from Exhibit I, Sheet 4.

Chapter 7 - Development Technique | Exhibit I
U.S. Industry Auto | Sheet 4
Projection of Ultimate Claims Using Reported and Paid Claims($000)

						Unpaid Claim Estimate at 12/31/07			
			Projected Ultimate Claims		Case	IBNR - Based on		Total - Based on	
Accident	Claims at 12/31/07		Using Dev. Method with		Outstanding	Dev. Method with		Dev. Method with	
Year	Reported	Paid	Reported	Paid	at 12/31/07	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6) =[(2) - (3)]	(7)=[(4) - (2)]	(8)=[(5) - (2)]	(9)=[(6) + (7)]	(10)=[(6) + (8)]
1998	47,742,304	47,644,187	47,742,304	47,739,475	98,117	0	-2,829	98,117	95,288
1999	51,185,767	51,000,534	51,185,767	51,204,536	185,233	0	18,769	185,233	204,002

6 Reporting and Payment Patterns 93 - 94

A reporting pattern of claims is the % of ultimate claims that are reported in each year.

Reporting patterns are derived from cumulative reported claim development factors (CDFs).

The following table shows the reporting pattern from the cumulative reported CDFs for U.S. Industry

Table 3 — Reporting Pattern

Age (Months)	Cumulative Reported Claim Development	Cumulative% Reported	Incremental % Reported
12	1.292	77.40%	77.4%
24	1.110	90.10%	12.7%
36	1.051	95.10%	5.0%
48	1.023	97.80%	2.7%
60	1.011	98.90%	1.1%
72	1.006	99.40%	0.5%
84	1.003	99.70%	0.3%
96	1.001	99.90%	0.2%
108	1.000	100.00%	0.1%
120	1.000	100.00%	0.0%

The % reported = 1/CDF

At 12 months, the percentage reported = 1.000/1.292 = 77.4% (i.e. 77.4% of ultimate claims are reported through 12 months).

The incremental percentage reported for the 12-24 month period = 90.1% - 77.4%, or 12.7%.

An implied payment pattern based on the cumulative paid claim development factors can also be determined.

Table 4 — Payment Pattern

Age (Months)	**Cumulative Paid Claim Development**	**Cumulative Paid**	**Incremental % Paid**
12	2.390	41.8%	41.8%
24	1.404	71.2%	29.4%
36	1.184	84.5%	13.3%
48	1.085	92.2%	7.7%
60	1.040	96.2%	4.0%
72	1.020	98.0%	1.8%
84	1.011	98.9%	0.9%
96	1.006	99.4%	0.5%
108	1.004	99.6%	0.2%
120	1.002	99.8%	0.2%

Note: The incremental %s reported and paid in each successive interval are less than or equal to that of the previous age interval. These patterns are consistent with reasonable expectations for the underlying process of settling a portfolio of claims. When underlying development patterns are erratic, actuarial judgment is needed in the selection process to achieve claim development patterns that exhibit such a steady, decreasing pattern.

The reporting and payment patterns can be used in other techniques for estimating unpaid claims and in monitoring the development of claims during the year.

The payment pattern is also often used for present value (i.e. discounting) calculations.

7 Observations and Common Relationships 95

Cumulative CDFs are often greatest for the most recent AYs and the smallest for the oldest accident years.

Actuaries refer to the most recent, less-developed AYs as immature and the oldest, most-developed AYs as mature.

Therefore, the highest values of estimated IBNR are for the most recent accident years (the less mature years).

As AYs mature and more claims are reported and settled, the estimate of total unpaid claims will go to zero.

Also, development factors tend to increase as the retention increases.

In E. Pinto and D.F. Gogol's paper titled "An Analysis of Excess Loss Development" they observed that:

- excess business exhibits much slower reporting than primary business,
- there is a relationship between the layer for which business is written and the resulting development pattern.
- development is not only caused by late reported claims and increases in the average reported loss per claim but also by changes at successive maturities in the proportion of claims with losses which are large multiples of the average.

  Thus, the shape of the size of loss distribution changes at successive valuations.

Pinto and Gogol developed a model which illustrates the two influences underlying claim development:

1. the reporting pattern of claims over time and
2. the changing characteristics of the size of claims distribution at successive maturities.

Pinto and Gogol conclusions:

- Loss and ALAE development varies significantly by retention.
- Pricing and reserving estimates using development factors may produce large errors if this is not taken into account.
- As this applies to paid as well as reported loss development, recognizing the retention is a major factor in estimating discounted losses using paid development factors.

8 When the Development Technique Works and When It Does Not 95 - 97

The primary assumption of the development technique is that the reporting and payment of future claims will be similar to the patterns observed in the past.

- When using reported claims, it is assumed that there have been no significant changes in the adequacy of case outstanding during the experience period;
- When using paid claims, it is assumed that there have been no significant changes during the experience period in the speed of claims closure and payment.

The development method is appropriate for insurers in a stable environment.

- If there are changes to the insurer's operations (e.g. new claims processing systems; revisions to tabular formulae for case outstanding; or changes in claims philosophy, policyholder deductibles, or the insurer's reinsurance limits), the past may not be predictive of the future.
- Environmental changes, such as a major tort reform occurring (e.g. a cap on claim settlements or a restriction in the statute of limitations), may cause historical claim development experience to be less predictive of future claims experience.

The development technique requires a large volume of historical claims experience.

- It works best when the presence or absence of large claims does not greatly distort the data.
- If the volume of data is not sufficient, large claims could greatly distort the age-to-age factors, the projection of ultimate claims, and finally the estimate of unpaid claims using a development method.

The development technique may not be suitable when there is not a sufficient volume of credible data, as in the following situations:

- When entering a new line of business or new territory
- For smaller insurers with limited portfolios.

While the development technique may be used in such situations, relying on benchmark patterns (e.g. from comparable lines of business or available industry data) to select claim development factors, may be warranted.

The development technique is used for high-frequency, low-severity lines with stable and timely reporting of claims (evenly spread throughout the AY, PY, RY, etc.)

For long-tail lines of insurance (e.g. WC or GL), cumulative CDFs can become very large for the most recent AYs when using the paid claim development technique.

These highly leveraged factors can result in unreasonable projections of ultimate claims for the most recent accident years.

In these situations, alternative techniques for estimating unpaid claims are often used.

9 XYZ Insurer 97 - 98

Chapter 6 Recap: After discussions with XYZ insurer claims department management, we know that:

- both a speed up in the rate of claims settlement and a strengthening in case reserves have been implemented.
- during the experience period, a major tort reform modifying the liability covered by the insurance product resulted in a change in the insurance product and in the insurer's market presence.

Q: Given the above, is the development technique appropriate for XYZ Insurer to use?

- A primary assumption of the reported claim development method is that there have been no significant changes in the adequacy of case outstanding over the experience period.
- A primary assumption of the paid claim development method is that there have been no significant changes in the rate of settlement over the experience period.

A: The underlying assumptions do not hold true, and we conclude that an adjustment for these changes is necessary for the development technique to be appropriate for XYZ Insurer.

However, for demonstration and comparison purposes to other methods presented in later chapters, the development technique is shown in Exhibit II, Sheets 1 - 4, for XYZ Insurer.

Exhibit II, Sheets 1 and 2 contain the reported and paid claim development triangles.

There is significant variability in the age-to-age factors down each column of the triangle, which we expect given our knowledge of the changing environment.

Selected age-to-age factors are based on the volume-weighted average of the latest two years (although in reality a higher degree of judgment would be needed in selecting the age-to-age factors).

XYZ Insurer - Auto BI
Reported Claims($000)

Exhibit II
Sheet 1

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			11,171	12,380	13,216	14,067	14,688	16,366	16,163	15,835	15,822
1999		13,255	16,405	19,639	22,473	23,764	25,094	24,795	25,071	25,107	
	:::	:::	:::	:::	:::	:::	:::	:::	:::		
2007	19,477	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120-132	To Ult
1998			1.108	1.068	1.064	1.044	1.114	0.988	0.980	0.999	
1999		1.238	1.197	1.144	1.057	1.056	0.988	1.011	1.001		
:::	:::	:::	:::	:::	:::	:::	:::	:::			
2007	1.629										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120-132	To Ult
Simple Average											
Latest 5	1.827	1.417	1.247	1.124	1.082	1.040	1.031	0.997	0.991	0.999	
Latest 3	1.671	1.330	1.187	1.083	1.062	1.033	1.003	0.997	0.991	0.999	
Latest 2	1.679	1.263	1.111	1.035	1.050	1.013	1.011	1.002	0.991	0.999	
Medial Average.											
Latest 5x1	1.715	1.419	1.273	1.118	1.080	1.046	1.011	0.993	0.991	0.999	
Volume-weighted Average											
Latest 4	1.802	1.376	1.185	1.094	1.081	1.033	1.019	0.998	0.993	0.999	
Latest 3	1.674	1.325	1.147	1.060	1.060	1.028	1.005	0.998	0.993	0.999	
Latest 2	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	
Geometric Average											
Latest 3	1.670	1.314	1.178	1.080	1.061	1.033	1.003	0.997	0.991	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120-132	To Ult
Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
CDF to Ultim	2.551	1.512	1.196	1.085	1.064	1.013	1.003	0.992	0.992	0.999	1.000
Percent Repo	39.2%	66.1%	83.6%	92.2%	94.0%	98.7%	99.7%	100.8%	100.8%	100.1%	100.0%

Projected ultimate claims based on the development technique applied to reported and paid claims are shown in Exhibit II, Sheet 3.

XYZ Insurer - Auto BI Exhibit II
Projection of Ultimate Claims Using Reported and Paid Claims($000) Sheet 3

Accident Year	Age of Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	15,822	15,822	1.000	1.010	15,822	15,980
1999	120	25,107	24,817	0.999	1.014	25,082	25,164
:::	:::	:::	:::	:::	:::	:::	:::
2007	24	31,732	11,865	1.512	6.569	47,979	77,941
2008	12	18,632	3,409	2.551	21.999	47,530	74,995
Total		449,626	330,627			514,929	605,028

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from XYX insurer.
(5) and (6) Based on CDF from Exhibit 2, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Estimated IBNR and the total unpaid claim estimate for the two development projections are shown in Exhibit II, Sheet 4.

XYZ Insurer - Auto BI Exhibit II
Projection of Ultimate Claims Using Reported and Paid Claims($000) Sheet 4

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08: IBNR - Based on Dev. Method with Reported	IBNR - Based on Dev. Method with Paid	Total - Based on Dev. Method with Reported	Total - Based on Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	15,822	15,822	15,822	15,980	0	0	158	0	158
1999	25,107	24,817	25,082	25,164	290	-25	57	265	347
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	31,732	11,865	47,979	77,941	19,867	16,247	46,209	36,114	66,076
2008	18,632	3,409	47,530	74,995	15,223	28,898	56,363	44,121	71,586
Total	449,626	330,627	514,929	605,028	118,999	65,303	155,402	184,302	274,401

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(3) and (4) Developed in Exhibit 2, Sheet 3
(6) =[(2) - (3)].
(7) =[(4) - (2)].
(8) =[(5) - (2)].
(9) =[(6) + (7)].
(10) =[(6) + (8)].

Comparison of the estimated IBNR for the U.S. Industry Auto and for XYZ Insurer:

- For U.S. Industry Auto, the estimated IBNR generated by the reported and paid claim development methods differs by approximately 10% and the estimate of total unpaid claims differs by only 4%.
- For XYZ Insurer, the estimated IBNR using the paid claim development technique differs by 138% from the reported claims indication; the total unpaid claim estimate differs by almost 50%.

Thus, alternative projection methods should be reviewed.

10	**Influence of a Changing Environment on the Claim Development Technique**	**98 -104**

Changes in Claim Ratios (i.e. loss ratios) and Case Outstanding Adequacy

To examine the effect of a changing environment on the estimates produced by the development technique, the U.S. private passenger automobile is used as an example.

Similar reporting and payment patterns as well as a similar ultimate claim ratio are used.

Compare estimated IBNR from the development technique to the "actual IBNR" under the following 4 scenarios:

* *Scenario 1* is a steady-state environment: Claim ratios are stable; there are no changes from historical levels of case outstanding strength (U.S. PP Auto Steady-State)
* *Scenario 2* environment: Increasing claim ratios; no change in case outstanding strength (U.S. PP Auto Increasing Claim Ratios)
* *Scenario 3* environment: Sable claim ratios; an increase in case outstanding strength (U.S. PP Auto Increasing Case Outstanding Strength)
* *Scenario 4* environment: Increasing claim ratios and increasing case outstanding strength (U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength)

This example with its four scenarios are used in Chapters 8, 9, and 10.

Key Assumptions

Computation of Actual IBNR (not known in real life)

For the purpose of demonstrating the affect of a changing environment, we calculate the "actual" or "true" IBNR requirement . In this example:

- A ten-year experience period is used (AYs 1999 – 2008).
- Assume EP is $1M for the first year (i.e. 1999), and increases 5% annually.

Actual IBNR is calculated in Exhibit III, Sheet 1, equals ultimate claims projection (based on the given ultimate claim ratio for each AY) minus the reported claims as of 12/31/2008.

Impact of Changing Conditions Exhibit III
Summary of Earned Premium and Claim Ratio Assumptions and Actual IBNR Sheet 1

Accident Year	Earned Premium	Ultimate Claim Ratio	Ultimate Claims	Reported Claims at 12/31/08	Actual IBNR	Ultimate Claim Ratio	Ultimate Claim	Reported Claim at 12/31/08	Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Steady-State				Increasing Claim Ratios			
1999	1,000,000	70.0%	700,000	700,000	0	70.0%	700,000	700,000	0
::	::	::	::	::	::	::	::	::	::
2004	1,276,282	70.0%	893,397	884,463	8,934	80.0%	1,021,026	1,010,815	10,211
2005	1,340,096	70.0%	938,067	919,306	18,761	85.0%	1,139,082	1,116,300	22,782
2006	1,407,100	70.0%	984,970	935,722	49,248	90.0%	1,266,390	1,203,071	63,319
2007	1,477,455	70.0%	1,034,219	930,797	103,422	95.0%	1,403,582	1,263,224	140,358
2008	1,551,328	70.0%	1,085,930	836,166	249,764	100.0%	1,551,328	1,194,523	356,805
Total	12,577,892		8,804,524	8,365,888	438,636		10,249,349	9,647,367	601,982
		Increasing Case Outstanding Strength				Increasing Claim Ratios and Case Outstanding Strength			
1999	1,000,000	70.0%	700,000	700,000	0	70.0%	700,000	700,000	0
::	::	::	::	::	::	::	::	::	::
2004	1,276,282	70.0%	893,397	884,463	8,934	80.0%	1,021,026	1,010,815	10,211
2005	1,340,096	70.0%	938,067	933,377	4,690	85.0%	1,139,082	1,133,386	5,696
2006	1,407,100	70.0%	984,970	962,808	22,162	90.0%	1,266,390	1,237,897	28,493
2007	1,477,455	70.0%	1,034,219	979,922	54,296	95.0%	1,403,582	1,329,895	73,687
2008	1,551,328	70.0%	1,085,930	931,185	154,745	100.0%	1,551,328	1,330,264	221,064
Total	12,577,892		8,804,524	8,551,189	253,335		10,249,349	9,901,691	347,658

Column Notes:
- (2) Assume 51,000,000 for first year in experience period (1999) and 5% annual increased thereafter.
- (3) and (7) Ultimate claim ratios assumed to be known for purpose of example.
- (4) =[(2) * (3)].
- (5) Latest diagonal of reported claim triangles in Exhibit III, Sheet 2 and 6
- (6) =[(4) - (5)].
- (8) =[(2) + (7)].
- (9) Latest diagonal of reported claim triangles in Exhibit III, Sheet 4 and 8
- (10) =[(8) - (9)].

In the steady-state environment, assume an ultimate claim ratio of 70% for all ten accident years

Table 5 — Key Assumptions
Steady-State Environment
Reporting and Payment Patterns

As **of Month**	**0/0 Reported**	% **Paid**
12	77%	42%
24	90%	71%
36	95%	84%
48	98%	92%
60	99%	96%
72	99%	98%
84	100%	99%
96	100%	99%
108	100%	100%
120	100%	100%

In the increasing claim ratio scenarios, assume the following claim ratios by accident year:

Table 6 - Key Assumptions
Increasing Claim Ratio Scenarios

Accident Year	Ultimate Claim Ratio
1999-2003	70%
2004	80%
2005	85%
2006	90%
2007	95%
2008	100%

EP, ultimate claim ratios, and the above reporting and payment patterns are used to create reported and paid claim development triangles for each of the 4 scenarios (shown in Exhibit III, Sheets 2 – 9).

To simplify, select reported and paid age-to-age factors based on a five-year volume-weighted average.

By not incorporating judgmental adjustments to the examples showing changes in the environment, we demonstrate how the development technique reacts to a changing situation.

Scenario 1 — U.S. PP Auto Steady-State

As expected, the projected ultimate claims are the same for both the reported and paid claim development methods. Both methods produce estimated IBNR equal to actual IBNR (see the top section of Exhibit III, Sheet 10).

Impact of Changing Conditions — Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate — Sheet 10

Accident Year	Age of Accident at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimate IBNR Using Dev. Method with Reported	Estimate IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Reported	Difference from Actual IBNR Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Steady-State													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
::	::	::	::	::	::	::	::	::	::	::	::	::	::
2007	24	930,797	734,295	196,502	1.111	1.408	1,034,219	1,034,218	103,422	103,421	103,422	-1	1
2008	12	836,166	456,090	380,076	1.299	2.381	1,085,930	1,085,928	249,764	249,762	249,764	0	2
Total		8,365,888	7,573,547	792,341			8,804,527	8,804,522	438,639	438,634	438,636		

Scenario 2 — U.S. PP Auto Increasing Claim Ratios (and no case reserve strengthening)

See the bottom section of Exhibit III, Sheet 10.

Accident Year	Age of Accident at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimate IBNR Using Dev. Method with Reported	Estimate IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Reported	Difference from Actual IBNR Paid
Increasing Claim Ratios													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
::	::	::	::	::	::	::	::	::	::	::	::	::	::
2007	24	1,263,224	996,544	266,680	1.111	1.408	1,403,582	1,403,583	140,358	140,359	140,358	0	-1
2008	12	1,194,523	651,558	542,965	1.299	2.381	1,551,328	1,551,328	356,805	356,805	356,805	0	0
Total		9,647,367	8,575,113	1,072,254			10,249,351	10,249,350	601,984	601,983	601,982		

Observations:

- When comparing the top and bottom sections of Sheet 10, there are differences between reported and paid claims in Columns (3) and (4), as well as differences in the claim development triangles.
- The claim development triangles in Sheets 4 and 5 (increasing claim ratio scenario) are the same as the triangles in Sheets 2 and 3 (steady-state) for AYs 1999 - 2003.
- However, beginning in AY 2004, the reported and paid claims for all remaining years are higher for the increasing claim ratio scenario than the steady-state scenario (consistent with our assumption of increasing claim ratios for AYs 2004 - 2008).

Key: ***Since we assume no change in the adequacy of case outstanding, there are no changes in the age-to-age factors, and thus no changes in the cumulative claim development factors*** between the increasing claim ratio scenario and the steady-state environment.

The higher value of projected ultimate claims is solely due to higher values of claims reported and paid as of 12/31/2008.

The estimated IBNR is the same for both the reported and paid claim development methods, and is equal to the actual IBNR.

Thus, conclude that the development technique is responsive to changes in the underlying claim ratios assuming no changes in the underlying claims reporting or payment pattern.

Scenario 3 — U.S. PP Auto Increasing Case Outstanding Strength (and stable claim ratios)

Exhibit III, Sheets 6 and 7 contain the claim development triangles for this scenario.

Sheet 11 shows the calculations for projected ultimate claims and estimated IBNR in the top section.

Assume that case outstanding adequacy increased by 6% in 2007 and 25% in 2008 over the steady-state case outstanding (for the latest 4 AYs only) in the reported triangle.

This means that the next to last diagonal is 6% greater in this scenario than the steady-state scenario, and that the last diagonal is 25% greater in this scenario than the steady-state scenario.

What is expected to be seen?

- The true ultimate claims have not changed from the steady-state environment (since ultimate claims equal 70% of EP for each year in the experience period).
- We expect higher reported claims since case outstanding strength has increased.
- Given the same value of ultimate claims with higher values of reported claims at December 31, 2008, the IBNR should decrease.
- However, actual IBNR for <u>this</u> scenario of stable claim ratios and increases in case outstanding strength
- are $253,336, which is lower than the actual IBNR of the steady-state, which are $438,638.

See the top section of Exhibit III, Sheet 11.

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 11

Accident Year	Age of Accident at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimate IBNR Using Dev. Method with Reported	Estimate IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Reported	Difference from Actual IBNR Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Increasing Case Outstanding Strength													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	979,922	734,295	245,627	1.119	1.408	1,096,235	1,034,218	116,313	54,296	54,296	-62,017	1
2008	12	931,185	456,090	475,095	1.318	2.381	1,227,589	1,085,928	296,404	154,743	154,745	-141,659	2
Total		8,551,189	7,573,547	977,642			9,052,121	8,804,522	500,932	253,333	253,335	-247,597	2

Comparing the projections of Scenario 3 with those of the steady-state environment, we notice:

- For AYs 2005 – 2008, reported claims in Column (3) are greater than those in the steady-state.
- Reported CDFs (Column (6)) are higher for the latest three AYs as well.
- Projected ultimate claims based on the reported claim development technique are greater in Scenario 3 than the steady-state projection due to higher reported claims and higher CDFs.

Conclusion: *Without adjustment, the reported claim development method <u>overstates</u> the projected ultimate claims and thus the IBNR <u>in times of increasing case outstanding strength.</u>*

- An increase in case outstanding adequacy leads to higher CDFs.
- Multiplying a higher value of reported claims by a higher CDFs leads to an overstated the estimate of total unpaid claims.

Paid claim development triangles:

- There are no differences between the paid claim development triangles of Scenario 3 and the steady-state environment (because only the case outstanding are affected).
- Thus, the age-to-age factors, CDFs, and projected ultimate claims remain the same as the steady-state.
- Since there has been no change in the settlement of claims, the primary assumption of the development technique still holds true for paid claims.
- In times of changing case outstanding adequacy, the paid claim development method is an alternative to the reported claim development method.

One problem with the paid claim development method: The highly leveraged nature of the CDF for the most recent years in the experience period (especially for long-tail lines of insurance).

Scenario 4 — U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

See the bottom section of Exhibit III, Sheet 11.

- The claim ratios are the same as those of the second scenario
- Assume changes in case outstanding strength that is similar to the third scenario.

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 11

Accident Year	Age of Accident at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimate IBNR Using Dev. Method with Reported	Estimate IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Reported	Difference from Actual IBNR Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Increasing Claim Ratios and Case Outstanding Strength													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,329,895	996,544	333,351	1.120	1.408	1,488,875	1,403,583	158,980	73,688	73,687	-85,293	-1
2008	12	1,330,264	651,558	678,706	1.320	2.381	1,756,504	1,551,328	426,240	221,064	221,064	-205,176	0
Total		9,901,691	8,575,113	1,326,578			10,595,469	10,249,350	693,778	347,659	347,658	-346,119	-1

Column Notes:

(2) Age of accident year at December 31, 2008
(3) and (4) From last diagonal of reported and paid claim triangles in Exhibit III, Sheets 6 through 9.
(5) =[(3) - (4)].
(6) and (7) CDF based on 5-year volume-weighted average age-to-age factors presented in Exhibit III, Sheets 6 throught 9.
(8) =[(3) * (6)].
(9) =[(4) * (7)].
(10) =[(8) - (3)].
(11) =[(9) - (3)].
(12) Developed in Exhibit III, Sheet 1.
(13) =[(12) - (10)].
(14) =[(12) - (11)].

Again, the paid claim development method produces the actual value for IBNR.

The reported claim development method, while responsive to the increasing claim ratios, overstates the estimate of unpaid claims due to the changing case outstanding adequacy.

Effects of Changes in Product Mix on the Development Technique

A portfolio of contains both private passenger and commercial automobile insurance for the purpose of estimating unpaid claims.

While these types of business have different underlying claim development patterns and ultimate claim ratios, the development technique is an acceptable method for determining estimates of unpaid claims for the combined portfolio as long as there are no changes in the mix of business (i.e., one line of business is not significantly increasing or decreasing in volume relative to the other line of business).

Key Assumptions

We compare a steady-state environment that has no change in product mix (called U.S. Auto Steady-State) with a changing product mix (called U.S. Auto Changing Product Mix).

Assume:

- For U.S. Auto Changing Product Mix, the portfolio includes the same private passenger premiums as the steady-state, but commercial automobile insurance premiums increase at 30% instead of 5% per year starting in 2005.
- The ultimate claim ratio is 70% for private passenger automobile and 80% for commercial automobile.
- The following table shows the reporting and payment patterns for the two categories of business.

Table 7 — Key Assumptions — Product Mix Scenarios
Reporting and Payment Patterns

	Private Passenger		Commercial Automobile	
As of Month	% Reported	% Paid	% Reported	% Paid
12	77%	42%	59%	22%
24	90%	71%	78%	46%
36	95%	84%	89%	67%
48	98%	92%	96%	82%
60	99%	96%	98%	91%
72	99%	98%	100%	95%
84	100%	99%	100%	97%
96	100%	99%	100%	98%
108	100%	100%	100%	99%
120	100%	100%	100%	100%

The claim development triangles are created using the EP and ultimate claim ratios by AY as well as the given reporting and payment patterns.

Exhibit IV, Sheets 2 and 3 show reported and paid development triangles assuming no change in product mix;

Exhibit IV, Sheets 4 and 5 show the claim development triangles based on a changing product mix

Exhibit IV, Sheet 6 shows the calculation of actual IBNR.

U.S. Auto Steady-State (No Change in Product Mix) – See the top section of Exhibit IV, Sheet 6

- Both the reported and paid development techniques produce estimated IBNR equal to the actual IBNR.
- ***As long as the distribution between the different categories of business remains consistent (and there are no other operational or environmental changes), the claim development method should produce an accurate estimate of unpaid claims.***

Impact of Change in Product Mix Example Exhibit IV
U.S. Auto - Development of Unpaid Claim Estimate Sheet 6

Accident Year	Age of Accident at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimate IBNR Using Dev. Method with Reported	Estimate IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Reported	Difference from Actual IBNR Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Steady-State (No Change in Product Mix)													
1999	120	1,500,000	1,500,000	0	1.000	1.000	1,500,000	1,500,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,852,729	1,277,999	574,730	1.196	1.734	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	1,568,393	729,124	839,269	1.484	3.191	2,326,992	2,326,992	758,599	758,599	758,599	0	1
Total		17,472,205	15,270,788	2,201,417			18,866,839	18,866,837	1,394,634	1,394,632	1,394,634	0	1

U.S. Auto Changing Product Mix – See the bottom section of Exhibit IV, Sheet 6

- There are no differences between the two examples until AY 2005, in which commercial auto began to increase at a 30% annual rate.
- We expect higher reported and paid claims for 2005 through 2008.
- We expect higher CDFs for both paid and reported claims for AYs 2006, 2007 and 2008.

However, even with larger claims and CDFs, the development technique falls short of the actual IBNR.

Impact of Change in Product Mix Example Exhibit IV
U.S. Auto - Development of Unpaid Claim Estimate Sheet 6

Accident	Age of Accident	Claims at 12/31/08		Case	CDF to Ultimate		Projected Ultimate Claims Using Dev. Method with		Estimate IBNR Using Dev. Method with		Actual	Difference from Actual IBNR	
Year	at 12/31/08	Reported	Paid	Outstanding	Reported	Paid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Changing Product Mix													
1999	120	1,500,000	1,500,000	0	1.000	1.000	1,500,000	1,500,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	2,680,487	1,766,164	914,323	1.200	1.750	3,217,775	3,091,665	537,288	411,178	596,924	59,637	185,746
2008	12	2,556,695	1,097,644	1,459,051	1.503	3.273	3,842,646	3,592,941	1,285,951	1,036,246	1,445,385	159,434	409,139
Total		20,067,180	16,738,685	3,328,495			22,219,968	21,789,881	2,152,788	1,722,701	2,391,083	238,296	668,382

Column Notes:

(2)	Age of accident year at December 31, 2008
(3) and (4)	From last diagonal of reported and paid claim triangles in Exhibit IV, Sheets 2 through 5.
(5)	=[(3) - (4)].
(6) and (7)	CDF based on 5-year volume-weighted average age-to-age factors presented in Exhibit IV, Sheets 2 throught 5.
(8)	=[(3) * (6)].
(9)	=[(4) * (7)].
(10)	=[(8) - (3)].
(11)	=[(9) - (3)].
(12)	Developed in Exhibit IV, Sheet 1.
(13)	=[(12) - (10)].
(14)	=[(12) - (11)].

What is the correct age-to-age factor when a portfolio is changing its composition (see Exhibit IV, Sheet 1)?

- We know that commercial auto has a longer reporting pattern than private passenger automobile (and thus requires higher selected age-to-age factors).
- Since commercial auto claims are increasing in the portfolio, increasing age-to-age factors appear.
- Changing from a 5-year to 3-year volume-weighted average for selecting age-to-age factors helps move the estimated IBNR closer to the actual IBNR, but its still falls short by a significant amount.

Conclusions

- the reported development method is more responsive than the paid claim development method due to the shorter time frame in which claims are reported versus paid.
- both methods result in estimated IBNR that are significantly lower than the actual IBNR.

Sample Questions:

1. When analyzing data triangles of claims by accident year (AY), using Development Techniques:
   a. Explain how a cumulative reported CDF is calculated.
   b. Explain how a cumulative reported CDF is applied to calculate ultimate claim estimates, for one AY.
   c. What is the term used in Friedland to describe the ultimate claims minus the reported claims?
   d. Explain how a cumulative ***paid*** CDF is calculated.
   e. Explain how a cumulative ***paid*** CDF is applied to calculate ultimate claim estimates, for one AY.
   f. What is the term used in Friedland to describe the ultimate claims minus the ***paid*** claims?
   ("CDF" = claim development factor)

2. Describe a typical relationship between reporting patterns and payment patterns for many lines of P&C insurance.

3. What name does Brosius give to the method described in Friedland as the "Development" technique? What name does Patrik use for this method?

4. Summarize Friedland's key points re: "When the Development Technique Works and When it Does Not." List the two limitations mentioned.

5. List 5 characteristics Friedland suggests that actuaries may reference when reviewing claim development experience.

6. Based on the following data as of 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**1st Report**	**2nd Report**	**3rd Report**	**4th Report**	**5th Report**	**6th Report**
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

   a. Estimate the IBNR as of 12/31/08 using the following method: Development Technique
      To select claim development factors, use the volume-weighted averages for the latest three years.
      See also Friedland Chapter 8 and 9 for other methods.

   b. Using the data above and based on the discussion by Friedland, what is the 12-24 month age-to-age factor using:
      (i) Simple (arithmetic) average of the last three years
      (ii) Geometric average of the last four years
      (iii) Medial average for the latest five years excluding one high and low value, "Medial latest 5x1"

1995 Exam Questions (modified):

38. (1 point) Friedland states that the selection of a tail factor can be difficult. Describe two complicating factors.

44. You are given the following:

		Reported Claims including ALAE ($000's omitted) as of					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	
4,500	1990	2,000	2,600	2,990	3,283	3,283	
5,000	1991	2,102	2,638	3,086	3,343		
5,200	1992	2,234	2,938	3,408			
5,300	1993	2,339	2,985				
5,700	1994	2,482					

a. (1.5 points) See Friedland Chapter 9.

b. (0.5 points) Using the Development Technique described in Friedland, determine the IBNR as of 12/31/94. Select development factors using latest 3 years, volume-weighted. Show all work.

c. (1.5 points) See Friedland Chapter 15.

2002 Exam Questions (modified):

22. (4 points) You are given the following information:

Accident Year	Earned Premium	Reported Claims at 12-31-01	Expected Claim Ratio
1998	200	100	80%
1999	1,000	1,000	80%
2000	1,500	900	80%
2001	1,500	600	80%

Selected age-to-age reported claim development factors:

12 - 24 months	1.25
24 - 36 months	1.10
36 - 48 months	1.05
48 - 60 months	1.08

No further development after 60 months.

a. (1 point) Calculate the IBNR reserve as of December 31, 2001 using the Development technique.

b. (1 point) See Friedland Chapter 9

c. (0.5 points) See Friedland Chapters 9 and 15

e. (1 point) See Friedland Chapters 9 and 15

2003 Exam Questions (modified):

23. (3 points) You are given the following information:

		Reported Claims including ALAE ($000's omitted)				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**	
1,000	1999	250	500	750	825	
1,000	2000	200	350	490		
1,500	2001	300	450			
1,800	2002	400				

- Claim development factors should be calculated using an all-years simple average.
- The tail factor is 1.05 for development from 48 months to ultimate.

a. (1 point) Using the Development method, calculate the total IBNR reserve. Show all work.

b. (1 point) See Friedland Chapter 9.

c. (1 point) See Friedland Chapter 9.

2005 Exam Questions (modified):

10. (4 points) You are given the following information:

		Reported Claims by Development Age				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**	
19,000	2001	4,850	9,700	14,100	16,200	
20,000	2002	5,150	10,300	14,900		
21,000	2003	5,400	10,800			
22,000	2004	7,200				

Assume an expected Claim Ratio = 0.90 for all years.
Choose selected factors using a straight average of the age to age factors.
Assume no development past 48 months.

a. (1 point) Using the Development method, calculate the indicated IBNR for accident year 2004 as of December 31, 2004.

b. (0.5 point) See Friedland Chapter 9

c. (1 point) See Friedland Chapter 15.

d. (0.5 point) See Friedland Chapter 15.

e. (1 point) See Friedland Chapter 15.

2008 Exam Questions (modified):

2. (1.5 points) Given the following for policy year 2006 for a line of business:

Premium	1,600,000
Expected loss emerged at 24 months	68%
Expected loss emerged at 36 months	82%
Reported loss as of December 31, 2007	800,000
Bornhuetter-Ferguson estimate of ultimate loss	1,133,000

a. (0.5 point) See chapter 9.

b. (0.5 point) Calculate the ultimate loss estimate for policy year 2006 using the chain ladder method (Note Friedland terminology: ultimate claims estimate using Reported Loss Development Method)

c. (0.5 point) See chapters 9 and 15.

2008 Exam Questions (modified):

Question 10.

Given the following for an accident year:

- Earned Premium:	$20,000,000
- Reported Losses as of 12 months:	$10,000,000
- Expected loss ratio:	70%

- Expected reporting pattern:

Age (months)	% Reported
12	40%
24	60%
36	80%
48	90%
60	100%

a. (1.5 points) This portion of the problem is associated with the Brosius article that is now on Exam 7.

b. (1 point) Estimate the ultimate value of the claims currently aged at 12 months. Use the Development Method on reported claims, as described in Friedland.

c. (.75 points) See Mack/Benktander and Friedland Ch 9.

2009 Exam Questions

12. (2 points) Given the following information:

Valuation Date	Accident Year	Incremental Paid Loss
Dec. 31, 2008	2008	$1,000
Dec. 31, 2008	2007	500
Dec. 31, 2008	2006	100
Dec. 31, 2008	2005	50
Dec. 31, 2007	2007	1,500
Dec. 31, 2007	2006	600
Dec. 31, 2007	2005	150
Dec. 31, 2006	2006	1,500
Dec. 31, 2006	2005	400
Dec. 31, 2005	2005	1,100

Accident	Cumulative Paid Loss			
Year	12 Months	24 Months	36 Months	48 Months
2005	$1,100	$1,500	$1,650	$1,700
2006	1,500	2,100	2,200	
2007	1,500	A		
2008	1,000			

	12-24 Mos	24-36 Mos	36-48 Mos	48-Ultimate
Age-to-age factors	B	1.069	1.030	1.000

a. (1 point) Using the volume-weighted average for B, calculate the values for A and B.

b. (1 point) Use the development technique to estimate the unpaid claim liability for accident year 2008 as of December 31, 2008.

2010 Exam Questions

13. (1.5 points) Given the following information about two lines of insurance:

Commercial Auto Property Damage Reported Claims ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	10,000	14,000	16,800	18,480
2007	15,000	21,000	25,200	
2008	20,000	28,000		
2009	25,000			

Personal Auto Property Damage Reported Claims ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	10,000	12,000	13,200	13,332
2007	11,000	13,200	14,520	
2008	12,000	14,400		
2009	13,000			

a. (1 point) Based on the data, provide two reasons why it would be inappropriate to combine these two lines of business for estimating unpaid claims.

b. (0.5 point) Briefly describe two additional factors that generally should be considered when deciding whether to combine lines of business for estimating unpaid claims.

2011 Exam Questions

24. (3.5 points) Given the following claim data as of December 31, 2010:

Accident	Cumulative Reported Claims (000s)				
Year	12 Months	24 Months	36 Months	48 Months	60 Months
2006	$105	$265	$340	$375	$380
2007	$100	$275	$360	$390	
2008	$116	$285	$375		
2009	$122	$310			
2010	$128				

- No development is expected after 60 months.
- Use an all-year straight average for all factor selections.
- Accident year 2009 paid claims as of December 31, 2010 = $250,000

a. (1.5 points) Use the reported development technique to estimate the unpaid claims for AY 2009.

b. (0.5 point) Calculate the expected reported claims for accident year 2010 during the next 12 months.

c. (0.75 point) State three assumptions underlying the reported development technique.

d. (0.25 point) Briefly describe when a tail factor may be needed to estimate unpaid claims under the reported development technique.

e. (0.5 point) Briefly describe two approaches to determine a tail factor.

2011 Exam Questions

36. (3 points) An insurance company uses both the reported claim development method and the paid claim development method to estimate unpaid claims for its automobile liability business.

   a. (0.5 point) A state enacts legislation creating a court that specializes in hearing insurance liability claims to combat a backlog of liability cases in the regular court system. Briefly describe the expected impact of the legislation on the estimated unpaid claims in this state for each method.

   b. (0.5 point) A state enacts tort reform legislation that places caps on non-economic damages awarded in automobile liability lawsuits. Briefly describe the expected impact of the legislation on the estimated unpaid claims in this state for each method.

   c. (0.5 point) To gain market share, company management is focusing on writing $1,000,000 policy limits whereas previously policies were written with $500,000 policy limits. Briefly describe the expected impact of this strategic change on the estimated unpaid claims for each method.

   d. (1.5 points) For each scenario described in parts a, b, and c above, discuss a diagnostic test that would indicate whether the expected impact of the change is present in the data.

Solutions to Sample Questions:

1. When analyzing data triangles of claims by accident year (AY), using Development Techniques:
   a. A cumulative reported CDF is calculated by "successive multiplications beginning with the tail factor and the oldest age-to-age factor" as calculated and selected using triangles of reported claims.

   b. For the Reported Claim Development method, ultimate claims for each accident year are estimated as the product of the cumulative reported CDF at the valuation age, and reported claims through the valuation date. Note: (cumulative) Reported Claims = (cumulative) Paid Claims + Case Outstanding at valuation date

   c. Term used in Friedland to describe the ultimate claims minus the reported claims = IBNR (broadly defined)

   d. A cumulative paid CDF is calculated by "successive multiplications beginning with the tail factor and the oldest age-to-age factor" as calculated and selected using triangles of **paid** claims.

   e. For the Paid Claim Development method, ultimate claims for each accident year are estimated as the product of the cumulative paid CDF at the valuation age, and **paid** claims through the valuation date.

   f. Term used in Friedland to describe the ultimate claims minus the **paid** claims = Unpaid Claim Estimate

   Note: Unpaid Claim Estimate includes all Case Outstanding and IBNR (pure IBNR and IBNER)

2. Typical relationship between reporting and payment patterns: Cumulative paid CDFs are usually greater than cumulative reported CDFs at the same maturity factor.

3. What does Brosius and Patrick call the method described in Friedland as the "Development" technique?
   The "Link Ratio" (for ultimate loss estimates with full credibility to actual experience) in Brosius, and Patrik's "Chainladder" methods are analogous to the Development technique in Friedland.

4. Summarize Friedland's key points re: "When the Development Technique Works and When it Does Not."
   Friedland lists limitations:

   The development technique may not be suitable when there is not a sufficient volume of credible data, when entering a new line of business or new territory, or for smaller insurers with limited portfolios.
   For long-tail lines of insurance (e.g. WC or GL), the cumulative claim development factors can become very large for the most recent AYs when using the paid claim development technique. These highly leveraged factors can result in unreasonable projections of ultimate claims for the most recent accident years. See Friedland Chapter 7.

5. List 5 characteristics Friedland suggests that actuaries may reference when reviewing claim development experience:
   -Smooth progression of individual ATA factors and average factors across development periods
   -Stability of ATA factors for the same development period
   -Credibility of the experience
   -Changes in patterns
   -Applicability of the historical experience

6. a. Estimate the IBNR as of 12/31/08 using the following method: Development Technique

To select claim development factors, use the volume-weighted averages for the latest three years.

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**1st Report**	**2nd Report**	**3rd Report**	**4th Report**	**5th Report**	**6th Report**
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

Selected CDF calculations	***1st to 2nd Report***	***2nd to 3rd Report***	***3rd to 4th Report***	***4th to 5th Report***	***5th to 6th Report***
ATA: 3-yr Volume-weighted average	*1.2470*	***1.0896***	*1.0557*	*1.0000*	*1.0000*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.4344*	*1.1503*	*1.0557*	*1.0000*	*1.0000*

** Example of Age-to-Age calculation for 2nd to 3rd report, using 3-year volume-weighted average:*
(1900+1800+1710)/(1550+1725+1690) = 1.0897 or 1.09 as shown

*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.0896 for 2nd-to-3rd) * (1.0557 for 3rd-to-4th) * (1.00 for 4th-to-5th) * (1.0 tail) = 1.1503*

Accident Year	***Age of Data at 12/31/08***	***Reported Claims at 12/31/08***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
2003	*72 months*	*1,750*	*1.0000*	*1,750*	*0*		*0*
2004	*60 months*	*1,800*	*1.0000*	*1,800*	*0*		*0*
2005	*48 months*	*1,950*	*1.0000*	*1,950*	*0*		*0*
2006	*36 months*	*1,900*	*1.0557*	*2,006*	*106*		*106*
2007	*24 months*	*1,900*	*1.1503*	*2,186*	*286*		*286*
2008	*12 months*	*2,250*	*1.4344*	*3,227*	*977*		*977*
Total					***1,369***		***1,369***

b. What is the 12-24 month age-to-age factor using:

(i) 12-24 month age-to-age factor using Simple (arithmetic) average of the last three years =1.25

(ii) 12-24 month age-to-age factor using Geometric average of the last four years =1.28

(iii) 12-24 month age-to-age factor using Medial latest 5x1 =1.35

Age-to-Age Development Factors by Accident Year

Note: Did not need these "Link Ratios" to calculate the volume-weighted ATA selections:

ATA factors by AY:

Example:
12:24 month ATA
for AY 2005 =
(1725)/(1250) = 1.38
between 1st and 2nd
annual valuation dates

Accident Year	1st to 2nd Report	2nd to 3rd Report	3rd to 4th Report	4th to 5th Report	5th to 6th Report
	12:24 mo	**24:36 mo**	**36:48 mo**	**48:60 mo**	**50:72 mo**
2003	1.7234	1.049	1.029	1.000	1.000
2004	1.4083	1.012	1.053	1.000	
2005	1.3800	1.043	1.083		
2006	1.1071	1.226			
2007	1.2667				

Alternative ATA Selections	*12:24 mo*	*Calculation Details*
3-year Simple (Arithmetic) Average	*1.2513*	*= (1.3800+1.1071+1.2667)/3*
4-year Geometric Average	*1.2849*	*= (1.4083*1.38*1.1071*1.2667)^(1/4)*
"Medial latest 5x1"	*1.3517*	*= (1.4083+1.38+1.2667)/3*

Note: "Medial latest 5x1" excludes the highest and lowest values (1.7234 and 1.1071) in 5-yr period

Solutions to 1995 Exam questions (modified):

38. (1 point) Friedland states that the selection of a tail factor can be difficult. Describe two complicating factors.

    1. Lack of data on which to base the estimate of the tail factor.
    2. The tail factor affects all accident years reserve needs, thus has a disproportionate leverage on the total reserve need.

    In chapter 7, Friedland Comments:

    "Sometimes the data does not provide for enough development periods … [w]hen this occurs, the actuary will need to determine a tail factor … For some lines of insurance and some types of claims data, the tail factor can be especially difficult to select due to the limited availability of relevant data."

    "The tail factor is crucial as it influences the unpaid claim estimate for all accident years (in the experience period) and can create a disproportionate leverage on the total unpaid claims."

Solutions to 1995 Exam questions (modified):

44. a. See Friedland Chapter 9.
    b. Using the Development Technique described in Friedland, determine the IBNR as of 12/31/94.
    c. See Friedland Chapter 15.

		Reported Claims including ALAE ($000's omitted) as of					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	
4,500	1990	2,000	2,600	2,990	3,283	3,283	
5,000	1991	2,102	2,638	3,086	3,343		
5,200	1992	2,234	2,938	3,408			
5,300	1993	2,339	2,985				
5,700	1994	2,482					

Selected CDF calculations	***12: 24 mo***	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA: 3-yr Volume-weighted average	*1.2825*	***1.1600****	*1.0905*	*1.0000*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*1.6224*	***1.2650*****	*1.0905*	*1.0000*	*1.00*

** Example of Age-to-Age calculation for 24-to-36 months, using 3-year volume-weighted average:*
(2990+3086+3408)/(2938+2638+2600) = 1.1600
*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.1600 for 24:36 mo) * (1.0905 for 36:48 mo) * (1.0000 for 48:60 mo) * (1.0000 tail) = 1.2650*

Accident Year	***Age of Data at 12/31/94***	***Reported Claims at 12/31/94***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
1990	*60 months*	*3,283*	*1.0000*	*3,283*	*0*		*0*
1991	*48 months*	*3,343*	*1.0000*	*3,343*	*0*		*0*
1992	*36 months*	*3,408*	*1.0905*	*3,716*	*308*		*308*
1993	*24 months*	*2,985*	*1.2650*	*3,776*	*791*		*791*
1994	*12 months*	*2,482*	*1.6224*	*4,027*	*1,545*		*1,545*
Total					***2,644***		***2,644***

Solutions to 2002 Exam Questions (modified):

Question 22.

22 a. (1 point) Calculate the IBNR reserve as of December 31, 2001 using the Development technique.

b. (1 point) See Friedland Chapter 9.

c. (0.5 point) See Friedland Chapters 9 and 15.

d. (0.5 point) See Friedland Chapters 9 and 15.

e. (1 point) See Friedland Chapters 9 and 15.

		Reported Claims including ALAE ($000's omitted) as of					
Earned Premium	***Accident Year***	***12 mo, Report 1***	***24 mo, Report 2***	***36 mo, Report 3***	***48 mo, Report 4***	***60 mo, Report 5***	
200	*1998*				*100*		
1,000	*1999*			*1,000*			
1,500	*2000*		*900*				
1,500	*2001*	*600*					

	12: 24 mo	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA Factors	*1.25*	***1.10***	*1.05*	*1.08*	*given*
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*1.5593*	***1.2474***	*1.1340*	*1.0800*	*1.00*

Accident Year	***Age of Data at 12/31/01***	***Reported Claims at 12/31/01***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
1998	*48 months*	*100*	*1.0800*	*108*	*8*		*8*
1999	*36 months*	*1,000*	*1.1340*	*1,134*	*134*		*134*
2000	*24 months*	*900*	*1.2474*	*1,123*	*223*		*223*
2001	*12 months*	*600*	*1.5593*	*936*	*336*		*336*
Total					***700***		***700***

Solutions to 2003 Exam Questions (modified):

23. (3 points)

a. (1 point) Using the Development method, calculate the total IBNR reserve. Show all work.

b. (1 point) See Friedland Chapter 9.

c. (1 point) See Friedland Chapter 9.

	Reported Claims including ALAE ($000's omitted)				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**
1,000	1999	250	500	750	825
1,000	2000	200	350	490	
1,500	2001	300	450		
1,800	2002	400			

ATA factors by AY:
Example:
12:24 for AY 2000
1.75 = 350/200

AY	***12:24 mo***	***24:36 mo***	***36:48 mo***	***See tail factor***	
1999	*2.0000*	*1.500*	*1.100*		
2000	*1.7500*	*1.400*			
2001	*1.5000*				

	12: 24 mo	***24: 36 mo***	***36:48 mo***	
ATA: Simple Average (all yr)	***1.75****	*1.45*	*1.10*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo given***
Reported CDF to Ultimate	***2.9309*****	*1.6748*	*1.1550*	*1.05 tail*

** Example of Age-to-Age calculation for 12:24 months report, using all-year simple average:*
(2.00 + 1.75 + 1.50) / 3 = 1.75

*** Example of Ultimate CDF calculation for claims at 12 months of development:*
*(1.75 for 12:24 mo) * (1.45 for 24:36 mo) * (1.10 for 36:48 mo) * (1.05 for tail at 48 mo) = 2.9309*

Accident Year	***Age of Data at 12/31/02***	***Reported Claims at 12/31/02***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut ***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*	*(5)=(2)*[(3) - 1.0]*
1999	*48 months*	*825*	*1.0500*	*866*	*41*	*41*
2000	*36 months*	*490*	*1.1550*	*566*	*76*	*76*
2001	*24 months*	*450*	*1.6748*	*754*	*304*	*304*
2002	*12 months*	*400*	*2.9309*	*1,172*	*772*	*772*
Total					***1,193***	***1,193***

Solutions to 2005 Exam Questions (modified):
10. (4 points) You are given the following information:

Note: Expected Claim Ratio is not used in the Development technique.
Choose selected factors using a straight average of the age to age factors.
Assume no development past 48 months.

a. (1 point) Using the Development method, calculate the indicated IBNR for accident year 2004.
b. (0.5 point) See Friedland Chapter 9
c. (1 point) See Friedland Chapter 9
d. (0.5 point) See Friedland Chapters 9 and 15
e. (1 point) See Friedland Chapters 9 and 15

		Reported Claims by Development Age			
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**
19,000	2001	4,850	9,700	14,100	16,200
20,000	2002	5,150	10,300	14,900	
21,000	2003	5,400	10,800		
22,000	2004	7,200			

ATA factors by AY:

AY	***12:24 mo***	***24:36 mo***	***36:48 mo***	***See tail factor***	
2001	*2.000*	*1.4536*	*1.1489*		
2002	*2.000*	*1.4466*			
2003	*2.000*				

	12: 24 mo	***24: 36 mo***	***36:48 mo***	
ATA: Simple Average (all yr)	*2.0000*	*1.4501*	*1.1489*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo given***
Reported CDF to Ultimate	*3.3320*	*1.6660*	*1.1489*	*1.00 tail*

Accident Year	***Age of Data at 12/31/04***	***Reported Claims at 12/31/04***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
2001	*48 months*	*16,200*	*1.0000*	*16,200*	*0*		*0*
2002	*36 months*	*14,900*	*1.1489*	*17,119*	*2,219*		*2,219*
2003	*24 months*	*10,800*	*1.6660*	*17,993*	*7,193*		*7,193*
2004	*12 months*	*7,200*	*3.3320*	*23,990*	***16,790***		***16,790***
Total					*26,202*		*26,202*

Note: Only the calculations for Accident Year 2004 are required:

*7200 * (3.3320 - 1) =* ***16,790***

Solutions to 2008 Exam Questions

Question 2

a) See chapter 9.

b) Calculate the ultimate claim estimate for policy year 2006 using the Development Method.
(applied to reported claims)

Recall, claim development factor = the inverse of the percent emerged
CDF at 24 months: 1/.68 = 1.4706 *& at 36 mo:* 1.2195)

For the *development method*, *Ultimate Claims = Reported Claims * CDF*
Dev. Method Ultimate Claims = 800,000 * (1.4706) = 1,176,480

OR using an extra step:

Ultimate Claims = Reported Claims + IBNR
where ***Development Method est.*** *IBNR = (Reported Loss)*(CDF - 1)*
so expected IBNR = (800,000)*[1.4706 - 1] 376,480
Ultimate Claims = 800,000 + 376,480 = 1,176,480

c) See chapters 9 and 15.

Question 10

b. See also solution to 2008 #36 - See also Brosius, Mack, Friedland Ch 8 & 9
Ultimate $ = [Reported Losses] * [Development Factor to ult]
= $10M* 1/.4 since development factor = inverse of % reported
= 25,000,000

* Note: we used cumulative development factor of 2.5 (= 1/.4) The detail of % reported at other ages was not used.

Solutions to 2009 Exam Questions

Question 12 – Model Solution

a. (1 point) Using the volume-weighted average for B, calculate the values for A and B.

b. (1 point) Use the development technique to estimate the unpaid claim liability for accident year 2008 as of December 31, 2008.

a. A = AY 2007 Incremental paid loss valued as of 12/31/2008 = 500 + 1,500 = 2,000
B = 12-24 month vol wtd avg = (1,500 + 2,100 + 2,000) / (1,100 + 1,500 + 1,500) = 5,600/4,100 = 1.366

b. 2008 Ult = AY 2008 paid loss at 12 months * LDF to ult = (1,000)(1.366)(1.069)(1.03)(1.0) = 1,504.06
2008 Unpaid = Ult - Paid = 1,504.06 – 1,000 = 504.06
Also, 1,000 × (1.366 × 1.069 × 1.03 × 1 – 1) = 504.06

Solutions to 2010 Exam Questions

13a. (1 point) Based on the data, provide two reasons why it would be inappropriate to combine these two lines of business for estimating unpaid claims.

13b. (0.5 point) Briefly describe two additional factors that generally should be considered when deciding whether to combine lines of business for estimating unpaid claims.

Question 13 - Solution 1

a1. Commercial is growing at a faster pace than personal.

a2. Commercial has a longer reporting pattern (or at least a different reporting pattern)

b1. Severity may differ between the two lines

b2. Credibility of each line – may want to combine to improve credibility

Question 13 - Solution 2

a1. All year weighted Average LDF's

	12-24	24-36	36-48
Commercial APD	1.4	1.2 = [25.2+16.8]/[21+14]	1.1
Personal APD	1.2	1.1	1.01

The two lines of business have different reporting patterns as seen above

a2. AY trend in C-APD

	12	24	36
2006-2007	50%	50%=21/14 -1.0	50%
2007-2008	33%	33%	
2008-2009	25%		

AY trend in P-APD

	12	24	36
2006-2007	10%	10%	10%
2007-2008	9.1%	9.1%=14.4/13.2 -1.0	
2008-2009	8.3%		

It appears that the CAPD book is growing much faster than the PAPD based on the AY trends

b1. Credibility of data – want block of data to be large enough and homogenous enough

b2. Coverage trigger – don't want to group claims made policies with occurrence

Solutions to 2011 Exam Questions

a. (1.5 points) Use the reported development technique to estimate the unpaid claims for accident year 2009.

b. (0.5 point) Calculate the expected reported claims for accident year 2010 during the next 12 months.

c. (0.75 point) State three assumptions underlying the reported development technique.

d. (0.25 point) Briefly describe when a tail factor may be needed to estimate unpaid claims under the reported development technique.

e. (0.5 point) Briefly describe two approaches to determine a tail factor.

Question 24 – Model Solution 1

Age-age LDFs

	12-24	24-36	36-48	48-60	60-ult
2006	2.524	1.283	1.103	1.013	1.0
2007	2.750	1.309	1.083		
2008	2.457	1.316			
2009	2.541				

	12-24	24-36	36-48	48-60	60-ult
All Year Straight Average	2.568	1.303	1.093	1.013	1.0
	12-ult	24-ult	36-ult	48-ult	60-ult
Cumulative LDFs	3.705	1.443	1.107209=1.013*1.093	1.013	1.0

Note: This model solution ignored rounding issues beyond thee decimal places, yet still received full credit. Examiners will focus more on determining if the technique is applied correctly than on rounding. For example, see model solution 2.

a. AY 2009 Reported Losses * 24-ult LDF – AY 2009 Paid losses at 24 months

[310 x 1.443 -250] x 1000 = $\boxed{197{,}330}$

b. [2010 reported claims @ 12 mo] x [12-24 factor – 1]

128,000 x (2.568 – 1) = $\boxed{200{,}704}$

c. 1. Future development will be similar to prior dev.

2. Implied assumption that losses to immature accident year tell you something about losses not reported yet.

3. Stable claims practices (i.e., no change in case reserve adequacy)

d. When you don't have enough loss history in the triangles such that development ceases.

e. 1. Extrapolate based on selected development pattern

2. Use industry benchmarks that are appropriate for line of business being reviewed.

Solutions to 2011 Exam Questions

Question 24 – Model Solution 2

a. Age-to-age factors as of

AY	12-24	24-36	36-48	48-60
2006	2.5238	1.2830	1.1029	1.0133
2007	2.75	1.3091	1.0833	
2008	2.4569	1.3158		
2009	2.5410			

	12-24	24-36	36-48	48-60	60-ult
Selected link ratio	2.5679	1.3026	1.0931	1.0133	1.00
CDF to ultimate	3.7050	1.4428	1.1076	1.0133	1.00

AY 2009 unpaid claims = 310,000 x 1.4428 – 250,000 = 197,268

b. Initial comments

Expected reported claims in the calendar year are equal to:

[(ultimate claims selected at 12/31/2010 - actual reported claims at 12/31/2010) / (% unreported at 12/31/2010)] x (% reported at 12/31/2011 - % reported at 12/31/2010)]

The % unreported is computed as [1.00 - (1.00 / cumulative claim development factor)]. See Chapt 15.

AY 2010 Expected Reported Claims in the next 12 months

= [(128 * 3.7050 - 128)/(1 - (1/3.7050))] x (1/1.4428 – 1/3.7050) x 1000 = 200,694

c. 1. Reported claims will continue to development in a similar manner in the future.

2. Consistent claims process. no change in case reserve adequacy.

3. Consistent policy limits, retention limits, mix of claim types.

d. When the age-to age factor is still greater than 1.00 in the last development period.

e. 1. Use insurance industry benchmark data.

2. Fit a curve using average or selected LDF exponential decay model.

Question 36 – Model Solution 1

a. Will cause speed-up in claim settlement

Paid method – will overstate ult. Because dev. Factors are selected based on old pattern.

Reported method- accurate assuming reserves were set correctly and unaffected by this change

b. Will cause lower severity

Both methods will produce inaccurate estimates (overstated) if unadjusted for tort reform impact.

c. Increase in losses due to writing higher limits

Both methods will produce inaccurate estimates (Understated) – old data will have smaller dev factors because pol. limits were reached quicker.

d. i) look at ratios of paid-to-reported claims. They will show increase if there is speedup.

ii) Look at avg. paid and avg reported – they will show decrease

iii) Look at avg. paid, avg. reported, ult loss ratios – they all should show increase.

Solutions to 2011 Exam Questions

Question 36 – Model Solution 2

a. There will be a speed up of claims being settled so if the two developments are not adjusted for this change, they will overstate the unpaid claim liabilities.

b. The average losses should decrease with this tort reform, so the unadjusted methods (both paid and reported) will overstate the unpaid claim liabilities.

c. The losses should increase as the policy limits increase, so both methods will understate the unpaid claims if they are not adjusted.

d. i. Look at paid claims to reported and see if there is an increasing ratio or look at closed counts to reported counts ratios and see if it is increasing.

ii. Analyze the average reported and average paid values and look for downward trend between accident years.

iii. Analyze average reported and average paid amount and look for a positive trend between subsequent accident years.

1 Introduction 131

Expected claims are a critical component of other methods including the Bornhuetter-Ferguson and Cape Cod techniques (discussed in Chapters 9 and 10)

- The expected claims method can be used with all lines of insurance.
- The method can be used with data organized by AY, PY, U/W Y, and CY data.

2 Key Assumption 131

A better estimate of total unpaid claims can be made based on an a priori (or initial) estimate than from claims experience observed to date. At times, the claims experience reported to date may provide little information about ultimate claims (compared to the a priori estimate).

3 Common Uses of the Expected Claims Method 131

This method is used in lines of business with longer emergence patterns and settlement patterns. The expected claims method is often used:

* when an insurer enters a new line of business or a new territory.
* when operational or environmental changes make recent historical data irrelevant for projecting future claims activity for that cohort of claims.
* for the most recent years in the experience period, since cumulative CDFs are highly leveraged.
* when data is unavailable for other methods.
* for the latest year in the experience period after major changes in the legal environment take place. Examples: an increase in the statute of limitations for filing claims or expanded coverage due to recent court decisions are changes in the legal environment that can affect insurers' claims liabilities.

4 Mechanics of the Expected Claims Method 131 - 132

Ways to determine the a priori expected claims (from mathematically simple to complex statistical modeling):

1. Commercial insurers apply a claim ratio method. Ultimate claims = a selected expected claim ratio * EP
   This approach implicitly relies on accurate underwriting and policy pricing.
2. A complex simulation model may require variables such as the opinions of an experts, lawyers, and various practitioners as well as a detailed analyses of the frequency rate and severity of claims.

This chapter focuses on exposure-based methods for determining expected claims.

Expected claims = A predetermined exposure base * claims per unit of exposure (a.k.a. the pure premium or the loss rate).

The unpaid claim estimate = projected expected claims - paid claims.

Two challenges when using the expected claims method:

1. Determining the appropriate exposure base (often EP).
2. Estimating the measurement of claims relative to that exposure base (often the claim ratio).

Since self-insureds do not collect premiums in the same way that an insurer does, the exposure base that is chosen needs to be one that is closely related to the risk and thus the potential for claims and is readily observable and available.

The following table shows types of exposures often used for the analysis of self-insurers' unpaid claims.

Line of Insurance	Exposure
U.S. workers	Payroll
Automobile liability	Number of vehicles or miles driven
General liability for public	Population or operating expenditures
General liability for	Sales or square footage
Hospital professional	Average occupied beds and outpatient visits
Property	Property values
Crime	Number of employees

Computing the claim ratio or pure premium:

- Begin with a review of the historical claims and exposure experience.
- Two examples of the expected claims method are shown in Exhibit I, Sheets 1 and 2.
- The expected claims method is used to estimate unpaid claims for AY 2008 only.
- Historical reported and paid claims data as well as exposure data from each organization is also used.

5 Step-by Step Example – Auto BI Insurer 133 - 134

Step 1: Compute initial selected ultimate claims as the average of the reported and paid claim development projections. See Column (8).

Step 2: Develop an expected claim ratio for AY 2008. See Column (13) and Line (14)

Trended adjusted claim ratios = trended adjusted claims/ on-level earned premiums.

Trended adjusted claims = initial selected ultimate claims * trend factor * tort reform factor.

Trend factor uses a 14.5% annual claim trend rate for auto BI, incorporating both frequency and severity trends. The trend period is from the midpoint of the AY to 7/1/2008.

Tort reform factor. To account for the significant reform during 2004, historical claims are multiplied by a reform adjustment factor of 0.67 (i.e. removing 33% of the claims for the oldest years in the experience period). The adjustment rationale is that if the same type of claims that occurred in 2000 - 2003 were to occur in 2008, they would cost 33% less.

Since the reform was introduced during 2004, the pro rata adjustment factor for 2004 is only 0.75, a 25% reduction.

Development of Unpaid Claim Estimate for Accident Year 2008 Exhibit I
Auto BI Insurer Sheet 1

Accident Year	Claims at 12/31/098 Reported	Claims at 12/31/098 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultiamate Claims Based On Reported	Projected Ultiamate Claims Based On Paid	Initial Selected Ultimate Claims	On-Level Earned Premium	Trend at 14.50% to 7/1/08	Adjusted for Tort Reform	Trended Adj. Ultimate Claims	Trended Adjusted Claim Ratio
(1)	(2)	(3)	(4)	(5)	(6) = [(2) x (4)]	(7) = [(3) x(5)]	(8) =[(6)+(7)]/2	(9)	(10)	(11)	(12) = [(8) x(10) x(11)]	(13) = [(12) / (9)]
2000	10,000,000	9,500,000	1.005	1.050	10,050,000	9,975,000	10,012,500	24,000,000	2.954	0.670	19,816,540	82.6%
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2004	16,500,000	11,200,000	1.200	1.750	19,800,000	19,600,000	19,700,000	32,000,000	1.719	0.750	25,398,225	79.4%
2005	18,500,000	10,200,000	1.400	2.500	25,900,000	25,500,000	25,700,000	47,000,000	1.501	1.000	38,575,700	82.1%
2006	16,500,000	6,000,000	1.800	5.000	29,700,000	30,000,000	29,850,000	50,000,000	1.311	1.000	39,133,350	78.3%
2007	14,000,000	3,000,000	2.900	15.000	40,600,000	45,000,000	42,800,000	57,000,000	1.145	1.000	49,006,000	86.0%
2008	8,700,000	750,000	4.000	90.000	34,800,000	67,500,000	51,150,000	62,000,000	1.000	1.000	51,150,000	82.5%

(14) Average Claim Ratio at 7/1/2008 Cost Level	
Average 2000 to 2005	79.8%
Average 2000 to 2005 Excluding High and Low	79.9%
Average 2001 to 2006	79.0%
Average 2001 to 2006 Excluding High and Low	79.0%
(15) Selected Claim Ratio at 7/1/2008 Cost Level	80.0%
(16) Expected Claims for 2008 Accident Year	49,600,000
(17) Unpaid Claim Estimate for 2008 Accident Year	
Total	48,850,000
IBNR	40,900,000

Column and Line Notes:
(2) and (3) Based on data provided by commercial insurer.
(4) and (5) Based on commercial insurer historical claim development experience.
(9)Based on data provi-ded by commercial insurer.
(10) Assume 14.5% annual trend iii private passenger auto bodily injury liability claims. Trend front midpoint of accident year to 7/1/08.
(11) Adjusts for law reforms-in private passenger auto implemented during experience period.
(14) Various averages of claim ratios in (13).
(15) Selected based on claim ratios by year in (13) and various averages in (14).
(16) Based on selected claim ratio at 2008 cost level and accident year 2008 earned premiums. (16) = [(15) x (9) for 2008].
(17) Total unpaid claim estimate is equal to expected claims in (16) less paid claims for 2008. IBNR is equal to expected claims in (16) less reported claims for 2008.

Step 3: Determine the selected claim ratio at 7/1/2008 cost level. See Line (15)

Review various averages of individual AYs claim ratios, excluding claims ratios from the most recent years, because the paid and reported development factors from those years are highly leveraged.

Select a claim ratio based on a review of the individual AY projected claim ratios and the various averages.

Step 4: Determine expected claims for AY 2008 See Line (16)

Expected claims Line (16) equal to selected claim ratio of 80% * CY 2008 EP

Step 5: Compute estimated unpaid claims and IBNR for AY 2008 See Line (17)

Estimated unpaid claims = AY 2008 Expected claims – AY 2008 Paid claims

Estimated IBNR = AY 2008 Expected claims – AY 2008 Reported claims

6 Step-by Step Example – GL Self Insurer 134

Exhibit 1, Sheet 2: Calculation for a public entity self-insurer's general liability program (GL Self-Insurer).

Step 1: Compute initial selected ultimate claims as the average of the reported and paid claim development projections. See Column (8).

Step 2: Develop trended pure premiums for AY 2008. See Column (12) and Line (13)

Trended pure premiums = trended ultimate claims/ population

Trended ultimate claims = initial selected ultimate claims * trend factor

Trend factor uses a 7.5% annual claim trend rate, incorporating both frequency and severity trends. The trend period is from the midpoint of the AY to 7/1/2008.

An alternative to trending claims and exposures separately when the exposures are inflation-sensitive is to use a residual pure premium trend rate. For WC a residual pure premium trend is used that represents the trend in claims that is in excess of the trend in payroll.

Development of Unpaid Claim Estimate for Accident Year 2008 Exhibit I
Auto BI Insurer Sheet 2

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultiamate Claims Based On Reported	Projected Ultiamate Claims Based On Paid	Initial Selected Ultimate Claims	Population	Trend at 7.50% to 7/1/08	Trended Ultimate Claims	Trended Pure Premium
(1)	(2)	(3)	(4)	(5)	(6)=[(2)x(4)]	(7)=[(3)x(5)].	(8) =[(6)+(7)]/2	(9)	(10)	(11)=[(8)x(10)	(12)=[(11)/(9)]
1998	900,000	890,000	1.015	1.046	913,500	930,940	922,220	709,000	2.061	1,900,695	2.68
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	1,200,000	750,000	1.940	5.093	2,328,000	3,819,750	3,073,875	785,000	1.075	3,304,416	4.21
2008	600,000	170,000	3.104	20.373	1,862,400	3,463,410	2,662,905	790,000	1.000	2,662,905	3.37

(13) Average Pure Premium at 7/1/2008 Cost Level	
Average 2000 to 2005	3.55
Average 2000 to 2005 Excluding High and Low	3.52
Average 2001 to 2006	3.50
Average 2001 to 2006 Excluding High and Low	3.45
(14) Selected Pure Premium at 7/1/2008 Cost Level	3.50
(15) Expected Claims for 2008 Accident Year	2,765,000
(16) Unpaid Claim Estimate for 2008 Accident Year	
Total	2,595,000
IBNR	2,165,000

Column and Line Notes:
(2) and (3) Based on data provided by public entity.
(4) and (5) Based on insurance industry benchmark claim development patterns.
(9) Based on data provided by public entity.
(10) Assume 7.5% annual trend in general liability claims. Trend from midpoint of accident year to 7/1/08.
(13) Various averages of pure premium in (12).
(14) Selected based on pure premium by year in (12) and various averages in (13).
(15) Based on selected pure premium at 2008 cost level and accident year 2008 population. (15) = [(14) x (9) for 2008].
(16) Total unpaid claim estimate = expected claims in (15) - paid claims for 2008. IBNR = expected claims in (15) - reported claims for 2008

Step 3: Determine the selected pure premium at 7/1/2008 cost level. See Line (14)

Review averages of individual AYs trended pure premiums, excluding claims ratios from the most recent years, because the paid and reported development factors from those years are highly leveraged.

Select a pure premium based on a review of individual AY projected pure premiums and the various averages.

Step 4: Determine expected claims for AY 2008 See Line (15)

Expected claims Line (16) = selected pure premium * the 2008 population

Step 5: Compute estimated unpaid claims and IBNR for AY 2008 See Line (16)

Estimated unpaid claims = AY 2008 Expected claims – AY 2008 Paid claims

Estimated IBNR = AY 2008 Expected claims – AY 2008 Reported claims

7 Step-by Step Example – U.S. Industry Auto 135

Exhibits II through V continue with the examples presented in Chapter 7.

Exhibit II – Expected Claims Technique for the U.S. Industry Auto.

Step 1: Compute initial selected ultimate claims as the average of the reported and paid claim development projections. See Column (8).

Step 2: Compute estimated claims ratios equal to Step 1 result / EP. Since the EP represents consolidated results for the entire U.S. insurance industry, there is no detailed information regarding rate changes and thus premiums cannot be adjusted an on-level basis.

Chapter 8 - Expected Claims Technique
U. S. Industry Auto
Projection of Expected Claims ($000)

Exhibit II
Sheet 1

Accident	Claims at 12/31/098		CDF to Ultimate		Projected Ultimate Claims Using Dev. Method with		Initial Selected Ultimate	Earned	Claim Ratio		Expected
Year	Reported	Paid	Reported	Paid	Reported	Paid	Claims	Premium	Estimated	Selected	Claims
(1)	(2)	(3)	(4)	(5)	(6)= [(2) x (4)]	(7)= [(3) x (5)]	(8)=[((6)+(7))/2]	(9)	(10)	(11)	(12)=[(9)x(11)]
1998	47,742,304	47,644,187	1.000	1.002	47,742,304	47,739,475	47,740,890	68,574,209	69.6%	75.0%	51,430,657
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2002	58,592,712	57,807,215	1.006	1.020	58,944,913	58,971,536	58,958,225	79,228,887	74.4%	75.0%	59,421,665
2003	57,565,344	55,930,654	1.011	1.040	58,200,926	58,141,265	58,171,096	86,643,542	67.1%	65.0%	56,318,302
2004	56,976,657	53,774,672	1.023	1.085	58,297,009	58,359,672	58,328,341	91,763,523	63.6%	65.0%	59,646,290
2005	56,786,410	50,644,994	1.051	1.184	59,671,116	59,964,795	59,817,955	94,115,312	63.6%	65.0%	61,174,953
2006	54,641,339	43,606,497	1.110	1.404	60,632,434	61,234,435	60,933,434	95,272,279	64.0%	65.0%	61,926,981
2007	48,853,563	27,229,969	1.292	2.390	63,100,513	65,080,550	64,090,532	95,176,240	67.3%	65.0%	61,864,556

Column and Line Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) and (5) Developed in Chapter 7, Exhibit I, Sheets 1 and 2.
(8) Based on average of paid and reported claim projections. (8) = [((6)+(7))/2].
(9) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(10) = [(8) / (9)]
(11) Selected judgmentally based on experience in (10).

Note: (6) and (7) based on unrounded (4) and (5) CDFs. Thus, these values do not match those in the corresponding exhibit in the Friedland text. However, the formulas, which are shown correctly, are what matter most when preparing for the exam.

Exhibit II differs somewhat from the prior two examples in this chapter in the time period for which the expected claims method is used.

- In the first two examples, we use historical experience to select an expected claim ratio and an expected pure premium for the 2008 AY only. Experience period exposures and claims are adjusted to the 2008 cost level.
- In U.S. Industry Auto example, ultimate claims for each year in the experience period are projected based on the expected claims technique. This requires a claim ratio at the expected cost level for each year in the experience period.

  For the most recent years, either review estimated claim ratios from prior years on a trended and adjusted basis, or use significant judgment when selecting expected claim ratios.

See Column (11) of Exhibit II, Sheet 1.

Selected expected claim ratios are 75% for AYs 1998 - 2002 and 65% for AYs 2003 - 2007.

Actuarial judgment is used by selecting two different claim ratios to reflect the change in experience that is apparent between the older accident years and the more recent accident years.

In Exhibit II, Sheet 2

Estimated IBNR Column (6) = expected claims Column (4) - reported claims in Column (2).

Estimated total unpaid claims = expected claims - paid claims = (sum of case outstanding + IBNR).

U. S. Industry Auto Exhibit II
Development of Unpaid Claim Estimate($000) Sheet 2

Accident Year	Claims at 12/31/07 Reported	Paid	Expected Claims	Case Outstanding at 12/31/07	Unpaid Claim Estimate Based on Expected Claims Method IBNR	Total
(1)	(2)	(3)	(4)	(5) = [(2) - (3)]	(6) = [(4) - (2)]	(7) = [(4) - (3)]
1998	47,742,304	47,644,187	51,430,657	98,117	3,688,353	3,786,470
1999	51,185,767	51,000,534	51,408,736	185,233	222,969	408,202
2000	54,837,929	54,533,225	51,680,983	304,704	-3,156,946	-2,852,242
2001	56,299,562	55,878,421	54,408,716	421,141	-1,890,846	-1,469,705
2002	58,592,712	57,807,215	59,421,665	785,497	828,953	1,614,450
2003	57,565,344	55,930,654	56,318,302	1,634,690	-1,247,042	387,648
2004	56,976,657	53,774,672	59,646,290	3,201,985	2,669,633	5,871,618
2005	56,786,410	50,644,994	61,174,953	6,141,416	4,388,543	10,529,959
2006	54,641,339	43,606,497	61,926,981	11,034,842	7,285,642	18,320,484
2007	48,853,563	27,229,969	61,864,556	21,623,594	13,010,993	34,634,587
Total	543,481,587	498,050,368	569,281,839	45,431,219	25,800,252	71,231,471

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) Developed in Exhibit II, Sheet 1.

Negative IBNR for AYS 2000, 2001, and 2003:

- While negative IBNR is possible (e.g. for first-party lines subject to salvage and subrogation (S&S) recoveries, it is not likely for U.S. Industry Auto.
- Use of a priori estimate to determine expected claims is at times a strength of the expected claims method and at times (as in this example)a weakness of the method.
- The negative IBNR is a result of the selected a priori claim ratio being too low for certain AYs years.

An approach to correct negative IBNR:

- Use a 65% claim ratio assumption for AYs 2005 - 2007 and rely on the estimated claim ratios in Column (10) for all prior years (i.e. AYs 1998 - 2004).

Why this approach is sound:

Since expected claims unreported and unpaid for the older years are low, the claim development methods produce more reasonable results (Note, for AY 2004, the % of claim unreported at 12/31/2007 is only 2% and the % unpaid is 8%).

8 XYZ Insurer 136 - 137

See Exhibit III

Q. Should the claim development method be used for XYZ Insurer?

A. Due to the various changes experienced by XYZ Insurer, the primary claim development assumptions do not hold.

Alternatives for selecting expected claim ratios for XYZ Insurer include:

1. Use insurance industry experience for benchmark claim ratios.

   Ultimate claim ratios for the aggregated insurance industry experience are approximately 50%.

   However, since XYZ Insurer's undeveloped reported claim ratios (i.e. current value of reported claims/EP) are greater than 70% for 6 of the 7 earliest AYs in the experience period, using industry claim ratios does not appear reasonable.

2. Use the unadjusted reported and paid claim development methods as a starting point.

XYZ Insurer - Auto BI
Projection of Expected Claims ($000)

Exhibit III
Sheet 1

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Initial Selected Ultimate Claims	Earned Premium	Claim Ratio Estimated	Claim Ratio Selected	Expected Claims
(1)	(2)	(3)	(4)	(5)	(6)= [(2) x (4)]	(7) = I(3) x (5)]	(8)=[((6)+(7))/2]	(9)	(10)=[(8)/(9)]	(11)	(12) =[(9)x(11)]
1998	15,822	15,822	1.000	1.010	15,822	15,980	15,901	20,000	79.5%	78.3%	15,660
1999	25,107	24,817	0.999	1.014	25,082	25,165	25,124	31,500	79.8%	78.3%	24,665
2000	37,246	36,782	0.992	1.031	36,948	37,932	37,440	45,000	83.2%	78.3%	35,235
2001	38,798	38,519	0.992	1.054	38,488	40,598	39,543	50,000	79.1%	78.3%	39,150
2002	48,169	44,437	1.003	1.116	48,310	49,598	48,954	61,183	80.0%	78.3%	47,906
2003	44,373	39,320	1.013	1.268	44,948	49,856	47,402	69,175	68.5%	78.3%	54,164
2004	70,288	52,811	1.064	1.525	74,758	80,555	77,656	99,322	78.2%	87.1%	86,509
2005	70,655	40,026	1.085	2.007	76,651	80,346	78,499	138,151	56.8%	78.3%	108,172
2006	48,804	22,819	1.196	3.160	58,346	72,098	65,222	107,578	60.6%	65.8%	70,786
2007	31,732	11,865	1.512	6.569	47,990	77,938	62,964	62,438	100.8%	63.8%	39,835
2008	18,632	3,409	2.551	21.999	47,536	74,994	61,265	47,797	128.2%	82.5%	39,433

Column and Line Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheets 1 and 2.
(8) Based on average of paid and reported claim projections. (8) = [((6) + (7)) / 2].
(9) Based on data from insurer.
(11) Selected for 1998 through 2003, based on average of estimated claim ratios in (10) for these years. For 2004 through 2008, selected in Exhibit III, Sheet 2.

Exhibit III calculations:

i. Use the reported and paid development methods to determine an initial estimate of ultimate claims for AYs 1998 – 2003 (the most mature years in the experience period) and select the expected claim ratio based on the average of the estimated claim ratios in Column (10).

ii. Use selected expected claim ratios in Exhibit III, **Sheet 2**.

XYZ Insurer - Auto BI Exhibit III
Selection of Expected Claim Ratios ($000) Sheet 2

Accident Year	Initial Selected Ultimate Claims	Trend Adjustment 2004	2005	2006	2007	2008	Tort Reform Adjustmant 2004	2005	2006	2007	2008
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2002	48,954	1.070	1.106	1.144	1.183	1.224	1.000	1.000	0.893	0.670	0.670
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2008	61,265	0.874	0.904	0.935	0.967	1.000	1.493	1.493	1.333	1.000	1.000

Accident Year	Earned Premium	Real Level Adjustment 2004	2005	2006	2007	2008	Trended Adjusted On-Level Claim Ratios 2004	2005	2006	2007	2008
(1)	(2)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
2002	61,183	1.129	1.298	1.428	1.142	0.914	75.8%	68.2%	57.3%	55.5%	71.8%
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2008	47,797	0.205	1.420	1.563	1.250	1.000	135.4%	121.7%	102.3%	99.2%	128.2%

	2004	2005	2006	2007	2008
(24) Average Claim Ratios					
All Years	90.9%	81.8%	68.7%	66.6%	86.1%
All Years excluding High and Low	87.1%	78.3%	65.8%	63.8%	82.5%
Latest 5 Years	98.9%	89.0%	74.7%	72.5%	93.7%
Latest 3 Years	117.8%	105.9%	89.0%	86.3%	111.5%
(25) Selected Expected Claim Ratio	87.1%	78.3%	65.8%	63.8%	82.5%

Column and Line-Notes:
(2) Developed in Exhibit III, Sheet 1
(3) through (7) Assume annual pure premium trend rate of 3.425%. Adjust claims to average cost level of particular AY
(8) through (12)Based on independent analysis of tort reform. Adjust claims to tort environment of particular AY
(13) Based on data from XYZ Insurer.
(14) through(18) Based on rate level changes in Chapter 6. Adjusts earned premium to rate level in effect for particular AY
Students should refer to ratemaking papers for the on-level factors calculation procedure
(19) through (23) Equal to [(initial selected ultimate claims x trend adjustment x tort- reform adjustment)/(Epx rate level adj)].
(24) Averages based on claim ratios in (19) through (23).
(25) Selected based on review of claim ratios by year in (19) through (23) and average claim ratios in (24).

For the most recent AYs, 2004 - 2008, Columns (3) through (7) contain trend factors adjusted for inflation. The annual claim trend rate is 3.425% (based on an annual frequency trend of -1.50% and an annual severity trend of 5.00%).

Loss and Premium Adjustments:

Next, adjust the initial ultimate claims for each year in the experience period using these factors to the cost level for each particular year under examination (i.e. 2004 - 2008).

Adjusting initial ultimate claim examples:

For AY 2008 adjustment to the inflation level expected in accident year 2004, compute
$1.03425^{(2004-2008)}$ = .874 (appearing at the bottom of column (3)).

For AY 2002 adjustment to the inflation level expected in accident year 2004, compute
$1.03425^{(2004-2002)}$ = 1.070 (appearing at the top of column (3)).

A second adjustment to ultimate claims is for tort reform, shown in Columns (8) through (12).

A third adjustment is to bring EP to current rate level changes.

In Chapter 6, we summarized EP and the historical rate level changes for XYZ Insurer.

Columns (14) - (18) show on-level factors that adjust the EP in Column (13) to the rate level for the particular AY (i.e. this adjustment restates the premium as if the exposures were written at the rate level that was in effect for each particular year).

Next Step: Computing trended and adjusted on-level claim ratios (see Columns (19) - (23))
These claim ratios equal:

The initial estimate of ultimate claims * the trend factors and the tort reform adjustment factors/ EP adjusted to the appropriate rate level for each year.

Next Step: Select expected claim ratios (see Line (25) of Exhibit III, Sheet 2) after examining various averages of the claim ratios by year.

Final Step: Compute expected claims in Column (12) in Exhibit III, Sheet 1.

Expected claims in Column (12), for AYs 2004 – 2008, are calculated selected expected claim ratios in Column (11) (from Line (25) above) time EP in Column (9)

Estimated IBNR and estimated total unpaid claims are calculated in Exhibit III, Sheet 3.

XYZ Insurer - Auto BI Exhibit III
Development of Unpaid Claim Estimate ($000) Sheet 3

Accident Year	Claims at 12/31/08 Reported	Paid	Expected Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Expected Claims Method IBNR	Total
(1)	(2)	(3)	(4)	(5)=[(2)-(3)]	(6) = [(4)-(2))	(7) = [(4) - (3)]
1998	15,822	15,822	15,660	0	-162	-162
1999	25,107	24,817	24,665	290	-443	-153
2000	37,246	36,782	35,235	464	-2,011	-1,547
2001	38,798	38,519	39,150	279	352	631
2002	48,169	44,437	47,906	3,732	-263	3,469
2003	44,373	39,320	54,164	5,053	9,791	14,844
2004	70,288	52,811	86,509	17,477	16,221	33,698
2005	70,655	40,026	108,172	30,629	37,517	68,146
2006	48,804	22,819	70,786	25,985	21,982	47,967
2007	31,732	11,865	39,835	19,867	8,103	27,970
2008	18,632	3,409	39,433	15,223	20,801	36,024
Total	449,626	330,627	561,516	118,999	111,890	230,889

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit III, Sheet 1.

Finally, we compare the results of the expected claims method with the claim development method in:

- Exhibit III, Sheet 4 (projected ultimate claims) and in
- Exhibit III, Sheet 5 (estimated IBNR).

XYZ Insurer - Auto BI Exhibit III
Summary of Ultimate Claims ($000) Sheet 4

Accident	Claims at 12/31/08		Projected Ultimate Claims Development Method		Expected
Year	Reported	Paid	Reported	Paid	Claims
(1)	(2)	(3)	(4)	(5)	(6)
1998	15,822	15,822	15,822	15,980	15,660
1999	25,107	24,817	25,082	25,164	24,665
2000	37,246	36,782	36,948	37,922	35,235
2001	38,798	38,519	38,488	40,599	39,150
2002	48,169	44,437	48,314	49,592	47,906
2003	44,373	39,320	44,950	49,858	54,164
2004	70,288	52,811	74,786	80,537	86,509
2005	70,655	40,026	76,661	80,332	108,172
2006	48,804	22,819	58,370	72,108	70,786
2007	31,732	11,865	47,979	77,941	39,835
2008	18,632	3,409	47,530	74,995	39,433
Total	449,626	330,627	514,929	605,028	561,516

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Exhibit III, Sheet 1.

XYZ Insurer - Auto BI Exhibit III
Summary of IBNR ($000) Sheet 5

Accident	Case Outstanding	Estimated IBNR Development Method		Expected
Year	at 12/31/08	Reported	Paid	Claims
(1)	(2)	(3)	(4)	(5)
1998	0	0	158	-162
1999	290	-25	57	-443
2000	465	-298	676	-2,011
2001	278	-310	1,801	352
2002	3,731	145	1,423	-263
2003	5,052	577	5,485	9,791
2004	17,477	4,498	10,249	16,221
2005	30,629	6,006	9,677	37,517
2006	25,985	9,566	23,304	21,982
2007	19,867	16,247	46,209	8,103
2008	15,223	28,898	56,363	20,801
Total	118,997	65,303	155,402	111,890

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4
(5) Estimated in Exhibit III, Sheet 3

9 When the Expected Claims Technique Works and When It Does Not 137

An important assumption:

A reliable value of the expected claim ratio can be made that takes into account a changing legal environment for the insurance coverage.

Advantage to using the expected claims technique:

The technique maintains stability over time since actual claims do not enter into the calculations.
The claim ratios can be judgmentally adjusted based on historical experience due to a belief that either the pricing or underwriting or both are changing.

Disadvantage:

It is not responsive when actual claims experience differs from the initial expectations.
This was evident in the U.S. Industry Auto example discussed in this chapter.

10 Influence of a Changing Environment on the Expected Claim Technique 137 - 139

In Chapter 7, the performance of the development method during times of change was discussed. Below, the same examples are shown but now using the expected claims technique.

Scenario 1 — U.S. PP Auto Steady-State Environment

Exhibit IV, Sheet 1, top section.

Assume the expected claim ratio equals the ultimate claim ratios which equals 70%.

- Thus, the expected claims technique generates the correct estimate of IBNR in a steady-state environment.
- This is also true of the development technique in a steady-state environment.

Impact of Changing Conditions Exhibit IV
U. S. PP Auto - Development of Unpaid Claim Estimate Sheet 1

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	-1	-1	0
2003	1,215,506	70.0%	850,854	842,346	8,508	8,508	0
2004	1,276,282	70.0%	893,397	884,463	8,934	8,934	0
2005	1,340,096	70.0%	938,067	919,306	18,761	18,761	0
2006	1,407,100	70.0%	984,970	935,722	49,248	49,248	0
2007	1,477,455	70.0%	1,034,219	930,797	103,422	103,422	0
2008	1,551,328	70.0%	1,085,930	836,166	249,764	249,764	0
Total	12,577,892		8,804,524	8,365,888	438,636	438,636	0

Column Notes:
(2) Assume 51,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Assumed equal to 70% for all years.
(4) = [(2) x (3)].
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [(4) - (5)].
(7) Developed in Chapter 7, Exhibit III, Sheet 1.
(8)= [(7) - (6)]

Scenario 2 — U.S. PP Auto Increasing Claim Ratios
Exhibit IV, Sheet 1, bottom section.

Impact of Changing Conditions Exhibit IV
U. S. PP Auto - Development of Unpaid Claim Estimate Sheet 1

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Increasing Claim Ratios							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	-1	-1	0
2003	1,215,506	70.0%	850,854	842,346	8,508	8,508	0
2004	1,276,282	70.0%	893,397	1,010,815	-117,418	10,211	127,628
2005	1,340,096	70.0%	938,067	1,116,300	-178,233	22,782	201,014
2006	1,407,100	70.0%	984,970	1,203,071	-218,101	63,319	281,420
2007	1,477,455	70.0%	1,034,219	1,263,224	-229,006	140,358	369,364
2008	1,551,328	70.0%	1,085,930	1,194,523	-108,593	356,805	465,398
Total	12,577,892		8,804,524	9,647,367	-842,843	601,982	1,444,825

Column Notes:
(2) Assume 51,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Assumed equal to 70% for all years.
(4) = [(2) x (3)].
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [(4) - (5)].
(7) Developed in Chapter 7, Exhibit III, Sheet 1.
(8)= [(7) - (6)]

Unless the 70% expected claim ratio assumption is changed, the projected ultimate claims will be unchanged from Scenario 1.

- Since claims are increasing in Scenario 2, the estimated IBNR will be ***lower*** than the actual IBNR.
- One test to assess the adequacy of the expected claim ratio is to compare the reported claim ratio to date to the selected claim ratio. This test would:
  - i. have alerted the actuary to the fact that for AYs 2004 through 2008, the reported claim ratios are already greater than the expected claim ratio.
  - ii. suggest a higher expected claim ratio for more recent accident years and avoid the negative values for IBNR seen in Column (6) of Exhibit IV, Sheet 1 (bottom section).

Scenario 3 — U.S. PP Auto Increasing Case Outstanding Strength

Exhibit IV, Sheet 2, top section.

Impact of Changing Conditions Exhibit IV
U. S. PP Auto - Development of Unpaid Claim Estimate Sheet 2

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)= [(2) x (3)].	(5)	(6) = [(4) - (5)].	(7)	(8) =[(7) - (6)]
Increasing Case Outstanding Strength							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	-1	-1	0
2003	1,215,506	70.0%	850,854	842,346	8,508	8,508	0
2004	1,276,282	70.0%	893,397	884,463	8,934	8,934	0
2005	1,340,096	70.0%	938,067	933,377	4,690	4,690	0
2006	1,407,100	70.0%	984,970	962,808	22,162	22,162	0
2007	1,477,455	70.0%	1,034,219	979,922	54,296	54,296	0
2008	1,551,328	70.0%	1,085,930	931,185	154,745	154,745	0
Total	12,577,892		8,804,524	8,551,189	253,335	253,335	0

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Assumed equal to 70% for all years.
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit III, Sheets 6 and 8.
(7) Developed in Chapter 7, Exhibit III, Sheet I.

- The expected claims method produces an accurate estimate of IBNR
- Changes in the adequacy of case outstanding have no effect on the expected claim ratio method since actual claims experience does not enter the calculation.

Scenario 4 — U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

Exhibit IV, Sheet 2, bottom section.

Impact of Changing Conditions Exhibit IV
U. S. PP Auto - Development of Unpaid Claim Estimate Sheet 2

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)= [(2) x (3)].	(5)	(6) = [(4) - (5)].	(7)	(8) =[(7) - (6)]
Increasing Claim Ratios and Case Outstanding Strength							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	-1	-1	0
2003	1,215,506	70.0%	850,854	842,346	8,508	8,508	0
2004	1,276,282	70.0%	893,397	1,010,815	-117,418	10,211	127,628
2005	1,340,096	70.0%	938,067	1,133,386	-195,319	5,696	201,014
2006	1,407,100	70.0%	984,970	1,237,897	-252,927	28,493	281,420
2007	1,477,455	70.0%	1,034,219	1,329,895	-295,677	73,687	369,364
2008	1,551,328	70.0%	1,085,930	1,330,264	-244,334	221,064	465,398
Total	12,577,892		8,804,524	9,901,691	-1,097,167	347,658	1,444,825

- IBNR falls short of the actual IBNR requirements (similar to the situation in Scenario 2), and actual IBNR and estimated IBNR differ by the same amount for Scenarios 2 and 4.

Without a change in the expected claim ratio assumption, the expected claims method will not react appropriately to an environment of changing claim ratios.

U.S. Auto Steady-State (No Change in Product Mix)

Exhibit V, top section.

Assume that the expected claim ratio can be estimated appropriately for the combined portfolio (easier when the proportion of each of the two categories remains consistent over time).

Impact of Change in Product Mix Example Exhibit V
U. S. PP Auto - Development of Unpaid Claim Estimate

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)= [(2) x (3)]	(5)	(6) = [(4) - (5)]	(7)	(8) = [(7) - (6)]
Steady-State (No Change in Product Mix)							
1999	2,000,000	75.0%	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,438	1,736,438	-1	-1	0
2003	2,431,013	75.0%	1,823,260	1,814,751	8,509	8,508	0
2004	2,552,563	75.0%	1,914,422	1,885,068	29,354	29,354	0
2005	2,680,191	75.0%	2,010,143	1,948,499	61,644	61,644	0
2006	2,814,201	75.0%	2,110,651	1,937,577	173,074	173,074	0
2007	2,954,911	75.0%	2,216,183	1,852,729	363,454	363,454	0
2008	3,102,656	75.0%	2,326,992	1,568,393	758,599	758,599	0
Total	25,155,785		18,866,839	17,472,205	1,394,634	1,394,634	0

Column Notes:
(2) For no change scenario, assume 52,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3)Assumed equal to 75% for all years.
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit IV, Sheets 2 and 4.
(7) Developed in Chapter 7, Exhibit IV, Sheet I.

If so, the expected claims technique generates the correct IBNR requirement in times of no change.

U.S. Auto Changing Product Mix

Exhibit V, bottom section.

- Assume that the volume of commercial auto insurance is increasing at a greater rate than that of private passenger automobile insurance.
- Since commercial auto has higher ultimate claim ratios, the expected claim ratio assumption will need to be modified (critical to the expected claims technique).
- Without a change in the expected claim ratio, the expected claims technique produces an inadequate IBNR estimate.

Impact of Change in Product Mix Example Exhibit V
U. S. PP Auto - Development of Unpaid Claim Estimate

Accident Year	Earned Premium	Earned Claim Ratio	Expected Claims	Reported Claims at 12/31/2008	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)= [(2) x (3)]	(5)	(6) = [(4) - (5)]	(7)	(8) = [(7) - (6)]
Changing Product Mix							
1999	2,000,000	75.0%	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,438	1,736,438	-1	-1	0
2003	2,431,013	75.0%	1,823,260	1,814,751	8,509	8,508	0
2004	2,552,563	75.0%	1,914,422	1,885,068	29,354	29,354	0
2005	2,999,262	75.0%	2,249,447	2,193,545	55,902	71,855	15953
2006	3,564,016	75.0%	2,673,012	2,471,446	201,566	239,057	37491
2007	4,281,446	75.0%	3,211,085	2,680,487	530,598	596,924	66327
2008	5,196,516	75.0%	3,897,387	2,556,695	1,340,692	1,445,385	104693
Total	29,645,066		22,233,800	20,067,180	2,166,620	2,391,083	224,464

Column Notes:
(2) For no change scenario, assume 52,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3)Assumed equal to 75% for all years.
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit IV, Sheets 2 and 4.
(7) Developed in Chapter 7, Exhibit IV, Sheet I.

Sample Questions:

1. For the "Reported Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative reported CDF for the valuation age & reported claims through the valuation date.

   For the "Paid Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative paid CDF for the valuation age & paid claims through the valuation date.

   How are ultimate claims estimated using the "Expected Claims" technique, a given accident year?

2. Describe 2 ways an insurer may select an Expected Claim Ratio for use in Expected Claim methods.

3. List 2 challenges of the Expected Claims method, according to Friedland.

4. What name does Brosius give to the method described in Friedland as the "Expected Claims" technique?

Note: This question applies to the Brosius article, now on exam 7.

5. Summarize Friedland's key points re: "When the Expected Claims Technique Works and When it Does Not." Include 3 cases where the method may be appropriate, and potential disadvantage/advantage.

6. Based on the following data:

Reported Claims including ALAE ($000's omitted)

Earned Premium	Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

Estimate the IBNR as of 12/31/08 using the following method: Expected Claims Technique.

Use an Expected Claim Ratio = 80% for all years.

To select claim development factors, use the volume-weighted averages for the latest three years.

See also Friedland Chapter 7 and 9 for other methods.

2008 Exam Questions (modified):

Question 10.

Given the following for an accident year:

- Earned Premium: $20,000,000
- Reported Losses as of 12 months: $10,000,000
- Expected loss ratio: 70%
- Expected reporting pattern:

Age (months)	% Reported
12	40%
24	60%
36	80%
48	90%
60	100%

a. (1.5 points) This portion of the questions associated with the Brosius article, now on Exam 7.

b. (1 point) Estimate the ultimate value of the claims currently aged at 12 months. Use the Expected Claims Method, as described in Friedland.

c. (.75 points) See Mack/Benktander and Friedland Ch 9.

2009 Exam Questions

9. (2.5 points) Given the following information:

	Cumulative Incurred Loss			
Accident Year	12 Months	24 Months	36 Months	On-Level Earned Premium
2006	$5,630,000	$7,106,000	$8,282,000	$12,380,000
2007	6,380,000	8,051,000		13,430,000
2008	7,348,000			14,280,000

Selected Development Factors

12-Ultimate	24- Ultimate	36- Ultimate
1.570	1.250	1.070

- The annual loss ratio trend is 7.0%.
- Accident year 2008 paid losses as of December 31, 2008 total $6,100,000.

a. (1.5 points) Using the expected claims technique, calculate the IBNR for accident year 2008.

b. (1 point) Briefly describe two situations where the expected claims technique may be appropriate.

2011 Exam Questions

25. (2.5 points) Given the following information as of December 31, 2010:

Accident Year	Earned Premium	Paid Claims	On-Level Earned Premium Factors
2007	$21,000,000	$11,700,000	1.093
2008	$22,050,000	$8,200,000	1.061
2009	$23,152,500	$4,900,000	1.030
2010	$23,525,000	$1,900,000	1.000

Paid Loss Development Factors				
12-24	24-36	36-48	48-60	60-Ult
2.400	1.800	1.500	1.200	1.020

• Loss trend is 4% per year

a. (2.25 points) Use the expected claim technique to estimate ultimate claims for accident year 2010.

b. (0.25 point) Briefly describe a disadvantage of the expected claim technique.

2012 Exam Questions

21. (3 points) Given the following as of December 31, 2011:

Accident Year	Earned Premium	On-Level Earned Premium
2008	$2,491	$2,616
2009	$2,853	$2,853
2010	$2,898	$2,753
2011	$2,800	$2,800

Cumulative Paid Claims ($000s)

Accident Year	12 Months	24 Months	36 Months	48 Months
2008	1,100	$1,430	$1,573	$1,652
2009	$1,200	$1,560	$1,716	
2010	$1,100	$1,430		
2011	$1,000			

Cumulative Paid Claim Development Factors			
12-Ult	24-Ult	36-Ult	48-Ult
1.502	1.155	1.050	1.000

- Tort reform effective January 1, 2010 reduced expected losses by 5% for accident year 2010 and subsequent years.
- Loss trend is 0%.
- Case outstanding for accident year 2011 as of December 31, 2011 is $780.

a. (2.5 points) Use the expected claim technique to estimate IBNR for accident year 2011.

b. (0.5 point) Evaluate the reasonableness of negative IBNR.

Solutions to Sample Questions:

1. For the "Reported Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative reported CDF for the valuation age & reported claims through the valuation date.

   For the "Paid Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative paid CDF for the valuation age & paid claims through the valuation date.

   In the "Expected Claims" technique, ultimate claims for an accident year are calculated by multiplying the appropriate premium for the year by a selected "claim ratio."

2. 2 ways an insurer may select an Expected Claim Ratio for use in Expected Claim methods:
   Exposure-Based methods (may use adjusted historical data) & Statistical Modeling methods

3. List 2 challenges of the Expected Claims method, according to Friedland.
   Determining an appropriate exposure base,
   & Estimating the measurement of claims relative to that exposure base

4. What name does Brosius give to the method described in Friedland as the "Expected Claims" technique?
   The "Budgeted Loss" method (for ultimate loss estimates with no credibility to actual experience)
   Note: The term "Expected LOSS RATIO" method has also been used in some texts.

5. Summarize Friedland's key points re: "When the Expected Claims Technique Works and When it Does Not."

Friedland mentions 2 scenarios where the Expected Claims technique may be used:

1) Entering a new line of business or territory (using industry benchmarks for the claim ratios)

2) If the Cumulative CDFs are highly leveraged, an actuary may choose to use an Expected Claims technique for the most recent years in the experience period.

3) If an insurer undergoes or is impacted by a major change, may use Expected Claims method for years likely to be affected.

Friedland comments on **potential** advantages/disadvantages of the Expected Claims technique:

Since this method applies selected claim ratios to premiums, instead of developing the actual losses as in Chapter 7's Development method, we have:

1) Potential advantage in the stability of the projected ultimate losses.

2) Potential disadvantage in the lack of responsiveness to actual experience

However, by changing the selected claim ratios, the results of using the Expected Claims method can become more responsive (and less stable). In some examples, such as being impacted by a major change, an "actuary may be able to adjust the a priori expectation in advance of the changes being fully manifested in the data (so) the expected claims method could prove to be more responsive that data-dependent methods."

See Friedland Chapter 8.

6. Estimate the IBNR as of 12/31/08 using the following method: Expected Claims Technique.
Use an Expected Claim Ratio = 80% for all years.
To select claim development factors, use the volume-weighted averages for the latest three years.
See also Friedland Chapter 7 and 9 for other methods.

Reported Claims including ALAE ($000's omitted)

Earned Premium	Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

Accident Year	*Earned Premium*	*Expected Claim Ratio*	*Expected Claims (Ultimate)*	*Reported Claims at 12/31/2008*	*IBNR (broadly defined)*
	(1)	*(2)*	*(3)=(1)*(2)*	*(4) given*	*(5)=(4)-(3)*
2003	*2,000*	*80.00%*	*1,600*	*1,750*	*-150*
2004	*2,200*	*80.00%*	*1,760*	*1,800*	*-40*
2005	*2,500*	*80.00%*	*2,000*	*1,950*	*50*
2006	*2,650*	*80.00%*	*2,120*	*1,900*	*220*
2007	*3,000*	*80.00%*	*2,400*	*1,900*	*500*
2008	*3,150*	*80.00%*	*2,520*	*2,250*	*270*
Total					***850***

Solutions to 2008 Exam Questions (modified):
Question 10b.

Use Expected Claims = Earned Premium * "Expected Loss Ratio"
Then the Ultimate Estimate = $20M * 70% = 14,000,000

Note: Expected Claims method didn't use $ reported to date, or % reported, in order to estimate ultimate claims.

Solutions to 2009 Exam Questions

Question 9 - Model Solution 1

a. Using the Expected Claims Technique calculate the IBNR for Accident Year 2008.

	(1)	(2)	(3)=(1)×(2)	(4)	(5)=(3)×(4)	(6)	(7)=(5)/(6)
AY	Incurred Loss	CDF	Proj Ult Loss	Trend	Trended Ult	On level EP	Loss Ratio
2006	8,282,000	1.070	8,861,740	1.07^2	10,145,806	12,380,000	0.8195
2007	8,051,000	1.250	10,063,750	1.070	10,768,213	13,430,000	0.8018
2008	7,348,000	1.570	11,536,360	1.000	11,536,360	14,280,000	0.8079
						Average:	0.8097

Selected Expected Loss Ratio = 80.97%

AY 2008 Projected Ultimate Claim = 2008 OL EP * Selected ELR = 80.97% × 14,280,000 = 11,562,516

IBNR for AY 2008 = AY 2008 Ultimate Claims – AY 2008 Reported Losses at 12 months

= 11,562,516 – 7,348,000 = 4,214,516

b. When credible data is not available to use other estimation techniques, for instance, entering a new line of business and no historical claim experience.

When there is a significant change that makes historical claim experience irrelevant, example like major change in regulation.

Question 9 - Model Solution 2 – Part b.

b. Expected claims technique would be useful when entering a new line of business – could use industry benchmark ratio – where little is known about this line's loss behavior.

It could also be used for longer tailed lines where LDF's are highly leveraged, and an "a priori" estimate of expected claims is thought to be more accurate than the development method.

Solutions to 2011 Exam Questions

25a. (2.25 points) Use the expected claim technique to estimate ultimate claims for accident year 2010.

25b. (0.25 point) Briefly describe a disadvantage of the expected claim technique.

Question 25 – Model Solution

a. AY 2010 Projected Ultimate Claim = 2010 OL EP * Selected ELR

Selected ELR = Average $_{\text{[from 2007 – 2009]}}$ Trended Ultimate losses/ Onlevel Earned premium

CY OL EP = EP * OLEP Factor; AY Trended Ult Loss = Paid Claims * LDF to ult * Loss Trend Factor

Trend historical loss data from AY ending 12/31/20XX to 12/31/2010 using the given loss trend of 4%

Eg: CY2008 OLEP = $22,050,000 * 1.061; AY 2008 Trend Ult Loss = $8,200,000 * 1.500 * 1.200 * 1.0201 * .04

	On-Level EP	Trend Period	Trended Ult. Loss	Loss Ratio
2007	22,953,000	3	16,108,952	.702
2008	23,395,050	2	16,283,704	.696
2009	23,847,075	1	16,841,261	.706
2010	23,525,000	0	15,069,888	.641

Avg. Loss ratio 2007-2009 = 70.13%

AY 2010 expected Ult. Loss = 23,525,000 x 70.13%= $\boxed{\$16,498,082.50}$

b. The expected claims technique is relatively unresponsive to recent changes in claims experience.

Solutions to 2012 Exam Questions

21a. (2.5 points) Use the expected claim technique to estimate IBNR for accident year 2011.

21b. (0.5 point) Evaluate the reasonableness of negative IBNR.

Question 21 – Model Solution 1 (Exam 5B Question 6)

a.

On level Earned premium	Paid losses at 12/31/2011	Paid CDF To ultimate	Trend* 7/1/2011	Tort reform adjustments	Developed Projected losses	Loss ratio
2008: 2616	1652	1.000	1.0^3	0.95	1569.40	0.60
2009: 2853	1716	1.050	1.0^2	0.95	1711.71	0.60
2010: 2753	1430	1.155	1.0	1.00	1651.65	0.60
2011: 2800	1000	1.502	1.0	1.00	1502.00	0.54
Total:11,022					6434.76	0.58

*: Trend from 7/1 of each accident year to 7/1/2011

Select = 60% based on average of accident years 2008-2010

Accident year 2011 IBNR = Expected Ultimate Claims – Reported Claims

= 2800 (0.6)-(1000+780) = -100

b. For certain lines of business, negative IBNR can be possible if case reserves are historically set too strong in early maturities and develop downwards over time, or it is common in lines of business expecting future salvage and subrogation recoveries such as auto physical damage. Without knowing the specifics at the line of business in part A, it is difficult to tell if negative IBNR is reasonable. However, since the line of business involves tort reform, I would expect it to be a liability line which makes me believe negative IBNR for this line, especially since 2011 is only at 12 months of development, is inappropriate.

Question 21 – Model Solution 2 (Exam 5B Question 6)

a.

	AY Ult. Claims (trend is 0)	Est. Ult Claim Ratio = Ult Claims/on-level EP
08	1,652k	63.15%
09	1,716k (1.05) = 1,801.8k	63.15%
10	1,430k (1.155) = 1,651.65k	59.999% (which is 5% below '08 & '09)

Expected claim ratio for AY11= 59.99%

→ Ult. Claims for AY11=2800k(0.5999) = 1,679,720

→ IBNR for AY11= 1,679,720 - 1,000,000 - 780,000 = -100,280

b. Negative IBNR could be reasonable if this is reflecting anticipated recoveries such as salvage and subrogation. In this case, it seems likely that case reserves are excessive given the tort reforms recently taking hold.

Examiner's comments

a. This part of the question was generally well-answered. However, there were certain steps at which points were frequently lost. A number of candidates made no adjustment for tort reform. Among those that did, some calculated incorrect adjustment factors and/or applied the factors to the wrong years. Many candidates wrongly included AY 2011 in the calculation of the expected claim ratio. There were also a fair number who explicitly excluded it, but for the wrong reasons (e.g., "immature," "leveraged," "outlier"). One area of ambiguity in the question that was identified by some candidates was whether or not the case o/s of $780 was expressed, as were paid losses, in thousands of dollars. Some assumed that they were, while others assumed they were not. Though the expectation was that the former would be assumed, no points were deducted for assuming the latter.

b. Most candidates received partial credit for this part of the question, as either general or AY 2011 specific comments were made, but not both.

1 Introduction to the Bornhuetter-Ferguson (BF) Technique 152

The BF technique:

- is a commonly used claims estimation technique.
- is a blend of the development and expected claims techniques, by splitting ultimate claims into two components: actual reported (or paid) claims and expected unreported (or unpaid) claims.
- gives more weight to actual claims as experience matures, and less weight to expected claims .
- was developed to overcome the problems with the development and expected claims technique.

Problem with the development technique:

This technique can lead to erratic, unreliable projections when the CDF is large because a small swing in reported claims or the reporting of an unusually large claim could result in a very large swing in projected ultimate claims.

Problem with the expected claims technique:

It ignores actual reported results.

In "Loss Development Using Credibility," Brosius described the BF method as a credibility weighting between the development method and the expected claims method.

- In the development method, full credibility (i.e. Z = 1) is given to actual claims experience; and in the expected claims method, no credibility (i.e. Z = 0) is given to actual claims.
- In the BF method, credibility is equal to the % of claims developed at a particular stage of maturity, which is determined as Z = 1.00/CDF.
- Therefore, more weight is given to the expected claims method in less mature years, and more weight is given to the development method in more mature years of the experience period.

2 Key Assumptions 152 - 153

The BF method assumes that unreported (or unpaid) claims will develop based on expected claims.

- Reported claims do not contain informational value as to the amount of claims yet-to-be reported.
- This differs greatly from the development method where the primary assumption is that unreported (or unpaid) claims will develop based on reported (or paid) claims to date.

The reporting and payment patterns used in the BF methods and the development methods are the same.

The expected claims used in the BF method using reported claims are the same as those used in the BF method using paid claims.

How development factors are applied in the two methods differs.

3 Common Uses of the BF Technique 153 - 154

The BF technique:

- is most often applied to reported and paid claims
- can be used with number of claims and with ALAE.
- can be used with all lines of insurance (including short-tail lines and long-tail lines).
- is used with data organized in many different time intervals including:
  - * Accident year
  - * Policy year
  - * Underwriting year
  - * Report year
  - * Fiscal year

This technique can use data organized by month, quarter, or half-year.

4 Mechanics of the BF Technique 154 - 155

The BF technique is a blend of the development method and the expected claims method.
The following two formulae represent the reported and paid BF methods, respectively:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims
Ultimate Claims = Actual Reported Claims + (Expected Claims) x (% Unreported)

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims
Ultimate Claims = Actual Paid Claims + (Expected Claims) x (% Unpaid)

Implementing the BF Method:

The goal: To determine expected unreported and expected unpaid claims (since actual reported and paid claims are both known quantities).

The key step: To select claim development patterns and develop an expected claims estimate.

A step by step approach (See Exhibit I, Sheet 1 for U.S. Industry Auto) follows:

I. Compute Projected Ultimate Claims

Step 1: Use the reported and paid CDFs (from Chapter 7) to compute the %s unreported and %s unpaid (see Columns (5) and (6)).

The % unreported = 1.00 – 1/reported CDF.

The % unpaid = 1.00 – 1/paid CDF.

The selected claim development factors for reported and paid claims as well as the associated reporting and payment patterns in Table 1 below.

Table 1 - U.S. Industry Auto
Selected Reporting and Payment Patterns

	Reported Claims			Paid Claims		
Age (Month)	CDF to Ultimate	% Reported	% Unreported	CDF to Ultimate	% Paid	% Unpaid
12	1.292	77.4%	22.6%	2.390	41.8%	58.2%
24	1.11	90.1%	9.9%	1.404	71.2%	28.8%
36	1.051	95.1%	4.9%	1.184	84.5%	15.5%
48	1.023	97.8%	2.2%	1.085	92.2%	7.8%
60	1.011	98.9%	1.1%	1.040	96.2%	3.8%
72	1.006	99.4%	0.6%	1.020	98.0%	2.0%
84	1.003	99.7%	0.3%	1.011	98.9%	1.1%
96	1.001	99.9%	0.1%	1.006	99.4%	0.6%
108	1.000	100.0%	0.0%	1.004	99.6%	0.4%
120	1.000	100.0%	0.0%	1.002	99.8%	0.2%

Keep in mind that the primary assumption of the reported BF method is that unreported claims will emerge in accordance with expected claims.

U.S. Auto Industry Exhibit I
Projection of Ultimate Claims Using Reported and Paid Claims ($000) Sheet 1

Accident Year	Expected Claims	CDF to Ultimate		Percentage		Expected Claims		Claims at 12/31/07		Projected Ultimate Claims using B-F Method with	
		Reported	Paid	Unreported	Unpaid	Unreported	Unpaid	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7) = [(2) x(5)]	(8) =[(2) x (6)]	(9)	(10)	(11) = [(7)+(9]	(12)=[(8)+(10)]
1998	51,430,657	1.000	1.002	0.00%	0.20%	0	102,656	47,742,304	47,644,187	47,742,304	47,746,843
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2006	61,926,981	1.110	1.404	9.91%	28.77%	6,136,908	17,819,445	54,641,339	43,606,497	60,778,247	61,425,942
2007	61,864,556	1.292	2.390	22.60%	58.16%	13,981,773	35,979,805	48,853,563	27,229,969	62,835,336	63,209,774
Total	569,281,839					25,609,761	72,517,830	543,481,587	498,050,368	569,091,348	570,568,198

Column Notes:
(2) Developed in Chapter 8, Exhibit III, Sheet 1.
(3)and (4) Developed in Chapter 7, Exhibit II, Sheets 1 and 2, capped at a minimum of 1.00.
(5) =[1.00 - (1.00 / (3))].
(6) =[1.00 - (1.00 / (4))].
(9) and (10) Based on Best's Aggregates & Averages U.S. Private Passenger Auto Experience

Step 2: Calculate the expected unreported claims by AY.

Column (7) expected unreported claims equal Column (2) expected claims multiplied by % unreported in Column (5) for each AY.

Column (8) expected unpaid claims equal Column (2) expected claims multiplied by % unpaid in Column (6) for each AY.

A. Projected Ultimate Claims (continued):

Step 3: Calculate the projected ultimate claims.

Recall the BF formulae:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Note: For the reported BF projection, expected unreported claims equals estimated IBNR.

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims

Column (11) projected ultimate claims equal Column (9) actual reported claims plus Column (7) expected unreported claims.

Column (12) projected ultimate claims equal Column (10) actual paid claims plus Column (8) expected unpaid claims.

5 Unpaid Claim Estimate Based on the BF Technique 155

II. Compute Estimated IBNR and the Total Unpaid Claim Estimate (see Exhibit I, Sheet 2):

Step 4: Compute estimated IBNR and the total unpaid claim estimate

XYZ Insurer - Auto BI
Development of Unpaid Claim Estimate ($000)

Exhibit II
Sheet 2

						Unpaid Claim Estimate at 12/31/07			
			Projected Ultimate Claims		Case	IBNR Based on		Total Based on	
Accident	Claims at 12/31/07		Using B-F Method with		Outstanding	B- F Method with		B- F Method with	
Year	Reported	Paid	Reported	Paid	at 12/31/07	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)= [(2) - (3)]	(7)= [(4) - (2)]	(8)= [(5) - (2)]	(9)= [(6)+ (7)]	(10)= [(6)+(8)]
1998	47,742,304	47,644,187	47,742,304	47,746,843	98,117	0	4,539	98,117	102,656
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2006	54,641,339	43,606,497	60,778,247	61,425,942	11,034,842	6,136,908	6,784,603	17,171,750	17,819,445
2007	48,853,563	27,229,969	62,835,336	63,209,774	21,623,594	13,981,773	14,356,211	35,605,367	35,979,805
Total	543,481,587	498,050,368	569,091,348	570,568,198	45,431,219	25,609,761	27,086,611	71,040,980	72,517,830

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. Private Passenger Auto Experience
(4) and (5) Developed in Exhibit I, Sheet 1.

Columns (7 and 8) Estimated IBNR equals projected ultimate claims less reported claims

Projected ultimate claims come from Step 3 above

Columns (9 and 10) Total unpaid claim estimate equals Estimated IBNR + Case O/S reserves. Also,

Total unpaid claim estimate equals Estimated IBNR + (Reported – Paid Claims)

Total unpaid claim estimate equals projected ultimate claims minus paid claims.

6 When the BF Technique Works and When It Does Not 156

An advantage of the BF technique: Random fluctuations early in the life of an AY do not significantly distort the projections.

Example: While several large/unusual reported claims for an AY would produce an overly conservative ultimate claims estimate when using the reported claim development technique, such is not the case when using the BF technique.

The BF method can be used:

- for the most immature years associated with long-tail lines of insurance, due to the highly leveraged nature of claim development factors for such lines.
- if the data is extremely thin or volatile or both.

  For example, when an insurer enters a new line of business or a new territory and there is not yet a credible volume of historical claim development experience.

  The actuary would likely need to rely on benchmarks, either from similar lines at the same insurer or insurance industry experience, for development patterns and expected claim ratios (or pure premiums).
- for very short-tail lines (where the IBNR can be set equal to a multiple of the last few months EP).

7 The BF Method and Cumulative CDFs Less than 1.00 157

Downward development (i.e. CDFs < 1.00) does occur: Examples:

- For automobile physical damage and property, salvage and subrogation recoveries lag the reporting and payment of claims, resulting in report-to-report factors that are less than 1.00.
- For insurers with a conservative case outstanding reserving, downward development of reported claims as payments for claims may be less than the case outstanding set by claims adjusters. First, revisit the original premise of the BF method for lines of business in which CDFs are less than 1.00.

Recall that the BF method can be considered a credibility-weighting of the results from the development method and from the expected claims method.

The basic formula for calculating the credibility-weighted projection is:

[(Z) x (development method)] + [(1 - Z) x (expected claims method)] where, $0 \le Z \le 1$

Z is the credibility assigned to the development method; Z = 1.00/CDF, and

(1 - Z) is the complement of credibility assigned to the expected claims method.

Adjustments than can be made when working with CDFs less that 1.00:

- Limit the CDFs to a minimum value of 1.00 when applying the BF technique (used in this text).
- Perform the BF calculations, but rely on another technique to select ultimate claims for the year(s) in question (i.e. years with CDFs less than 1.00).

8 XYZ Insurer 157

Exhibit II, Sheets 1 and 2: Projected ultimate claims, IBNR and Total Unpaid claims based on the results of the reported and paid BF methods using Chapter 8 expected claims are shown

Exhibit II, Sheet 3 (projected ultimate claims) compares the results of the BF method with the expected claims method and the development method

Exhibit II, Sheet 4 (estimated IBNR) compares these results for the three projection methods.

XYZ Insurer - Auto BI Exhibit II
Projection of Ultimate Claims Using Reported and Paid Claims ($000) Sheet 1

Accident Year	Expected Claims	CDF to Ultimate Reported	CDF to Ultimate Paid	Percentage Unreported	Percentage Unpaid	Expected Claims Unreported	Expected Claims Unpaid	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims using B-F Method with Reported	Projected Ultimate Claims using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7) = [(2) x(5)]	(8) =[(2) x (6)]	(9)	(10)	(11) = [(7)+(9]	(12)=[(8)+(10)]
1998	15,660	1.000	1.010	0.0%	1.0%	0.00	155	15,822	15,822	15,822	15,977
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	39,835	1.512	6.569	33.9%	84.8%	13,489	33,771	31,732	11,865	45,221	45,636
2008	39,433	2.551	21.999	60.8%	95.5%	23,975	37,640	18,632	3,409	42,607	41,049
Total	561,516					63,581	223,842	449,626	330,627	513,207	554,469

Column Notes:
(2) Developed in Chapter 8, Exhibit III, Sheet 1.
(3) and (4) Developed in Chapter 7, Exhibit II, Sheets 1 and 2, capped at a minimum of 1.00.
(5) =[1.00 - (1.00 / (3))].
(6) =[1.00 - (1.00 / (4))].
(9) and (10) Based on data from XYZ Insurer.
(11) = [(7) + (9]
(12)= [(8)+ (10)].

XYZ Insurer - Auto BI Exhibit II
Development of Unpaid Claim Estimate ($000) Sheet 2

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08: IBNR Based on B- F Method with Reported	IBNR Based on B- F Method with Paid	Total Based on B- F Method with Reported	Total Based on B- F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)= [(2)-(3)]	(7)= [(4)-(2)]	(8)= [(5)-(2)]	(9)= [(6)+ (7)]	(10)= [(6)+(8)]
2007	31,732	11,865	45,221	45,636	19,867	13,489	13,904	33,356	33,771
2008	18,632	3,409	42,607	41,049	15,223	23,975	22,417	39,198	37,640
Total	449,626	330,629	513,207	554,471	118,997	63,581	104,845	182,578	223,842

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Exhibit II, Sheet 1.
(6)= [(2) - (3)]
(7)= [(4) - (2)]
(8)= [(5) - (2)].
(9)= [(6)+ (7)].
(10)= [(6) + (8)],

XYZ Insurer - Auto BI Exhibit II
Summary of Ultimate Claims ($000) Sheet 3

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims: Development Method Reported	Development Method Paid	Expected Claims	B-F Method Reported	B-F Method Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	('8)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977
1999	25,107	24,817	25,082	25,165	24,665	25,107	25,158
:::	:::	:::	:::	:::	:::	:::	:::
2007	31,732	11,865	47,990	77,938	39,835	45,227	45,636
2008	18,632	3,409	47,536	74,994	39,433	42,609	41,049
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Exhibit II, Sheet 1

XYZ Insurer - Auto BI
Summary of IBNR ($000)

Exhibit II
Sheet 4

	Case	Estimated IBNR				
Accident	Outstanding	Development Method		Expected	B-F Method	
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	0	0	158.22	-162	0	155
:::	:::	:::	:::	:::	:::	:::
2007	19,867	16,247	46,209	8,103	13,489	13,904
2008	15,223	28,898	56,363	20,801	23,975	22,417
Total	118,997	65,303	155,402	111,890	63,581	104,843

Column Notes:
(2)Based on data from XYZ Insurer.
(3)and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Exhibit II, Sheet 2.

9 Influence of a Changing Environment on the BF Technique 157 - 160

Similar to the analyses done in Chapters 7 and 8, we discuss the performance of the BF technique during times of change.

Scenario 1 — U.S. PP Auto Steady-State

Exhibit III, Sheet 1, top section. *Note: An expected claim ratio of 70% is used in Scenarios 1 through 4.*

- Since the steady-state environment also has a 70% ultimate claim ratio, the BF technique generates an accurate estimate of IBNR.
- The development and expected claims techniques also generated accurate IBNR values in a steady-state environment.

Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit III
Sheet 1

	Age of								Projected Ultimate Claims		Estimated IBNR			Diff from Actual IBNR	
Accident	Accident Year	Expected	Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Using B-F Method with		Using B-F Method with		Actual	Using B-F Method with	
Year	at 12/31/08	Claims	Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Steady-State															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2007	24	1,034,219	930,797	734,295	1.111	1.408	10.0%	29.0%	1,034,219	1,034,218	103,422	103,421	103,422	-1	0
::	::	::	::	::	::	::	::	::	::	::	::	::	::	::	::
2008	12	1,085,930	836,166	456,090	1.299	2.381	23.0%	58.0%	1,085,930	1,085,929	249,764	249,763	249,764	0	1
Total		8,804,524	8,365,888	7,573,547					8,804,526	8,804,523	438,638	438,635	438,636	-2	1

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit IV, Sheet 1.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 2 through 5
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 2 through 5.
(8) = [1.00 - (1.00 / (6))],
(9)= [1.00 -(1.00 / (7))].
(10) = [((3) x(8)) +(4)]
(11) = [((3) x (9)) + (5)]
(11) = [((3) x (9))+ (5)]
(12) = [(10)-(4)]
(13) = [(11)-(4)]
(12) = [(10) - (4)]
(13) = [(11) - (4)]
(14) Developed in Chapter 7, Exhibit III, Sheet 1.
(15) = [(14) - (12)]
(16) = [(14) - (13)]

Scenario 2 — U.S. PP Auto Increasing Claim Ratios

The weakness of the expected claims method is also a weakness of the BF method.

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims

Projected ultimate claims increase between Scenarios 1 and 2, due to higher values of actual reported and paid claims (and not higher estimates of the expected unreported and unpaid claims).

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 1

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Estimated IBNR Using B-F Method with Reported	Estimated IBNR Using B-F Method with Paid	Actual IBNR	Diff from Actual IBNR Using B-F Method with Reported	Diff from Actual IBNR Using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Increasing Claim Ratios															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,034,219	1,263,224	996,544	1.111	1.408	10.0%	29.0%	1,366,646	1,296,467	103,422	33,243	140,358	36,936	107,116
2008	12	1,085,930	1,194,523	651,558	1.299	2.381	23.0%	58.0%	1,444,287	1,281,397	249,764	86,874	356,805	107,042	269,931
Total		8,804,524	9,647,367	8,575,113					10,086,005	9,806,090	438,638	158,723	601,982	163,345	443,260

Since the expected claims estimate does not change, the expected unreported and unpaid claims remain the same between Scenario 1 and Scenario 2.

Without a change in the expected claim ratio, this method does not respond to an increasing claim ratios scenario.

- For the reported BF technique, the estimated IBNR is identical between the Scenario 1 and Scenario 2.
- The paid BF performs even worse than the reported BF technique, since the expected unpaid claims is understated to an even greater degree than the expected unreported claims. This is due to the longer-term nature of the payment pattern than the reporting pattern.

Scenario 3 — U.S. PP Auto Increasing Case Outstanding Strength

Exhibit III, Sheet 2, top section

The reported BF technique produces an estimate of IBNR that is greater than the actual IBNR.

However, the overstatement is less for the reported BF method than for the reported claim development method because we did not increase the expected claims.

The paid BF method is unaffected by changes only in case outstanding strength (similar to the paid claim development technique)

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 2

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Estimated IBNR Using B-F Method with Reported	Estimated IBNR Using B-F Method with Paid	Actual IBNR	Diff from Actual IBNR Using B-F Method with Reported	Diff from Actual IBNR Using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Increasing Case Outstanding Strength															
1999	120	700,000	700,000	700,000	1.000	1.000	0.00%	0.00%	700,000	700,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,034,219	979,922	734,295	1.119	1.408	10.61%	29.00%	1,089,655	1,034,218	109,733	54,296	54,296	-55,437	0
2008	12	1,085,930	931,185	456,090	1.318	2.381	24.15%	58.00%	1,193,385	1,085,929	262,200	154,744	154,745	-107,455	1
Total		8,804,524	8,551,189	7,573,547					9,009,508	8,804,523	458,319	253,334	253,335	-204,984	1

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit IV, Sheet 2.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 6 through 9
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 6 through 9
(8) = [1.00 - (1.00/(6))]
(9) = - [1.00 - (1.00/ (7))]
(10) = [((3) x (8)) + (4)]
(11) = [(3) x (9)) + (5)]
(12) = [(10) - (4)]
(13) = [(11) -(4)]
(14) Development in Chapter 7, Exhibit III, Sheet 1
(15) = [(14) - (12)]
(16) = [(14) - (13)]

Understanding the relative IBNR values being produced:

A. First review aspects of the development technique:

2 forces contribute to the excessive estimate of IBNR using the development technique.

1. Age-to-age factors increase due to increases in case reserves, and
2. The resulting higher CDFs are multiplied higher reported claims due to the increase in case outstanding strength. This is known as the leveraging effect due to higher CDFs.

B. Higher CDFs will result in greater percentages of expected unreported claims.

Recall that the CDFs are an important input to the BF method, and that higher CDFs will result in greater percentages of expected unreported claims.

However, the leveraging effect is not as great because the BF method uses expected claims, not actual claims, as the basis for determining unreported claims, and expected claims have not changed.

Scenario 4 — U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

Exhibit III, Sheet 2, bottom section. Keep in mind there is no change in the expected claims assumption.

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 2

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Estimated IBNR Using B-F Method with Reported	Estimated IBNR Using B-F Method with Paid	Actual IBNR	Diff from Actual IBNR Using B-F Method with Reported	Diff from Actual IBNR Using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Increasing Claim Ratios and Case Outstanding Strength															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,034,219	1,329,895	996,544	1.120	1.408	10.7%	29.0%	1,440,327	1,296,467	110,432	-33,428	73,687	-36,745	107,115
2008	12	1,085,930	1,330,264	651,558	1.320	2.381	24.3%	58.0%	1,593,780	1,281,397	263,516	-48,867	221,064	-42,452	269,931
Total		8,804,524	9,901,691	8,575,113					10,362,125	9,806,090	460,434	-95,601	347,658	-112,776	443,260

Observations:

- Estimated IBNR based on the reported BF method is overstated.
- Estimated IBNR based on the paid BF projection is understated.
- The expected claims used in the example are too low for both projections.

Comments on the results from the paid BF method (given no change in expected claims):

- The paid BF method produces an IBNR estimate $443,260 lower than the actual IBNR, ***because there is no change in expected claims***.

  This is the same difference between estimated and actual IBNR that we saw in Scenario 2, where claim ratios increased and case outstanding strength remained stable.
- Since the payment pattern is unaffected by changes in case outstanding adequacy, there is no effect on the paid BF method, and the understatement of expected claims the sole reason for the inadequacy of the paid BF method.

Understanding the relative IBNR values being produced from reported BF technique:

- In Scenario 2 (increasing claim ratios and stable case outstanding strength), the reported BF technique produces an estimated IBNR that is ***lower*** than the actual IBNR.
- In Scenario 3 (stable claim ratio and increasing case outstanding strength), the reported BF technique produces an estimated IBNR that is ***higher*** than the actual IBNR.

  These factors in Scenarios 2 and 3 work in opposite ways in Scenario 4.

  While expected claims are too low, higher CDFs more than offsets this effect, leading to an estimated IBNR is $112,773 higher than the actual IBNR.

Key: In general, the difference from the actual IBNR using the BF method could be positive or negative *depending on the extent of case outstanding strengthening and the deterioration in the claim ratio.*

U.S. Auto Steady-State (No Change in Product Mix)
Exhibit IV, top section (See the exhibit at the end of this chapter)

The BF technique generates the correct IBNR requirement when there is no change in the product mix (this is similar to the projections using the claim development and expected claims techniques. To understand why, review the rationale given in these examples in prior chapters).

U.S. Auto Changing Product Mix (i.e. the volume of commercial auto insurance is increasing at a greater rate than that of private passenger auto insurance).

Exhibit IV, bottom section (See the exhibit at the end of this chapter)

- Both the reported and paid BF methods produce estimated IBNR lower than the actual IBNR.

  This is due to the expected claim ratio assumption being unchanged from the U.S. Auto Steady-State.

Adjustments needed:

- The expected claim ratio assumption needs to be modified (due to the commercial auto segment growing at a greater rate than the private passenger auto segment).
- The reporting and payment patterns also require change. With an increasing proportion of commercial auto, the reporting and payment patterns lengthen, and results in the requirement for a higher IBNR value.

Benktander Technique (See Volume 1b for commentary on this technique)

An advantage of the BF technique versus the development technique is stability in the presence of sparse data.

The Benktander method is a credibility-weighted average of the BF technique and the development technique.

The advantage of the method is that it will prove more responsive than the BF technique and more stable than the development technique (see "Credible Claims Reserves: The Benktander Method").

The Benktander method is an iterative BF method. The only difference in the two methods is the derivation of the expected claims.

- For the BF method, expected claim = expected claim ratio * earned premium.
- For the Benktander technique, expected claims are the projected ultimate claims from an initial BF projection (thus, the reference to the Benktander method as an iterative BF method).
- The Benktander projection of ultimate claims will approach the projected ultimate claims produced by the development technique after sufficient iterations (see Mack's 2000 ASTIN paper for the detailed proof.)

Exhibits V and VI: The Benktander technique is shown using the six examples of changing environments.

The same exhibit format used for the BF technique is used for the Benktander method.

The only difference in the two methods is the expected claims that are used (see prior page).

(See the exhibit at the end of this chapter)

The following table summarizes the differences from the true unpaid claims, in thousands of dollars, based on the BF technique and the Benktander technique for the six examples related to changing environments.

	Difference from True IBNR ($000) Using			
	Bornhuetter-Ferguson Method		Benktander Method	
Example Name	Reported	Paid	Reported	Paid
U.S. PP Auto Steady-State	0	0	0	0
U.S. PP Auto Increasing Claim Ratios	163	443	29	196
U.S. PP Auto Increasing Case Outstanding Strength	-205	0	-239	0
U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength	-113	443	-300	196
U.S. Auto Steady-State	0	0	0	0
U.S. Auto Changing Product Mix	223	400	233	498

Observations:

The Benktander technique is:

- significantly more responsive to changes in the underlying claim ratio
- less responsive to changes in the case outstanding adequacy.
- less responsive to changes in the product mix than the BF technique.

The Benktander method always gives greater credibility to the development technique.

Thus, given no changes in the underlying claim development patterns, we expect the Benktander method to be more responsive than the BF method.

When claim development patterns are changing, the Benktander method may not produce the most appropriate estimate (as seen in the examples with changing case outstanding adequacy and changes in product mix).

With the changing product mix, the Benktander method would have proven responsive to the changing claim ratio but not to the changes in the underlying development patterns.

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Change in Product Mix Example
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit IV

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Projected Ultimate Claims Using B-F Method with		Estimated IBNR Using B-F Method with		Actual IBNR	Diff from Actual IBNR Using B-F Method with	
			Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid		Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Steady-State (No Change in Product Mix)															
1999	120	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,751	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,437	0	-1	-1	-1	0
2003	72	1,823,260	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,260	1,823,259	8,509	8,508	8,508	0	0
2004	60	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,010,143	1,948,499	1,742,124	1.032	1.154	3.1%	13.3%	2,010,144	2,010,143	61,645	61,644	61,644	0	0
2006	36	2,110,651	1,937,577	1,581,581	1.089	1.335	8.2%	25.1%	2,110,650	2,110,651	173,073	173,074	173,074	0	0
2007	24	2,216,183	1,852,729	1,277,999	1.196	1.734	16.4%	42.3%	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	2,326,992	1,568,393	729,124	1.484	3.191	32.6%	68.7%	2,326,992	2,326,992	758,599	758,599	758,599	0	0
Total		18,866,839	17,472,205	15,270,788					18,866,839	18,866,838	1,394,634	1,394,633	1,394,634	0	0
Changing Product Mix															
1999	120	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,751	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,437	0	-1	-1	-1	0
2003	72	1,823,260	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,260	1,823,259	8,509	8,508	8,508	0	0
2004	60	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,249,447	2,193,545	1,951,435	1.032	1.154	3.1%	13.3%	2,262,528	2,251,361	68,983	57,816	71,855	2,871	14,039
2006	36	2,673,012	2,471,446	1,983,482	1.090	1.336	8.3%	25.2%	2,692,025	2,656,353	220,579	184,907	239,057	18,478	54,150
2007	24	3,211,085	2,680,487	1,766,164	1.200	1.750	16.7%	42.9%	3,216,658	3,142,864	536,171	462,377	596,924	60,754	134,547
2008	12	3,897,387	2,556,695	1,097,644	1.503	3.273	33.5%	69.4%	3,860,965	3,804,379	1,304,270	1,247,684	1,445,385	141,115	197,701
Total		22,233,800	20,067,180	16,738,685					22,235,046	22,057,827	2,167,866	1,990,647	2,391,083	223,217	400,438

Column Notes:

(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit V.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit IV, Sheets 2 through 5.
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit IV, Sheets 2 through 5.
(8) = [1.00 - (1.00 / (6))].
(9) = [1.00 - (1.00 / (7))].
(10) = [((3) x (8)) + (4)].
(11) = [((3) x (9)) + (5)].
(12) = [(10) - (4)].
(13) = [(11) - (4)].
(14) Developed in Chapter 7, Exhibit IV, Sheet 1.
(15) = [(14) - (12)]
(16) = [(14) - (13)].

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Changing Conditions
U.S. PP Auto -Development of Unpaid Claim Estimate Using Gunnar Benktander Method

Exhibit V
Sheet 1

Accident Year	Age of Accident Year at 12/31/08	Expected ultimate Claims Using B-F Method with Reported	Paid	Claims at 12/31/08 Reported	Paid	CDF to Ultimate Reported	Paid	Expected Percentage Unreported	Unpaid	Projected Ultimate Claims Using G-B Method with Reported	Paid	Estimated IBNR Using G-B Method with Reported	Paid	Actual IBNR	Diff from Actual IBNR Using G-B Method with Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Steady-State																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,751	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,751	0	1	0	0	-1
2002	84	810,338	810,337	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,337	0	-1	-1	-1	0
2003	72	850,855	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,855	850,854	8,509	8,508	8,508	0	0
2004	60	893,397	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	938,068	938,067	919,306	863,022	1.020	1.087	2.0%	8.0%	938,068	938,067	18,762	18,761	18,761	0	0
2006	36	984,970	984,970	935,722	827,375	1.053	1.190	5.0%	16.0%	984,970	984,970	49,248	49,248	49,248	0	0
2007	24	1,034,219	1,034,218	930,797	734,295	1.111	1.408	10.0%	29.0%	1,034,219	1,034,218	103,422	103,421	103,422	-1	1
2008	12	1,085,930	1,085,929	836,166	456,090	1.299	2.381	23.0%	58.0%	1,085,930	1,085,928	249,764	249,762	249,764	0	1
Total		8,804,526	8,804,523	8,365,888	7,573,547					8,804,527	8,804,523	438,639	438,635	438,636	-2	2
Increasing Claim Ratios																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,751	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,751	0	1	0	0	-1
2002	84	810,338	810,337	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,337	0	-1	-1	-1	0
2003	72	850,855	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,855	850,854	8,509	8,508	8,508	0	0
2004	60	1,019,749	1,015,920	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,021,013	1,020,821	10,198	10,006	10,211	13	205
2005	48	1,135,061	1,123,000	1,116,300	1,047,955	1.020	1.087	2.0%	8.0%	1,139,001	1,137,795	22,701	21,495	22,782	80	1,287
2006	36	1,252,320	1,221,363	1,203,071	1,063,768	1.053	1.190	5.0%	16.0%	1,265,687	1,259,186	62,616	56,115	63,319	703	7,204
2007	24	1,366,646	1,296,467	1,263,224	996,544	1.111	1.408	10.0%	29.0%	1,399,889	1,372,519	136,665	109,295	140,358	3,693	31,063
2008	12	1,444,287	1,281,397	1,194,523	651,558	1.299	2.381	23.0%	58.0%	1,526,709	1,394,768	332,186	200,245	356,805	24,619	156,560
Total		10,086,005	9,806,090	9,647,367	8,575,113					10,220,241	10,053,031	572,874	405,664	601,982	29,108	196,318

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit III, Sheet 1
(5) and (6) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 2 through 5.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 2 through 5.
(9) = [1.00 - (1.00 / (7))].
(10) = [1.00 - (1.00 / (8))]
(11) = [((3) x (9)) + (5)]
(12) = [((4) x (10)) + (6)]
(13) = [(11) - (5)].
(14) = [(12) - (5)].
(15) Developed in-Chapter 7, Exhibit III, Sheet I.
(16) = [(15) - (13)].
(17) = [(15) - (14)].

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Changing Conditions
U.S. Auto -Development of Unpaid Claim Estimate Using Gunnar Benktander Method

Exhibit V
Sheet 2

	Age of	Expected Ultimate Claims								Projected Ultimate Claims		Estimated IBNR			Diff from Actual IBNR	
Accident	Accident Year	Using B-F Method with		Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Using G-B Method with		Using G-B Method with		Actual	Using G-B Method with	
Year	at 12/31/08	Reported	Paid	Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Increasing Case Outstanding Strength																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,751	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,751	0	1	0	0	-1
2002	84	810,338	810,337	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,337	0	-1	-1	-1	0
2003	72	850,855	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,855	850,854	8,509	8,508	8,508	0	0
2004	60	893,397	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	951,396	938,067	933,377	863,022	1.020	1.087	1.9%	8.0%	951,652	938,067	18,275	4,690	4,690	-13,585	0
2006	36	1,013,733	984,970	962,808	827,375	1.055	1.190	5.2%	16.0%	1,015,220	984,970	52,412	22,162	22,162	-30,250	0
2007	24	1,089,655	1,034,218	979,922	734,295	1.119	1.408	10.6%	29.0%	1,095,537	1,034,218	115,615	54,296	54,296	-61,319	1
2008	12	1,193,385	1,085,929	931,185	456,090	1.318	2.381	24.1%	58.0%	1,219,330	1,085,928	288,145	154,743	154,745	-133,401	1
Total		9,009,508	8,804,523	8,551,189	7,573,547					9,043,079	8,804,523	491,890	253,334	253,335	-238,554	2
Increasing Claim Ratios and Case Outstanding Strength																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,751	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,751	0	1	0	0	-1
2002	84	810,338	810,337	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,337	0	-1	-1	-1	0
2003	72	850,855	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,855	850,854	8,509	8,508	8,508	0	0
2004	60	1,019,749	1,015,920	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,021,013	1,020,821	10,198	10,006	10,211	13	205
2005	48	1,151,324	1,123,000	1,133,386	1,047,955	1.019	1.087	1.9%	8.0%	1,155,403	1,137,795	22,017	4,409	5,696	-16,321	1,287
2006	36	1,289,001	1,221,363	1,237,897	1,063,768	1.055	1.190	5.2%	16.0%	1,304,776	1,259,186	66,879	21,289	28,493	-38,386	7,204
2007	24	1,440,327	1,296,467	1,329,895	996,544	1.120	1.408	10.7%	29.0%	1,483,691	1,372,519	153,796	42,624	73,687	-80,109	31,063
2008	12	1,593,780	1,281,397	1,330,264	651,558	1.320	2.381	24.3%	58.0%	1,717,017	1,394,768	386,753	64,504	221,064	-165,689	156,560
Total		10,362,125	9,806,090	9,901,691	8,575,113					10,549,842	10,053,031	648,151	151,340	347,658	-300,493	196,318

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit III, Sheet 2.
(5) and (6) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 6 through 9.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 6 through 9.
(9) = [1.00 - (1.00 / (7))].
(10) = [1.00 - (1.00 / (8))]..
(11) = [((3) x (9))+ (5)]:
(12) = [((4) x (10)) + (6)]..
(13) = [(11) - (5)].
(14) = [(12) - (5)].
(15) Developed in Chapter7, Exhibit III, Sheet 1
(16)= [(15) - (13)]
(17) = [(15) - (14)].

Chapter 9 - Bornhuetter-Ferguson Technique Exhibit VI
Impact of Change in Product Mix Example
U.S. Auto -Development of Unpaid Claim Estimate Using Gunnar Benktander Method

	Age of	Expected Ultimate Claims								Projected Ultimate Claims		Estimated IBNR			Diff from Actual IBNR	
Accident	Accident Year	Using B-F Method with		Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Using G-B Method with		Using G-B Method with		Actual	Using G-B Method with	
Year	at 12/31/08	Reported	Paid	Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Steady-State (No Change in Product Mix)																
1999	120	1,500,000	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,751	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,751	0	1	0	0	-1
2002	84	1,736,438	1,736,437	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,437	0	-1	-1	-1	0
2003	72	1,823,260	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,260	1,823,259	8,509	8,508	8,508	0	0
2004	60	1,914,422	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,010,144	2,010,143	1,948,499	1,742,124	1.032	1.154	3.1%	13.3%	2,010,144	2,010,143	61,645	61,644	61,644	0	0
2006	36	2,110,650	2,110,651	1,937,577	1,581,581	1.089	1.335	8.2%	25.1%	2,110,650	2,110,651	173,073	173,074	173,074	0	0
2007	24	2,216,183	2,216,183	1,852,729	1,277,999	1.196	1.734	16.4%	42.3%	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	2,326,992	2,326,992	1,568,393	729,124	1.484	3.191	32.6%	68.7%	2,326,992	2,326,992	758,599	758,599	758,599	0	1
Total		18,866,839	18,866,838	17,472,205	15,270,788					18,866,839	18,866,838	1,394,634	1,394,633	1,394,634	0	1
Changing Product Mix																
1999	120	1,500,000	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,751	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,751	0	1	0	0	-1
2002	84	1,736,438	1,736,437	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,437	0	-1	-1	-1	0
2003	72	1,823,260	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,260	1,823,259	8,509	8,508	8,508	0	0
2004	60	1,914,422	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,262,528	2,251,361	2,193,545	1,951,435	1.032	1.154	3.1%	13.3%	2,262,929	2,251,616	69,384	58,071	71,855	2,470	13,783
2006	36	2,692,025	2,656,353	2,471,446	1,983,482	1.090	1.336	8.3%	25.2%	2,693,594	2,652,160	222,148	180,714	239,057	16,909	58,343
2007	24	3,216,658	3,142,864	2,680,487	1,766,164	1.200	1.750	16.7%	42.9%	3,217,588	3,113,616	537,101	433,129	596,924	59,823	163,795
2008	12	3,860,965	3,804,379	2,556,695	1,097,644	1.503	3.273	33.5%	69.4%	3,848,776	3,739,785	1,292,081	1,183,090	1,445,385	153,304	262,295
Total		22,235,046	22,057,827	20,067,180	16,738,685					22,225,758	21,960,046	2,158,578	1,892,866	2,391,083	232,505	498,217

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit IV.
(5) and (6) Front last diagonal of reported and paid claim triangles in Chapter 7, Exhibit IV, Sheets 2 through 5.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit IV, Sheets 2 through 5.
(9)= (1.00 - (1.00 / (7))].
(10)= [1.00 - (1.00 /.(8))].
(1l) = [((3) x (9)) + (5)].
(12 = [((4) x (10)) + (6)]
(13) = [(11) - (5)]
(14) = [(12) - (5)]
(15) Developed in Chapter 7, Exhibit IV, Sheet I.
(16) = [(15) - (13)].
(17) = [(15) - (14)].

Sample Questions:

1. For the "Reported Claim *Development*" method, ultimate claims for each accident year were estimated as the product of the cumulative reported CDF at the valuation age, and reported claims through the valuation date.

   For the "Paid Claim *Development*" method, ultimate claims for each accident year were estimated as the product of the cumulative paid CDF at the valuation age, and paid claims through the valuation date.

   For the "*Expected Claims*" technique, ultimate claims for an accident year were calculated by multiplying the appropriate premium for the year by a selected "claim ratio."

   How are ultimate claims estimated using the "*Bornhuetter-Ferguson*" technique, for one accident year?

2. The "Percentage Unpaid" as described for the Bornhuetter - Ferguson technique, is equal to which of the following, where CDF = "Claim Development Factor"

   ❶ 1.00/(cumulative paid CDF)
   ❷ 1.00 - (1.00/(cumulative paid CDF))
   ❸ (cumulative paid CDF) - 1.00
   ❹ ((cumulative paid CDF) - 1.00)/(cumulative paid CDF)

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

3. Based on the following information, calculate the "Percentage Unreported" as described for the Bornhuetter - Ferguson technique, where CDF = "Claim Development Factor"

Earned Premium	5,000
Cumulative Paid CDF (ultimate)	2.987
Cumulative Reported CDF (ultimate)	2.457
Reported Claims	3,500
Paid Losses	2,200
Reported Age-to-Age Factor (12-24 months)	1.5

4. True or False: Bornhuetter-Ferguson method produces Ultimate Claims that are a credibility weighting between the Development method and the Expected Claims method, where the credibility assigned to the Development method results is "the percent of claims developed at a particular stage of maturity."

5. Summarize Friedland's key points re: "When the B-F Technique Works and When it Does Not."
   Include an advantage over Development techniques, and potential uses of the B-F method.

6. Based on the following data as of 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

6a. Estimate the IBNR as of 12/31/08 using the following method: Bornhuetter-Ferguson

Use Expected Claim Ratio = 80% for all years.
To select claim development factors, use the volume-weighted averages for the latest three years.
See also Friedland Chapter 7 and 8 for other methods.

6b. Show that the Bornhuetter-Ferguson method produces Ultimate Claims that are a credibility weighting between the Development method and the Expected Claims method.

7. Based on the following information through 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	Accident Year	as of 12/31/03	as of 12/31/04	as of 12/31/05	as of 12/31/06	as of 12/31/07	as of 12/31/08
1,500	2003	500	800	1,000	1,200	1,250	1,250
1,650	2004		700	1,200	1,250	1,300	1275
1,875	2005			850	1,275	1450	1425
2,000	2006				550	1200	1550
2,250	2007					900	1350
2,400	2008						775

Estimate the IBNR using the Bornhuetter-Ferguson Technique if expected claim ratio = 60%
To select claim development factors, use the volume-weighted averages for the latest three years.

8. Based on the following information through 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	Accident Year	12 mo, Report 1	24 mo, Report 2	36 mo, Report 3	48 mo, Report 4	60 mo, Report 5	
4,000	2004	1,500	2,000	2,250	2,500	2,500	
4,400	2005	1,650	2,250	2,588	3,000		
4,840	2006	1,815	2,531	2,976			
5,324	2007	1,997	2,848				
5,856	2008	2,196					

Estimate the IBNR as of 12/31/08 using B-F method if expected claim ratio = 80% for all years.
To select claim development factors, use the volume-weighted averages for the latest three years.

9. Based on the following information through 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	Accident Year	12 mo, Report 1	24 mo, Report 2	36 mo, Report 3	48 mo, Report 4	60 mo, Report 5	72 mo, Report 6
2,000	2003	200	800	1,200	1,650	1,750	1,750
2,200	2004	290	403	1,269	1,639	1,800	
2,000	2005	209	2,225	1,224	960		
1,900	2006	205	1,519	1,486			
2,150	2007	228	1,126				
2,250	2008	143					

Expected Claim Ratio = 80% for all years.

a. List three aggregate methods (discussed in Friedland chapters 7-9) that you could use to estimate IBNR losses as of 12/31/08.

b. Of the three methods listed in (a.), which do you feel is most appropriate? Why?

c. Estimate the IBNR as of 12/31/08 based on the selected method.
To select claim development factors, use the volume-weighted averages for the latest 3 years.

10. Based on the following information (amounts in 000's):

Accident Year	Earned Premium	Reported Claims at 12-31-08	Expected Claim Ratio
2005	120,000	25,000	85%
2006	120,000	50,000	85%
2007	120,000	75000	85%
2008	120,000	90000	85%

Selected ultimate reported claim development factors (CDFs):

12 months	4.00
24 months	2.25
36 months	1.25
48 months	1.10

What is the Bornhuetter-Ferguson IBNR estimate at 12/31/08?

1995 Exam Questions (modified):

44. You are given the following data:

		Reported Claims including ALAE ($000's omitted) as of					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	
4,500	1990	2,000	2,600	2,990	3,283	3,283	
5,000	1991	2,102	2,638	3,086	3,343		
5,200	1992	2,234	2,938	3,408			
5,300	1993	2,339	2,985				
5,700	1994	2,482					

Assume that all claims reach ultimate settlement at 60 months, and the expected claim ratio is 75%.

a. (1.5 points) Using the Bornhuetter-Ferguson Technique described in Friedland, determine the IBNR as of 12/31/94.

   Select development factors using latest 3 years, volume-weighted. Show all work.

b. (0.5 points) See Friedland Chapter 7.

c. (1.5 points) See Friedland Chapter 15.

2001 Exam Questions (modified):

1. According to Friedland, it is not appropriate to derive the IBNR reserve as a function of expected losses for a new line of business using Bornhuetter-Ferguson technique.

2002 Exam Questions (modified):

22. (4 points) You are given the following information:

Accident Year	Earned Premium	Reported Claims at 12-31-01	Expected Claim Ratio
1998	200	100	80%
1999	1,000	1,000	80%
2000	1,500	900	80%
2001	1,500	600	80%

Selected age-to-age reported claim development factors:

12 - 24 months	1.25
24 - 36 months	1.10
36 - 48 months	1.05
48 - 60 months	1.08

No further development after 60 months.

a. (1 point) See Friedland Chapter 7.

b. (1 point) Calculate the IBNR reserve as of December 31, 2001 using the Bornhuetter-Ferguson technique. Show all work.

c. (0.5 pt) Identify one situation in which it would be preferable to use the Bornhuetter-Ferguson method rather than the Development method to estimate the IBNR.

d. (1 point) See Friedland Chapter 15.

2003 Exam Questions (modified):

23. (3 points) You are given the following information:

		Reported Claims including ALAE ($000's omitted)				
Earned Premium	Accident Year	at age 12 mo	at age 24 mo	at age 36 mo	at age 48 mo	
1,000	1999	250	500	750	825	
1,000	2000	200	350	490		
1,500	2001	300	450			
1,800	2002	400				

- The expected claim ratio is 75% (including adjustment expenses)
- Claim development factors should be calculated using an all-years simple average.
- The tail factor is 1.05 for development from 48 months to ultimate.

a. (1 point) See Friedland Chapter 7.

b. (1 point) Using the Bornhuetter-Ferguson method, calculate the total IBNR reserve. Show all work.

c. (1 point) Briefly identify two situations when the use of the Bornhuetter-Ferguson method to develop an IBNR reserve would be preferred over the Development method.

2004 Exam Questions (modified):

25. (2 points) You are given the following information:

- An insurance company was formed to write workers compensation business in 2001.
- Earned premium in 2001 was $1,000,000.
- Earned premium growth through 2003 has been constant at 20% per year.
- The expected claim ratio for accident year 2001 is 60%.
- As of December 31, 2003, the company's reserving actuary believes the expected loss ratio has increased two percentage points each accident year since the company's inception.
- Selected incurred loss development factors are as follows:

12 to 24 months	1.500
24 to 36 months	1.336
36 to 48 months	1.126
48 to 60 months	1.057
60 to 72 months	1.050
72 to ultimate	1.000

Using the Bornhuetter-Ferguson method, calculate the total IBNR reserve as of December 31, 2003. Show all work.

2005 Exam Questions (modified):

10. (4 points) You are given the following information:

		Reported Claims by Development Age				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**	
19,000	2001	4,850	9,700	14,100	16,200	
20,000	2002	5,150	10,300	14,900		
21,000	2003	5,400	10,800			
22,000	2004	7,200				

Assume an expected Claim Ratio = 0.90 for all years.

Choose selected incremental development factors using a straight average of the age-to-age factors.

Assume no development past 48 months.

a. (1 point) See Friedland Chapter 7.

b. (0.5 point) Using the Bornhuetter-Ferguson method, calculate the indicated IBNR for accident year 2004 as of December 31, 2004.

c, d, and e: See Friedland Chapter 15.

2006 Exam Questions (modified):

1. Given the following information:

Written Premium	$7,000,000
Earned Premium	6,000,000
Accident Year Paid Loss	300,000
Accident Year Case Reserve	1,200,000
Expected Loss Ratio	60%
Incurred Loss Development Factor	1.800

Compute the ultimate claim ratio using the Bornhuetter-Ferguson method.

A. < 37.5%
B. $\geq$ 37.5% but < 47.5%
C. $\geq$ 47.5% but < 57.5%
D. $\geq$ 57.5% but < 67.5%
E. $\geq$ 67.5%

2007 Exam Questions (modified):

46. (2 points) Given the following information for a large deductible policy effective January 1, 2004 through December 31, 2004:

- Premium: $475,000
- Observed loss as of 36 months: $350,000
- Age-to-ultimate development factor as of 36 months: 1.250
- Expected ultimate loss ratio for the insurer's large deductible book of business: 60%
- This policy written by the same insurance company for over 10 years.

a. (0.5 point) Use the Bornhuetter-Ferguson approach to estimate the ultimate loss for the 2004 policy as of December 31, 2006.

b. (0.5 point) Explain how much credibility the Bornhuetter-Ferguson formula assigns to the loss development projection for this policy.

c. (0.5 point) Briefly describe a disadvantage of the Bornhuetter-Ferguson approach.

d. (0.5 point) Describe a possible improvement to the accuracy of this estimate while still using the Bornhuetter-Ferguson approach.

2008 Exam Questions

Question 10. Given the following for an accident year:

- Earned Premium: $20,000,000
- Reported Losses as of 12 months: $10,000,000
- Expected loss ratio: 70%
- Expected reporting pattern:

Age (months)	% Reported
12	40%
24	60%
36	80%
48	90%
60	100%

a. (1.5 points) This portion of the questions is associated with the Brosius article, now on exam 7.

b. (1 point) Estimate the ultimate value of the claims currently aged at 12 months using the Bornhuetter-Ferguson Method on reported claims, as described in Friedland.

c. (.75 points) Explain how the Benktander formula can be described as a credibility weighted average. (Note: See also Mack, now on exam 7)

2009 Exam Questions

10. (3 points) Given the following information evaluated as of December 31, 2008:

Accident Year	Exposure Units	Incurred Loss	Incurred Loss Development Factor to Ultimate
2005	19,000	$3,500,000	1.37
2006	19,750	4,000,000	1.54
2007	21,000	3,800,000	2.22
2008	21,500	2,000,000	5.00

- The expected loss rate for all the accident years is $250 per exposure unit.
- The company has no exposure prior to 2005.

a. (1 point Use the Bornhuetter-Ferguson method to calculate the IBNR at 12/31/2008 for all accident years.

b. (1.5 points) Use the Cape Cod method to calculate the IBNR at December 31, 2008 for all accident years.

c. (0.5 point) For this book of business, briefly discuss whether the Bornhuetter-Ferguson method or the Cape Cod method would be expected to produce a more accurate IBNR estimate.

2011 Exam Questions

27. (3 points) Given the following information as of December 31, 2010:

Accident Year	Earned Premium	Claims Reported	Selected CDF to Ultimate
2008	$950,000	$510,000	1.050
2009	$975,000	$520,000	1.120
2010	$1,000,000	$450,000	1.300

a. (1 point) Use the Bornhuetter-Ferguson technique and an expected claims ratio of 60% to estimate the IBNR for accident year 2010.

b. (1.5 points) Use the Cape Cod technique to estimate the IBNR for accident year 2010.

c. (0.5 point) Describe the primary difference between the Bornhuetter-Ferguson technique and the Cape Cod technique.

2012 Exam Questions

18. (3.25 points) Given the following information evaluated as of December 31, 2011:

Accident Year	Earned Premium	Earned Premium	On-Level Claims Reported	Reported CDF to Ultimate
2009	$950,000	$978,500	$510,000	1.05
2010	$975,000	$1,023,750	$520,000	1.12
2011	$1,000,000	$1,000,000	$465,000	1.30

a. (0.75 point) Use the Bornhuetter-Ferguson technique and an expected claims ratio of 60.0% to estimate the IBNR for accident year 2010.

b. (2 points) Use the Cape Cod technique to calculate the IBNR for accident year 2010.

c. (0.5 point) Describe the difference in the underlying assumption between the two techniques.

Solutions to Sample Questions:

1. For the "Reported Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative reported CDF at the valuation age, and reported claims through the valuation date.

   For the "Paid Claim Development" method, ultimate claims for each accident year were estimated as the product of the cumulative paid CDF at the valuation age, and paid claims through the valuation date.

   For the "Expected Claims" technique, ultimate claims for an accident year were calculated by multiplying the appropriate premium for the year by a selected "claim ratio."

   a. How are ultimate claims estimated using the "Bornhuetter-Ferguson" technique, for one accident year?

   Friedland suggests it is easiest to split the ultimate losses in two components for the B-F method:

   1) Actual claims reported to date +

   2) Expected "IBNR" calculated using a-priori expected ultimate claims and the expected percent unreported.

   (or Actual paid + Expected unpaid, if the B-F method is performed using paid instead of reported claims)

2. The "Percentage Unpaid" as described for the Bornhuetter - Ferguson technique, is equal to which of the following, where CDF = "Claim Development Factor"

➊	1.00/(cumulative paid CDF)	No
➋	1.00 - (1.00/(cumulative paid CDF))	**Yes**
➌	(cumulative paid CDF) - 1.00	No
➍	((cumulative paid CDF) - 1.00)/(cumulative paid CDF)	**Yes**

   1. ➊   2. ➋   3. ➊, ➋   4. ➊, ➋, ➌   **5. Neither 1,2,3 or 4**

   Note: "Cumulative" CDFs reflect ultimate levels, while Age-to-Age factors are incremental.

   Also, there are two sets of CDFs we can calculate, for paid or reported claims. Here we use paid.

3. Based on the following information, calculate the "Percentage Unreported" as described for the Bornhuetter - Ferguson technique, where CDF = "Claim Development Factor"

   "Percentage Unreported" Factor = 1 - (1/2.457) = .593

   Note: Here we use the ultimate CDF for reported claims.

   Keep in mind: For B-F method, IBNR = (Expected Claims) * (% unreported)

4. a. True or False: Bornhuetter-Ferguson method produces Ultimate Claims that are a credibility weighting between the Development method and the Expected Claims method, where the credibility assigned to the Development method results is "the percent of claims developed at a particular stage of maturity."

   TRUE: See sample question below. Similar statement can be made for IBNR. Friedland, Brosius, Mack, Siewert and Patrik all discuss credibility weightings.

5. Summarize Friedland's key points re: "When the B-F Technique Works and When it Does Not."

   Advantage: B-F method is less affected by random fluctuations in observed claim activity (that can significantly distort Development method results).

   Uses of B-F: Cases where data is thin and/or volatile, Long-tailed lines (particularly for the most recent years)

   Friedland also notes that the B-F method can be a useful method for short-tail lines as well.

6. Based on the following data as of 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**1st Report**	**2nd Report**	**3rd Report**	**4th Report**	**5th Report**	**6th Report**
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

a. Finding IBNR at 12/31/08

Selected CDF calculations	***1st to 2nd Report***	***2nd to 3rd Report***	***3rd to 4th Report***	***4th to 5th Report***	***5th to 6th Report***
ATA: 3-yr Volume-weighted average	*1.2470*	***1.0896****	*1.0557*	*1.0000*	*1.0000*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.4344*	***1.1503*****	*1.0557*	*1.0000*	*1.0000*

** Example of Age-to-Age calculation for 2nd to 3rd report, using 3-year volume-weighted average:*
(1900+1800+1750)/(1550+1725+1690) = 1.0896
*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.0896 for 2nd-to-3rd) * (1.0557 for 3rd-to-4th) * (1.00 for 4th-to-5th) * (1.0 tail) = 1.1503*

Accident Year	***Age of Data at 12/31/08***	***Reported CDF to Ultimate***	***Percent Reported 12/31/08***	***Percent Unreport 12/31/08***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
2003	*72 months*	*1.0000*	*100.0%*	*0.0%*
2004	*60 months*	*1.0000*	*100.0%*	*0.0%*
2005	*48 months*	*1.0000*	*100.0%*	*0.0%*
2006	*36 months*	*1.0557*	*94.7200%*	*5.2800%*
2007	*24 months*	*1.1503*	*86.9300%*	*13.0700%*
2008	*12 months*	*1.4344*	*69.7200%*	*30.2800%*
Total				

Note: The Percent Unreported
= 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or Shortcut using Expected Claims * Percent Unreported* ***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*	*(8)=(5)*(6)*[1.0-1.0/CDF]*
2003	*2,000*	*80.0%*	*1,600*	*0*	*0*
2004	*2,200*	*80.0%*	*1,760*	*0*	*0*
2005	*2,500*	*80.0%*	*2,000*	*0*	*0*
2006	*2,650*	*80.0%*	*2,120*	*111.9360*	*111.9360*
2007	*3,000*	*80.0%*	*2,400*	*313.6800*	*313.6800*
2008	*3,150*	*80.0%*	*2,520*	*763.0560*	*763.0560*
Total				***1,188.6720***	***1,188.6720***

b. Since Expected Ultimate Claims = Actual Reported + Expected Unreported:

		Bornhuetter-Ferguson	"B-F"		Development Method	Expected Claims	Credibility Weighted
Accident Year	Reported Claims at 12/31/08	"IBNR" Expected Unreport	Expected Ultimate Claims	Credibility to "Actual" by B-F	Expected Ultimate Claims	Expected Ultimate Claims	Expected Ultimate Claims
	(9)	(10)=(8)	(11)=(9)+(10)	(12)=(3)	(13) Ch 7.	(14) Ch. 8	(15)
2003	1,750	0	1,750	100.0%	1,750	1,600	1,750
2004	1,800	0	1,800	100.0%	1,800	1,760	1,800
2005	1,950	0	1,950	100.0%	1,950	2,000	1,950
2006	1,900	111.9360	2,011.9360	94.7200%	2,006	2,120	2,011.8582
2007	1,900	313.6800	2,213.6800	86.9300%	2,186	2,400	2,213.5960
2008	2,250	763.0560	3,013.0560	69.7200%	3,227	2,520	3,013.1993
Total			**12,738.6720**	(15) = (12)*(13) + [1.0-(12)]*(14)			**12,738.6535**
(13) & (14) See details in Ch. 7 & Ch. 8 Q & A.				Matches B-F Expected Ultimate Claims in (11)			

Minor rounding issues do exist.

7. Estimate the IBNR using the Bornhuetter-Ferguson Technique if expected claim ratio = 60%
To select claim development factors, use the volume-weighted averages for the latest three years.

Note: Friedland warns that data/triangles may be accumulated in different ways. First, we reorganize:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	**72 mo, Report 6**
1,500	2003	500	800	1,000	1,200	1,250	1,250
1,650	2004	700	1,200	1,250	1,300	1,275	
1,875	2005	850	1,275	1,450	1,425		
2,000	2006	550	1,200	1,550			
2,250	2007	900	1,350				
2,400	2008	775					

Selected CDF calculations	***12: 24 mo***	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA: 3-yr Volume-weighted average	*1.6630*	*1.1565*	*1.0608*	*1.0100*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*2.0606*	*1.2391*	*1.0714*	*1.0100*	*1.00*

Accident Year	***Age of Data at 12/31/08***	***Reported CDF to Ultimate***	***Percent Reported 12/31/08***	***Percent Unreport 12/31/08***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
2004	*60 months*	*1.00*	*100.00%*	*0.00%*
2005	*48 months*	*1.0100*	*99.01%*	*0.99%*
2006	*36 months*	*1.0714*	*93.34%*	*6.66%*
2007	*24 months*	*1.2391*	*80.71%*	*19.29%*
2008	*12 months*	*2.0606*	*48.53%*	*51.47%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or Shortcut using Expected Claims * Percent Unreported*	***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*		*(8)=(5)*(6)*[1.0-1.0/CDF]*
2004	*1,650*	*60.0%*	*990.0*	*0.0000*		*0*
2005	*1,875*	*60.0%*	*1,125.0*	*11.1375*		*11.1375*
2006	*2,000*	*60.0%*	*1,200.0*	*79.9200*		*79.9200*
2007	*2,250*	*60.0%*	*1,350.0*	*260.4150*		*260.4150*
2008	*2,400*	*60.0%*	*1,440.0*	*741.1680*		*741.1680*
Total				***1,092.6405***		***1,092.6405***

8. Estimate the IBNR using the Bornhuetter-Ferguson Technique if expected claim ratio = 80%
   To select claim development factors, use the volume-weighted averages for the latest three years.

Selected CDF calculations	***12: 24 mo***	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA: 3-yr Volume-weighted average	*1.3967*	*1.1523*	*1.1368*	*1.0000*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*1.8295*	*1.3099*	*1.1368*	*1.0000*	*1.0000*

Accident Year	***Age of Data at 12/31/08***	***Reported CDF to Ultimate***	***Percent Reported 12/31/08***	***Percent Unreport 12/31/08***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
2004	*60 months*	*1.0000*	*100.00%*	*0.00%*
2005	*48 months*	*1.0000*	*100.00%*	*0.00%*
2006	*36 months*	*1.1368*	*87.97%*	*12.03%*
2007	*24 months*	*1.3099*	*76.34%*	*23.66%*
2008	*12 months*	*1.8295*	*54.66%*	*45.34%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or Shortcut using Expected Claims * Percent Unreported* ***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*	*(8)=(5)*(6)*[1.0-1.0/CDF]*
2004	*4,000*	*80.0%*	*3,200.0*	*0.0000*	*0*
2005	*4,400*	*80.0%*	*3,520.0*	*0.0000*	*0.0000*
2006	*4,840*	*80.0%*	*3,872.0*	*465.8016*	*465.8016*
2007	*5,324*	*80.0%*	*4,259.2*	*1007.7267*	*1,007.7267*
2008	*5,856*	*80.0%*	*4,684.8*	*2124.0883*	*2,124.0883*
Total				***3,597.6166***	***3,597.6166***

9. a. List three aggregate methods (discussed in Friedland chapters 7-9) that you could use to estimate IBNR losses as of 12/31/08.
   1. Development Technique
   2. Expected Claims Technique
   3. Bornhuetter-Ferguson Technique

9b. Of the three methods listed in (a.), which do you feel is most appropriate? Why?
   Bornhuetter-Ferguson Technique, because of the volatility of the data

9c. Estimate the IBNR as of 12/31/08 based on the selected method.

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	**72 mo, Report 6**
2,000	2003	200	800	1,200	1,650	1,750	1,750
2,200	2004	290	403	1,269	1,639	1,800	
2,000	2005	209	2,225	1,224	960		
1,900	2006	205	1,519	1,486			
2,150	2007	228	1,126				
2,250	2008	143					

ATA factors by AY:

Accident Year	1st to 2nd Report	2nd to 3rd Report	3rd to 4th Report	4th to 5th Report	5th to 6th Report
	12:24 mo	**24:36 mo**	**36:48 mo**	**48:60 mo**	**50:72 mo**
2003	4.0000	1.5000	1.3750	1.0606	1.0000
2004	1.3897	3.1489	1.2916	1.0982	
2005	10.6459	0.5501	0.7843		
2006	7.4098	0.9783			
2007	4.9386				

Selected CDF calculations	***12: 24 mo***	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA: 3-yr Volume-weighted average	*7.5857*	*0.9595*	*1.1506*	*1.0794*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*9.0399*	*1.1917*	*1.2420*	*1.0794*	*1.00*

Accident Year	***Age of Data at 12/31/08***	***Reported CDF to Ultimate***	***Percent Reported 12/31/08***	***Percent Unreport 12/31/08***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
2004	*60 months*	*1.0000*	*100.00%*	*0.00%*
2005	*48 months*	*1.0794*	*92.64%*	*7.36%*
2006	*36 months*	*1.2420*	*80.52%*	*19.48%*
2007	*24 months*	*1.1917*	*83.91%*	*16.09%*
2008	*12 months*	*9.0399*	*11.06%*	*88.94%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*		*(8)=(5)*(6)*[1.0-1.0/CDF]*
2004	*2,200*	*80.0%*	*1,760.0*	*0.000*		*0.000*
2005	*2,000*	*80.0%*	*1,600.0*	*117.760*		*117.760*
2006	*1,900*	*80.0%*	*1,520.0*	*296.096*		*296.096*
2007	*2,150*	*80.0%*	*1,720.0*	*276.748*		*276.748*
2008	*2,250*	*80.0%*	*1,800.0*	*1,600.920*		*1,600.920*
Total				***2,291.524***		***2,291.524***

10. What is the Bornhuetter-Ferguson IBNR estimate at 12/31/08?
To select claim development factors, use the volume-weighted averages for the 3 three years.

Accident Year	Age of Data at 12/31/08	Reported CDF to Ultimate	Percent Reported 12/31/08	Percent Unreport 12/31/08
	(1)	(2) given	(3)=1.0/(2)	(4)=1.-(3)
2005	48 months	1.10	90.9091%	9.0909%
2006	36 months	1.25	80.0000%	20.0000%
2007	24 months	2.25	44.4444%	55.5556%
2008	12 months	4.00	25.0000%	75.0000%
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	Earned Premium	A priori Expected Claim Ratio	A priori Expected Claims	"IBNR" Expected Unreport	Or shortcut using Est. Expected Claims x Percent Unreported	IBNR (broadly defined)
	(5) given	(6) given	(7)=(5)*(6)	(8)=(7)*(4)		(8)=(5)*(6)*[1.0-1.0/CDF]
2005	120,000	85.0%	102,000	9,272.718		9,272.718
2006	120,000	85.0%	102,000	20,400.000		20,400.000
2007	120,000	85.0%	102,000	56,666.712		56,666.712
2008	120,000	85.0%	102,000	76,500.000		76,500.000
Total				**162,839.430**		**162,839.430**

Solutions to 1995 Exam questions (modified):

44. You are given the following:

		Reported Claims including ALAE ($000's omitted) as of					
Earned Premium	**Accident Year**	**12 mo, Report 1**	**24 mo, Report 2**	**36 mo, Report 3**	**48 mo, Report 4**	**60 mo, Report 5**	
4,500	1990	2,000	2,600	2,990	3,283	3,283	
5,000	1991	2,102	2,638	3,086	3,343		
5,200	1992	2,234	2,938	3,408			
5,300	1993	2,339	2,985				
5,700	1994	2,482					

Assume that all claims reach ultimate settlement at 60 months, and the expected claim ratio is 75%.

a. (1.5 points) Using the Bornhuetter-Ferguson Technique described in Friedland, determine the IBNR as of 12/31/94.

Select development factors using latest 3 years, volume-weighted. Show all work.

Selected CDF calculations	***12: 24 mo***	***24: 36 mo***	***36:48 mo***	***48:60 mo***	
ATA: 3-yr Volume-weighted average	*1.2825*	***1.1600****	*1.0905*	*1.0000*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***tail***
Reported CDF to Ultimate	*1.6224*	***1.2650*****	*1.0905*	*1.0000*	*1.0000*

** Example of Age-to-Age calculation for 24-to-36 months, using 3-year volume-weighted average:*
(2990+3086+3408)/(2938+2638+2600) = 1.1600

*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.1600 for 24:36 mo) * (1.0905 for 36:48 mo) * (1.00 for 48:60 mo) * (1.0 tail) = 1.2650*

Accident Year	***Age of Data at 12/31/94***	***Reported CDF to Ultimate***	***Percent Reported 12/31/94***	***Percent Unreport 12/31/94***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
1990	*60 months*	*1.00*	*100.0%*	*0.0000%*
1991	*48 months*	*1.00*	*100.0%*	*0.0000%*
1992	*36 months*	*1.0905*	*91.7011%*	*8.2989%*
1993	*24 months*	*1.2650*	*79.0514%*	*20.9486%*
1994	*12 months*	*1.6224*	*61.6371%*	*38.3629%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*		*(8)=(5)*(6)*[1.0-1.0/CDF]*
1990	*4,500*	*75.0%*	*3,375.0*	*0*		*0*
1991	*5,000*	*75.0%*	*3,750.0*	*0*		*0*
1992	*5,200*	*75.0%*	*3,900.0*	*323.6571*		*323.6571*
1993	*5,300*	*75.0%*	*3,975.0*	*832.7069*		*832.7069*
1994	*5,700*	*75.0%*	*4,275.0*	*1,640.0140*		*1,640.0140*
Total				***2,796.3779***		***2,796.3779***

Solutions to 2001 Exam Questions (modified):

1 According to Friedland, it is not appropriate to derive the IBNR reserve as a function of expected losses for a new line of business using Bornhuetter-Ferguson technique.

False. New lines of business are an example where Bornhuetter-Ferguson is likely to be appropriate.

Solutions to 2002 Exam Questions (modified):

Question 22. a. (1 point) See Friedland Chapter 7.

b. Calculate the IBNR reserve as of December 31, 2001 using the Bornhuetter-Ferguson technique:

Selected ATA factors (given)		*Reported Ultimate CDF*		*Exp. % Unreported*	*Accident*
	(1)		*(2) = product of (1)*	*(3) = 1.0 - 1.0 / (2)*	*Year*
Tail at 60 months	*1.00*	*Tail Factor*	*1.0000*	*0.0%*	*prior*
48 - 60 months	*1.08*	*at 48 mo.*	*1.0800*	*7.4074%*	*1998*
36 - 48 months	*1.05*	*at 36 mo.*	*1.1340*	*11.8166%*	*1999*
24 - 36 months	*1.10*	*at 24 mo.*	*1.2474*	*19.8333%*	*2000*
12 - 24 months	*1.25*	*at 12 mo.*	*1.5593*	*35.8687%*	*2001*

(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(4) given	*(5) given*	*(6)=(4)*(5)*	*(7)=(6)*(3)*	(7)=(Premium)*(Exp Claims %)*[1-1/CDF]	
1998	*200*	*80.0%*	*160.0*	*11.8518*		*12*
1999	*1,000*	*80.0%*	*800.0*	*94.5328*		*95*
2000	*1,500*	*80.0%*	*1,200.0*	*237.9996*		*237.9996*
2001	*1,500*	*80.0%*	*1,200.0*	*430.4244*		*430.4244*
Total				***774.8086***		***774.8086***

Note: Compare back to Chapter 7 Q&A (Development Method) for part A.

c. (0.5 point) Identify one situation in which it would be preferable to use the Bornhuetter-Ferguson method rather than the Development method to estimate the IBNR.

The B-F method is preferable to use when historical data is sparse or non-credible. Insurers face this when writing new lines of business.

e. (1 point) See Friedland Chapter 15.

Thus, the amount of loss emergence during CY 2002 on AYs 1998 – 2001 is 335,726.

Solutions to 2003 Exam Questions (modified):

23. (3 points)

a. (1 point) See Friedland Chapter 7.

b. (1 point) Using the Bornhuetter-Ferguson method, calculate the total IBNR reserve. Show all work.

		Reported Claims including ALAE ($000's omitted)				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**	
1,000	1999	250	500	750	825	
1,000	2000	200	350	490		
1,500	2001	300	450			
1,800	2002	400				

ATA factors by AY:	*AY*	*12:24 mo*	*24:36 mo*	*36:48 mo*	*See tail factor*	
Example:	*1999*	*2.0000*	*1.5000*	*1.1000*		
12:24 for AY 2000	*2000*	*1.7500*	*1.4000*			
1.75 = 350/200	*2001*	*1.5000*				
		12: 24 mo	***24: 36 mo***	***36:48 mo***		
	ATA: Simple Average (all yr)	***1.7500****	*1.4500*	*1.1000*	*1.05 tail*	

Selected ATA factors (given)		*Reported Ultimate CDF*		*Exp. % Unreported*	*Accident*
	(1)		*(2) = product of (1)*	*(3) = 1.0 - 1.0 / (2)*	*Year*
Tail at 48 months	*1.05*	*at 48 mo.*	*1.05*	*4.7619%*	*1999*
36 - 48 months	*1.10*	*at 36 mo.*	*1.1550*	*13.4199%*	*2000*
24 - 36 months	*1.45*	*at 24 mo.*	*1.6748*	*40.2914%*	*2001*
12 - 24 months	*1.75*	*at 12 mo.*	*2.9309*	*65.8808%*	*2002*

(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(4) given	*(5) given*	*(6)=(4)*(5)*	*(7)=(6)*(3)*	(7)=(Premium)*(Exp Claims %)*[1-1/CDF]	
1999	*1,000*	*75.0%*	*750*	*35.7143*		*35.7143*
2000	*1,000*	*75.0%*	*750*	*100.6493*		*100.6493*
2001	*1,500*	*75.0%*	*1,125*	*453.2783*		*453.2783*
2002	*1,800*	*75.0%*	*1,350*	*889.3908*		*889.3908*
Total				***1,479.0327***		***1,479.0327***

Note: Compare back to Chapter 7 Q&A (Development Method) for part A.

c. Two reasons to use Bornhuetter-Ferguson method over the Development method:

CAS:

1. Data lacks credibility (i.e. no data volume)
2. Loss development patterns are volatile (i.e. large standard error between selected factors and age to age factors derived from data)

Friedland comments in Chapter 9:

"Actuaries frequently use the Bornhuetter-Ferguson method for long-tail lines of insurance, particularly for the most immature years, due to the highly leveraged nature of claim development factors for such lines.

Actuaries may also use the Bornhuetter-Ferguson method if the data is extremely thin or volatile or both. For example, when an insurer has recently entered a new line of business or a new territory . . ."

Solutions to 2004 Exam Questions (modified):

25. (2 points) Based on the given information, Use the Bornhuetter-Ferguson method to calculate the total IBNR reserve as of December 31, 2003. Show all work.

Accident Year	***ATA Factors Given***	***Reported CDF to Ultimate***	***Percent Reported Given***	***Percent Unreport Given***
	(1)	*(2) from (1)*	*(3)=1.0/(2)*	*(4)=1.-(3)*
1999	*1.050*	*1.0500*	*95.2381%*	*4.7619%*
2000	*1.057*	*1.1099*	*90.0982%*	*9.9018%*
2001	*1.126*	*1.2497*	*80.0192%*	*19.9808%*
2002	*1.336*	*1.6696*	*59.8946%*	*40.1054%*
2003	*1.500*	*2.5044*	*39.9297%*	*60.0703%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported* ***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*	*(8)=(5)*(6)*[1.0-1.0/CDF]*
1999	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
2000	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
2001	*1,000,000*	*60.0%*	*600,000*	*119,884.8000*	*119,884.8000*
2002	*1,200,000*	*62.0%*	*744,000*	*298,384.1760*	*298,384.1760*
2003	*1,440,000*	*64.0%*	*921,600*	*553,607.8848*	*553,607.8848*
Total				***971,876.8608***	***971,876.8608***

Note: Many problems use the same Expected Claims Ratio for all years. This problem does not.

Solutions to 2005 Exam Questions (modified):

10. (4 points) You are given the following information:

		Reported Claims by Development Age				
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**	
19,000	2001	4,850	9,700	14,100	16,200	
20,000	2002	5,150	10,300	14,900		
21,000	2003	5,400	10,800			
22,000	2004	7,200				

Assume an expected Claim Ratio = 0.90 for all years.

Choose selected factors using a straight average of the age to age factors.

Assume no development past 48 months.

a. (1 point) See Friedland Chapter 7

b. (0.5 point) Using the Bornhuetter-Ferguson method, calculate the indicated IBNR for accident year 2004 as of December 31, 2004.

ATA factors by AY:	*AY*	***12:24 mo***	***24:36 mo***	***36:48 mo***	***See tail factor***	
	2001	*2.000*	*1.4536*	*1.1489*		
	2002	*2.000*	*1.4466*			
	2003	*2.000*				
		12: 24 mo	***24: 36 mo***	***36:48 mo***		
ATA: Simple Average (all yr)		*2.0000*	*1.4501*	*1.1489*	*1.00 tail*	

Selected ATA factors		*Reported Ultimate CDF*		*Exp. % Unreported*	*Accident*
	(1)		*(2) = product of (1)*	*(3) = 1.0 - 1.0 / (2)*	*Year*
Tail at 48 months	*1.00*	*at 48 mo.*	*1.00*	*0.0%*	*2001*
36 - 48 months	*1.15*	*at 36 mo.*	*1.15*	*12.9602%*	*2002*
24 - 36 months	*1.45*	*at 24 mo.*	*1.6660*	*39.9760%*	*2003*
12 - 24 months	*2.00*	*at 12 mo.*	*3.3320*	*69.9880%*	*2004*

(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(4) given	*(5) given*	*(6)=(4)*(5)*	*(7)=(6)*(3)*	(7)=(Premium)*(Exp Claims %)*[1-1/CDF]	
2001	*19,000*	*90.0%*	*17,100*	*0*		*0*
2002	*20,000*	*90.0%*	*18,000*	*2,332.8360*		*2,332.8360*
2003	*21,000*	*90.0%*	*18,900*	*7,555.4640*		*7,555.4640*
2004	*22,000*	*90.0%*	*19,800*	***13,857.6240***		***13,857.6240***
Total				*23,745.9240*		*23,745.9240*

Note: Only the calculations for Accident Year 2004 are required:

*22,000 * 90% * (1 - 1/3.3320) = 19,800 * 70% =* ***13,857.6240***

Note: Compare back to Chapter 7 Q&A (Development Method) for part A.

2005 #10 parts c, d, e: See Friedland Chapter 15

Solutions to 2006 Exam Questions (modified):

1. Given the following information:

Written Premium	$7,000,000
Earned Premium	6,000,000
Accident Year Paid Loss	300,000
Accident Year Case Reserve	1,200,000
Expected Loss Ratio	60%
Incurred Loss Development Factor	1.800

Compute the ultimate claim ratio using the Bornhuetter-Ferguson method.

A.< 37.5%   B. $\geq$ 37.5% but < 47.5%   C. $\geq$ 47.5% but < 57.5%   D. $\geq$ 57.5% but < 67.5%

The formula for the ultimate loss ratio using the BF method is as follows:

$$\text{Ultimate Loss Ratio} = \left(\frac{\text{Paid Loss + Case Reserve + IBNR estimate}}{\text{Earned Premium}}\right)$$

The formula to compute IBNR using the BF method is as follows:

$$\text{IBNR} = \text{Expected Loss * Expected Loss IBNR Factor} = \text{Expected Loss * }\left(1.000-\frac{1.000}{\text{LDF to ultimate}}\right)$$

Expected Loss = (Earned Premium)(Expected Loss Ratio) = (6,000,000)(.60) = 3,600,000

IBNR Factor =1.0 - 1/1.80=.4444   Thus, IBNR = (3,600,000)(.4444) = 1,600,000

Therefore, the ultimate loss ratio using the BF method is computed as follows:

$$\text{Ultimate Loss Ratio} = \left(\frac{300{,}000 + 1{,}200{,}000 + 1{,}600{,}000}{6{,}000{,}000}\right) = .5167 = 51.67\%$$ **Answer C**

Solutions to 2007 Exam Questions (modified):

Question 46

a. (0.5 point) Use the BF approach to estimate the ultimate loss for the 2004 policy as of 12/31/2006.
b. (0.5 point) Explain how much credibility the BF formula assigns to the loss dev projection for this policy.
c. (0.5 point) Briefly describe a disadvantage of the Bornhuetter-Ferguson approach.
d. (0.5 point) Describe a possible improvement to the accuracy of this estimate while still using the BF approach.

Question 46 - Model Solution 1

a. BF Ult = Observed + (1 – 1/LDF)*(Prem)*(Loss Ratio) = 350,000 + (1 – 1/1.25)*(475,000)*(0.6) = 407,000
b. Solve for Z: 350k*(1.25)*Z + 475k*(0.6)*(1 – Z) = 407,000; Z = 0.8
c. It reduces the use of actual losses to the extent of the complement of credibility
d. Use the Benktander iterative approach. (See Friedland Chapter 9)

Question 46 - Model Solution 2

a. BF Ult = 350,000 + (1 – 1/1.25)*(475,000)*(0.6) = 407,000
b. It gives credibility to the extent that losses were expected to emerge up to the given age ie Z = 1 /LDF.
c. This approach is tied to an arbitrary expected loss so it isn't as responsive to deteriorating emerging losses as other methods
d. The Stanard-Buhlmann method uses the B-F method but gives a way of calculating the expected loss method on historical losses so it is less arbitrary. (See Friedland Chapter 10)

Solutions to 2008 Exam Questions
Question 10

b) First, note:

1) Development Method Est. Ultimate: Already shown in Ch 7 as $25M

2) Expected Claims Method Est. Ultimate: Already shown in Ch 8 as $14M

We can show the Bornhuetter-Ferguson estimate of Ultimate Claims in two ways:

(i) B-F Ultimate = Reported Claims + IBNR (as Premium * LR * % unreported)
= 10M + 20M * .7 * (1-40%) = 18.4M

OR

*(ii) B-F Ultimate = p * [Development Method Est] + [1-p]*[<u>Budgeted Loss Est.</u>]*
where p = percent reported
= (40%) * 25M + (1-40%) * 14M = 18.4M

c) We can show the Benktander estimate of Ultimate Claims in two ways too:

(i) Est. Ultimate = Reported Claims + IBNR (as ***<u>B-F Est. Ultimate</u>*** ** % unreported)*
= 10M + 18.4M * (1-40%) = 21.04M

…Note: since the B-F output was an input for the Bentander method, it is sometimes referred to as an "iterative Bornhuetter-Ferguson Method"
See Mack and Friedland Chapter 9 for more details.

(ii) The second way to find the Benktander estimated ultimate::

*Benktander Ultimate = p * [Development Method Ult.] + [1-p]*[***<u>B-F Est. Ultimate</u>***]*
where p = percent reported
= (40%) * 25M + (1-40%) * 18.4M = 21.04M

Alternatively, by APPLYING DIFFERENT WEIGHTS, we can also illustrate a weighting of the Development Method and the Bedgeted Loss method. Then, the weight applied to the Budgeted Loss Method is [% unreported]^2 and the rest to the Development Method (chain ladder)

*Benktander Ult. = [1-q^2] * [Dev. Method Ult.] + [q^2]*[<u>Budgeted Loss Ult.</u>]*
Note switch: Mack shows here it is easier to use q = percent <u>un</u>reported
= (1-60%^{2}) * 25M + (60%^{2}) * 14M = 21.04M

Solutions to 2009 Exam Questions

Question 10 - Model Solution

a. Use the Bornhuetter-Ferguson method to calculate the IBNR at December 31, 2008 for all accident years.

AY	(1) Exp Unit	(2)Expected Ult. Loss	(3) % unreported	(4) IBNR
2005	19,000	4,750,000	0.27	1,282,500
2006	19,750	4,937,500	0.35	1,728,125
2007	21,000	5,250,000	0.55	2,887,500
2008	21,500	5,375,000	0.80	4,300,000
Total				10,198,125

(2) = (1) × 250, where 250 is the expected loss rate for all AYs. (3) = 1 – 1/LDF_{Ult}

(4) IBNR = (2) × (3). Total IBNR = 10,198,125

b. Use the Cape Cod method to calculate the IBNR at December 31, 2008 for all accident years.

AY	(5) Used Up Exp Unit	(6) Reported Loss
2005	13,870	3,500,000
2006	12,837.5	4,000,000
2007	9,450	3,800,000
2008	4,300	2,000,000
Total	40,457.5	13,300,000

(5) = (1) * (1.0 – (4))

Expected Loss per exposure = 13,300,000 / 40,457.5 = 328.74

Total SB IBNR = Expected loss per exposure * Unused Exposure Units

= 328.74 × (19,000 × 0.27 + 19,250 × 0.35 + 21,000 × 0.55 + 21,500 × 0.8) =13,410,126

= BF_{IBNR} × 328.74/250 =13,410,126

c1. Since the calculated expected loss per exposure with the Cape Cod method is relatively different from the a prior expectation, I would prefer to use the Cape Cod method since the a prior estimate might be too low and is not responsive at all to in development pattern.

c2. Select Cape Cod method, because it seems there is deterioration in loss ratios as shown above. Cape Cod method is more responsive in this case than BF method.

Solutions to 2011 Exam Questions

a. (1 point) Use the BF technique and an expected claims ratio of 60% to estimate the IBNR for AY 2010.

b. (1.5 points) Use the Cape Cod technique to estimate the IBNR for accident year 2010.

c. (0.5 point)Describe the primary difference between the BF technique and the Cape Cod technique.

Question 27 – Model Solution

a. AY 2010 IBNR = EP * ELR *(1.0 – 1/LDF-ult) = 1,000,000 x 0.6 x (1 - 1.30^{-1}) = $\boxed{138,462}$ IBNR

b. Comments: Cape Cod ELR computation: "Used-up premium" = EP * % reported. = EP /LDF-Ult

Estimated claim ratios = Actual reported claims/ Used-up premium.

b. Cape Cod ELR = (510 + 520 + 450) / (950/1.05 + 915/1.12 + 1000/1.3) = 0.5816

AY 2010 IBNR = EP * ELR *(1.0 – 1/LDF-ult) = 0.5816 x 1,000,000 x (1 – 1.30^{-1}) = $\boxed{134,215}$ IBNR

c. The BF method uses an a priori estimate of the claims ratio. The Cape Cod method uses a claims ratio calculated from the actual experience.

Solutions to 2012 Exam Questions

18a. (0.75 point) Use the Bornheutter-Ferguson technique and an expected claims ratio of 60.0% to estimate the IBNR for accident year 2010.
18b. (2 points) Use the Cape Cod technique to calculate the IBNR for accident year 2010.
18c. (0.5 point) Describe the difference in the underlying assumption between the two techniques.

Question 18 – Model Solution 1 (Exam 5B Question 3)

a. IBNR 2010 = 975,000 * 60% (1.0 -1/1.12) = 62,679 as of 2010

b. Cape Cod. Compute the Estimated Claim Ratio (ECR)

$$ECR = \frac{\sum \text{rpt}}{\sum \text{used-up premium}} = \frac{(510,000 + 520,000 + 465,000)}{(978,500 * 1/1.05 + 1,023,750 * 1/1.12 + 1,000,000 * 1/1.3)} = 57.166\%$$

Unadj ECR for AY 2010 = 57.166% * 1,023,750/975,000 = 60%

AY 2010 IBNR = 60% * 975,000 (1.0 - 1/1.12) = 62,704

c. the difference is the expected claim ratio. In B-F expected claim ratio is usually from independent analysis or judgmentally selected. In cape cod ECR is derived from experience period.

Question 18 – Model Solution 2 (Exam 5B Question 3)

a. BF IBNR = EP x LR x (1 -%RPT) = 975,000 x 60% x (1.0 – 1/1.12) = 62,678.57

b. Cape Cod method

$$\text{ECR} = \frac{\sum \text{rpt}}{\sum \text{AdjEP} \times \%\text{Rpt}} = \frac{(510 + 520 + 465) \times 1,000}{(978.5 \times 1/1.05 + 1,023.75 \times 1/1.12 + 1,000 \times 1/1.3) \times 1000} = 0.5717$$

$$\text{ECR for AY 2010} = \frac{1,023,750}{975,000} \times 0.5717 = 0.60$$

AY 2010 IBNR= 0.60 x 975,000 x (1.0 - 1/1.12) = 62,678.57

c. For BF method the underlying assumption is future claim ratio will be the same as the prior selected ratio which is independent from loss experience. Cape cod method estimate selected loss ratio from historical loss experience and apply it to estimate reserves.

Examiner's comments

a. Candidates generally understood the problem and calculation. Half the candidates used earned premium, the other half used on level earned premium. Both answers were accepted.
b. Generally candidates did well on this part as well. Most candidates were very close to the concept of calculating a different expected claims ratio to apply in a fashion similar to the BF method. Some common mistakes included not calculating Used Up Premium in order to derive the Cape Cod ECR, not completing the ECR calculations using all years of data, selecting a simple average instead of a weighted average, or incorrectly using EP instead of OLEP.
c. Most candidates received full credit.

1 Key Assumptions 174

The key assumption: Unreported claims will develop based on *expected claims*, which are computed using reported (or paid) claims and earned premium.

This is the same assumption under the BF method.

This assumption *differs* from the primary assumption under the development method, which is unreported claims will develop based on *reported claims to date*.

2 Common Uses of the Cape Cod Technique 174

Reinsurers often use the Cape Cod technique.

The technique can used:

- with reported claims and paid claims.
- for all lines of insurance including short-tail lines and long-tail lines.

Similar to the development and BF methods, the Cape Cod method can use data organized in the following time intervals:

* Accident year
* Policy year
* Underwriting year
* Report year
* Fiscal year

This technique can be applied to monthly, quarterly, semiannual or annual data.

3 Mechanics of the Cape Cod Technique 174 - 175

Similarities to the BF technique:

It is a blend of the claim development method and the expected claims method.

The formula of the reported BF method is the same for the Cape Cod method:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

The difference between the Cape Cod and BF technique is how expected claims are computed.

- The key innovation according to Patrik in "Reinsurance" is that the SB (Stanard-Buhlmann) Method is the use of an ultimate expected loss ratio computed using an overall all years combined reported claims experience. *See Foundations of CAS, Chapter 7, "Reinsurance" for Patrik's development of the formulae underlying the Cape Cod technique (a.k.a. the SB Method).*
- In the BF method, the ultimate expected loss ratio is selected judgmentally

A problem with both the SB Method and BF method is that the IBNR by year is highly dependent upon the rate level adjusted premium by year (meaning each year's premium must be adjusted to reflect the rate level cycle on a relative basis).

Exhibit I, Sheet 1: Development of Expected Claim Ratios:

U.S. Industry Auto Exhibit I
Development of Expected Claim Ratio Sheet 1

Accident Year	Earned Premium	Age of Accident at 12/31/07	Reported Year Claims at 12/31/2007	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
1998	68,574,209	120	47,742,304	1.000	100.0%	68,574,209	69.6%
1999	68,544,981	108	51,185,767	1.000	100.0%	68,544,981	74.7%
2000	68,907,977	96	54,837,929	1.001	99.9%	68,839,138	79.7%
2001	72,544,955	84	56,299,562	1.003	99.7%	72,327,971	77.8%
2002	79,228,887	72	58,592,712	1.006	99.4%	78,756,349	74.4%
2003	86,643,542	60	57,565,344	1.011	98.9%	85,700,833	67.2%
2004	91,763,523	48	56,976,657	1.023	97.8%	89,700,413	63.5%
2005	94,115,312	36	56,786,410	1.051	95.1%	89,548,346	63.4%
2006	95,272,279	24	54,641,339	1.110	90.1%	85,830,882	63.7%
2007	95,176,240	12	48,853,563	1.292	77.4%	73,665,820	66.3%
Total	820,771,905		543,481,587			781,488,943	69.5%

Column and Line Notes:
(2) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(3) Age of accident year in (1) at December 31, 2007.
(4) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(5) Developed in Chapter 7, Exhibit I, Sheet 1.
(6) = [1.00 / (5)].
(7) = [(2) x (6)].
(8) = [(4) / (7)]

Column (2) shows unadjusted earned premiums by year. Reinsurers often use ultimate premiums in instead.

Column (4) reported claims are the latest diagonal from the development triangle in Chapter 7, used to derive the CDFs in Column (5)

Column (6) is the reporting pattern, where the % reported equals 1/CDF

Column (7), the "used-up premium" equals Column (2) EP * Column (6) % reported.

Column (8) estimated claim ratios, by AY, equal Column (4) actual reported claims/Column (7) used-up premium.

Notes: An alternative to the use of premium and claim ratios.

Use exposures and pure premiums instead of calculating used-up premium.

Calculate used-up exposures and calculate estimated pure premiums instead of estimated claim ratios for each year in the experience period.

The used-up premium is the denominator in determining expected claim ratio.

This premium allocation represents the premium corresponding to claims expected to be reported through the valuation date.

The U.S. Industry Auto example:

- There is a change in the claim ratios for the latest AYs compared with the earliest years (i.e. 1998 through 2002).

  The average estimated claim ratio for AYs 1998 - 2002 is 75.2% and the claim ratios vary from a low of 69.6% to a high of 79.7%.

  The average estimated claim ratio for AYs 2003 – 2007 is 64.8%
- In the expected claims technique and the BF technique, we rely on different claim ratios for the earlier years and the latest years in the experience period to best reflect our expectation of expected claims for each year.
- In contrast, the Cape Cod method uses a weighted average claim ratio from all years.

Thus, a mechanical approach of developing expected claims is used in the Cape Cod method while actuarial judgment is used the BF method to determine an a priori expected claim estimate.

4 Unpaid Claim Estimate Based on Cape Cod Technique 176

We follow a similar procedure for determining the unpaid claim estimate based on the Cape Cod technique as presented in the prior chapters. Estimated IBNR is equal to projected ultimate claims less reported claims and the total unpaid claim estimate is equal to the difference between projected ultimate claims and paid claims.

Exhibit 1, Sheet 2: Projection of Ultimate Claims using Reported Claims

U.S. Industry Auto
Projection of Ultimate Claims Using Reported Claims ($000)

Exhibit I
Sheet 2

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/2007	Promected Ultimate Claims
(1)	(2)	(3)	(4)	(4) = [(2) x (3)]	(6)=1.0- (1.0/(5))	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]
1998	68,574,209	69.5%	47,689,504	1.000	0.0%	0	47,742,304	47,742,304
1999	68,544,981	69.5%	47,669,177	1.000	0.0%	0	51,185,767	51,185,767
2000	68,907,977	69.5%	47,921,621	1.001	0.1%	47,874	54,837,929	54,885,803
2001	72,544,955	69.5%	50,450,934	1.003	0.3%	150,900	56,299,562	56,450,462
2002	79,228,887	69.5%	55,099,233	1.006	0.6%	328,624	58,592,712	58,921,336
2003	86,643,542	69.5%	60,255,708	1.011	1.1%	655,601	57,565,344	58,220,945
2004	91,763,523	69.5%	63,816,367	1.023	2.2%	1,434,777	56,976,657	58,411,434
2005	94,115,312	69.5%	65,451,904	1.051	4.9%	3,176,068	56,786,410	59,962,478
2006	95,272,279	69.5%	66,256,509	1.110	9.9%	6,565,960	54,641,339	61,207,299
2007	95,176,240	69.5%	66,189,720	1.292	22.6%	14,959,286	48,853,563	63,812,849
Total	820,771,905		570,800,677			27,319,090	543,481,587	570,800,677

Column Notes:
(2) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(3) Based on total weighted estimated claim ratios developed in Exhibit I, Sheet 1.
(5) Developed in Chapter 7, Exhibit I, Sheet 1.
(8) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.

Exhibit 1, Sheet 3: Calculations associated with the Development of Unpaid Claim Estimate

Columns (2) and (3) contain reported and paid claims data as of 12/31/2007.

Column (4) projected ultimate claims are from Exhibit I, Sheet 2 = expected unreported + reported claims.

Column (5) case outstanding = Columns (2) – Column (3)

Column (6) Estimated IBNR = Projected ultimate claims - Reported claims.

Column (7) total unpaid claim estimate = Case outstanding + Estimated IBNR.

5 When the Cape Cod Technique Works and When it Does Not 176

Note: Similar comments apply to the Cape Cod method as to the BF technique.

An advantage of the Cape Cod method (over the development technique) is that it may not be distorted by random fluctuations early in the development of an AY.

A shortcoming of the Cape Cod method (compare with the BF technique): It is not necessarily as appropriate as the BF method if the data is extremely thin or volatile or both.

Since expected claims are based on reported claims to date, there must be a sufficient volume of credible reported claims to derive a reliable expected claims estimate.

Data adjustments applicable to the Cape Cod and BF methods:

EP adjustments (from a theoretical perspective): Include using historical rate level changes to adjust historical premiums to an on-level basis.

Claims would also be adjusted for trend, benefit-level changes, and other similar factors.

From a practical perspective, such data is often unavailable, and one may continue to use both the BF and Cape Cod methods to develop the unpaid claim estimate without the adjustment of premiums or claims.

When evaluating the results of various techniques and selecting final ultimate claims values, take into account any simplifying assumptions (e.g. not adjusting premium for rate level changes) made.

6 XYZ Insurer 176 - 177

Weaknesses in Cape Cod method are due to the uncertainty in the selected development patterns for reported claims.

- Due to the changes the insurer has faced, uncertainty lies in the applicability of historical claim development patterns.
- Since the Cape Cod method uses these patterns to calculate used-up premium (a critical component in computing the expected claim ratio), this method may not be appropriate
- Similar to the BF method, reported CDFs are limited to a minimum of 1.00 for the Cape Cod method.

Exhibit II, Sheet 1:

XYZ Insurer - Auto BI
Development of Expected Claim Ratio

Exhibit II
Sheet 1

Accident Year	Earned Premium	On-Level Adjustment	On-Level Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Pure Premium Trend	Tort Reform Factors	Adjusted Claims at 12/31/08	Reported CDF to Ultimate	% of Ultimate Reported	Used Up On-Level Premium	Claim Ratios Estimated Adjusted	Claim Ratios Selected Adjusted	Claim Ratios Estimated Unadjusted
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=[1.00 /(10)]	(12) = [(4) x (11)]	(13) = [(9) / (12)]]	(14)=[ToT in(13)]	(15)
1998	20,000	0.989	19,780	132	15,822	1.400	0.670	14,845	1.000	100.0%	19,780	75.1%	70.8%	74.6%
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	62,438	0.800	49,950	24	31,732	1.034	1.000	32,819	1.512	66.1%	33,036	99.3%	70.8%	54.7%
2008	47,797	1.000	47,797	12	18,632	1.000	1.000	18,632	2.551	39.2%	18,737	99.4%	70.8%	70.8%
Total	732,144		600,140		449,626			374,740			529,484	70.8%		

Column and Line Notes:
(2) Based on data from insurer.
(3) For 2002 and after, based on Chapter 8, Exhibit III , Sheet 2. For 1998-2001, assume a 2% rate change per annum.
(4) = [(2) x (3)].
(5) Age of accident year in (1) at December 31, 2008.
(6) Based on data from insurer.
(7) Assume an annual pure premium trend rate of 3.425%.
(8) Based on independent analysis of tort reform.
(9) = [(6) x (7) x (8)].
(10) Developed in Chapter 7, Exhibit II, Sheet 1, in which the CDF are limited to a minimum of 1.00.
(15) = [(14) x (3) / (7) / (8)].

1. Compute Column (4) On-Level EP using EP and Column (3) rate level adjustment factors from Exhibit III, Sheet 2 from Chapter 8 for AYs 2002 and after. Assume a 2% rate change for prior years.
2. Compute Column (9) Adjusted Claims by multiplying reported claims by Column (7) pure premium trend and Column (8) tort reform factors.
3. Compute Column (12) Used Up OLEP by multiplying OLEP by % of ultimate reported claims (based on the Column (10) reported CDFs
4. Compute Column (13) "Estimated Adjusted Claim Ratios" by dividing adjusted claims by Used Up OLEP.

   "Estimated Adjusted Claim Ratios" indicates that the reported claims are adjusted for inflation and tort reform.
5. Compute Column (14) "Selected Adjusted Claim Ratios" by using the all years computed claim ratio from Column (13)
6. Compute Column (15) "Estimated Unadjusted Claim Ratios", which are adjusted back to the rate level, inflationary level, and tort environment for each AY. These become our starting point for projecting expected claims in Exhibit II, Sheet 2. The computation is [Column (14)*Column(3)/ Column (7)/Column(8)]

Exhibit II Sheet 2: Projection of Ultimate Claims Using Reported Claims ($000)

XYZ Insurer - Auto BI
Projection of Ultimate Claims Using Reported Claims ($000)

Exhibit II
Sheet 2

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate Unreported	Percentage Unreported	Expected Unreported Claims	Reported Claims 12/3/2008	Projected Ultimate Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	20,000	74.6%	14,920	1.000	0.0%	0	15,822	15,822
:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	62,438	54.7%	34,181	1.512	33.9%	11,575	31,732	43,307
2008	47,797	70.8%	33,828	2.551	60.8%	20,567	18,632	39,199
Total	732,144		510,046			54,672	449,626	504,298

Column Notes:
(2) Based on data from XYZ Insurer.
(3) Selected based on estimated claim ratios developed in Exhibit II, Sheet 1.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit II, Sheet 1, limited to a minimum of 1.00.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) Based on data from insurer.
(9) = [(7) + (8)]

Exhibit II Sheet 3: Development of Unpaid Claim Estimate ($000)

XYZ Insurer - Auto BI Exhibit II
Development of Unpaid Claim Estimate ($000) Sheet 3

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Cape Cod Method IBNR	Unpaid Claim Estimate Based on Cape Cod Method Total
(1)	(2)	(3)	(4)	(5) = [(2) - (3)]	(6) = [(4) - (2)]	(7) = [(4) - (3)]
1998	15,822	15,822	15,822	0	0	0
:::	:::	:::	:::	:::	:::	:::
2007	31,732	11,865	43,307	19,867	11,575	31,442
2008	18,632	3,409	39,199	15,223	20,567	35,790
Total	449,626	330,627	504,298	118,999	54,672	173,671

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit II, Sheet 2.
(5) = [(2) - (3)]
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Exhibit II, Sheet 4 (projected ultimate claims) compares the results of the Cape Cod method with the BF method, the expected claims method, and the claim development method.

XYZ Insurer - Auto BI Exhibit II
Summary of Ultimate Claims ($000) Sheet 4

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims: Development Method Reported	Development Method Paid	Expected Claims	B-F Method Reported	B-F Method Paid	Cape Cod
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822
:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,199
Total	449,626	330,627	514,929	605,028	561,516	513,207	554,469	504,298

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Exhibit II, Sheet 2.

Exhibit II, Sheet 5 (Estimated IBNR) compares the results of the Cape Cod method with the BF method, the expected claims method, and the claim development method.

XYZ Insurer - Auto BI Exhibit II
Summary of IBNR ($000) Sheet 5

Accident Year	Case Outstanding at 12/31/08	Estimated IBNR: Development Method Reported	Development Method Paid	Expected Claims	B-F Method Reported	B-F Method Paid	Cape Cod
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	0	0	158	-162	0	155	0
:::	:::	:::	:::	:::	:::	:::	:::
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,567
Total	118,997	65,303	155,402	111,890	63,581	104,843	54,672

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Exhibit II, Sheet 3.

7 Influence of a Changing Environment on the Cape Cod Method 177 - 179

We continue from prior chapters in with these examples using the Cape Cod method.

Scenario 1 — U.S. PP Auto Steady-State

Exhibit III, Sheets 1 and 3 top sections

Exhibit III, Sheet 1: Scenarios 1 and 2 - Development of Expected Claim Ratio

Exhibit III, Sheet 3: U.S. PP Auto - Development of Unpaid Claim Estimate

Impact of Changing Conditions
Scenarios 1 and 2 - Development of Expected Claim Ratio

Exhibit III
Sheet 1

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims 12/31/2008	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
Steady-State							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
:::	:::	:::	:::	:::	:::	:::	:::
2007	1,477,455	24	930,797	1.111	90.0%	1,329,709	70.0%
2008	1,551,328	12	836,166	1.299	77.0%	1,194,523	70.0%
Total	12,577,893		8,365,888			11,951,266	70.0%

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(5) Developed in Chapter 7, Exhibit III, Sheets 2 and 4.

Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit III
Sheet 3

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claim	Reported Claim at 12/31/2008	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4) = [(2) x (3)]	(5)	(6)	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]	(10) = [(9)-(8)]	(11)	(12)= [(11) - (10)]
Steady-State											
1999	1,000,000	70.0%	700,000	1.000	0.0%	0	700,000	700,000	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	1,477,455	70.0%	1,034,219	1.111	10.0%	103,422	930,797	1,034,219	103,422	103,422	-1
2008	1,551,328	70.0%	1,085,930	1.299	23.0%	249,764	836,166	1,085,930	249,764	249,764	0
Total	12,577,893		8,804,527			438,639	8,365,888	8,804,527	438,639	438,637	-2

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Selected based on estimated overall claim ratio developed in Exhibit III, Sheet 1.
(5) Developed in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [1.00 - (1.00 / (5))].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(11) Developed in Chapter 7, Exhibit III, Sheet I.
(12)= [(11) - (10)].

In Chapters 7 – 9, the development technique, expected claims technique, and BF techniques all generate an accurate IBNR value in a steady-state environment. This is also the case for the Cape Cod Method.

Scenario 2 — U.S. PP Auto Increasing Claim Ratios

Exhibit III, Sheets 1 and 3 bottom sections

Advantage of the Cape Cod Method:

Column (8) estimated claim ratios responds to the changing environment in claims experience, since the expected claim ratio based on reported claims through the valuation date. The total all years combined estimated claim ratio is 80.7%

Impact of Changing Conditions Exhibit III
Scenarios 1 and 2 - Development of Expected Claim Ratio Sheet 1

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims 12/31/2008	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
Increasing Claim Ratios							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
:::	:::	:::	:::	:::	:::	:::	:::
2005	1,340,096	48	1,116,300	1.020	98.0%	1,313,294	85.0%
2006	1,407,100	36	1,203,071	1.053	95.0%	1,336,745	90.0%
2007	1,477,455	24	1,263,224	1.111	90.0%	1,329,710	95.0%
2008	1,551,328	12	1,194,523	1.299	77.0%	1,194,523	100.0%
Total	12,577,893		9,647,367			11,951,266	80.7%

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(5) Developed in Chapter 7, Exhibit III, Sheets 2 and 4.

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 3

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claim	Reported Claim at 12/31/2008	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4) = [(2) x (3)]	(5)	(6)	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]	(10) = [(9)-(8)]	(11)	(12)= [(11) - (10)]
Increasing Claim Ratios											
1999	1,000,000	80.7%	807,225	1.000	0.0%	0	700,000	700,000	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2005	1,340,096	80.7%	1,081,759	1.020	2.0%	21,635	1,116,300	1,137,935	21,635	22,782	1,146
2006	1,407,100	80.7%	1,135,847	1.053	5.0%	56,792	1,203,071	1,259,863	56,792	63,319	6,527
2007	1,477,455	80.7%	1,192,640	1.111	10.0%	119,264	1,263,224	1,382,488	119,264	140,358	21,094
2008	1,551,328	80.7%	1,252,272	1.299	23.0%	288,022	1,194,523	1,482,545	288,022	356,805	68,783
Total	12,577,893		10,153,196			505,829	9,647,367	10,153,196	505,829	601,982	96,154

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Selected based on estimated overall claim ratio developed in Exhibit Ill, Sheet 1.
(5) Developed in Chapter 7, Exhibit Ill, Sheets 2 and 4.
(6) = [1.00 - (1.00 / (5))].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(11) Developed in Chapter 7, Exhibit III, Sheet I.

Shortcoming of the Expected Claims Method and the BF Method:

The shortcoming is the lack of responsiveness to actual emerging claims.

Estimated IBNR (BF vs. Cape Cod Method)

- In the BF reported claim projection, there is no change in the estimated IBNR of $438,638 between Scenario 1 and Scenario 2 since the expected claim ratio does not change.
- Using the Cape Cod method, the estimated IBNR is $505,828 for Scenario 2.

  While this value is smaller than the actual IBNR required of $601,984, the Cape Cod technique is more responsive than the BF method when the claim ratios are increasing.

Scenario 3 — U.S. PP Auto Increasing Case Outstanding Strength

Exhibit III, Sheets 2 and 4 top section

Exhibit III, Sheet 2 – Scenario 3 - Development of Expected Claim Ratio

Exhibit III, Sheet 4 – Scenario 3 - Development of Unpaid Claim Estimate

Impact of Changing Conditions Exhibit III
Scenarios 3 and 4 - Development of Expected Claim Ratio Sheet 2

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/2008	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
Increasing Case Outstanding Strength							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
:::	:::	:::	:::	:::	:::	:::	:::
2005	1,340,096	48	933,377	1.020	98.1%	1,314,355	71.0%
2006	1,407,100	36	962,808	1.055	94.8%	1,334,351	72.2%
2007	1,477,455	24	979,922	1.119	89.4%	1,320,694	74.2%
2008	1,551,328	12	931,185	1.318	75.9%	1,176,757	79.1%
Total	12,577,893		8,551,189			11,923,151	71.7%

Column Notes:

(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.

(3) Age of accident year at December 31, 2008.

(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 6 and 8.

(5) Developed in Chapter 7, Exhibit III, Sheets 6 and 8.

Impact of Changing Conditions Exhibit III
U.S. PP Auto - Development of Unpaid Claim Estimate Sheet 4

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/2008	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4) = [(2) x (3)]	(5)	(6)	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]	(10) = [(9)-(8)]	(11)	(12)= [(11) - (10)]
Increasing Case Outstanding Strength											
1999	1,000,000	71.7%	717,192	1.000	0.0%	0	700,000	700,000	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2005	1,340,096	71.7%	961,106	1.020	1.9%	18,461	933,377	951,838	18,461	4,690	-13,771
2006	1,407,100	71.7%	1,009,161	1.055	5.2%	52,176	962,808	1,014,984	52,176	22,162	-30,014
2007	1,477,455	71.7%	1,059,619	1.119	10.6%	112,428	979,922	1,092,350	112,428	54,296	-58,132
2008	1,551,328	71.7%	1,112,600	1.318	24.1%	268,640	931,185	1,199,825	268,640	154,745	-113,895
Total	12,577,893		9,020,765			469,576	8,551,189	9,020,765	469,576	253,335	-216,240

Column Notes:

(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.

(3) Selected based on estimated overall claim ratio developed in Exhibit III, Sheet 2.

(4) = [(2) x (3)].

(5) Developed in Chapter 7, Exhibit III, Sheets 6 and 8.

(6) = [1.00 - (1.00 / (5))].

(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 6 and 8.

(11) Developed in Chapter 7, Exhibit III, Sheet 1.

Observations:

The Cape Cod method results in an estimated IBNR that ***overstates*** the actual IBNR by an even greater amount than the reported BF technique.

- Expected claims for the BF method remain unchanged, the expected claims increase using the Cape Cod method because the method reflects the higher level of reported claims.
- Projected ultimate claims are increasing for the Cape Cod method under Scenario 3 due to both increasing expected claims and higher CDFs.

Scenario 4 — U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

Exhibit III, Sheets 2 and 4 bottom section

Impact of Changing Conditions
Scenarios 3 and 4 - Development of Expected Claim Ratio

Exhibit III
Sheet 2

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/2008	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
Increasing Claim Ratios and Case Outstanding Strength							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
:::	:::	:::	:::	:::	:::	:::	:::
2007	1,477,455	24	1,329,895	1.120	89.3%	1,319,695	100.8%
2008	1,551,328	12	1,330,264	1.320	75.7%	1,174,877	113.2%
Total	12,577,893		9,901,691			11,920,130	83.1%

Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit III
Sheet 4

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/2008	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4) = [(2) x (3)]	(5)	(6)	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]	(10) = [(9)-(8)]	(11)	(12)= [(11) - (10)]
Increasing Claim Ratios and Case Outstanding Strength						0					
1999	1,000,000	83.1%	830,670	1.000	0.0%	0	700,000	700,000	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	1,477,455	83.1%	1,227,278	1.120	10.7%	131,047	1,329,895	1,460,942	131,047	73,687	-57,360
2008	1,551,328	83.1%	1,288,641	1.320	24.3%	312,707	1,330,264	1,642,971	312,707	221,064	-91,643
Total	12,577,893		10,448,075			546,384	9,901,691	10,448,075	546,384	347,658	-198,726

Cape Cod method Observations:

- the method ***can*** overstate the actual IBNR (e.g. the method responds effectively to the change in claim ratios, but it overreacts to the change in case outstanding adequacy).
- the method significantly overstates the actual IBNR needed (i.e. indicating that the effect of increasing case outstanding strength exceeds the influence of increasing claim ratios).
- The estimated claim ratios are higher than their true values by the combined effects of Scenario 4.

U.S. Auto Steady-State (No Change in Product Mix)

Exhibit IV, Sheets 1 and 2 top section:

Similar to our projections using the development and expected claims techniques, the Cape Cod technique generates the correct IBNR requirement when there is no change in the product mix.

U.S. Auto Changing Product Mix

Exhibit IV, Sheets 1 and 2 bottom section:

Impact of Change in Product Mix Example Exhibit IV
Scenarios 5 and 6 - Development of Expected Claim Ratio Sheet 1

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/2008	Reported CDF to Ultimate	% Ultimate Reported	Used Up Premium	Extimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
Changing Product Mix							
1999	2,000,000	120	1,500,000	1.000	100.0%	2,000,000	75.0%
:::	:::	:::	:::	:::	:::	:::	:::
2005	2,999,262	48	2,193,545	1.032	96.9%	2,907,284	75.4%
2006	3,564,016	36	2,471,446	1.090	91.7%	3,269,911	75.6%
2007	4,281,446	24	2,680,487	1.200	83.3%	3,566,552	75.2%
2008	5,196,516	12	2,556,695	1.503	66.5%	3,457,489	73.9%
Total	29,645,066		20,067,180			26,754,578	75.0%

Column and Line Notes:
(2) For no change scenario, assume $2,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit IV, Sheets 2 and 4.
(5) Developed in Chapter 7, Exhibit IV, Sheets 2 and 4.

Impact of Change in Product Mix Example Exhibit IV
Scenarios 5 and 6 - Development of Unpaid Claim Ratio Sheet 2

Accident Year	Earned Premium	Expected Claim Ratio	Extimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/2008	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4) = [(2) x (3)]	(5)	(6)	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]	(10) = [(9)-(8)]	(11)	(12)= [(11) - (10)]
Changing Product Mix											
1999	2,000,000	75.0%	1,500,093	1.000	0.0%	0	1,500,000	1,500,000	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2005	2,999,262	75.0%	2,249,586	1.032	3.1%	68,988	2,193,545	2,262,533	68,988	71,855	2,867
2006	3,564,016	75.0%	2,673,178	1.090	8.3%	220,593	2,471,446	2,692,039	220,593	239,057	18,464
2007	4,281,446	75.0%	3,211,284	1.200	16.7%	536,204	2,680,487	3,216,691	536,204	596,924	60,720
2008	5,196,516	75.0%	3,897,629	1.503	33.5%	1,304,351	2,556,695	3,861,046	1,304,351	1,445,385	141,034
Total	29,645,066		22,235,181			2,168,001	20,067,180	22,235,181	2,168,001	2,391,083	223,083

Column Notes:
(2) For no change scenario, assume $2,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3) Selected based on estimated overall claim ratios developed in Exhibit IV, Sheet I.
(5) Developed in Chapter 7, Exhibit IV, Sheets 2 and 4.
(6) = [1.00 - (1.00 / (5))].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit IV, Sheets 2 and 4.
(11) Developed in Chapter 7, Exhibit IV, Sheet I.

The Cape Cod method produces estimated IBNR that is lower than the actual IBNR.
Although reported claims are increasing, there are also changes in the reporting pattern.
Thus, the Cape Cod method does not respond correctly to the changing product mix.

Sample Questions:

1. The Cape Cod method is very similar to the Bornhuetter-Ferguson (B-F) method. What is the difference Friedland cites between the Cape Cod and the B-F methods?

2. What weakness is shared by both the Expected Claims Method and the Bornhuetter-Ferguson Method, but not the Cape Cod technique?

3. State the primary assumption underlying the Development technique that Friedland notes is not true for the Cape Cod method or the B-F method.

4. Summarize Friedland's key points re: "When the Cape Cod Technique Works and When it Does Not." Include comments on data adjustments that might be made using this method and the B-F method.

5. What other name does Patrik use to describe the method Friedland calls the Cape Cod technique?
Note: Patrik is now on the exam 7 syllabus.

6. Based on the following data as of 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2,000	2003	940	1,620	1,700	1,750	1,750	1,750
2,200	2004	1,200	1,690	1,710	1,800	1,800	
2,500	2005	1,250	1,725	1,800	1,950		
2,650	2006	1,400	1,550	1,900			
3,000	2007	1,500	1,900				
3,150	2008	2,250					

Estimate the IBNR as of 12/31/08 using the following method: Cape Cod Technique
To select claim development factors, use the volume-weighted averages for the latest three years.
See also Friedland Chapter 7, 8 and 9 for other methods.

1997 Exam Questions (modified):

11. Calculate the Cape Cod technique IBNR estimate at 12-31-96, given the following data:

Accident Year	Premium Actual	Premium Adjusted	Reported Claims at 12-31-96	Reported Ult CDF
1993	200	200	150	1.33
1994	200	250	200	1.49
1995	250	300	100	2.50
1996	250	350	50	10.00
Total	900	1,100	500	

2000 Exam Questions (modified):

68. (2 points) You are given the following information as of 12/31/99:

Accident Year	Premium Adjusted	Case Outstanding at 12-31-99	Paid Claims at 12-31-99	Reported Percent
1996	200,000	27,000	120,000	90%
1997	300,000	90,000	80,000	75%
1998	350,000	135,000	45,000	50%
1999	425,000	140,000	20,000	35%
Total	1,275,000	392,000	265,000	

Use the Cape Cod method to calculate the IBNR as of 12/31/99.

2004 Exam Questions (modified):

49. (2 points) You are given the following information:

Accident Year (AY)	Premium		Reported Claims at 12-31-03	Reported Ult CDF
	Actual	Adjusted		
1998	4,500	6,200	3,200	1.00
1999	5,000	6,500	3,400	1.05
2000	5,500	7,500	3,500	1.18
2001	6,000	7,800	2,800	1.43
2002	6,500	7,800	2,100	2.00
2003	7,000	7,000	1,600	4.00
Total	34,500	42,800	16,600	

Calculate the Cape Cod estimates of IBNR and Ultimate Losses, for AY 2002 only.

2005 Exam Questions (modified):

38. (1.5 points) You are given the following information:

Accident Year	Premium		Reported Claims at 12-31-04	Reported CDF (ultimate)
	Actual	Adjusted		
2001	6,000	8,000	5,000	1.143
2002	7,500	8,000	4,000	1.333
2003	9,000	10,000	4,000	2.000
2004	10,000	10,000	2,000	3.333
Total	32,500	36,000	15,000	

Calculate the a priori “expected claim ratio” to be used in the Cape Cod technique.

2008 Exam Questions (modified):

36. (1.5 points)

Given the following as of December 31, 2001:

Calendar Accident Year	Earned Premium	Adjusted Premium	Aggregate Reported Loss	Aggregate Loss Report Lag
2003	10,000	9,000	8,000	0.95
2004	11,000	9,000	8,000	0.88
2005	13,000	11,000	7,000	0.75
2006	15,000	13,000	6,000	0.55
2007	17,000	15,000	4,000	0.30

Calculate the IBNR as of December 31, 2007 using the Stanard-Buhlmann method.
(Note Friedland terminology: using the Cape Cod Method. See also Patrik.)

2010 Exam Questions

18. (2 points) Given the following data for a reinsurer as of December 31, 2009:

Calendar/ Accident Year	Earned Premium	Adjusted Premium	Aggregate Reported Loss	Age-to-Ultimate LDF
2005	$10,000	$12,000	$9,000	1.03
2006	11,000	12,000	9,000	1.11
2007	13,000	13,000	7,000	1.25
2008	15,000	14,000	10,000	1.47
2009	17,000	15,000	6,000	2.00

a. (1 point) Use the Stanard-Buhlmann method to calculate the IBNR for accident year 2008 as of December 31, 2009.

b. (1 point) Discuss two problems that may affect the accuracy of a reinsurer's earned premium data.

2011 Exam Questions

27. (3 points) Given the following information as of December 31, 2010:

Accident Year	Earned Premium	Claims Reported	Selected CDF to Ultimate
2008	$950,000	$510,000	1.050
2009	$975,000	$520,000	1.120
2010	$1,000,000	$450,000	1.300

a. (1 point) Use the Bornhuetter-Ferguson technique and an expected claims ratio of 60% to estimate the IBNR for accident year 2010.

b. (1.5 points) Use the Cape Cod technique to estimate the IBNR for accident year 2010.

c. (0.5 point)Describe the primary difference between the Bornhuetter-Ferguson technique and the Cape Cod technique.

2012 Exam Questions

18. (3.25 points) Given the following information evaluated as of December 31, 2011:

Accident Year	Earned Premium	On-Level Earned Premium	Claims Reported	Reported CDF to Ultimate
2009	$950,000	$978,500	$510,000	1.05
2010	$975,000	$1,023,750	$520,000	1.12
2011	$1,000,000	$1,000,000	$465,000	1.30

a. (0.75 point) Use the Bornheufter-Ferguson technique and an expected claims ratio of 60.0% to estimate the IBNR for accident year 2010.
b. (2 points) Use the Cape Cod technique to calculate the IBNR for accident year 2010.
c. (0.5 point) Describe the difference in the underlying assumption between the two techniques.

Solutions to Sample Questions:

1. The Cape Cod method is very similar to the Bornhuetter-Ferguson method. What is the difference Friedland cites between the Cape Cod and the B-F methods?

   While the a-priori expected claim ratio for B-F can be selected judgmentally (allowing it to take on a wide range of possible values), the a-priori expected claim ratio for Cape Cod is calculated in a specified way.

   In particular, Cape Cod relies on the claims experience to date and requires the calculation of "used-up" premium. See examples below.

2. What weakness is shared by both the Expected Claims Method and the Bornhuetter-Ferguson Method, but not the Cape Cod technique?

   The "lack of responsiveness to actual emerging claims" does not apply to Cape Cod, since the a-priori expected claim ratio is derived using reported claims (with some adjustments where applicable)

3. State the primary assumption underlying the Development technique that Friedland notes is not true for the Cape Cod method or the B-F method.

   Development Method assumes that IBNR will develop based on reported (not expected) claims to date –

   The B-F and Cape Cod methods both use the idea of an "a priori" expected claim estimate.

4. Summarize Friedland's key points re: "When the Cape Cod Technique Works and When it Does Not."

   Compared to the Development technique, Cape Cod estimates may not suffer the same distortion in the early development stages of an accident year.

   Comments on data adjustments:

   Friedland notes that, ideally, it would be best to make adjustments to actual data, for BOTH the Bornhuetter-Ferguson AND Cape Cod techniques. These adjustments include bringing premium on-level (for rate changes) as well as adjusting claims for trends and benefit-level changes.

5. What other name does Patrik use to describe the method Friedland calls the Cape Cod technique?

   Stanard-Buhlmann

Note: Patrik is now on the exam 7 syllabus.

6. Estimate the IBNR as of 12/31/08 using the following method: Cape Cod Technique
   To select claim development factors, use the volume-weighted averages for the latest three years.

Selected CDF calculations	***1st to 2nd Report***	***2nd to 3rd Report***	***3rd to 4th Report***	***4th to 5th Report***	***5th to 6th Report***
ATA: 3-yr Volume-weighted average	*1.2470*	*1.0896*	*1.0557*	*1.0000*	*1.0000*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.4344*	*1.1503*	*1.0557*	*1.0000*	*1.0000*

Accident Year	***Adjusted Premium if avail.*****	***Reported CDF to Ultimate***	***Percent Reported to date***	***Used-Up Premium to date***	***Reported Claims as avail.*****	"CC" Estimated Claim Ratio
	(1) given	*(2) above*	*(3)=1.0/(2)*	*(4)=(1)*(3)*	*(5) given*	*(6)=(5)/(4)*
2003	*2,000*	*1.0000*	*100.0000%*	*2,000*	*1,750*	*see total*
2004	*2,200*	*1.0000*	*100.0000%*	*2,200*	*1,800*	*see total*
2005	*2,500*	*1.0000*	*100.0000%*	*2,500*	*1,950*	*see total*
2006	*2,650*	*1.0557*	*94.7239%*	*2,510.1834*	*1,900*	*see total*
2007	*3,000*	*1.1503*	*86.9338%*	*2,608.0140*	*1,900*	*see total*
2008	*3,150*	*1.4344*	*69.7156%*	*2,196.0414*	*2,250*	*see total*
Total	*15,500*			*14,014.2388*	*11,550*	**82.4162%**

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*
(4) Used-Up premium also equals (1)/(2): Adjusted Premium divided by Ult. CDF
(6) " … method requires the use of the weighted average claim ratio from all years.'

Accident Year	***"CC" Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using C.C. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(6) total	*(7)=(1)*(6)*	*(8)=(7)*[1-(3)]*		*(8)=(Prem)*(CC %)*[1.0-1.0/CDF]*
2003	*82.4162%*	*1,648.3240*	*0.0000*		*0*
2004	*82.4162%*	*1,813.1564*	*0.0000*		*0*
2005	*82.4162%*	*2,060.4050*	*0.0000*		*0*
2006	*82.4162%*	*2,184.0293*	*115.2316*		*115.232*
2007	*82.4162%*	*2,472.4860*	*323.0600*		*323.059*
2008	*82.4162%*	*2,596.1103*	*786.2164*		*786.217*
Total			*1,224.5080*		*1,224.508*

Note: See Ch. 9 Q&A. If B-F claim ratio = "CC" claim ratio, results would be identical.

Solutions to 1997 Exam Questions (modified):

11. Calculate the Cape Cod technique IBNR estimate at 12-31-96, given the following data:

Accident Year	Premium Actual	Premium Adjusted	Reported Claims at 12-31-96	Reported Ult CDF
1993	200	200	150	1.33
1994	200	250	200	1.49
1995	250	300	100	2.50
1996	250	350	50	10.00
Total	900	1,100	500	

Accident Year	*Adjusted Premium if avail.***	*Reported CDF to Ultimate*	*Percent Reported to date*	*Used-Up Premium to date*	*Reported Claims as avail.***	"CC" Estimated Claim Ratio
	(1) given	*(2) given*	*(3)=1.0/(2)*	*(4)=(1)*(3)*	*(5) given*	*(6)=(5)/(4)*
1993	*200*	*1.3333*	*75.0019%*	*150.0038*	*150*	*see total*
1994	*250*	*1.4925*	*67.0017%*	*167.5043*	*200*	*see total*
1995	*300*	*2.5000*	*40.0000%*	*120.0000*	*100*	*see total*
1996	*350*	*10.0000*	*10.0000%*	*35.0000*	*50*	*see total*
Total	***1100***			*472.5081*	***500***	**105.8183%**

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*
(4) Used-Up premium also equals (1)/(2): Adjusted Premium divided by Ult. CDF
(6) " … method requires the use of the weighted average claim ratio from all years.'

Accident Year	*"CC" Claim Ratio*	*A priori Expected Claims*	*"IBNR" Expected Unreport*	*Or shortcut using C.C. Expected Claims x Percent Unreported*	*IBNR (broadly defined)*
	(6) total	*(7)=(1)*(6)*	*(8)=(7)*[1-(3)]*	*(8)=(Prem)*(CC %)*[1.0-1.0/CDF]*	
1993	*105.8183%*	*211.6366*	*52.9051*		*52.9052*
1994	*105.8183%*	*264.5458*	*87.2956*		*87.2957*
1995	*105.8183%*	*317.4549*	*190.4729*		*190.4729*
1996	*105.8183%*	*370.3641*	*333.3277*		*333.3276*
Total			***664.0013***		***664.0014***

Note: Patrik is now on the exam 7 syllabus.

Solutions to 2000 Exam Questions (modified):

68. (2 points) You are given the following information as of 12/31/99:

Accident Year	Premium Adjusted	Case Outstanding at 12-31-99	Paid Claims at 12-31-99	Reported Percent
1996	200,000	27,000	120,000	90%
1997	300,000	90,000	80,000	75%
1998	350,000	135,000	45,000	50%
1999	425,000	140,000	20,000	35%
Total	1,275,000	392,000	265,000	

Use the Cape Cod method to calculate the IBNR as of 12/31/99:

Accident Year	*Adjusted Premium if avail.***	*Reported CDF to Ultimate*	*Percent Reported to date*	*Used-Up Premium to date*	*Reported Claims as avail.***	"CC" Estimated Claim Ratio
	(1) given	*(2)=1.0/(3)*	*(3) given*	*(4)=(1)*(3)*	*(5) See note*	*(6)=(5)/(4)*
1996	*200,000*	*not used*	*90.0%*	*180,000*	*147,000*	*see total*
1997	*300,000*	*not used*	*75.0%*	*225,000*	*170,000*	*see total*
1998	*350,000*	*not used*	*50.0%*	*175,000*	*180,000*	*see total*
1999	*425,000*	*not used*	*35.0%*	*148,750*	*160,000*	*see total*
Total	***1,275,000***			*728,750*	***657,000***	***90.1544%***

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*

(5) Be sure to add the Paid Claims + Case Outstanding = Reported Claims

(6) " … method requires the use of the weighted average claim ratio from all years.'

Accident Year	*"CC" Claim Ratio*	*A priori Expected Claims*	*"IBNR" Expected Unreport*	*Or shortcut using C.C. Expected Claims x Percent Unreported*	*IBNR (broadly defined)*
	(6) total	*(7)=(1)*(6)*	*(8)=(7)*[1-(3)]*	*(8)=(Prem)*(CC %)*[1.0-(3)]*	
1996	*90.1544%*	*180,308.80*	*18,030.88*		*18,030.88*
1997	*90.1544%*	*270,463.20*	*67,615.80*		*67,615.80*
1998	*90.1544%*	*315,540.40*	*157,770.20*		*157,770.20*
1999	*90.1544%*	*383,156.20*	*249,051.53*		*249,051.53*
Total			***492,468.41***		***492,468.41***

Note: Patrik is now on the exam 7 syllabus.

Solutions to 2004 Exam Questions (modified):

49. (2 points) You are given the following information:

Accident Year (AY)	Premium Actual	Premium Adjusted	Reported Claims at 12-31-03	Reported Ult CDF
1998	4,500	6,200	3,200	1.00
1999	5,000	6,500	3,400	1.05
2000	5,500	7,500	3,500	1.18
2001	6,000	7,800	2,800	1.43
2002	6,500	7,800	2,100	2.00
2003	7,000	7,000	1,600	4.00
Total	34,500	42,800	16,600	

Calculate the Cape Cod estimates of IBNR and Ultimate Losses, for AY 2002 only.

Accident Year	*Premium if avail.***	*CDF to Ultimate*	*Reported to date*	*Premium to date*	*Claims as avail.***	*Estimated Claim Ratio*
	(1) given	*(2) given*	*(3)=1.0/(2)*	*(4)=(1)*(3)*	*(5) given*	*(6)=(5)/(4)*
1998	*6,200*	*1.00*	*100.0000%*	*6,200.0000*	*3,200*	*see total*
1999	*6,500*	*1.05*	*94.9668%*	*6,172.8420*	*3,400*	*see total*
2000	*7,500*	*1.18*	*85.0340%*	*6,377.5500*	*3,500*	*see total*
2001	*7,800*	*1.43*	*69.9790%*	*5,458.3620*	*2,800*	*see total*
2002	***7,800***	***2.00***	***50.0000%***	***3,900.0000***	***2,100***	***see total***
2003	*7,000*	*4.00*	*25.0000%*	*1,750.0000*	*1,600*	*see total*
Total	*42,800*			*29,858.7540*	*16,600*	***55.5951%***

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*

(4) Used-Up premium also equals (1)/(2): Adjusted Premium divided by Ult. CDF

(6) " … method requires the use of the weighted average claim ratio from all years.'

Accident Year	*"CC" Claim Ratio*	*A priori Expected Claims*	*"IBNR" Expected Unreport*	*Or shortcut using C.C. Expected Claims x Percent Unreported*	*IBNR (broadly defined)*
	(6) total	*(7)=(1)*(6)*	*(8)=(7)*[1-(3)]*	*(8)=(Prem)*(CC %)*[1.0-1.0/CDF]*	
1998	*55.5951%*	*3,446.8962*	*0.0000*		*0*
1999	*55.5951%*	*3,613.6815*	*181.8838*		*181.89*
2000	*55.5951%*	*4,169.6325*	*624.0272*		*624.027*
2001	*55.5951%*	*4,336.4178*	*1,301.8360*		*1,301.836*
2002	***55.5951%***	***4,336.4178***	***2,168.2089***		*2,168.2089*
2003	*55.5951%*	*3,891.6570*	*2,918.7428*		*2,918.7428*
Total			*7,194.6987*		***7,194.699***

See also Patrik.

Note: To find AY 2002 IBNR, only the calculations for 2002 are required:

However, to find the 55.6% "CC" a-priori claim ratio, all years are used.

7800 * 55.5951% * (1 - 1/2.0) = 2,168.2089

Finally:

Cape Cod Estimated Ultimate Claims = Reported Claims + IBNR as above

AY 2002 Cape Cod Estimated Ultimate Claims = 2,100 + 2,168.2089 4,268.2089

Solutions to 2005 Exam Questions (modified):

38. (1.5 points) You are given the following information:

Accident Year	Premium Actual	Premium Adjusted	Reported Claims at 12-31-04	Reported CDF (ultimate)
2001	6,000	8,000	5,000	1.1429
2002	7,500	8,000	4,000	1.3333
2003	9,000	10,000	4,000	2.0000
2004	10,000	10,000	2,000	3.3333
Total	32,500	36,000	15,000	

Calculate the a priori "expected claim ratio" to be used in the Cape Cod technique:

Accident Year	*Adjusted Premium if avail.***	*Reported CDF to Ultimate*	*Percent Reported to date*	*Used-Up Premium to date*	*Reported Claims as avail.***	"CC" Estimated Claim Ratio
	(1) given	*(2) given*	*(3)=1/(2)*	*(4)=(1)*(3)*	*(5) given*	*(6)=(5)/(4)*
2001	*8,000*	*1.1429*	*87.4967%*	*6,999.7360*	*5,000*	*see total*
2002	*8,000*	*1.3333*	*75.0019%*	*6,000.1520*	*4,000*	*see total*
2003	*10,000*	*2.0000*	*50.0000%*	*5,000.0000*	*4,000*	*see total*
2004	*10,000*	*3.3333*	*30.0003%*	*3,000.0300*	*2,000*	*see total*
Total	***36,000***			*20,999.9180*	***15,000***	**71.42890%**

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*

(4) Used-Up premium also equals (1)/(2): Adjusted Premium divided by Ult. CDF

(6) " … method requires the use of the weighted average claim ratio from all years.'

Note: Patrik is now on the exam 7 syllabus.

Solutions to 2008 Exam Questions (modified):

Question 36

Stanard-Buhlmann (Cape Cod) is just a B-F technique with a particular Expected Claims Ratio!

Accident Year	Adjusted Premium if avail.**	Percent Reported "LAG"	Used-Up Premium to date	Reported Claims 12/31/2007	"SB" or "CC" Estimated Claim Ratio
	(1) given	(3) given *	(4)=(1)*(3)	(5) given	(6)=(5)/(4)
2003	9,000	0.95	8,550	8,000	see total
2004	9,000	0.88	7,920	8,000	see total
2005	11,000	0.75	8,250	7,000	see total
2006	13,000	0.55	7,150	6,000	see total
2007	15,000	0.30	4,500	4,000	see total
Total	57,000		36,370	33,000	90.7341%

*** The Cape Cod technique allows/prefers use of **adjusted** data where available.*

**Recall, "lag" = the percent emerged = the inverse of CDF*

(4) Used-Up premium also equals Adjusted Premium divided by Ult. CDF

*(6) " … method requires the use of the weighted average claim ratio from **all years**."*

Accident Year	"SB" or "CC" Exp. Claim Ratio	A priori Expected Claims	"IBNR" Expected Unreport	Or shortcut using C.C. Expected Claims x Percent Unreported	IBNR (broadly defined)
	SB%=(6)total	(7)=(1)*SB%	(8)=(7)*[1-(3)]	(8)=(Adj. Prem)*(SB %)*[1.0-"lag"]	
2003	90.7341%	8,166.0690	408.3035		408.3035
2004	90.7341%	8,166.0690	979.9283		979.9283
2005	90.7341%	9,980.7510	2,495.1878		2,495.1878
2006	90.7341%	11,795.4330	5,307.9449		5,307.9449
2007	90.7341%	13,610.1150	9,527.0805		9,527.0805
Total			18,718.4450	OR	18,718.4450

Solutions to questions from the 2010 Exam:

18a. (1 point) Use the Stanard-Buhlmann method to calculate the IBNR for accident year 2008 as of December 31, 2009.

18b. (1 point) Discuss two problems that may affect the accuracy of a reinsurer's earned premium data.

Question 18 - Solution 1

a. SB ELR = (9+9+7+10+6)/(12/1.03+12/1.11+13/1.25+14/1.47+15/2) = 0.82 ←Rounding; see next sol.

0.82 × 14,000 × (1-1/1.47) = 3,678

b. i) Inaccurate rate change data

ii) Imprecise by line breakdown

Solutions to questions from the 2010 Exam:

Question 18 - Solution 2

a.

C/AY	"Used-Up" Premium	SB IBNR
2005	11,650	
2006	10,811	
2007	10,400	
2008	9,524	14,000 × (.8219)(1-1/1.47)=3,679
2009	7,500	
TOTAL	49,885	

LR = 41,000/49,885 = 82.19%

B 1. The reinsurer relies on the insurer to report premium, there can be a lag in this reporting.
2. Earned premium is often reported in aggregate to reinsurer, so the reinsurer must make assumptions to split premium.

Solutions to questions from the 2011 Exam:

27a. (1 point) Use the Bornhuetter-Ferguson technique and an expected claims ratio of 60% to estimate the IBNR for accident year 2010.

27b. (1.5 points) Use the Cape Cod technique to estimate the IBNR for accident year 2010.

27c. (0.5 point) Describe the primary difference between the Bornhuetter-Ferguson technique and the Cape Cod technique.

Question 27 – Model Solution

a. AY 2010 IBNR = EP * ELR *(1.0 – 1/LDF-ult) = 1,000,000 x 0.6 x (1 - 1.30^{-1}) = $\boxed{138,462}$ IBNR

b. Comments: Cape Cod ELR computation:
Compute Estimated claim ratios = Actual reported claims/ Used-up premium.
Compute: "Used-up premium" = EP * % reported = EP /LDF-Ult

b. Cape Cod ELR = (510 + 520 + 450) / (950/1.05 + 915/1.12 + 1000/1.3) = 0.5816
Note: The model solution has a rounding problem. Using the values above, the CC ELR = .59414
AY 2010 IBNR = EP * ELR *(1.0 – 1/LDF-ult) = 0.5816 x 1,000,000 x (1 – 1.30^{-1}) = $\boxed{134,215}$ IBNR

c. The BF method uses an a priori estimate of the claims ratio. The Cape Cod method uses a claims ratio calculated from the actual experience.

Solutions to 2012 Exam Questions

18a. (0.75 point) Use the Bornhuetter-Ferguson technique and an expected claims ratio of 60.0% to estimate the IBNR for accident year 2010.
18b. (2 points) Use the Cape Cod technique to calculate the IBNR for accident year 2010.
18c. (0.5 point) Describe the difference in the underlying assumption between the two techniques.

Question 18 – Model Solution 1 (Exam 5B Question 3)

a. IBNR 2010 = 975,000 * 60% (1.0 -1/1.12) = 62,679 as of 2010

b. Cape Cod. Compute the Estimated Claim Ratio (ECR)

$$ECR = \frac{\sum \text{rpt}}{\sum \text{used-up premium}} = \frac{(510,000 + 520,000 + 465,000)}{(978,500 * 1/1.05 + 1,023,750 * 1/1.12 + 1,000,000 * 1/1.3)} = 57.166\%$$

Unadj ECR for AY 2010 = 57.166% * 1,023,750/975,000 = 60%

AY 2010 IBNR = 60% * 975,000 (1.0 - 1/1.12) = 62,704 ← rounding; s/b 62,678.57 (see sol below)

c. the difference is the expected claim ratio. In B-F expected claim ratio is usually from independent analysis or judgmentally selected. In cape cod, ECR is derived from experience period.

Question 18 – Model Solution 2 (Exam 5B Question 3)

a. BF IBNR = EP x LR x (1 -%RPT) = 975,000 x 60% x (1 – 1/1.12) = 62,678.57

b. Cape cod method

$$\text{ECR} = \frac{\sum \text{rpt}}{\sum \text{AdjEP} \times \%\text{Rpt}} = \frac{(510 + 520 + 465) \times 1000}{(978.5 \times 1/1.05 + 1023.75 \times 1/1.12 + 1,000 \times 1/1.3) \times 1000} = 0.5717$$

$$\text{ECR for AY 2010 } = \frac{1,023,750}{975,000} \times 0.5717 = 0.60$$

AY 2010 IBNR= 0.6 x 975,000 x (1.0 -1/1.12) = 62,678.57

c. For BF method the underlying assumption is future claim ratio will be the same as the prior selected ratio which is independent from loss experience. Cape cod method estimate selected loss ratio from historical loss experience and apply it to estimate reserves.

Examiner's comments

a. Candidates generally understood the problem and calculation. Half the candidates used earned premium, the other half used on level earned premium. Both answers were accepted.

b. Generally candidates did well on this part as well. Most candidates were very close to the concept of calculating a different expected claims ratio to apply in a fashion similar to the BF method. Some common mistakes included not calculating Used Up Premium in order to derive the Cape Cod ECR, not completing the ECR calculations using all years of data, selecting a simple average instead of a weighted average, or incorrectly using EP instead of OLEP.

c. Most candidates received full credit.

Note: To keep the number of pages in this manual to a minimum, we have uploaded all the exhibits associated with chapter to our website. Login to your account and click on the addendum link to download these exhibits.

1 Introduction 194

Frequency-Severity (FS) techniques provide additional unpaid claim estimates and help to understand the drivers in claims activity.

In "Evaluating Bodily Injury Liabilities Using a Claims Closure Model," Adler and Kline discuss the rhythm in the claims settlement process:

> Claims *emerge* at an identifiable rate, they *are settled* at an identifiable rate, the payments *grow* at an identifiable rate and the *accuracy of individual case estimates improves* at an identifiable rate.

Using the FS technique:

- projected ultimate claims = estimated ultimate number of claims (i.e. frequency) x estimated ultimate average value (i.e. severity).

  By analyzing frequency and severity, trends and patterns in the rates of claims emergence (i.e. reporting) and settlement (i.e. closure) as well as in the average values of claims can be determined.

  This can be valuable when an entity is undergoing change in operations, philosophy, or management.
- can help in validating or rejecting the findings from other actuarial projection techniques.

2 Common Uses of Frequency-Severity Techniques 194

FS techniques:

- can be used for projecting unpaid claim estimates for both primary layers of coverage and excess layers of insurance.
- can be used with AY, PY, RY and CY data.
- are appropriate for all lines of insurance but are more often used for long-tail lines.
- are generally not used by reinsurers, since underwriting year data does not have the detailed statistics regarding the number of claims.

From a technical basis:

- frequency equals the number of claims per unit of exposure, and severity equals the average cost per claim.
- historical data for claims, number of claims, and exposures is needed.

In practice, "FS methods" refers to projections of ultimate claim counts multiplied by ultimate severities (without using an exposure measurement).

3 Types of Frequency-Severity Techniques 194 - 195

Three types of FS projection methods are examined in this chapter.

Note: The consolidated industry example is not analyzed because the number of claims is not available from the industry source data (i.e. Best's Aggregates & Averages)

FS approach 1: The development technique applied separately to claim counts and average values.

This method is presented in Exhibit I for a Canadian portfolio of private passenger automobile collision coverage (Auto Collision Insurer) and in Exhibit II for XYZ Insurer.

FS approach 2: Projecting ultimate claims for ***the most recent two accident years***.

The expected claims and BF techniques are often used methods to supplement claim development method.

Recall that highly leveraged CDFs for the most recent AYs (from the development method) lead to greater uncertainty in projections of ultimate claims; which leads to greater uncertainty in the unpaid claim estimate.

FS approach 3: The Disposal Rate Technique

- It builds upon the basic development triangle used with both claims and claim counts.
- The rate of claim count closure at each maturity age and the incremental paid severity by maturity age are examined.

See Exhibit V as an example of this approach for a portfolio of general liability insurance (GL Insurer) and Exhibit VI for XYZ Insurer.

4 FS Approach #1 – Development Method with Claim Counts and Severities 195 - 200

Two Key Assumptions

1. Individual claim counts are defined in a consistent manner over the experience period.

   Example: Do not group claimant counts and occurrence counts together (i.e. recording all claimants under an occurrence as a single claim), unless the mix of the two ways of counting a claim is consistent.

2. Claim counts are reasonably homogenous.

   Example: Do not analyze first-dollar, low-limit claims with high-layer, multi-million dollar, excess claims.

Again, FS methods rely on the development technique, which assumes that claims reported (or paid) to date will continue to develop in a similar manner in the future.

In a FS method, it is assumed that:

- claim counts reported (or closed) to date will continue to develop in a similar manner in the future, and that
- the relative change in a given year's severities from one evaluation point to the next is similar to the relative change in prior years' severities at similar evaluation points.

Mechanics of the Technique

Exhibit I, Sheets 1 through 8, present the first FS example for Auto Collision Insurer.

This first example has four basic steps:

1. Project and select ultimate claim counts
2. Project ultimate severity
3. Project ultimate claims
4. Develop unpaid claim estimate

In this example, we use semi-annual accident periods and valuations in intervals of six months.

1. Project and Select Ultimate Claim Counts

Exhibit I, Sheets 1 – 3 used the development technique to project both closed and reported claim counts to an ultimate basis. *(See exhibits located on our website).*

- Closed claim counts include claim counts closed with payments or claim-related expense payments or both, but do not include claim counts closed with no payment (CNP).
- Reported claim counts include the number of closed claims in addition to the number of open claims with a case outstanding (for claim only or claim-related expense) greater than $0.

  Since the reported claim counts exclude CNP counts, we observe negative (or downward) development (i.e. age-to-age factors less than 1.00) in Exhibit I, Sheet 2.

  a. private passenger collision is a very fast reporting and settling coverage of auto insurance.
  b. due to the fast-reporting nature of this coverage, there are more claim counts closed without payment in subsequent valuations than new claim counts reported.

     Thus, we see age-to-age factors of less than 1.00 for every accident half-year at 6-to-12 months. and similar behavior through 36 months for the reported claim count triangle of age-to-age factors.

The importance of understanding the type of data provided by the insurer

- If the closed counts exclude CNP counts but reported counts include the CNP counts, both cannot be used to produce comparable estimates of the ultimate number of claims.
- If claims include all claim adjustment expense (with or without claim payments or case outstanding) but counts do not include claims with claim adjustment expense only, an appropriate match cannot be made of the number of claims and the dollars that are spent on the claims.
- Claimant count versus occurrence count: Does the insurer record one count or multiple counts for accidents involving injuries to multiple parties involved in a single occurrence?
- How are claims recorded when the payment is below the deductible?

Exhibit I, Sheets 1 and 2 shown the development triangles for closed and reported claim counts

Selected age-to-age factors are based on the simple average for the latest three half-years for both counts.

Notice the variability from accident half-year to accident half-year at 6-to-12 months for the closed claim counts, while the averages appear relatively close to one another (this is reviewed later)

In Exhibit I, Sheet 3, we project the ultimate number of claims by accident half-year.

Note: Accident half-year 2008-1, which represents the period from 1/1/2008 – 6/30/ 2008 is six months old as of 6/30/2008; and accident half-year 2007-2, which represents the period from 7/1/2007 – 12/31/2007 is 12 months old at 6/30/2008 (begin counting with the beginning of the accident half-year period).

A method to determine if changes or patterns are taking place in the triangular data is to use the development diagnostic: ratio of closed-to-reported claim counts

Exhibit I, Sheet 4: ratio of closed-to-reported claim counts (exhibits located on our website).

Look down the column at age six months, and evidence of seasonality in the relationship between closed and reported counts can be seen.

- For accident half-years ending with a 2 (i.e. 7/1 – 12/31), the average ratio of closed-to-reported counts is 0.71, (with minimal variability from period to period around this average).
- For accident half-years ending with a 1 (i.e. 1/1 – 6/30), the average ratio of closed-to-reported counts is 0.81, (with minimal variability from period to period around this average).

* Reasons for a lower proportion of claim counts closed at six months for the accident half-years ending 12/31 than for those ending 6/30:

- A higher number of claims reported in Canada in November and December may be due to more hazardous driving conditions at the beginning of winter.
- There is less time to settle these claims with a 12/31 closing date than those claims occurring in January and February with a half-year closing date of 6/30.
- There may less time available to process and close November and December claims due to the shorter work period for companies that close over the Christmas holidays.

Thus, discussions with the claims department management are needed to understand the reasons for such patterns in the data.

Note: There are no material differences or patterns evident in any maturities beyond six months.

* Discern if any patterns exist in either the closed count triangle or the reported count triangle or both since a distinctive pattern is observed in the ratio of closed-to-reported claim counts at six months

Part 2 of Exhibit I, Sheet 1

A closer review of age-to-age factors for closed claim counts shows differences in the age-to-age factors for accident half-years ending June versus December.

There are no patterns in the reported claim count triangle at the 6-to-12 month interval (see the table below):

	Age-to-Age Factors at 6-12 Months	
Accident Half-Year	Closed Claim Counts	Reported Claim Counts
2003-2	1.281	0.932
2004-1	1.153	0.934
2004-2	1.275	0.910
2005-1	1.154	0.956
2005-2	1.327	0.942
2006-1	1.181	0.966
2006-2	1.353	0.956
2007-1	1.212	0.983
2007-2	1.312	0.995
Accident Half Years 1		
Simple Average All Years	1.175	0.960
Simple Average Latest 3 Years	1.183	0.968
Accident Half Years 2		
Simple Average All Years	1.310	0.947
Simple Average Latest 3 Years	1.331	0.964

Based on the above commentary, our selected age-to-age factor for closed counts is revised from 1.292 (the simple average of the latest 3 accident half-years) to 1.183 (the simple average latest three accident half-years ending at 6/30).

The new projected ultimate claim counts for accident half-year 2008-1 based on closed counts are:

[(closed claim counts at 6/302008) x (development factor to ultimate)] =

[(2,533) x (1.001 x 1.009 x 1.183)] = [(2,533) x (1.195)] = 3,027

The projected number of ultimate claims based on reported claim counts for accident half-year 2008-1 is 3,061 (very close to our new projected value of 3,027, based on closed claim counts).

2. Project Ultimate Severity

Exhibit I, Sheet 5 – Reported Claims and Severities

Exhibit I, Sheet 6 - The reported severity triangle is analyzed and development factors are selected.

- There appears to be greater development for accident half-years ending December rather than June, and further explanation from claims management is needed to fully understand the factors influencing the claim development patterns.
- A 6-to-12 month factor of 1.039 based on the medial average (i.e. average excluding high and low values) is selected, assuming that the experience of the most recent few years is more representative of future experience than the earlier periods.
- We also use the medial average to select the age-to-age factors for the remaining maturities.

3. Project Ultimate Claims

Exhibit I, Sheet 7 – Projected Ultimate Claims = [projected ultimate severities] * [projected ultimate claim counts]

4. Develop Unpaid Claim Estimate

Exhibit I, Sheet 8. Total unpaid claim estimates = Case O/S +estimated IBNR

Estimated IBNR = projected ultimate claims - reported claims.

For Auto Collision Insurer, the estimated IBNR is negative for all accident half-years except the latest period, 2008-1.

Negative IBNR is a result of:

a. salvage and subrogation recoveries (S&S), which are included with the claim development data, or
b. a conservative philosophy towards setting case outstanding.

In this example, negative IBNR is a result of the downward (i.e., favorable) development of claim counts

Analysis for XYZ Insurer

Exhibit II - the FS approach for XYZ Insurer uses the same approach used in Exhibit 1 (see Exhibit II located on our website)

Recall that based on interviews with management of XYZ Insurer and reviews of the diagnostic development triangles, there have been significant changes in both their internal and external environments. (It may be valuable to review the diagnostic triangles presented in Chapter 6 for XYZ Insurer.)

As a result, we select the volume-weighted average of the age-to-age factors ***for the latest two years*** to reflect the most recent operating environment at XYZ Insurer.

Exhibit II, Sheet 3: Projected ultimate claim counts.

- The two projections of claim counts are close for AYs 1998 - 2005,
- There are significant differences in the projected number of ultimate claims for 2006 - 2008.
- For every year starting in 2000 - 2008, ultimate count projections based on closed counts are greater than those based on reported counts.

Exhibit II, Sheet 5 – Reported severities triangle.

- In the age-to-age factors triangle, the latest point in each column is usually the lowest point in the column, which is consistent with management's assertion that there has been a significant increase in case outstanding strength (in CY 2007).
- The latest two years are used for selected development factors (to best reflect the current environment at this insurer).

Exhibit II, Sheet 6 - Projected Ultimate Claims = [projected ultimate severities] * [projected ultimate claim counts]

Exhibit II, Sheet 7 – Development of IBNR and the Unpaid Claim Estimate

Observations:

- The estimated IBNR and total unpaid claim estimate are:
  a. ***higher*** than those generated from the reported claim development technique and
  b. ***lower*** than those generated from the paid claim development technique.
- Recall Exhibit II, Sheet 3 – Projected ultimate claim counts:
  a. based on closed counts are significantly greater than those based on reported counts.
  b. is consistent with conclusions regarding an increased rate of claims settlement.

Thus, rely on the reported count projection which is not affected by changes in claims closure patterns.

5 FS Approach #2 — Incorporating Exposures and Inflation in the Method 201 - 205

Key Assumptions

This second FS approach relies on the development technique, with critical assumptions that include:

1. Claim counts and reported claims to date will continue to develop in a similar manner in the future.
2. Claim counts are defined consistently over time.
3. The mix by claim type is consistent (since potential claims can vary significantly by type of claim).

New to this approach:

Three trend rates (exposure trend, frequency trend, and severity trend) are incorporated into the analysis of both frequency and severity parameters.

Considerations when selecting trend rates:

1. Economic inflationary factors
2. Societal factors (that tend to increase both the number and claim size over time).
3. Rates varying by line of business (and by sub-coverage within a line of business).
4. Variation in trend rates for exposures, frequency, and severity by geographic region (e.g. country, state/province and subdivisions within a state/province).
5. Variation based on the limits (i.e. retention) carried by the insurer or self-insurer.

Note: Beyond inflationary trend factors, WC often requires adjustments for statutory benefit changes.

Sources to use when selecting trend assumptions:

1. General insurance industry data
2. Government statistical organizations
3. Economic indices
4. Insurer-specific experience.

Note: When using regression on an insurer's own claims experience, the accuracy and appropriateness of selected trend rates is critical for many FS methods, since the longer the projection period, the greater the uncertainty (as trend factors become large and highly leveraged).

Two examples shown: a self-insurer of U.S. workers compensation (WC Self-Insurer) and XYZ Insurer.

Mechanics of the Approach

This approach to FS has 5 basic steps:

1. Project and select ultimate claim counts
2. *Compare ultimate claim counts to exposures and select frequency (new compared to approach 1)*
3. Project ultimate severity
4. Project ultimate claims
5. Develop unpaid claim estimate

1. Project and Select Ultimate Claim Counts

Exhibit III, Sheets 1 – 3 - Project closed and reported claim counts and select ultimate claim counts by AY.

Select development factors based on the volume-weighted average for the latest five years.

a. For the closed claim count triangle (84-to-96 months), select a development factor of 1.003 (resulting in a smoother pattern than the one data point of 1.008)
b. Judgmentally select a tail factor for closed claim counts of 1.007 (based on a review of closed and reported claim counts at ages of 72, 84, and 96 months).

Exhibit III, Sheet 3, selected ultimate claim counts are based on the average of the two projections.

2. Compare Ultimate Claim Counts to Exposures and Select Frequency

Exhibit III, Sheet 4.

New to this approach: The frequency analysis compares ultimate claim counts by AY to an exposure base.

For WC, the exposure base is payroll (in hundreds of dollars).

The goal: Determine the proper frequency (i.e., number of claims per exposure unit) for the latest two AYs.

- Since payroll is inflation-sensitive, adjust payroll for each AY to a common time period.
- To simplify, assume a 2.5% annual inflation rate for payroll for all years in the experience period and trend all historical payroll to the cost level of AY 2008 (see Columns (5) - (7))

Similarly, trend factors should be used to reflect changes in counts.

- It is ideal to analyze the self-insurer's own historical experience to determine the frequency trend rate.
- In this example, there insufficient historical data, and the actuary relies on knowledge of U.S. WC in general and the specific industry of this self-insured organization; we assume a -1.0% annual trend in the number of claims.(See Columns (2) - (4)).

Trended ultimate frequency equals ultimate trended claim counts divided by trended payroll in Column (7).

After a review of these rates by AY in Column (8), we see a change in frequency between 2001 - 2004 and 2006 - 2008.

Thus, the actuary should speak to management to understand what caused the change in frequency.

- Has there been a new cost containment program introduced?
- Has there been a change in the definition of a claim?
- Has there been a change in third-party administrators?
- Was there a change in the type of work performed by employees?
- There was a large increase in both claims and payroll between 2005 and 2006. Was this the result of a corporate acquisition?

In this example, the change in frequency is due to a major acquisition, resulting in the hiring of a new risk manager and the introduction of new safety and risk control procedures.

- A 2008 frequency rate of 0.36% is selected (reflective of the new and improved environment with respect to claims at this organization).
- The 2007 frequency rate of 0.37% equals 0.36% * 1.025 (the adjustment for payroll inflation) / .99 (the adjustment for claims trend).

3. Project Ultimate Severity

Exhibit III, Sheets 5 – 8: Projected paid severities and reported severities to an ultimate value

Exhibit III, Sheet 6 – 7: The analysis for paid and reported severities.

Development factors were selected based on the medial average (i.e. average excluding high and low values) for the latest five years.

Tail factors at 96 months of 1.025 for reported severities and 1.15 for the paid severities were selected (based on analysis of insurance industry benchmark development patterns for U.S. WC).

Exhibit III, Sheet 8: Comparison of the two projections and selection of ultimate severities for AYs 2001 – 2006.

Exhibit III, Sheet 9: Selection of 2008 and 2007 Severities

Adjust the severities for each historical AY year to the cost level of AY 2008.

- A 7.5% annual severity trend rate is selected.
- The authors chose to simplify the model by not incorporating an adjustment of claims by year to the 2008 statutory benefits level.
- A 2008 severity value of $7,100 was selected. The 2007 severity value $6,605 = $7,100/1.075.

4. Project Ultimate Claims

Exhibit III, Sheet 10 - Projection of Ultimate Claims and Development of Unpaid Claim Estimate for AY 2007 and 2008.

Payroll for both AYs was given

1. Multiply payroll by the selected frequency rates to compute the projected ultimate number of claims (Line (3)).
2. Multiply ultimate number of claims by the selected severities to derive the projected ultimate claims (Line (5)).

5. Develop Unpaid Claim Estimate

Total unpaid claim estimate = Case outstanding + estimated IBNR

Estimated IBNR = Projected ultimate claims - Reported claims.

Analysis for XYZ Insurer

Exhibit IV, Sheets 1 - 3 use FS#2 approach to review the experience of older, more mature accident years for the purpose of determining estimates of both frequency and severity for 2007 and 2008..

In this approach, adjustments for rate level changes, inflation, and tort reform are incorporated.

Exhibit IV, Sheet 1 - Projection of Ultimate Frequency

- Selected ultimate claim counts for AYs 2002 – 2006 are obtained from the reported claim count projection in Exhibit II, Sheet 3.
- An annual -1.5% claims frequency trend is used based on analysis of insurance industry trends.

Exposure base:

Vehicle or policy count are ideal exposure bases when conducting an analysis of unpaid claims for auto liability insurance, however this information is not available and so XYZ uses EP as an exposure base.

Columns (5) - (7) of Exhibit IV, Sheet 1: Adjust historical earned premiums to the 2008 rate level.

Column (8) trended ultimate frequency equals column (4) trended claim counts divided by OLEP.

- The 2008 selected frequency rate is 2.36%.
- The 2007 selected frequency rate is 2.36% divided by the annual claim count trend (-1.5%) and multiplied by the rate level change that took place in 2008. 1.92% = 2.36% * 0.8/0.985

Exhibit IV, Sheet 2 - Selection of 2008 and 2007 Severities

Column (5) Trended ultimate severities equal Column (2) projected ultimate severities from Exhibit II, Sheet 6 multiplied by a 5% annual severity trend and by tort reform factors from Chapter 8, Exhibit III Sheet 2.

- The 2008 selected ultimate severity is 26,720 (after review column (5) averages).
- The 2007 selected ultimate severity is $25,448 (the 2008 value adjusted for one less year of trend).

Exhibit IV, Sheet 3 - Projection of Ultimate Claims and Development of Unpaid Claim Estimate

Projected ultimate claims for 2007 and 2008 are based on the multiplication of:

- Projected ultimate counts (EP * selected frequency %) and
- Projected ultimate severity values (the latter two from Exhibit IV, Sheets 1 and 2)

It's advisable to compare the projection of ultimate claim counts, severities, and claims using FS #1 approach and FS #2 approach. The following table summarizes these values.

	Approach # 1	**Approach # 2**
2007 Ultimate Claim Counts		
Closed Counts Projection	1,804	
Reported Counts Projection	1,308	
Selected Value	*1,556*	*1,199*
2007 Severity	***37,606***	***25,448***
2008 Ultimate Claim Counts		
Closed Counts Projection	1,679	
Reported Counts Projection	1,172	
Selected Value	*1,426*	*1,128*
2008 Severity	***41,544***	***26,720***
Projected Ultimate Claims ($000)		
Accident Year 2007	**58,516**	**30,512**
Accident Year 2008	**59,242**	**30,140**

Notice that ultimate claims from the second approach are roughly half of the projections from the first approach due to lower projections of both ultimate claim counts and average values per claim.

In Chapter 15, we compare and contrast the various projection methods for this example.

6 FS Approach #3 – Disposal Rate Technique 205 - 212

Key Assumptions

It is assumed that historical patterns of claims emergence and settlement are predictive of future patterns of reported and closed claim counts.

It is implicitly assumed that that there are no significant partial (i.e. interim) payments.

The assumed severity trend rate (to adjust for inflation) must be selected carefully.

A slight change in trend can result in a material change in the estimated of unpaid claims.

Mechanics of the Approach

The 7 steps in the FS method #3 are:

1. Project ultimate claim counts and select ultimate claim counts by accident year
2. Develop disposal rate triangle and select disposal rate by maturity age
3. Project claim counts by accident year and maturity (complete the square)
4. Analyze severities and select severities by maturity
5. Calculate severities by maturity age and accident year (complete the square)
6. Multiply claim counts by severities to determine projected claims
7. Determine unpaid claim estimate

1. Project Ultimate Claim Counts and Select Ultimate Claim Counts by Accident Year

For this example, a portfolio of occurrence basis, general liability insurance data (GL Insurer) is reviewed.

Exhibit V, Sheets 1 – 3: Development of closed, reported and projected ultimate claim counts

- Exhibit V, Sheet 2: Downward (i.e. negative) development in the age-to-age factors for reported claim counts are shown, is most likely caused by the data excluding CNP counts.
- Selected development factors based on the volume-weighted averages for the latest 3 years.
- Select tail factors are based on experience for the oldest maturities, including the ratio of closed-to-reported claim counts, and benchmark patterns for a similar portfolio of coverage.

Exhibit V, Sheet 3: Selected ultimate counts are based on the average of the paid and reported projections.

2. Develop Disposal Rate Triangle and Select Disposal Rate by Maturity Age

Exhibit V, Sheet 4: - Development of Disposal Rate

- Disposal rates are cumulative closed claim counts (for each AY-maturity age cell) / selected ultimate claim count for a particular AY.
- Each ratio represents the % of ultimate claim counts that are closed at a given stage of maturity for a given AY.
- The medial five-year average is used to select a disposal rate at each maturity age.
- There is considerable stability in the disposal rates at each maturity.
- Expect disposal rates to monotonically increase over time (see table below)

Maturity Age (Months)	Selected Disposal Rate
12	0.2
24	0.433
36	0.585
48	0.71
60	0.791
72	0.862
84	0.882
96	0.912

3. Project Claim Counts by Accident Year and Maturity (Complete the Square)

Exhibit V, Sheet 5: Development of Closed Claim Counts

Top section: Closed Claim Counts

Bottom section: Incremental and Projected Incremental Closed Claim Counts

- Selected disposal rates by maturity and the selected ultimate claim counts by AY are used to complete the square of the incremental closed claim count triangle.
- Incremental claim counts in the column labeled 12 represent counts that are closed in the first 12 months from the start of the AY. Those in the column labeled 24 represent the counts that are closed in the 12-24 month period.
- Incremental Count Triangle:

  The top left part of the "completed square" is computed based on the differences between successive columns of the cumulative closed claim count triangle.

  The bottom-right, highlighted (projected) part of the incremental closed claim count square, is computed by first adjusting the cumulative closed claim counts at the latest valuation to an ultimate basis and then applying the selected disposal rates for each age interval.

  For example, for AY x at Age y, projected incremental closed claim counts are computed as follows:

  [(ultimate claim counts for AY x – cumulative closed claim counts for AY x along latest diagonal) / (1.00 – selected disposal rate at maturity of latest diagonal)] x [disposal rate at y – disposal rate at y-1]

  Examples:

  The estimated incremental closed claim counts for AY 2008 at 24 months are equal to:

  [(609 – 127) / (1.000 - 0.200)] x [0.433 – 0.200] = 140

  The estimated incremental closed claim counts for AY 2005 at 84 months are:

  [(588 – 403) / (1.000 – 0.710)] x [0.882 – 0.862] = 13

  Projected ultimate claims equal incremental closed claim counts * average incremental paid claims.

  The use of incremental claim counts and incremental severities is unique to this FS method

4. Analyze Severities and Select Severities by Maturity

Exhibit V, Sheet 6 - Calculation of Severities

1. Compute the incremental paid claim triangle from the cumulative paid claim triangle.

2. Compute incremental paid severities: [incremental paid claims/ incremental closed claim counts]

Note: There are patterns in this incremental triangle of paid severities.

- In general, the paid severities increase as the claims mature, which is:
  a. consistent with the belief that smaller claims settle quicker than more complicated/costly claims.
  b. common for long-tail lines of insurance (e.g. U.S. general liability)

3. Adjust the severities to a common time period (i.e. cost level) before severities selections are made.

   Exponential regression is often used to determine annual trend rates. Reasons include:

   i. Its use implies a constant % increase in inflation.
   ii. It is believed to be most indicative of the normal inflation process.
   iii. A weighted exponential least squares fit gives greater weight to more recent experience.
   iv. Linear projections are rarely used (due to the implied decreasing % trend).

Exhibit V, Sheet 7: A summary of regression analyses for incremental paid severities.

i. To determine a severity trend, fit exponential curves to incremental paid severities at each maturity age.

ii. Run a variety of combinations of years and test for the goodness-of-fit of the regression.

Estimated annual rates of change (i.e. trend rate) and goodness-of-fit tests (i.e. R-squared) are shown.

Observations:

i. A good fit to the data is not found based on GL Insurer's experience alone

ii. Using industry-wide experience, supplemented with the insurer's limited data, a 5% annual severity trend is selected.

iii. Notice that there is some evidence that trend rates differ and may be greater for the older maturities.

However, to simplify, a single trend rate for all maturities is used.

Exhibit V, Sheet 8, middle section: Restatement of all incremental paid severities at the 2008 cost level.

Examples:

i. The incremental paid severity for AY 2007 at 12 months is $10,086; after adjustment for trend to the 2008 cost level, the severity is $10,590 ($10,086 x 1.05^1).

ii. The incremental paid severity for AY 2003 at 72 months is $46,648; after adjustment for trend to the AY 2008 cost level, the severity is $59,536 ($46,648 x 1.05^5).

Exhibit V, Sheet 8, bottom section - averages of trended severities

Observations:

i. An increasing pattern in paid severities exists by age from 12 months - 96 months.

ii. Selected incremental paid severities at the 2008 cost level for maturity ages 12- 60 months are made but beyond this point, the data becomes sparse and a simple average of the latest 3 years is used.

Given variability in trended severities, consider combining the experience of several maturity ages. Variability may be due to:

a. the result of 1 or more large claims closed at older ages.

b. a smaller number of claims in the data set at the oldest maturity ages.

By combining multiple years of experience, the influence of random large claims or other factors is reduced.

Exhibit V, Sheet 9 - Development of Trended Severity (at ages 60 and older and 72 and older)

1. A triangle of incremental closed claim counts for maturities 60 through 96 months is given (from E5S6).
2. A triangle of incremental paid claims for these same maturities is given (from E5S6).
3. Adjusted paid claims using the 5% annual severity trend to bring all payments to the 2008 cost level.
4. Estimated trended tail severity equals [sum trended claim payments]/[sum incremental closed claim counts].

Tail severities selection requires substantial judgment. Considerations as to the maturity age at which to combine data for tail factor analysis depends on:

i. The age(s) at which the results become erratic

ii. The influence on the total projections of selecting a particular age

iii. The % of claims expected to be closed beyond the selected maturity age

Tail Severity Selection Thought Process:

i. Greater variability in trended severities begins at age 60.

ii. The selected disposal rate at 60 months is 0.791 (i.e. we expect more than 20% of the claim counts to remain open at this age). .791 is from E5S4.

iii. Given the large change in increment closed counts (227 at 60 months compared with 124 at age 72 months), it is clear that for ages 72 months and older, the experience should be combined for selecting an incremental tail severity.

iv. What should be done at 60 months?

An incremental trended severity of $140,802 at 60 months based on the experience of 60-month data *only* is selected, but this is not very different from the estimated severity of $144,160 for ages 60 *and older* developed in Sheet 9.

The importance of selecting the appropriate point at which data should be combined for determining a tail severity:

* A trended tail severity of $175,816 is selected based on the experience of ages 72 and greater.
* The affect of selecting a tail severity based on the experience of 60 months and greater would be a reduction of the unpaid claim estimate of more than 10%.

The following table is a summary of the selected severities, at the 2008 cost level, by maturity.

Maturity Age (Months)	Selected Severity at 2008 Cost Level
12	11,259
24	32,980
36	65,523
48	80,544
60	140,802
72 and older	175,816

Final Notes:

- While the selected severities for GL Insurer are increasing for all maturities through 72 months, at some point in time, the average value will likely not continue to increase.
- Consider the influence of large claims on the incremental average paid values.
  Consider capping claims to a predetermined value or excluding large claims in their entirety.
  In either case, a provision for large claims to the estimate of unpaid claims will need to be added.

5. Calculate Severities by Maturity Age and Accident Year (Complete the Square)

Exhibit V, Sheet 10 – Development of Severities

Given: 1. The top part of the square is the incremental paid severity triangle.
2. The bottom part is computed using selected severities at each age at the 2008 cost level and the selected trend rate.

To complete the square for incremental paid severities:

Adjust the selected severities at the 2008 cost level to the cost level expected for each AY.

Examples:

For AY 2006 at age 48 months, $73,056 = $80,544 (selected 2008 cost level severity at 48 months)/1.05^2.

For AY 2002 at 96 months, $131,197 = selected 2008 cost level severity of $175,816/$1.05^6$.

6. Multiply Claim Counts by Severities to Determine Projected Claims

Exhibit V, Sheet 11: Projection of Ultimate Claims

1. Projected incremental paid claims equals multiplication of the two completed squares
   = [the incremental closed claim counts] * [incremental paid severities]
2. Cumulate the projected incremental paid claims to derive projected cumulative paid claims (i.e. projected ultimate claims).

7. Determine Unpaid Claim Estimate

Exhibit V, Sheet 12: Estimated IBNR and the Total Unpaid Claim Estimates

Observations (reviewing the results for this technique):

An unusually low IBNR for AY 2004 (-$1,950) exists compared with the AY2003 value ($3,611) and the AY 2005 value ($9,340).

Return to the data to see if there is anything unusual in either the claims or the severity for this year.

i. Closed claim counts in Exhibit V, Sheet 1 seem reasonable when compared with other years.

ii. Paid severity for AY 2004 at 60 months is low compared to prior AY at 60 months and compared to AY 2005 at 48 months.

iii. There is an unusually high case outstanding for AY 2004 in comparison with other years.

iv. However, the estimate of total unpaid claims for 2004 is reasonable when compared to other years.

v. AY 2003 seems to have similar issues. The incremental paid severity is unusually low when compared to other AYs, and the IBNR is lower than usual when compared to AY 2002 and 2005.

Turn to claims department management to:

- understand the reasons for the high value of case outstanding and the low values for average payments, and to
- determine if there are any factors that might preclude using this type of projection method.

Analysis for XYZ Insurer

Initial commentary:

Recall from Chapter 6 that:

- closed claim counts for XYZ Insurer exclude claims closed with no payment (CNP) and
- paid claims include partial payments as well as payments on closed claims.

Thus, the average paid claim triangle is a combination of payments on settled and on claims still open.

Due to the mismatch of collars and claim counts, management is contacted and since there is not a large volume of partial payments, we proceed with the analysis.

Exhibit VI, Sheets 1 – 8: The disposal rate method for XYZ Insurer.

As in Approach #2, projected ultimate claim counts are derived from the reported claim count experience.

Exhibit VI, Sheet 1:

- Selected disposal rates are based on the simple average of the latest two years.
- Evidence of a change in disposal rates for the latest valuations, at 12, 24 and 36 months exists.

Exhibit VI, Sheet 2: Complete the square of projected incremental claim counts.

Exhibit VI, Sheet 3: Incremental paid severities are determined.

Exhibit VI, Sheet 4: Select severity values at the 2008 cost level (after adjustment for trend and tort reform) by maturity age.

- Assume a 5% severity trend
- Increasing severity values for each successive maturity age are observed.
- A look at the triangle of incremental paid severities shows that the severities along the latest diagonal are the highest value in each column for 6 of the 8 AYs in the experience period.
- Has the speed-up in settlement resulted in a shift in the type of claim now being closed at each maturity age? Consider the affect of this phenomenon on the projection method and the true unpaid claims requirement for XYZ Insurer.

Exhibit VI, Sheet 5: Development of Trended Tail Severity for ages 84 and 96 months.

A tail severity of $70,432 for ages 84 and 96 is selected.

Exhibit VI, Sheets 6 and 7: The development of projected ultimate claims by AY-maturity age cell.

Exhibit VI, Sheet 8: The calculation of estimated IBNR and the total unpaid claim estimate.

Exhibit VI, Sheet 9 (projected ultimate claims) and Exhibit VI, Sheet 10 (estimated IBNR):

A comparison of the results of the 3 FS projections for XYZ Insurer with the results of the Cape Cod method, the BF method, the expected claims method, and the development method are shown.

7 When Frequency-Severity Techniques Work and When they Do Not 205 - 212

Advantages to using a FS approach:

1. Its use in developing estimated unpaid claim estimates for the most recent AYs.
   a. Both paid and reported claim development methods can prove unstable and inaccurate for the more recent AYs.
   b. This weaknesses can be addressed by separating estimates of ultimate claims into frequency and severity.

      The number of reported claims reported is usually stable, and thus the projection of ultimate claim counts produces reliable estimates.

      Since severity estimates for the more mature AYs can be obtained with greater certainty, adjusting these severities using tend factors can help in developing estimates of severities for the most recent AYs.
2. Its used to gain greater insight into the claims process (e.g. the rate of claims reporting and settlement and the average dollar value of claims)
3. It can be used with paid claims data only. Thus, changes in case outstanding philosophy or procedures will not affect the results.
4. Its ability to explicitly reflect inflation in the projection methodology instead of assuming that past development patterns will properly account for inflationary forces.

   A potential disadvantage in doing so is its highly sensitive to the inflation assumption.

Disadvantages to using a FS approach:

1. The unavailability of data.
2. Changes in the definition of claim counts, claims processing, or both may invalidate the assumption that future claim count development will be similar to historical claim count development.

   Thorne in his discussion of the Berquist and Sherman paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach" states: "*A change in the meaning of a 'claim' can cause substantial errors in the resulting reserve estimates when relying on the projection of ultimate severity for recent accident years. These changes need not even be internal to the company. For example, changes in the waiting periods, statutes of limitation, and no-fault coverage can have a significant effect on the meaning of a 'claim' and thus on ultimate severity.*"

3. If the mix of claims is inconsistent, this will distort a FS analysis unless an adjustment is made for the change in the mix of claim types or claim causes.

8 Enhancements for Frequency-Severity Techniques 213

Considerations when using FS Techniques include:

1. The influence of seasonality on both the frequency and the severity of claims.
2. The influence of inflation on both the number of claims and the average value of claims.
3. Using more sophisticated trending analyses into the FS techniques.
4. Understanding the data (paid claims and claim counts) underlying the analysis of unpaid claims.
   Questions include:
   * Do paid claims data include significant partial payments?
   * Are claim count statistics available for the number of paid claims or only closed claim counts?
   * If only closed counts are available, is it reasonable to calculate an average paid value using paid claims that contain substantial partial payments?
   * How are reopened claims treated in the claims database? They may appear as a negative reported claim count or as a new claim.

     Reopened claims were ignored in the examples in this chapter.

     i. Depending on how reopened claims are handled (e.g. is the claim assigned the original claim identification number or a new claim identification number?) there could be distortions in the claim count statistics due to reopened claims.
     ii. This could affect both frequency and severity indications.
     iii. Reopened claims are more prevalent in U.S. WC and in Canadian auto accident benefits, than in other lines.

     Thus, it may be wise to segregate reopened claims from other claims and analyze reopened claims separately.

9 Frequency-Severity Projection as Input to BF Technique 214

Projected ultimate claims from a FS technique are often valuable as an alternative expected claims estimate for the BF technique.

Further, actuary may feel more comfortable selecting frequency and severity values than an expected claim ratio (or pure premium) value.

Thus, the unpaid claim estimate can be computed using one of the FS projections as used as the expected claims with the BF technique.

Sample Questions:

1. The methods discussed in Friedland's chapters 7 through 10 could all be applied to data compiled on an aggregate basis. How does the technique discussed in chapter 11 differ?

2. Describe the three types of Frequency-Severity methods that Friedland demonstrates.

3. Define the "Disposal Rate" that is used in the Frequency Severity *Disposal Rate* technique.

4. What does Friedland mean by "completing the square"?

5. Summarize Friedland's key points re: "When the Frequency-Severity Techniques Work and When they Do Not." Include 4 advantages and 4 disadvantages/limitations.

6. Use the Frequency-Severity *Development* technique, along with select data from Friedland's Chapter 11 Exhibits for the Auto Collision Insurer (as given below), to answer the following questions.
   Note: No adjustments for exposures or severity trend are made.

   6a. Given the following data, project ultimate claim counts for accident periods in 1/1/2006 - 6/30/2008.
   Use a 3-period simple average to select age-to-age factors. Assume no development after 30 months.

		Reported Claim Counts: Data Triangle				
Accident Half Year	**Period Ending**	**1st report 6 mo.**	**2nd report 12 mo.**	**3rd report 18 mo.**	**4th report 24 mo.**	**5th report 30 mo.**
2006	30-Jun	2,808	2,712	2,704	2,701	2,700
2006	31-Dec	2,799	2,675	2,670	2,668	
2007	30-Jun	2,578	2,533	2,529		
2007	31-Dec	2,791	2,778			
2008	30-Jun	3,139				

   6b. Given this additional data, project ultimate claim severities for accident periods in 1/1/2006 - 6/30/2008.

		Reported Claims ($1000): Data Triangle				
Accident Half Year	**Period Ending**	**1st report 6 mo.**	**2nd report 12 mo.**	**3rd report 18 mo.**	**4th report 24 mo.**	**5th report 30 mo.**
2006	30-Jun	11,947	11,856	11,820	11,772	11,760
2006	31-Dec	12,503	12,762	12,706	12,697	
2007	30-Jun	11,662	11,523	11,492		
2007	31-Dec	12,647	12,854			
2008	30-Jun	14,071				

   Use a "5 period x 1 medial average" to select age-to-age factors (see additional data in solution).
   Assume no development after 30 months.

   6c. Project ultimate claim severities for accident periods in 1/1/2006 - 6/30/2008.
   6d. Calculate the IBNR estimates for accident periods in 1/1/2006 - 6/30/2008.

2001 Exam Questions (modified):

33. (2 points) You are given the following information:

Accident Year	Estimated Ultimate Claim Count	Cumulative Loss Payments Age of Development (Months) 12	24	36
1998	1,000	300,000	930,000	1,490,000
1999	1,200	396,000	1,189,800	
2000	1,300	471,900		

Age of Accident Year	Disposal Rates
12 Months	30%
24 Months	72%
36 Months	100%

Using a Frequency-Severity *Disposal Rate* technique, calculate the cumulative claim payments for accident year 2000 at 24 and 36 months of development. Assume 5% future annual inflation and no partial payments. Show all work and state any additional assumptions.

2004 Exam Questions (modified):

20. (3 points) You are given the following information:

Annual Average Severity Trend: 5%

Accident Year	Incremental Closed Claim Counts (months of development) *0 to 12*	*12 to 24*	*24 to 36*	*36 to 48*	Ultimate Claim Counts
2000	10	15	10	15	50
2001	17	12	17		60
2002	15	12			70
2003	13				70

Accident Year	Incremental Payments on Closed Claims (months of development) *0 to 12*	*12 to 24*	*24 to 36*	*36 to 48*
2000	10,000	12,500	15,000	25,000
2001	20,000	26,000	30,000	
2002	18,000	25,000		
2003	16,000			

Using a Frequency-Severity *Disposal Rate* method, determine the projected ultimate payments for accident year 2003.

Show all work and state any additional assumptions.

2005 Exam Questions (modified):

14. (2 points) You are given the following information:

Accident Year	Incremental Number of Closed Claims (Age of Development in Months)				Projected Ultimate Claims
	12	24	36	48	
2001	260	770	430	170	1,630
2002	310	710	520		1,640
2003	250	680			1,760
2004	340				1,690

Average Paid Severity by Age at Closure	
0-12 months	560
12-24	830
24-36	1,530
36-48	2,000

- Assume no inflation.
- Select the most recent diagonal of disposal rates for projections (see note in solution regarding Friedland's selections in chapter 11 exhibits).

Using a Frequency-Severity *Disposal Rate* approach, what is the estimate of Unpaid Claims as of December 31, 2004 for accident year 2003? Show all work and state any additional assumptions.

2007 Exam Questions (modified):

35. (3 points) Given the following information:

Accident Year	Incremental Closed Claim Counts (months of development)				Ultimate Claim Counts
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	40	80	60	20	200
2004	48	96	72		240
2005	36	72			180
2006	44				220

Accident Year	Incremental Payments on Closed Claims (months of development)			
	0 to 12	12 to 24	24 to 36	36 to 48
2003	40,000	100,000	90,000	40,000
2004	50,000	118,000	108,000	
2005	38,000	90,000		
2006	45,000			

- The average annual severity trend is 10%.

Using a Frequency-Severity *Disposal Rate* approach, determine the projected ultimate payments for accident year 2006. Show all work and state any additional assumptions.

2008 Exam Questions (modified):

Question 3. Given the following information

Accident Year	Incremental Closed Claim Counts (months of development)				Ultimate Claim Counts
	0 to 12	*12 to 24*	*24 to 36*	*36 to 48*	
2004	500	300	150	50	1000
2005	600	360	180		1200
2006	750	450			1500
2007	900				1800

\$000's Accident Year	Incremental Payments on Closed Claims (months of development)			
	0 to 12	*12 to 24*	*24 to 36*	*36 to 48*
2004	400.0	300.0	180.0	75.0
2005	504.0	378.0	226.8	
2006	662.0	496.0		
2007	833.0			

- The annual severity trend is 5%.

a. (2.5 points) Using a Frequency-Severity "Disposal Rate" method:
Estimate unpaid claims as of 12/31/07. Show all work.

2009 Exam Questions

4. (4 points) Given the following information for an insurance carrier:

Cumulative Closed Claim Counts

Accident Year	As of 12 Months	As of 24 Months	As of 36 Months	As of 48 Months	As of 60 Months	As of 72 Months	Selected Ultimate Claim Counts
2003	98	255	302	351	395	410	418
2004	110	275	348	363	375		400
2005	93	246	284	348			395
2006	83	269	328				417
2007	87	292					447
2008	95						413

Selected Cumulative Disposal Rates

12 Months	24 Months	36 Months	48 Months	60 Months	72 Months
0.250	0.650	0.800	0.900	0.950	0.980

Cumulative Loss Paid ($000)

Accident Year	As of 12 Months	As of 24 Months	As of 36 Months	As of 48 Months	As of 60 Months	As of 72 Months
2003	402	2,050	3,080	4,882	5,675	6,200
2004	495	2,475	5,278	5,800	6,250	
2005	446	2,191	3,904	6,567		
2006	423	3,399	5,264			
2007	487	3,562				
2008	532					

Use the disposal rate frequency-severity technique to answer the following:

a. (1 point) Calculate the expected incremental closed claim counts for periods 60-72 and 72-ultimate for accident year 2004.

b. (1.5 points) Using a 6% annual trend factor, estimate the 60-ultimate tail severity at 2008 levels.

c. (1.5 points) Estimate the ultimate losses for accident year 2004.

2010 Exam Questions

16. (4 points) Given the following information:

Reported Claim Counts Excluding Claims Closed With No Payment

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	200	250	350	375
2007	250	350	370	
2008	300	310		

Reported Claims ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	1,000	1,500	2,200	2,600
2007	1,100	1,900	2,300	
2008	1,250	1,725		

- The 48-to-ultimate development factor for claim counts is 1.010.
- The 48-to-ultimate development factor for reported severity is 1.025.
- The selected annual frequency trend is +2.0% for 2006 to 2009.
- The selected annual severity trend is -1.5% for 2006 to 2009.
- Volume-weighted averages are used to calculate development factors.
- Exposures have been constant and there is no exposure trend.

a. (3.25 points) Use the frequency-severity technique to calculate the expected ultimate claim cost estimate for accident year 2009.

b. (0.75 point) State the three key assumptions underlying the frequency-severity technique.

2011 Exam Questions

26. (2.5 points) Given the following information as of December 31, 2010:

Accident	Incremental Closed Claim Counts		
Year	72 Months	84 Months	96 Months
2003	2,000	2,000	1.000
2004	3,000	2,000	
2005	3,000		

Accident	Incremental Paid Claims (000s)		
Year	72 Months	84 Months	96 Months
2003	$20,000	$28,000	$25,000
2004	$33,000	$36,000	
2005	$36,000		

- Selected annual severity trend = 10%

a. (2 points) Use the volume-weighted average to estimate the trended tail severity for maturity ages of 72 months and older.

b. (0.5 point) Briefly describe two considerations in selecting the maturity age at which to combine data for estimating a tail factor.

2011 Exam Questions - continued:

28. (1.75 points) Given the following:

Cumulative Total Closed Claim Counts				
Accident Year	12 Months	24 Months	36 Months	48 Months
2007	550	700	800	840
2008	700	855	925	
2009	625	800		
2010	675			

Cumulative Claim Counts Closed with No Payment				
Accident Year	12 Months	24 Months	36 Months	48 Months
2007	30	80	105	120
2008	55	105	130	
2009	35	60		
2010	40			

Accident Year	Projected Ultimate Severity per Claim Closed with Payment
2007	$3350
2008	$3400
2009	$3275
2010	$3450

- Assume no further closed claim development after 48 months.
- Use an all-year volume-weighted average for all factor selections.

Use the frequency-severity technique to estimate the ultimate claim amount for accident year 2010.

2012 Exam Questions :

20. (3 points) Given the following:

Cumulative Reported Claim Counts

Accident Year	12 Months	24 Months	36 Months
2009	210	312	320
2010	221	340	
2011	212		

Cumulative Reported Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$1,175	$2,100	$2,375
2010	$1,210	$2,305	
2011	$1,215		

- Assume no reported claim count development or claim development after 36 months.

Use a frequency-severity technique to estimate the ultimate claim amount for accident year 2011.

Solutions to Sample Questions:

1. The methods discussed in Friedland's chapters 7 through 10 could all be applied to data compiled on an aggregate basis. How does the technique discussed in chapter 11 differ?

   Chapter 11 discusses methods that examine claim frequency and severity components separately, instead of looking only at total aggregate claims (as in the Development, Expected Claims, B-F and CC methods). In addition, some f-s methods using incremental development techniques.

2. Friedland shows 3 Frequency-Severity approaches:

   #1) Development Technique with Claim Counts and Severities,

   Same procedure as applied to aggregate claims in Chapter 7, but applied separately to the frequency and severity components. The ultimate counts and ultimate severities are multiplied to find the estimated Ultimate Claims.

   #2) Incorporation of Exposures and Inflation into Methodology #1:

   For example, may involve trending both frequency and severity components.

   #3) Disposal Rate Technique

   The mechanics of this method are quite different from #1.

   -In addition to calculating the ultimate claim count frequency, we also need "disposal rates."

   -Incremental paid severities are restated / incorporating trend.

   See older (2007 and prior) exam questions for Adler-Kline and Fisher-Lange, as examples.

3. Define the "Disposal Rate" that is used in projecting the frequency of claims.

   Friedland defines "the <u>**cumulative**</u> **closed claim count** for each accident year-maturity … divided by the selected **ultimate** claim count for the particular accident year." See past exam questions, but be careful since a previous syllabus reading (Fisher-Lange) defined "disposal rates" as incremental ratios …

4. What does Friedland mean by "completing the square" ?

   If the actual data (either frequencies or severities) through the most recent valuation is arranged as a **triangle**: When we make estimates for the future values, we can use those projections to extend the original triangle to form a **square**.

5. Summarize Friedland's key points re: "When the Frequency-Severity Techniques Work and When they Do

   Friedland discusses 4 advantages:

   (1) Where development methods can be unstable, inaccurate, or unreliable for less mature years, Frequency-Severity methods can provide an alternative.

   (2) Freq-Sev methods offer insight into the claims process (claims reporting and settling)

   (3) Since the ultimate claims are calculated without depending on case-outstanding reserves, any changes in the reserving strategy or philosophy surrounding case reserves will not distort Freq-Sev methods.

   (4) Freq-Sev methods allow for inflation to be considered explicitly (which also leads to a disadvantage).

   Friedland discusses 4 disadvantages:

   (1) Freq-Sev methods can be highly sensitive to the inflation assumption.

   (2) Freq-Sev methods require more data than aggregate methods, may be unavailable

   (3) Also, the data available may not be relevant due to changes in the ways claims are defined or processed

   (4) Freq-Sev methods can be distorted by a mix of claims (types/causes) that is not relatively consistent

6. Use the Frequency-Severity Development technique, along with select data from Friedland's Chapter 11 Exhibits for the Auto Collision Insurer (as given below), to answer the following questions.

Note: No adjustments for exposures or severity trend are made.

(A) Given Frequency

		Reported Claim Counts: Data Triangle				
Accident Half Year	**Period Ending**	**1st report 6 mo.**	**2nd report 12 mo.**	**3rd report 18 mo.**	**4th report 24 mo.**	**5th report 30 mo.**
2006	30-Jun	2,808	2,712	2,704	2,701	2,700
2006	31-Dec	2,799	2,675	2,670	2,668	
2007	30-Jun	2,578	2,533	2,529		
2007	31-Dec	2,791	2,778			
2008	30-Jun	3,139				

(B) ATA and CDF Frequency

		Reported Claim Counts: Age-to-Age Factors				
Accident Half Year	***Period Ending***	***1st to 2nd 6:12 mo***	***2nd to 3rd 12:18 mo***	***3rd to 4th 18:24 mo***	***4th to 5th 24:30 mo***	***See Tail Below***
2006	*30-Jun*	*0.9658*	*0.9971*	*0.9989*	*0.9996*	
2006	*31-Dec*	*0.9557*	*0.9981*	*0.9993*		
2007	*30-Jun*	*0.9825*	*0.9984*			
2007	*31-Dec*	*0.9953*				*Given*
3-period simple avg ATA		*0.9778*	*0.998*	*0.999*	*0.9996*	*1.000*
Development Age		***6 mo.***	***12 mo.***	***18 mo.***	***24 mo.***	***30 mo.***
CDF to Ultimate		*0.9745*	*0.9966*	*0.9987*	*0.9996*	*1.0000*

(C) Est. Ultimate Frequency

Accident Half Year	***6 mo. Period Ending***	***Age of Data at 6/30/08***	***Reported Counts at 6/30/08***	***CDF to Ultimate***	***Estimated Ultimate Counts***
		(1)	*(2) from (A)*	*(3) from (B)*	*(4)=(2)*(3)*
2006	*30-Jun*	*30 months*	*2,700*	*1.000*	*2,700.0000*
2006	*31-Dec*	*24 months*	*2,668*	*0.9996*	*2,666.9328*
2007	*30-Jun*	*28 months*	*2,529*	*0.9987*	*2,525.7123*
2007	*31-Dec*	*12 months*	*2,778*	*0.9966*	*2,768.5548*
2008	*30-Jun*	*6 months*	*3,139*	*0.9745*	*3,058.9555*

Note: Friedland performs this work twice: on closed claims and on reported claims, and considers both in selecting the Ultimate Claim Counts in Exhibit I, sheet 3.

Solution to Sample Question 6 (continued)

6b. Project Ultimate Severity using the Frequency-Severity *Development* technique

(D) Given Claims

		Reported Claims ($000s): Data Triangle				
Accident Half Year	**Period Ending**	**1st report 6 mo.**	**2nd report 12 mo.**	**3rd report 18 mo.**	**4th report 24 mo.**	**5th report 30 mo.**
2006	30-Jun	11,947	11,856	11,820	11,772	11,760
2006	31-Dec	12,503	12,762	12,706	12,697	
2007	30-Jun	11,662	11,523	11,492		
2007	31-Dec	12,647	12,854			
2008	30-Jun	14,071				

*(E) =(D)/(A) * 1000 Severities*

MUST DIVIDE FOR …		*Reported Severity: Data Triangle (calculated)*				
Accident Half Year	***Period Ending***	***1st report 6 mo.***	***2nd report 12 mo.***	***3rd report 18 mo.***	***4th report 24 mo.***	***5th report 30 mo.***
2006	*30-Jun*	*4,254.6296*	*4,371.6814*	*4,371.3018*	*4,358.3858*	*4,355.5556*
2006	*31-Dec*	*4,466.9525*	*4,770.8411*	*4,758.8015*	*4,758.9955*	
2007	*30-Jun*	*4,523.6618*	*4,549.1512*	*4,544.0886*		
2007	*31-Dec*	*4,531.3508*	*4,627.0698*			
2008	*30-Jun*	*4,482.6378*				

(F) ATA and CDF Severities

		Severities: Age-to-Age Factors				
Accident Half Year	***Period Ending***	***1st to 2nd 6:12 mo***	***2nd to 3rd 12:18 mo***	***3rd to 4th 18:24 mo***	***4th to 5th 24:30 mo***	***See Tail Below***
**** 2005 ****	*31-Dec*	*1.115*	*1.001*	*0.9985*	*0.9990*	
2006	*30-Jun*	*1.0275*	*0.9999*	*0.997*	*0.9994*	
2006	*31-Dec*	*1.0680*	*0.9975*	*1.000*		
2007	*30-Jun*	*1.0056*	*0.9989*			
2007	*31-Dec*	*1.0211*				*Given*
*Medial Avg 5x1 ATA **		*1.0389*	*0.999*	*0.9985*	*0.999*	*1.000*
Development Age		***6 mo.***	***12 mo.***	***18 mo.***	***24 mo.***	***30 mo.***
CDF to Ultimate		*1.0361*	*0.9973*	*0.9979*	*0.9994*	*1.0000*

** "Medial Avg 5x1" requires 5 periods, and excludes the highest and lowest ATA factor.*
*For the 5th period, ATA factors for the **12-31-05 period are added** to the table above.*
Example: 6 mo. Medial Avg 5x1 = [1.0275+1.0680+1.0211] / 3 = 1.0389
1.115 and 1.006 are taken out, leaving only three medial factors.

(G) Est. Ultimate Severities

Accident Half Year	***6 mo. Period Ending***	***Age of Data at 6/30/08***	***Reported Severities 6/30/08***	***CDF to Ultimate***	***Estimated Ultimate Severities***
		(1)	*(2) from (E)*	*(3) from (F)*	*(4)=(2)*(3)*
2006	*30-Jun*	*30 months*	*4,355.5556*	*1.0000*	*4,355.5556*
2006	*31-Dec*	*24 months*	*4,758.9955*	*0.9994*	*4,756.1401*
2007	*30-Jun*	*28 months*	*4,544.0886*	*0.9979*	*4,534.5460*
2007	*31-Dec*	*12 months*	*4,627.0698*	*0.9973*	*4,614.5767*
2008	*30-Jun*	*6 months*	*4,482.6378*	*1.0361*	*4,644.4610*

Solution to Sample Question 6 (continued)

6c. Project Ultimate Claims using the Frequency-Severity *Development* technique

(H)=(C)(G)*
Ultimate Claims

Accident Half Year	*6 mo. Period Ending*	*Estimated Ultimate Counts*	*Estimated Ultimate Severities*	*Product of Frequency and Severity (/1000) = Est. Ultimate Claims*
		(1) = (C4)	*(2) = (G4)*	*(3) = (1) * (2) / 1000*
2006	*30-Jun*	*2,700.0000*	*4,355.5556*	*11,760.0001*
2006	*31-Dec*	*2,666.9328*	*4,756.1401*	*12,684.3060*
2007	*30-Jun*	*2,525.7123*	*4,534.5460*	*11,452.9586*
2007	*31-Dec*	*2,768.5548*	*4,614.5767*	*12,775.7085*
2008	*30-Jun*	*3,058.9555*	*4,644.4610*	*14,207.1995*
Estimated Ult. Claims for Accident Periods 1/1/06 thru 6/30/08				*62,880.1727*

6d. Develop IBNR Estimates ($000) using the Frequency-Severity *Development* technique

(I)=(H)-(D)
IBNR

Accident Half Year	*6 mo. Period Ending*	*Estimated Ultimate Claims*	*Reported Claims at 6/30/08*	*Estimated IBNR (broadly defined to include IBNER)*
		(1) = (H3)	*(2) from (D)*	*(3) = (1) - (2)*
2006	*30-Jun*	*11,760.0001*	*11,760*	*0.0001*
2006	*31-Dec*	*12,684.3060*	*12,697*	*-12.6940*
2007	*30-Jun*	*11,452.9586*	*11,492*	*-39.0414*
2007	*31-Dec*	*12,775.7085*	*12,854*	*-78.2915*
2008	*30-Jun*	*14,207.1995*	*14,071*	*136.1995*
Estimated IBNR for Accident Periods 1/1/02 thru 6/30/08				*6.1727*

Note: Compare to Exhibit 1, Sheet 8 in Friedland's Chapter 11, which also includes a total Unpaid Claims estimate. Rounding differences exist.

Solutions to 2001 Exam Questions (modified):

33. Calculate the cumulative claim payments for accident year 2000 at 24 and 36 months of development. Assume 5% future annual inflation and no partial payments. Show all work.

Note: Extra detail included to show the steps of the Disposal Rate method.

Disposal Rate Method STEP 1: Select Ultimate Claim Counts by year

(A) GIVEN (otherwise could same procedure as for development method)

Accident Year	*Cumulative Claim Counts*			
	Age of Development (Months)			
	12	*24*	*36*	*Ultimate*
1998				*1,000*
1999				*1,200*
2000				*1,300*

Solution to 2001 #33 (continued):

Disposal Rate Method STEP 2A: Select Disposal Rates

(B) GIVEN (otherwise find as Cumulative closed counts / Ultimate counts)

Accident Year	Selected Disposal Rates Age of Development (Months) 12	24	36	Ultimate
1998				
1999				
2000				
Selected	30%	72%	100%	100%

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

Important: This step is included in the formula Friedland gives for calculating projected incremental claim counts for accident year X at age Y using the Freq Sev Disposal Rate Method: (ultimate claim counts for accident year X - cumulative closed claim counts for accident year x along the latest diagonal)
/ (1 - selected disposal rate at maturity of latest diagonal)
x (disposal rate at y - disposal rate at [prior y])

(C) = [Difference in consecutive selections in (B)] / [1.0 minus earlier in (B)]

Accident Year	Conditional Factor from Disposal Rates Age of Development (Months) 0 to 12	12 to 24	24 to 36	
1998	30.0%	60.0%	100.0%	
1999	30.0%	60.0%	100.0%	
2000	30.0%	60.0%	100.0%	
Selected*	30.0%	60.0%	100.0%	

**Based on selected disposal rates. Example: 60% = (72% - 30%) / (1 - 30%)*

STEP 3: Project Claim Counts (Incremental)

(D) = [Factor selected in (C)] [(A) ultimate - all prior entries for (D)]*

WARNING: This can be tricky to do in one step.

Accident Year	Incremental Claim Counts (incl projections) Age of Development (Months) 0 to 12	12 to 24	24 to 36	
1998	300	420	280	
1999	360	504	336	
2000	390	***546***	***364***	

*Example: 390 = 30% * [1300 - 0] and 546 = 60% * [1300 - 390]*
*… and 364 = 100% * [1300 - 390 - 546]*

*STEP 4A: To analyze severities, first need Incremental **Claims** to date*
(E) Given cumulative claims, we can calculate the following:

Accident Year	Incremental Claims to date – Age of Development (Months) 12	24	36	
1998	300,000	630,000	560,000	
1999	396,000	793,800		
2000	471,900			

Solution to 2001 #33 (continued):

*STEP 4B: To analyze severities, next find Average **Severities** to date*
(F) = (E)/(D)

Accident Year	Actual Average Severities to date – Age of Development (Months) 12	24	36	
1998	1,000	1,500	2,000	
1999	1,100	1,575		
2000	1,210			

STEP 5: Project Severities, Incorporating trend
(G) Trend factors (given at 5% annually)

Accident Year	Trend Factors to 2000 (at given 5%) – Age of Development (Months) 12	24	36	
1998	1.103	1.103	1.103	
1999	1.050	1.050		
2000	1.000			

(H)=(F)(G)*

Accident Year	Trended Average Severities to date – Age of Development (Months) 12	24	36	
1998	1,103	1,654	2,205	
1999	1,155	1,654		
2000	1,210			
Selected at 2000 level		**1,654**	**2,205**	

(I) from (H) for AY 2000 only including selected projections

Accident Year	Trended Average Severities to date – Age of Development (Months) 12	24	36	
2000	1,210	1,654	2,205	

STEP 6A: Multiply Severities by Counts for Incremental Paid Claims
*(J) = (I) * (D)*

Accident Year	Estimated Total $ Claims (Projected) Age of Development (Months)			
	0 to 12	12 to 24	24 to 36	
1998				
1999				
2000	471,900	902,948	802,620	

Solution to 2001 #33 (continued):

STEP 6B: Add Across Incremental for Cumulative Paid Claims
(K) from (J)

Accident Year	Estimated Total $ Claims (Incl. Projected)			
	Age of Development (Months)			
	12	24	36	
1998				
1999				
2000	471,900	**1,374,848**	**2,177,468**	

Cumulative loss payments for accident year 2000:
at 24 months of development 1,374,848
at 36 months of development 2,177,468

Solutions to 2004 Exam Questions (modified):

Question 20. Using a Frequency-Severity Disposal Rate method, determine the projected ultimate payments for accident year 2003.

Show all work and state any additional assumptions.

Disposal Rate Method STEP 1: Select Ultimate Claim Counts by year
(A) Almost given (but need to cumulate the incremental counts)

Accident Year	Cumulative Claim Counts				
	Age of Development (Months)				
	12	24	36	48	Ultimate
2000	10	25	35	50	50
2001	17	29	46		60
2002	15	27			70
2003	13				70

Disposal Rate Method STEP 2A: Select Disposal Rates
(B) Calculate as Cumulative closed counts / Ultimate counts

Accident Year	Selected Disposal Rates				
	Age of Development (Months)				
	12	24	36	48	Ultimate
2000	20.0%	50.0%	70.0%	**100.0%**	100%
2001	28.3%	48.3%	**76.7%**		100%
2002	21.4%	**38.6%**			100%
2003	**18.6%**				100%
Selected*	**18.6%**	**38.6%**	**76.7%**	**100.0%**	

**Selected from latest diagonal. Note: If not told how to select, state your assumption. Friedland shows 3-yr and 5-yr simple average, and medial 5x1.*

Solution to 2004 #20 (continued):

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

DON'T FORGET THIS STEP.

(C) = [Difference in consecutive selections in (B)] / [1.0 minus earlier percent in (B)]

Accident Year	Conditional Factor from Disposal Rates (incremental) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2000	20.0%	37.5%	40.0%	100.0%	
2001	28.3%	27.9%	54.8%	use 100.0%	
2002	21.4%	21.8%	use 62.0%	use 100.0%	
2003	18.6%	use 24.6%	use 62.0%	use 100.0%	
Projection*	18.6%	24.6%	62.0%	100.0%	to use

** Note: These projections are based on the selected disposal rates above.*
Example: for 12 to 24 mo.: 24.6% = (38.6% - 18.6%) / (1 - 18.6%)

Disposal Rate Method STEP 3: Project Claim Counts (Incremental)

(D) = [Factor selected in (C)] [(A) ultimate - all prior entries for (D)]*

WARNING: This can be tricky to do in one step.

Accident Year	Incremental Claim Counts (incl projections) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2000	10	15	10	15	
2001	17	12	17	14.0	
2002	15	12	26.7	16.3	
2003	**13**	**14.0**	**26.7**	**16.3**	

Example for 2003: 13 = 18.6%[70 - 0] and 14 = 24.6%*[70 - 13] and*
. . . and 26.7 = 62%[70-13-14] and 16.3 = 100%*[70-13-14-26.7]*

*STEP 4A: To analyze severities, first need Incremental **Claims** to date*

(E) Given

Accident Year	Incremental Claims to date Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2000	10,000	12,500	15,000	25,000	
2001	20,000	26,000	30,000		
2002	18,000	25,000			
2003	16,000				

*STEP 4B: To analyze severities, next find Average **Severities** to date*

(F) = (E)/(D)

Accident Year	Actual Average Severities to date Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2000	1,000	833	1,500	1,667	
2001	1,176	2,167	1,765		
2002	1,200	2,083			
2003	1,231				

Solution to 2004 #20 (continued):

STEP 5: Project Severities, Incorporating trend

(G) Trend factors (given at 5% annually)

Accident Year	Trend Factors to 2003 (at given 5%)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2000	1.158	1.158	1.158	1.158	
2001	1.103	1.103	1.103		
2002	1.050	1.050			
2003	1.000				

(H)=(F)(G)*

Accident Year	Trended Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2000	1,158	965	1,736	**1,929**	
2001	1,297	2,389	**1,946**		
2002	1,260	**2,188**			
2003	**1,231**				
Selected Severity *		**2,188**	**1,946**	**1,929**	2003 level

**Selected from latest diagonal. Note: If not told how to select, state your assumption. Friedland shows 3-yr and 5-yr simple average, and medial 5x1.*

(I) from (H) for AY 2003 only including selected projections

Accident Year	Trended Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2000					
2001					
2002					
2003	1,231	2,188	1,946	1,929	

STEP 6A: Multiply Severities by Counts for Incremental Paid Claims

*(J) = (I) * (D)*

Accident Year	Estimated Total $ Claims (Projected)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2000					
2001					
2002					
2003	16,000	30,625	51,882	31,513	

STEP 6B: Add Across Incremental for Cumulative Paid Claims

(K) from (J)

Accident Year	Estimated Total $ Claims (Incl. Projected)				
	Age of Development (Months)				
	12	24	36	48	**SOLUTION**
2000					
2001					
2002					
2003	16,000	46,625	98,507	130,020	**130,020**

Solution to 2005 Exam Questions (modified):

14. (2 points) Using a Frequency-Severity Disposal Rate approach, what is the unpaid claims estimate as of December 31, 2004 for accident year 2003?

Disposal Rate Method STEP 1: Select Ultimate Claim Counts by year

(A) Almost given (but need to cumulate the incremental counts)

Accident Year	Cumulative Claim Counts – Age of Development (Months) 12	24	36	48	Ultimate
2001	260	1030	1460	1630	1,630
2002	310	1,020	1,540		1,640
2003	250	930			1,760
2004	340				1,690

Disposal Rate Method STEP 2A: Select Disposal Rates

(B) Calculate as Cumulative closed counts / Ultimate counts

Accident Year	Selected Disposal Rates – Age of Development (Months) 12	24	36	48	Ultimate
2001	16.0%	63.2%	89.6%	100.0%	100%
2002	18.9%	62.2%	93.9%		100%
2003	14.2%	52.8%			100%
2004	20.1%				100%
Selected*	***20.1%***	***52.8%***	***93.9%***	***100.0%***	

**Selected from latest diagonal. Note: If not told how to select, state your assumption. Friedland shows 3-yr and 5-yr simple average, and medial 5x1.*

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

DON'T FORGET THIS STEP . . . Only need 2003 here.

(C) = [Difference in consecutive selections in (B)] / [1.0 minus earlier percent in (B)]

Accident Year	Conditional Factor from Disposal Rates (incremental) – Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2003	***14.2%***	***45.0%***	**use 87.1%**	**use 100.0%**	
*Projections**			*87.1%*	*100.0%*	*to use*

* Note: These projections are based on the selected disposal rates above.
Example for 24 to 36 mo.: 87.1% = (93.9% - 52.8%) / (1 - 52.8%)

Solution to 2005 #14 (continued):

Disposal Rate Method STEP 3: Project Claim Counts (Incremental)
(D) = [Factor selected in (C)] [(A) ultimate - all prior entries for (D)]*
WARNING: This can be tricky to do in one step . . . Only need 2003 here.

Accident Year	Incremental Claim Counts (incl projections) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2003	**250**	**680**	**722.7**	**107.3**	

*Example: 250 = 14.2% * [1760 - 0] and 680 = 45% * [1760 - 250] . . .*
*722.7 = 87.1% * [1760 - 250 - 680] and 107.3 = 100%*[1760-250-680-722.7]*

STEPS 4 & 5: Analyze and Select Severities (simplified here since given amounts to use)
(E) Given . . . Only need 2003 here.

Accident Year	Average Severities (given 0% inflation here) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2001	560	830	1,530	2,000	
2002	560	830	1,530	2,000	
2003	**560**	**830**	**1,530**	**2,000**	
2004	560	830	1,530	2,000	

STEP 6: Multiply Severities by Counts for Incremental Paid Claims
*(F) = (D) * (E) . . . For Accident Year 2003*

Accident Year	Estimated Total $ Claims (Including Projected) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2003	**140,000**	**564,400**	**1,105,705**	**214,634**	

STEP 7: Determine Unpaid Claims Estimate
(G) = (F) Projections only . . . For Accident Year 2003

Accident Year	Estimated Total $ Claims (Future Projected Only) Age of Development (Months) 12	24	36	48	**SOLUTION** Est. Unpaid
2003			**1,105,705**	**+214,634=**	**1,320,339**

Solution to 2007 Exam Questions (modified):

Question 35. Using a Frequency-Severity Disposal Rate approach, determine the projected ultimate payments for accident year 2006.

Disposal Rate Method STEP 1: Select Ultimate Claim Counts by year

(A) Almost given (but need to cumulate the incremental counts)

Accident Year	Cumulative Claim Counts – Age of Development (Months)				
	12	24	36	48	Ultimate
2003	40	120	180	200	200
2004	48	144	216		240
2005	36	108			180
2006	44				220

Disposal Rate Method STEP 2A: Select Disposal Rates

(B) Calculate as Cumulative closed counts / Ultimate counts

Accident Year	Selected Disposal Rates – Age of Development (Months)				
	12	24	36	48	Ultimate
2003	20.0%	60.0%	90.0%	100.0%	100%
2004	20.0%	60.0%	90.0%		100%
2005	20.0%	60.0%			100%
2006	20.0%				100%
Selected	**20.0%**	**60.0%**	**90.0%**	**100.0%**	

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

DON'T FORGET THIS STEP.

(C) = [Difference in consecutive selections in (B)] / [1.0 minus earlier percent in (B)]

Accident Year	Conditional Factor from Disposal Rates (incremental) – Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	20.0%	50.0%	75.0%	100.0%	
2004	20.0%	50.0%	75.0%	use 100.0%	
2005	20.0%	50.0%	use 75.0%	use 100.0%	
2006	20.0%	use 50.0%	use 75.0%	use 100.0%	
Projection*	20.0%	50.0%	75.0%	100.0%	to use

* Note: These projections are based on the selected disposal rates above.
Example: for 12 to 24 mo.: 50% = (60% - 20%) / (1 - 20%)

Solution to 2007 #35 (continued):

Disposal Rate Method STEP 3: Project Claim Counts (Incremental)

(D) = [Factor selected in (C)] [(A) ultimate - all prior entries for (D)]*

WARNING: This can be tricky to do in one step.

Accident Year	Incremental Claim Counts (incl projections)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	40	80	60	20	
2004	48	96	72	24.0	
2005	36	72	54.0	18.0	
2006	**44**	**88.0**	**66.0**	**22.0**	

Example for 2006: 44 = 20%[220 - 0] and 88 = 50%*[220 - 44] and*
. . . and 66 = 75%[220-44-88] and 22 = 100%*[220-44-88-66]*

*STEP 4A: To analyze severities, first need Incremental **Claims** to date*

(E) Given

Accident Year	Incremental Claims to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	40,000	100,000	90,000	40,000	
2004	50,000	118,000	108,000		
2005	38,000	90,000			
2006	45,000				

*STEP 4B: To analyze severities, next find Average **Severities** to date*

(F) = (E)/(D)

Accident Year	Actual Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	1,000	1,250	1,500	2,000	
2004	1,042	1,229	1,500		
2005	1,056	1,250			
2006	1,023				

STEP 5: Project Severities, Incorporating trend

(G) Trend factors (given at 10% annually)

Accident Year	Trend Factors to 2003 (at given 5%)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2003	1.331	1.331	1.331	1.331	
2004	1.210	1.210	1.210		
2005	1.100	1.100			
2006	1.000				

Solutions to 2007 #35 (continued):

(H)=(F)(G)*

Accident Year	Trended Average Severities to date – Age of Development (Months): 0 to 12	12 to 24	24 to 36	36 to 48	
2003	1,331	1,664	1,997	**2,662**	
2004	1,260	1,487	**1,815**		
2005	1,161	**1,375**			
2006	**1,023**				
Selected Severity *		**1,375**	**1,815**	**2,662**	2006 level

**Selected from latest diagonal. Note: If not told how to select, state your assumption. Friedland shows 3-yr and 5-yr simple average, and medial 5x1.*

(I) from (H) for AY 2006 only including selected projections

Accident Year	Trended Average Severities to date – Age of Development (Months): 0 to 12	12 to 24	24 to 36	36 to 48	
2003					
2004					
2005					
2006	**1,023**	**1,375**	**1,815**	**2,662**	

STEP 6A: Multiply Severities by Counts for Incremental Paid Claims

*(J) = (I) * (D)*

Accident Year	Estimated Total $ Claims (Projected) – Age of Development (Months): 0 to 12	12 to 24	24 to 36	36 to 48	
2003					
2004					
2005					
2006	**45,000**	**121,000**	**119,790**	**58,564**	

STEP 6B: Add Across Incremental for Cumulative Paid Claims

(K) from (J)

Accident Year	Estimated Total $ Claims (Incl. Projected) – Age of Development (Months): 12	24	36	48	**Solution**
2003					
2004					
2005					
2006	45,000	166,000	285,790	344,354	**344,354**

Solution to 2008 #3 (modified):

Using a Frequency-Severity "Disposal Rate" method:
Estimate unpaid claims as of 12/31/07. Show all work.

STEP 1: Create Cumulative Triangle & Select Ultimate Counts

(A) Almost given (but need to cumulate the incremental counts)

Accident Year	Cumulative Claim Counts				
	Age of Development (Months)				
	12	24	36	48	Ultimate
2004	500	800	950	1,000	1,000
2005	600	960	1,140		1,200
2006	750	1,200			1,500
2007	900				1,800

STEP 2A: Select Disposal Rates

(B) Calculate as Cumulative closed counts / Ultimate counts

Accident Year	Selected Disposal Rates				
	Age of Development (Months)				
	12	24	36	48	Ultimate
2004	50.0%	80.0%	95.0%	100.0%	100%
2005	50.0%	80.0%	95.0%		100%
2006	50.0%	80.0%			100%
2007	50.0%				100%
Selected	50.0%	80.0%	95.0%	100.0%	

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

DON'T FORGET THIS STEP.

(C)= [Difference in consecutive selections in (B)] / [1.0 minus earlier % in (B)]

For all Accident Years Projections*	Conditional Factor from Disposal Rates (incremental)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
	50.0%	60.0%	75.0%	100.0%	to use

** Note: These projections are based on the selected disposal rates above.*
Example: for 12 to 24 mo.: 60% = (80% - 50%) / (1 - 50%)

Disposal Rate Method STEP 3: Project Claim Counts (Incremental)

(D) = [Factor selected in (C)]* [(A) ultimate - all prior entries for (D)]
WARNING: Can be tricky to do in one step …
May want to practice combining steps 2 & 3.

Accident Year	Incremental Claim Counts (incl projections)				
	Age of Development (Months)				FYI
	0 to 12	12 to 24	24 to 36	36 to 48	Ultimate
2004	500	300	150	50	1000
2005	600	360	180	60	1200
2006	750	450	225	75	1500
2007*	**900**	**540**	**270**	90	**1,800**

** Example for 2007: **900** as given; **540** = 60%*[1800-900];*
. . . 270 = 75%[1800-900-540] and **90** = 100%*[1800-900-540-270]*

Solution to 2008 #3 (continued):

*STEP 4A: To analyze severities, first need Incremental **Claims** to date*

(E) Given

Accident Year	Incremental Claims to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2004	400	300	180	75	
2005	504	378	227		
2006	662	496			
2007	833				

*STEP 4B: To analyze severities, next find Average **Severities** to date*

(F) = (E)/(D)

Accident Year	Actual Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2004	0.800	1.000	1.200	1.500	
2005	0.840	1.050	1.260		
2006	0.883	1.102			
2007	0.926				

STEP 5: Project Severities, Incorporating trend

(G) Trend factors (given at 5% annually)

Accident Year	Trend Factors to 2007 (at given 5%)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2004	1.158	1.158	1.158	1.158	
2005	1.103	1.103	1.103		
2006	1.050	1.050			
2007	1.000				

(H)=(F)(G)*

Accident Year	Trended Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2004	0.926	1.158	1.389	1.736	
2005	0.926	1.158	1.389		
2006	0.927	1.157			
2007	0.926				
Selected Severity *		1.158	1.389	1.736	at '07 level

*Note: Nice here, but if not clear how to select, state your assumption.

Solution to 2008 #3 (continued):

(I) based on (H) for AY 2007 **and de-trended at 5% for prior years**
HERE, WE ONLY NEED TO LOOK AT PROJECTED AMOUNTS

Accident Year	Trended Average Severities to date				**Notes**
	Age of Development (Months)				Selected 07 Severity Divided by
	0 to 12	12 to 24	24 to 36	36 to 48	
2004					
2005				1.575	1.05^2
2006			1.323	1.654	1.05^1
2007		1.158	1.389	1.736	$1.05^0 = 1$

STEP 6A: Multiply Severities by Counts for Incremental Paid Claims
*(J) = (I) * (D)*

Accident Year	Estimated Total $ Claims (Projected)				Estimated Unpaid Claims
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2004					0.000
2005				94.500	94.500
2006			297.675	124.031	421.706
2007		625.065	375.071	156.279	1,156.415
2008					1,672.621

($000's)

Solutions to 2009

Question 4 – Model Solution

a. Expected incremental closed claim counts for periods 60-72 and 72-ultimate for accident year 2004.

For AY x at Age y, projected incremental closed claim counts are computed as follows:

[(ultimate claim counts for AY x – cumulative closed claim counts for AY x along latest diagonal) / (1.00 – selected disposal rate at maturity of latest diagonal)] x [disposal rate at y – disposal rate at y-1]

AY 2004 60 – 72:	(400 – 375) × (.98-.95) / (1-.95) = 15
AY 2004 72 – Ult:	25 × (1-.98)/(1-.95) = 10

b. (1.5 points) Using a 6% annual trend factor, estimate the 60-ultimate tail severity at 2008 levels.

Solution 1: 60-ultimate tail severity = [Incremental paid losses (60-72)/incremental closed claims] * 1.06^{2008-t}

Using AY 2003 data:

- incremental paid losses (60-72) = 6,200 – 5,675 = 525
- incremental closed claims (60-72) = (400 – 375) × (.98-.95) / (1-.95) = 15

2008 level 60-ultimate tail severity = [525/15] * 1.06^5 = 46,838

Solution 2: 60-ultimate tail severity = [Incremental paid losses (60-72)/incremental closed claims] * 1.06^{2008-t}

Using AY 2003 and 2004 data:

Incremental closed claim counts:

AY	60	72
2003	44	15
2004	12	

44=395-351. The sum of these counts = 44+15+12=71

Trended incremental paid claims (000)

AY	60	72
2003	1061.21	702.57
2004	568.11	

1061.21 = (5,675 – 4,882)×1.06^5. The sum of these losses = 1,061.21+702.57+568.11 = 2,331.89

2008 level (in 000s) 60-ultimate tail severity = 2,331.89 / 71 = 32.84

c. (1.5 points) Estimate the ultimate losses for accident year 2004.

Solution 1: 2004 ultimate loss = Cumulative paid loss at 60 months + Incremental paid loss from 60-72

2004 Incremental paid loss from 60-72 = Tail severity at 2004 levels * Incremental cnts (60-72)

= ($6,200 – $5,675)/15 × 1.06 = $37,100; 400 – 375 = 25

2004 ultimate loss = $6,250,000 + $37,100 * 25 = $6,250,000 + $927,500 = 7,177,500

Solution 2: 2004 ultimate loss = Cumulative paid loss at 60 months + Incremental paid loss from 60-72

= 6,250 + [15 + 10] × 32.84/1.06^4 = 6,900.31 in (000s)

Solutions to 2010 Exam Questions

16a. (3.25 points) Use the frequency-severity technique to calculate the expected ultimate claim cost estimate for accident year 2009.

16b. (0.75 point) State the three key assumptions underlying the frequency-severity technique.

Question 16 - Solution 1

AY 2009 Expected Ultimate Claim Cost

= AY09 Trended and Developed Claim Count * AY09 Trended and Developed Severity

1. Compute Reported Claim Count Link Ratios

12-24	24-36	36-48	48-ult
1.213	1.200	1.071	1.010
12-ult	24-ult	36-ult	48-ult
1.575	1.298	1.082	1.010

2. Compute trended and developed claim counts.

AY	data	ATU	trend	Trended ult
2006	375	1.010	1.02^3	402
2007	370	1.082	1.02^2	416
2008	310	1.298	1.02	410
Select				409

3. Compute Reported Severity = Reported Claims / Claim Count

AY	12	24	36	48
2006	5,000	6,000	6,286	$6,933
2007	4,400	5,429	6,216	
2008	$4,167	5,565		

4. Compute Reported Severity Link Ratios

12-24	24-36	36-48	48-ult
1.253	1.094	1.103	1.025
12-ult	24-ult	36-ult	48-ult
1.550	1.237	1.131	1.025

5. Compute trended and developed severities

AY	Reported Sev	ATU	trend	Trended Ult
2006	6,933	1.025	0.985^3	$6,791
2007	6,216	1.131	0.985^2	$6,821
2008	5,565	1.237	0.985	$6,781
				$6,798

AY09 Trended and Developed Claim Count * AY09 Trended and Developed Severity

AY 09 Expected Ultimate Claim Cost = 409 × $6,798 = 2,780,382

b1. Definition of claim counts is consistent throughout experience period.

b2. Development of future claim is similar to development of prior claims.

b3. Mix of claim type is relatively consistent.

Solutions to 2010 exam questions continued:

16a. (3.25 points) Use the frequency-severity technique to calculate the expected ultimate claim cost estimate for accident year 2009.

16b. (0.75 point) State the three key assumptions underlying the frequency-severity technique.

Question 16 - Solution 2

a. Selected Rpt Claim Count Dev Factors

	12-24	24-36	36-48	48– ult
	1.213	1.20	1.071	1.01
To-ult	1.575	1.298	1.082	1.01

	AY Ult. Claim Counts	Freq Trend to 2009 Level
06	(375)(1.01) = 379	379 × 1.02^3 = 402
07	(370)(1.082) = 400	400 × 1.02 ^2 = 416
08	(310)(1.298) = 402	402 × 1.02 = 410

Rept Severities

AY	12	24	36	48
06	5000	6000	6286	6933
07	4400	5429	6216	
08	4167	5565		

Selected Age-to-age

	12-24	24-36	36-48	48– ult
	1.253	1.094	1.103	1.025
To-ult	1.550	1.237	1.131	1.025

AY	Ult. Severities	Sev Trend to 2009 Level
06	7106	7106× 0.985^3 = 6791
07	7030	7030 × 0.985 ^2 = 6821
08	6884	6884 × .985 = 6781

Selected ultimate claims = 409 (straight average of 06-08)

Selected ultimate Severity = 6798

2009 Estimated ult claim cost = 409 × 6798 = 2,780,382

b1. The definition of a claim is consistent over historical period used

b2. The mix of types of claims used is consistent

b3. Claims and claim count will continue to develop in a similar manner in the future as they have in historical periods.

Solutions to questions from the 2011 exam:

26a. (2 points) Use the volume-weighted average to estimate the trended tail severity for maturity ages of 72 months and older.

26b. (0.5 point) Briefly describe two considerations in selecting the maturity age at which to combine data for estimating a tail factor.

Question 26 – Model Solution

Intial comments: See Exh V, S9 - Development of Trended Severity (at ages 60 and older and 72 and older)

1. A triangle of incremental closed claim counts for maturities 60 through 96 months is given (from E5S6).
2. A triangle of incremental paid claims for these same maturities is given (from E5S6).
3. Adjusted paid claims using the 5% annual severity trend to bring all payments to the 2008 cost level.
4. Estimated trended tail severity equals [sum trended claim payments]/[sum incremental closed claim counts].

a. Sum[incremental paid claims trended to 2010 @ 10% and divide by sum incremental closed claim counts]

$[(20{,}000)(1.10)^7 + (28{,}000)(1.10)^7 + (25{,}000)(1.10)^7 + (33{,}000)(1.10)^6 + (36{,}000)(1.10)^6 + (36{,}000)(1.10)^5]/$
$[2{,}000 + 2{,}000 + 1{,}000 + 3{,}000 + 2{,}000 + 3{,}000] \times 1{,}000 = \boxed{24{,}806}$

b. 1. Consider the age at which the data becomes erratic.

2. Consider the % of claims expected to closed beyond the selected age.

28. Use the frequency-severity technique to estimate the ultimate claim amount for accident year 2010.
Ult Claim Am for AY 2010 = $Proj Ult Severity per Clm Clsd with Payment * Ult Claim Count with Payment

Question 28 – Model Solution 1

1. Compute: Closed claim with payment triangle

AY	12	24	36	48
2007	520	620	695	720 = 840-120
2008	645	750	795	
2009	590	740		
2010	675-40 = 635			

2. Compute volume weighted avg for LDF selections

12-24 = (620 + 750 + 740) / (520 + 645 + 590) = 1.2023

24-36 = (695 + 795) / (620 + 750) = 1.08759

36-48 = 720 / 695 = 1.0359

LDF to ULT (12-ULT) = 1.2023(1.08759)(1.0359) = 1.35465

3. Compute Ult claim count with payment for AY 2010 = 1.35465(635) = 860.2

4. Ult Claim Amount for AY 2010 = Proj Ult Severity per Clm Clsd with Payment * Ult claim count with payment

AYT 2010 Ult Claim Amount = $3,450 * 860.2 = $\boxed{2{,}967{,}690}$

Solutions to 2011 exam questions:

Question 28 – Model Solution 2

Ult Claims = Ult Sev x Ult Count

Cum. Claim count closed with payment = total closed - total closed with no payment

AY	12	24	36	48
07	520	620	695	720
08	645	750	795	
09	590	740		
10	635			

Compute age to age and age to ultimate LDFs

12-24	24-36	36-48
(620 + 750 + 740) / (520 + 645 + 590) = 1.202	1.088	1.036
CLDF 1.355	1.127	1.036

AY	Ult Severity	Count	Age-Ult LDF	Ult Count	Ult Claims = Ult Sev x Ult Count
07	\$3,350	720	1	720	\$2,412,000
08	3,400	795	1.036	824	2,801,600
09	3,275	740	1.127	834	2,731,350
10	\$3,450	635	1.355	860	\$2,967,000

AY10 Ult claim amount = \$2,967,000

Solutions to 2012 exam questions:

20. Use a frequency-severity technique to estimate the ultimate claim amount for accident year 2011.

Question 20 – Model Solution 1 (Exam 5B Question 5)

AY 2011 Ultimate claims = AY 2011 Ultimate Severity * AY 2011 Ultimate Claim Count

	Reported	Claim Count	Age-to-age
	12-24	24-36	36-ult.
2009:	1.486	1.026	
2010:	1.538		

Selected:	1.512	1.026	1.000 => selected = straight average
Cumulative:	1.551	1.026	1.000
			Ultimate claim count 2011 = 212* 1.551 = **329**

Severities= Cum. Reported Claims/Cum Reported Counts

	12	24	36
2009:	5595	6731	7442
2010:	5475	6779	
2011	5731		

5,731 = 1,215,000/212

Severities Age-to-Age

	12-24	24-36	36-ult
2009:	1.203	1.103	
2010:	1.238		
Average=Selected:	1.221	1.103	1.000
Cumulative:	**1.346**	**1.103**	**1.000**

*Ult Severities

2009	7,422 * 1.00 = 7,422
2010	6,779 * 1.10 = 7,477
2011	**5,731** * 1.346 =**7,714**

*Ultimate claims 2011 = **7,714 * 329 = 2,537,906**

Solutions to 2012 exam questions:

20. Use a frequency-severity technique to estimate the ultimate claim amount for accident year 2011.

Question 20 – Model Solution 2 (Exam 5B Question 5)

Link Ratios (claim counts)

	12-24	24-36	36-ult
Selected (vol wtd)	1.5128	1.0256	1.000
CDF Ult	1.5515	1.0256	1.000

Ult claims (AY11) = 1.5515 x 212 = **329**

Disposal Rates = Cumulative Rptd/ Proj ult

AY	@12		@24	@36	ult
09	0.65625	= 210/330	0.975	1.0000	320
10	0.6332		0.9742	1.000	349=340x1.0256
11	0.6444		0.975		329
Selected	0.6446				

Projected Rptd Counts: (AY11)

@12 =212

@24 =(.975-.6446/1-.6446)(329-212) = **109**

@36 =329 – 109 – 212 = **8**

Avg Severity = Incremental Rptd Claim/ Incremental closed counts

AY	@12	@24	@36
09	5595	9069	34375
10	5475	*9202	
11	5731		
Selected (Simple Avg)			
	5600	**9136**	**34,375**

$$* = \frac{(2305000 - 1210000)}{340 - 221}$$

Ult Claims AY 2011 = 1,215,000 + 109 (9,136) + 8 (34,375) = 2,485,824

Examiner's Comments

The question was straightforward with a majority of candidates receiving full credit.

Candidates lost points for:

using 12-24 age-to-age factor (as opposed to 12-ultimate factor) to derive ultimate counts or ultimate severity, mixing incremental approach with cumulative approach,

using just the reported claim (loss) dollars triangle given in the question as severity triangle as opposed to the approach of deriving the severity triangle, or derive 2011 ultimate counts by taking average of 2009 and 2010 (and sometimes also 2011) ultimate counts.

1 Case O/S Development Technique – Approach #1 265 - 268

Key Assumptions

- Claims activity related to IBNR is related in a consistent manner to claims already reported.
- Assumptions similar to those for the development techniques also apply to the case (O/S) development technique.

Common Uses

- This method is appropriate when applied to lines of insurance for which most of the claims are reported in the first accident period. Therefore, claims-made coverages and report year analysis use the case O/S technique because the claims for a given AY are known at the end of the AY.
- The assumption that IBNR claim activity is related to claims already reported (i.e. development on known claims versus pure IBNR) limits its use, and so it is not used extensively by actuaries.

Mechanics of the Method

Exhibit I, Sheet 1: The development triangles for case O/S and incremental paid claims.

These are derived from the reported and paid claim triangles in Chapter 7.

Chapter 12 - Case Outstanding Development Technique
U.S. Industry Auto
Case Outstanding and Incremental Paid Claims ($000)

Exhibit I
Sheet 1

Accident Year	Case Outstanding as of (months) 12	24	36	48	60	72	84	96	108	120
1998	18,478,233	9,937,970	5,506,911	2,892,519	1,440,783	767,842	413,097	242,778	169,222	98,117
1999	18,544,291	9,955,034	5,623,522	3,060,431	1,520,760	764,736	443,528	284,732	185,233	
2000	19,034,933	10,395,464	5,969,194	3,217,937	1,567,806	842,849	457,854	304,704		
2001	19,401,810	10,487,914	5,936,461	3,056,202	1,532,147	777,926	421,141			
2002	20,662,461	11,176,330	6,198,509	3,350,967	1,609,188	785,497				
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690					
2004	21,047,539	11,150,459	6,316,995	3,201,985						
2005	21,260,172	11,087,832	6,141,416							
2006	20,973,908	11,034,842								
2007	21,623,594									

Accident Year	incremental paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1998	18,539,254	14,691,785	6,830,969	3,830,031	2,004,496	868,887	455,900	225,555	108,579	88,731
1999	20,410,193	15,680,491	7,168,718	3,899,839	2,049,291	953,511	463,714	253,051	121,726	
2000	22,120,843	16,855,171	7,413,268	4,173,103	2,172,895	1,004,821	544,233	248,891		
2001	22,992,259	17,103,939	7,671,637	4,326,081	2,269,520	1,015,365	499,620			
2002	24,092,782	17,702,531	8,108,490	4,449,081	2,401,492	1,052,839				
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453					
2004	24,369,770	17,120,093	7,746,815	4,537,994						
2005	25,100,697	17,601,532	7,942,765							
2006	25,608,776	17,997,721								
2007	27,229,969									

Exhibit I, Sheet 2: Ratio of Incremental Paid Claims to Previous Case Outstanding

Calculate the ratio of the incremental paid claims at age x to the case O/S at age x-12.

This ratio tells us the proportion of claims that were paid during the development interval (i.e. age x-12 to age x) on the claims O/S at the beginning of the age (i.e. age x-12).

Chapter 12 - Case Outstanding Development Technique Exhibit I
U.S. Industry Auto Sheet 2
Ratio of Incremental Paid Claims to Previous Case Outstanding

Accident	Ratio of Incremental Paid Claims to Previous Case Outstanding as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	To Ult
1998		0.795	0.687	0.695	0.693	0.603	0.594	0.546	0.447	0.524	
1999		0.846	0.720	0.693	0.670	0.627	0.606	0.571	0.428		
2000		0.885	0.713	0.699	0.675	0.641	0.646	0.544			
2001		0.882	0.731	0.729	0.743	0.663	0.642				
2002		0.857	0.726	0.718	0.717	0.654					
2003		0.821	0.691	0.705	0.684						
2004		0.813	0.695	0.718							
2005		0.828	0.716								
2006		0.858									
2007											

Averages of the Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Simple Average											
Latest 5		0.836	0.712	0.714	0.698	0.638	0.622	0.553	0.437	0.524	
Latest 3		0.833	0.701	0.714	0.714	0.653	0.631	0.553	0.437	0.524	
Medial Average											
Latest 5x1		0.835	0.712	0.714	0.692	0.641	0.624	0.546	0.437	0.524	

Selected Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Selected		0.833	0.701	0.714	0.714	0.653	0.631	0.553	0.437	0.524	1.100

AY 1998 ratio of incremental paid claims (12-24 months) to previous case O/S (at 12 months):

Incremental paid claims were $14,691,785 between the 12-24 month interval (labeled 24 months in the development triangle).

Case O/S at 12 months was $18,478,233.

Thus, 79.5% (i.e. $14,691,785/$18,478,233) of the case O/S at 12 months results from the incremental payment in the 12-to-24 month interval.

AY 2004 ratio of incremental paid claims (24-36 months) to previous case O/S (at 24 months):

Incremental paid claims were $7,746,815 between the 24-36 month interval.

Case O/S at 24 months was $11,150,459.

Thus, 69.5% (i.e. $7,746,815/$11,150,459) of the case O/S at 24 months results from the incremental payment in the 24-36 month interval.

Selected ratios are based on the simple average of the latest 3 years.

A judgmentally selected ratio of 1.10 for the ratio to ultimate was made (this assumes that 10% more than the case O/S at 120 months will ultimately be paid out).

Exhibit I, Sheet 3: Ratio of Case Outstanding to Previous Case Outstanding

The ratios = case O/S at age x / case O/S at age x-12.

Chapter 12 - Case Outstanding Development Technique Exhibit I
U.S. Industry Auto Sheet 3
Ratio of Case Outstanding to Previous Case Outstanding

Accident Year	Ratio of Case Outstanding to Previous Case Outstanding as of (months) 12	24	36	48	60	72	84	96	108	120	To Ult
1998		0.538	0.554	0.525	0.498	0.533	0.538	0.588	0.697	0.580	
1999		0.537	0.565	0.544	0.497	0.503	0.580	0.642	0.651		
2000		0.546	0.574	0.539	0.487	0.538	0.543	0.666			
2001		0.541	0.566	0.515	0.501	0.508	0.541				
2002		0.541	0.555	0.541	0.480	0.488					
2003		0.527	0.577	0.536	0.476						
2004		0.530	0.567	0.507							
2005		0.522	0.554								
2006		0.526									
2007											

Averages of the Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Simple Average											
Latest 5		0.529	0.564	0.528	0.488	0.514	0.551	0.632	0.674	0.580	
Latest 3		0.526	0.566	0.528	0.486	0.511	0.555	0.632	0.674	0.580	
Medial Average											
Latest 5x1		0.527	0.562	0.530	0.488	0.515	0.542	0.642	0.674	0.580	

Selected Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Selected		0.526	0.566	0.528	0.486	0.511	0.555	0.632	0.674	0.580	0

AY 1998 at 24 months:

Case O/S for AY 1998 is $9,937,970 at 24 months and $18,478,233 at 12 months.

.538 = $9,937,970/$18,478,233 is the ratio of the case O/S at 24 months to case O/S at 12 months.

AY 2004 at 24 months:

Case O/S for is $6,316,995 at 36 months and $11,150,459 at 24 months.

.567 = $6,316,995/$11,150,459 is the ratio of the case O/S at 36 months to case O/S at 24 months.

Selected ratios are based on the simple average of the latest 3 years.

A judgmentally selected ratio of 0.10 for the ratio to ultimate was made (this assumes that there will be no case O/S remaining for 132 months and later).

A challenge of this technique: Selection of the "to ultimate" ratios for both the ratio of incremental paid claims to previous case O/S and the ratio of case O/S to previous case O/S.

The goal of the case O/S development method: To project ultimate claims based on completing the square of incremental paid claims, which are related to the case O/S at the beginning of an interval.

Next step: Complete the square of the case O/S triangle (used to project the incremental paid claims).

Use selected ratios of case O/S to previous case O/S (from Exhibit I, Sheet 3) to project the case O/S for each AY and age (in Exhibit I, Sheet 4.)

U. S. Industry Auto Exhibit I
Projection of Paid Claims ($000) Sheet 4

Accident	Case Outstanding as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,478,233	9,937,970	5,506,911	2,892,519	1,440,783	767,842	413,097	242,778	169,222	98,117	0
1999	18,544,291	9,955,034	5,623,522	3,060,431	1,520,760	764,736	443,528	284,732	185,233	107,435	0
2000	19,034,933	10,395,464	5,969,194	3,217,937	1,567,806	842,849	457,854	304,704	205,370	119,115	0
2001	19,401,810	10,487,914	5,936,461	3,056,202	1,532,147	777,926	421,141	266,161	179,393	104,048	0
2002	20,662,461	11,176,330	6,198,509	3,350,967	1,609,188	785,497	435,951	275,521	185,701	107,707	0
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690	835,327	463,606	292,999	197,481	114,539	0
2004	21,047,539	11,150,459	6,316,995	3,201,985	1,556,165	795,200	441,336	278,924	187,995	109,037	0
2005	21,260,172	11,087,832	6,141,416	3,242,668	1,575,936	805,304	446,943	282,468	190,384	110,422	0
2006	20,973,908	11,034,842	6,245,721	3,297,740	1,602,702	818,981	454,534	287,266	193,617	112,298	0
2007	21,623,594	11,374,010	6,437,690	3,399,100	1,651,963	844,153	468,505	296,095	199,568	115,749	0

Accident	Incremental Paid Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,539,254	14,691,785	6,830,969	3,830,031	2,004,496	868,887	455,900	225,555	108,579	88,731	107,929
1999	20,410,193	15,680,491	7,168,718	3,899,839	2,049,291	953,511	463,714	253,051	121,726	97,062	118,179
2000	22,120,843	16,855,171	7,413,268	4,173,103	2,172,895	1,004,821	544,233	248,891	133,156	107,614	131,026
2001	22,992,259	17,103,939	7,671,637	4,326,081	2,269,520	1,015,365	499,620	232,891	116,312	94,002	114,452
2002	24,092,782	17,702,531	8,108,490	4,449,081	2,401,492	1,052,839	495,649	241,081	120,403	97,307	118,477
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453	1,067,453	527,091	256,374	128,041	103,480	125,993
2004	24,369,770	17,120,093	7,746,815	4,537,994	2,286,217	1,016,176	501,771	244,059	121,890	98,509	119,941
2005	25,100,697	17,601,532	7,942,765	4,384,971	2,315,265	1,029,087	508,147	247,160	123,439	99,761	121,465
2006	25,608,776	17,997,721	7,735,424	4,459,444	2,354,587	1,046,564	516,777	251,357	125,535	101,455	123,528
2007	27,229,969	18,012,454	7,973,181	4,596,511	2,426,958	1,078,732	532,661	259,083	129,394	104,574	127,324

Accident	Cumulative Paid Claims as of (months										
Year	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,539,254	33,231,039	40,062,008	43,892,039	45,896,535	46,765,422	47,221,322	47,446,877	47,555,456	47,644,187	47,752,116
1999	20,410,193	36,090,684	43,259,402	47,159,241	49,208,532	50,162,043	50,625,757	50,878,808	51,000,534	51,097,596	51,215,775
2000	22,120,843	38,976,014	46,389,282	50,562,385	52,735,280	53,740,101	54,284,334	54,533,225	54,666,381	54,773,995	54,905,021
2001	22,992,259	40,096,198	47,767,835	52,093,916	54,363,436	55,378,801	55,878,421	56,111,312	56,227,624	56,321,626	56,436,079
2002	24,092,782	41,795,313	49,903,803	54,352,884	56,754,376	57,807,215	58,302,864	58,543,944	58,664,347	58,761,654	58,880,132
2003	24,084,451	41,399,612	49,070,332	53,584,201	55,930,654	56,998,107	57,525,198	57,781,572	57,909,613	58,013,093	58,139,086
2004	24,369,770	41,489,863	49,236,678	53,774,672	56,060,889	57,077,065	57,578,836	57,822,895	57,944,785	58,043,294	58,163,235
2005	25,100,697	42,702,229	50,644,994	55,029,965	57,345,230	58,374,316	58,882,463	59,129,623	59,253,061	59,352,822	59,474,287
2006	25,608,776	43,606,497	51,341,921	55,801,366	58,155,952	59,202,517	59,719,294	59,970,651	60,096,186	60,197,641	60,321,169
2007	27,229,969	45,242,423	53,215,604	57,812,115	60,239,072	61,317,804	61,850,464	62,109,548	62,238,941	62,343,515	62,470,839

AY 1999 projected case O/S at 120 months:

$107,435 equals 0.580 (selected ratio at 120 months) * $185,233 (case O/S at 108 months)

AY 2007 projected case O/S at 24 months:

$11,374,010 equals 0.526 (selected ratio at 24 months) * $21,623,594 (case O/S at 12 months)

Next Step: Use the selected ratios of incremental paid claims to case O/S to project incremental paid claims for all AYs and maturities. (See middle section of Exhibit I, Sheet 4.)

AY 2000 projected incremental payments for 120 months (i.e. the interval 108 to 120):

$107,614 = $205,370 x 0.524, where 0.524 is the selected ratio at 120 months and $205,370 is the case O/S at 108 months

AY 2006 incremental paid claims at 48 months:

$4,459,444 equals 0.714 (the selected ratio at 48 months) * $6,245,721 (case O/S at 36 months)

Note: The highlighted cells are the projected values; the others values are from the original data triangles

Next Step: Calculation of cumulative paid claims (see bottom section of Exhibit I, Sheet 4)

Projected ultimate claims (the sum of the incremental paid claims) appear in the "To Ult" column.

Ultimate claims are carried forward to Column (4) of Exhibit I, Sheet 5.

Final Step: Exhibit I, Sheet 5: Calculate estimated IBNR and the total unpaid claim estimate
These are calculated in the same manner as those shown in the preceding chapters.

Chapter 12 - Case Outstanding Development Technique Exhibit I
U.S. Industry Auto Sheet 5
Development of Unpaid Claim Ratio ($000)

					Unpaid Claim Estimate Based on Cape Outstanding Development Method	
Accident	Claims at 12/31/08		Projected Ultimate	Case Outstanding		
Year	Reported	Paid	Claims	at 12/31/08	IBNR	Total
(1)	(2)	(3)	(4)	(5) = [(2) - (3)]	(6) = [(4) - (2)]	(7) = [(4) - (3)]
1998	47,742,304	47,644,187	47,752,116	98,117	9,812	107,929
1999	51,185,767	51,000,534	51,215,775	185,233	30,008	215,241
2000	54,837,929	54,533,225	54,905,021	304,704	67,092	371,796
2001	56,299,562	55,878,421	56,436,079	421,141	136,517	557,658
2002	58,592,712	57,807,215	58,880,132	785,497	287,420	1,072,917
2003	57,565,344	55,930,654	58,139,086	1,634,690	573,742	2,208,432
2004	56,976,657	53,774,672	58,163,235	3,201,985	1,186,578	4,388,563
2005	56,786,410	50,644,994	59,474,287	6,141,416	2,687,877	8,829,293
2006	54,641,339	43,606,497	60,321,169	11,034,842	5,679,830	16,714,672
2007	48,853,563	27,229,969	62,470,839	21,623,594	13,617,276	35,240,870
Total	543,481,587	498,050,368	567,757,738	45,431,219	24,276,151	69,707,370

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) Developed in Exhibit I , Sheet 4.

Estimated IBNR equals projected ultimate claims minus reported claims; Total unpaid claim estimate equals projected ultimate claims less paid claims.

Compare the results of the case O/S development method with the reported and paid claim development projections from Chapter 7.

XYZ Insurer (Example shown in Exhibit II, Sheets 1 through 5)

Exhibit II, Sheets 1 – 5, following the exact same format as Exhibit I.

1. Exhibit II, Sheet 1: Given case O/S and incremental paid claim triangles.
2. Exhibit II, Sheet 2: Calculate the ratios of incremental paid claims to previous case O/S
3. Exhibit II, Sheet 3: Calculate ratios of case O/S to previous case O/S

   Given the operational and environmental changes noted in our discussions with management, selected ratios are based on the latest two years of experience (to reflect the most current operating environment for XYZ)
4. Exhibit II, Sheet 4: Complete the square for both case O/S and incremental paid claims.

   Projected ultimate claims using the case O/S development technique are based on the cumulative paid claims through all maturities.
5. Exhibit II, Sheet 5: Calculate estimated IBNR and the total unpaid claim estimate in Columns (6) and (7).

Exhibit II, Sheet 6 (projected ultimate claims) and Exhibit II, Sheet 7 (estimated IBNR).

These exhibits compare the results of the case O/S development technique method with the FS method, the Cape Cod method, the BF method, the expected claims method, and the development method.

Chapter 12 - Case Outstanding Development Technique Exhibit II
XYZ Insurer - Auto BI Sheet 6
Summary of Ultimate Claims ($000)

			Projected Ultimate Claims										
Accident	Claims at 12/31/08		Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822	15,822			15,822
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158	25,107	25,084			25,054
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841	37,246	37,071			36,913
2001	38,798	38,519	38,488	40,599	39,150	38,798	40,525	38,798	38,772		39,192	38,804
2002	48,169	44,437	48,314	49,592	47,906	48,312	49,417	48,313	48,666		46,869	48,796
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768	45,062	46,105		44,510	45,093
2004	70,288	52,811	74,786	80,537	86,509	75,492	82,593	74,756	76,606		71,947	74,874
2005	70,655	40,026	76,661	80,332	108,172	79,129	94,301	77,930	80,740		71,700	77,725
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205	58,758	64,510		50,077	58,666
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307	58,527	30,487	31,831	46,198
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,199	59,214	30,172	29,847	46,005
Total	449,626	330,627	514,929	605,028	561,516	513,207	554,469	504,298	551,117			513,949

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Exhibit II, Sheet 2.
(10) Developed in Chapter 11, Exhibit II, Sheet 6.
(11) Developed in Chapter 11, Exhibit IV, Sheet 3.
(12) Developed in Chapter 11, Exhibit VI, Sheet 7.
(13) Developed in Exhibit II, Sheet 4.

Chapter 12 - Case Outstanding Development Technique Exhibit II
XYZ Insurer - Auto BI Sheet 7
Summary of IBNR ($000)

	Case	Estimated IBNR									
Accident	Outstanding	Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	0	0	158	-162	0	155	0	0			0
1999	290	-25	57	-443	0	51	0	-23			-53
2000	465	-298	676	-2,011	0	595	0	-175			-333
2001	278	-310	1,801	352	0	1,727	0	-26		394	6
2002	3,731	145	1,423	-263	143	1,248	144	497		-1,300	627
2003	5,052	577	5,485	9,791	695	6,395	689	1,732		106	720
2004	17,477	4,498	10,249	16,221	5,204	12,305	4,468	6,318		1,618	4,586
2005	30,629	6,006	9,677	37,517	8,474	23,646	7,275	10,085		1,029	7,070
2006	25,985	9,566	23,304	21,982	11,600	22,401	9,954	15,706		1,109	9,862
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575	26,795	-1,245	73	14,466
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,567	40,582	11,540	11,196	27,373
Total	118,997	65,303	155,402	111,890	63,581	104,843	54,672	101,491			64,323

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Chapter 10, Exhibit II, Sheet 3.
(9) Estimated in Chapter 11, Exhibit II , Sheet 7.
(10) Estimated in Chapter 11, Exhibit IV, Sheet 3.
(11) Estimated in Chapter 11, Exhibit VI, Sheet 8.
(12) Estimated in Exhibit II, Sheet 5.

When the Case O/S Development Technique Works and When it Does Not

Limitations when using the case O/S development technique.

1. The assumption that future IBNR is related to claims already reported does not hold true for many lines of insurance.
2. The infrequent use and the absence of benchmark data (for AY applications of this method).
3. A lack of intuitive sense and experiential knowledge as to what ratios are appropriate at each maturity for both the incremental paid claims to previous case O/S and the case O/S to previous case O/S across lines of insurance.

2 Case O/S Development Technique – Approach #2 268 - 269

Self-Insurer Case Only: Assume that the only data available for our self-insurer is case O/S.

- This situation is not common, but it can occur (especially for older years).
- The absence of historical cumulative paid claims can arise following times of transition (e.g. mergers and acquisitions of corporations with self-insurance programs or consolidation of self-insured public entities.)
- Organizations that create self-insurance programs may only have current case O/S for claims in the process of investigation and settlement available for years prior to the start of the self-insurance program.

Key Assumptions

- The assumptions from Chapter 7 regarding the development technique are applicable in this example.
- Industry-based reporting and payment development patterns are used to derive case O/S development patterns.
- Claims recorded to date will develop in a similar manner in the future as our industry benchmark (i.e., the historical industry experience is indicative of the future experience for the self-insurer).

Common Uses

Used most often due to the absence of other reliable claims data for the purpose of developing an unpaid claim estimate.

Mechanics of the Method

The standard development technique is used with case O/S to project an estimate of total unpaid claims

- In the Self-Insurer Case Only example, there are no historical paid claims.
- Insurance industry benchmark development patterns are used to project the GL case O/S values that are available.
- Projected paid claims are estimates of unpaid claims and ***not*** ultimate claims.

The projection of the unpaid claim estimates for GL Self-Insurer Case Only is shown below:

Chapter 12 - Case Outstanding Development Technique Exhibit III
Self-Insurer Case Outstanding Only - General Liability
Development of Unpaid Claim Ratio ($000)

Accident Year	Case Outstanding at 12/31/08	CDF to Ultimate Reported	CDF to Ultimate Paid	CDF to Ultimate Case Outstanding	Unpaid Claim Estimate
(1)	(2)	(3)	(4)	(5)	(6)
1998	500,000	1.015	1.046	1.506	753,000
1999	650,000	1.020	1.067	1.454	945,100
2000	800,000	1.030	1.109	1.421	1,136,800
2001	850,000	1.051	1.187	1.445	1,228,250
2002	975,000	1.077	1.306	1.439	1,403,025
2003	1,000,000	1.131	1.489	1.545	1,545,000
Total	4,775,000				7,011,175

Column Notes:
(2) Based on data from Self-Insurer Case Outstanding Only.
(3) and (4) From Exhibit I, Sheet 2 in Chapter 8.
(5) = { [(3) - (1) * (4)]/ ((4) -(3))} +1
(6) = [(2) * (5)].

The following formula is used to develop the case O/S development factor:

$$\frac{\text{(Reported CDF to Ultimate - 1.00) x (Paid CDF to Ultimate)}}{\text{(Paid CDF to Ultimate - Reported CDF to Ultimate)}} + 1.00$$

The case development factor includes provisions for case O/S and IBNR (the broad definition of IBNR, which includes development on known claims). The estimated unpaid claims are shown in Column (6) and equal the current estimate of case O/S * the derived case O/S CDF to ultimate.

Potential Limitations

1. Benchmarks may prove to be inaccurate in projecting future claims experience for the insurer.
2. It is inappropriate for the more recent, less mature years due to the increased variability of results related to the highly leveraged development factors.
3. Large claims in the case O/S data can distort the results of projections based on this method.

Sample Questions:

1. Summarize Friedland's key points re: "When the Case Outstanding Development Technique Works and When it Does Not." Include 3 limitations of the method.
2. Friedland notes that the Case Outstanding Development technique is not extensively used. When is it most appropriate to use this method?
3. Based on the following information and using the Case Outstanding Development Technique, calculate an estimate of unpaid claims as of 12/31/08.

   Assume all claims are closed by 60 months and that the final "Ratio of Incremental Paid Claims to Previous Case Outstanding" is 1.0.

Report	Reported Claims as of Months			
Year	12	24	36	48
2005	23,000	24,000	24,800	24,786
2006	24,840	25,920	26,784	
2007	26,082	27,216		
2008	27,386			

Report	Paid Claims (cumulative)			
Year	12	24	36	48
2005	20,000	22,000	23,000	23,486
2006	21,600	23,760	25,056	
2007	22,680	24,948		
2008	23,814			

1995 Exam Questions (modified):

51. Given the following data, and assuming that all claims are reported within the first 12 months of an accident year (i.e., during the accident year): Use the Case Outstanding Development Technique to estimate ultimate claims by accident year.

    Assume all claims are closed by 60 months and that the final "Ratio of Incremental Paid Claims to Previous Case Outstanding" is 1.0.

Accident	Reported Claims as of Months			
Year	12	24	36	48
1990	131,800	189,145	204,764	212,850
1991	136,900	197,635	214,780	
1992	135,000	195,030		
1993	126,500			

Accident	Paid Claims (cumulative)			
Year	12	24	36	48
1990	52,300	116,800	159,900	196,400
1991	52,500	121,000	166,500	
1992	52,000	119,500		
1993	49,300			

1997 Exam Questions (modified):

9. T/F. The selection of a tail factor is not an issue when projecting the "Ratio of Case Outstanding to Previous Case Outstanding" described by Friedland.

2001 Exam Questions (modified):

32. (4 points) You are given the following information as of December 31, 2000:

Report Year	Case Outstanding as of Months			
	12	**24**	**36**	**48**
1997	200	150	75	25
1998	300	250	150	
1999	350	275		
2000	400			

Report Year	Paid Claims (incremental)			
	12	**24**	**36**	**48**
1997	100	75	70	50
1998	125	80	100	
1999	175	110		
2000	225			

Assume all claims are closed by 60 months and that the final "Ratio of Incremental Paid Claims to Previous Case Outstanding" is 1.25. Based on the Case Outstanding Development Technique, calculate the Ultimate Claim Estimates for report years 1997 through 2000. Show all work.

2003 Exam Questions (modified):

21. (1.5 points) You are given the following information:

- The accident year 2002 reported claims as of December 31, 2002 = $16,500,000.
- The accident year 2002 paid claims as of December 31, 2002 = $3,000,000.

Selected Ratios by Accident Year Development Interval:

"Ratio of Incremental Paid Claims to Previous Case Outstanding"

12-24	24-36	36-48	48-60	60 – Ult
0.55	0.55	0.50	0.64	1.03

"Ratio of Case Outstanding to Previous Case Outstanding"

12-24	24-36	36-48	48-60	60 – Ult
0.90	0.60	0.55	0.40	0.00

Using the Case Outstanding Development Technique, calculate the ultimate claims for Accident Year 2002.

2004 Exam Questions (modified):

8. You are given the following information:

- 2003 accident year reported claims as of December 31, 2003 = $20,000
- 2003 accident year case outstanding as of December 31, 2003 = $16,000

Selected Ratios by Accident Year Development Interval:

"Ratio of Incremental Paid Claims to Previous Case Outstanding"

12 to 24	24 to 36	36 to 48	48 to Ult
0.50	0.60	0.48	1.05

"Ratio of Case Outstanding to Previous Case Outstanding"

12 to 24	24 to 36	36 to 48	48 to Ult
0.80	0.70	0.55	0

Using the Case Outstanding Development Technique, find the ultimate claims for Accident Year 2003:

A. < $26,000
B. ≥ $26,000 but < $27,000
C. ≥ $27,000 but < $28,000
D. ≥ $28,000 but < $29,000
E. ≥ $29,000

2005 Exam Questions (modified):

22. (2 points) You are given the following information:

Report Year	Case Outstanding as of Months				
	12	24	36	48	60
2000	42,000	29,000	16,000	8,000	4,000
2001	45,000	33,000	19,000	9,000	
2002	44,000	30,000	18,000		
2003	45,000	32,000			
2004	39,000				

Report Year	Paid Claims (incremental)				
	12	24	36	48	60
2000	22,000	16,000	13,000	9,000	4,000
2001	24,000	17,000	14,000	10,000	
2002	25,000	19,000	15,000		
2003	27,000	18,000			
2004	24,000				

Using the Case Outstanding Development Technique, calculate the estimated Unpaid Claims for Report Year 2004 as of December 31, 2004.

Assume all claims are closed by 72 months and that the final "Ratio of Incremental Paid Claims to Previous Case Outstanding" is 1.0.

2010 Exam Questions:

2. (4 points) Given the following information:

Case Outstanding ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	3,860	4,630	4,500	3,565
2007	4,020	4,680	4,390	
2008	4,150	5,230		
2009	4,300			

Cumulative Paid Claims ($000)

Accident Year	12 Months	24 Months	36 Months	48 Months
2006	1,520	3,500	6,450	9,950
2007	2,150	3,760	6,760	
2008	1,790	3,390		
2009	2,000			

- Assume no further reported claim development after 48 months
- Use an all-year straight average for all factor selections

a. (3.5 points) Use Friedland's case outstanding development technique Approach #1 to estimate the paid loss for accident years 2006 through 2009 as of 48 months.

b. (0.5 point) Explain whether the case outstanding development technique is generally more suitable for accident year or report year analysis.

2011 Exam Questions:

29. (1.25 points) Given the following data as of December 31, 2010:

	Case Outstanding (000s)		
Accident Year	12 Months	24 Months	36 Months
2008	$1,200	$1,100	$450
2009	$1,500	$1,350	
2010	$1,650		

	Incremental Paid Claims (000s)		
Accident Year	12 Months	24 Months	36 Months
2008	$1,500	$960	$650
2009	$1,700	$1,200	
2010	$1,650		

- Selected ratio of case outstanding to previous case outstanding:

24 Months	36 Months	48 Months
0.90	0.40	0.00

- Selected ratio of incremental paid claims to previous case outstanding:

24 Months	36 Months	48 Months
0.80	0.60	1.05

- Assume no further closed claim development after 48 months

a. (1 point) Use the case outstanding development technique to estimate the ultimate claims for accident year 2009.

b. (0.25 point) Briefly describe when the case outstanding development technique is appropriate.

2012 Exam Questions:

19. (2 points) Given the following data as of December 31, 2011:

Accident Year	Case Outstanding Claims ($000s)	Paid Claims ($000s)
2009	$450	$3,200
2010	$1,350	$2,850
2011	$1,650	$1,900

- Selected ratio of case outstanding to previous case outstanding:

24 Months	36 Months	48 Months
0.90	0.30	0.00

- Selected ratio of incremental paid claims to previous case outstanding:

24 Months	36 Months	48 Months
0.80	0.60	1.05

- Assume no further closed claim development after 48 months.

a. (1.5 points) Use the case outstanding development technique to estimate unpaid claims for accident year 2011.

b. (0.5 point) Briefly describe two assumptions of this technique.

Solutions to Sample Questions:

1. Summarize Friedland's key points re: "When the Case Outstanding Development Technique Works and When it Does Not."

   Limitation 1: The assumption that "future IBNR is related to claims already reported" is often not true.

   Limitation 2: For accident year applications, the "infrequent use and absence of benchmark data" is also a drawback.

   Limitation 3: The "lack of intuitive sense and experiential knowledge" surrounding the ratios required by these methods.

2. Friedland notes that the Case Outstanding Development technique is not extensively used. It is most appropriate for lines or classes for which most of the claims are reported in the first accident period: Claims-Made coverages and Report Year analyses

3. Using the Case Outstanding Development Technique, estimate the unpaid claims:

(1)

Report	**Reported Claims as of Months**			
Year	**12**	**24**	**36**	**48**
2005	23,000	24,000	24,800	24,786
2006	24,840	25,920	26,784	
2007	26,082	27,216		
2008	27,386			

(2)

Report	**Paid Claims (cumulative)**			
Year	**12**	**24**	**36**	**48**
2005	20,000	22,000	23,000	23,486
2006	21,600	23,760	25,056	
2007	22,680	24,948		
2008	23,814			

(3) = (1) - (2)

Example: 2006 at 36m
= 26,784 -25,056
= 1,728

Report	***Case Outstanding as of Months***			
Year	***12***	***24***	***36***	***48***
2005	*3,000*	*2,000*	*1,800*	*1,300*
2006	*3,240*	*2,160*	*1,728*	
2007	*3,402*	*2,268*		
2008	*3,572*			

(4) = (2) - (2)prior

Example: 2006 at 36m
= 25,056-23,760
= 1,296

Report	***Paid Claims (incremental)***			
Year	***12***	***24***	***36***	***48***
2005	*20,000*	*2,000*	*1,000*	*486*
2006	*21,600*	*2,160*	*1,296*	
2007	*22,680*	*2,268*		
2008	*23,814*			

(5) = (4) / (3)prior

Example: 2006 at 36m
= 1296/2160
= 60%

Ratio: Paid Claims (incr) to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*n/a*	*66.7%*	*50.0%*	*27.0%*	
2006	*n/a*	*66.7%*	*60.0%*		
2007	*n/a*	*66.7%*			
2008	*n/a*				
Selected		***66.7%***	***55.0%***	***27.0%***	*100%*
Three-Year Simple Averages					*given*

(6) = (5) & projections
where projections
= selected ratio

Example: 2007 at 48m
= 27%

Complete the square: Ratios with Incremental Paids					*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*n/a*	*66.7%*	*50.0%*	*27.0%*	***100.0%***
2006	*n/a*	*66.7%*	*60.0%*	***27.0%***	***100.0%***
2007	*n/a*	*66.7%*	***55.0%***	***27.0%***	***100.0%***
2008	*n/a*	***66.7%***	***55.0%***	***27.0%***	***100.0%***

CAREFUL: These ratios apply to Case Outstanding, so we also need to "complete the square" for Case Outstanding before we can actually use these ratios.

To do so, we use another ratio - the Case Outstanding at a given age, divided by the Case Outstanding at the prior age. NOTE: It may be tempting to try to use 1 minus the ratio above, (the incremental Paid / prior Case Outstanding), but that logic only considers the effect that payments have on Case Outstanding, and ignores other changes in estimates.

(7) = (3) / (3)prior

Example: 2006 at 36m
= 1728/2160
= 80%

Ratio: Case Outstanding to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*n/a*	*66.7%*	*90.0%*	*72.2%*	
2006	*n/a*	*66.7%*	*80.0%*		
2007	*n/a*	*66.7%*			
2008	*n/a*	*0.0%*			
Selected		***66.7%***	***85.0%***	***72.2%***	*0%*
Three-Year Simple Averages					*definition*

(8) = (7) & projections
where projections
= selected ratio

Example: 2007 at 48m
= 72.2%

Complete the square: Ratios Case Outstanding / Prior					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*n/a*	*66.7%*	*90.0%*	*72.2%*	***0.0%***
2006	*n/a*	*66.7%*	*80.0%*	***72.2%***	***0.0%***
2007	*n/a*	*66.7%*	***85.0%***	***72.2%***	***0.0%***
2008	*n/a*	***66.7%***	***85.0%***	***72.2%***	***0.0%***

(9) = (3) & projections
where projections
*= (8) * (9) prior*

Example: 2007 at 48m
*.722 * 1,928 = 1,392*
*[.85 * 2,268 = 1,928]*

Complete the square: Case Outstanding & projections					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*3,000*	*2,000*	*1,800*	*1,300*	***0***
2006	*3,240*	*2,160*	*1,728*	***1,248***	***0***
2007	*3,402*	*2,268*	***1,928***	***1,392***	***0***
2008	*3,572*	***2,381***	***2,024***	***1,462***	***0***

Be sure to go out until the is no more case outstanding.
Otherwise, the cumulative paid will not equal ultimate claims.

NOW: We can go use those ratios we found in step (6), and project out the future INCREMENTAL claim payments

(10) = (4) & projected
where projected
*= (6) * **(9) prior***

Example: 2007 at 48m
*.27 * 1,928 = 521*

Complete the square: Incremental Paid & projections					*Final Paid*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2005	*20,000*	*2,000*	*1,000*	*486*	*1,300*
2006	*21,600*	*2,160*	*1,296*	***467***	*1,248*
2007	*22,680*	*2,268*	***1,247***	***521***	*1,392*
2008	*23,814*	***2,381***	***1,310***	***547***	*1,462*

Showing Ultimates: *as in Friedland*

To get to the Ultimate Claim amounts, we must use CUMULATIVE paids since the Estimated Total Claims Payments are the Estimated Ultimate Claims, by definition.

(11) = Sum across (10)

Year	*Cumulative Paid & Projections at Ultimate*					*Ultimate*
2005	*20,000*	*+ 2,000*	*+ 1,000*	*+ 486*	*+ 1,300*	***= 24,786***
2006	*21,600*	*+ 2,160*	*+ 1,296*	*+ 467*	*+ 1,248*	***= 26,771***
2007	*22,680*	*+ 2,268*	*+ 1,247*	*+ 521*	*+ 1,392*	***= 28,108***
2008	*23,814*	*+ 2,381*	*+ 1,310*	*+ 547*	*+ 1,462*	***= 29,513***
Total Estimate of Ultimate Claims using Case Outstanding Dev. Method						***109,178***

FINALLY: To get the total "unpaid claim estimate," do the subtraction below:

Year	***Estimated Ultimate Claims***	***Actual Paid to date***	***Total Unpaid Claims Estimate***
	(12) in (11)	*(13) in (2)*	*(14) = (12) - (13)*
2005	*24,786*	*23,486*	*1,300*
2006	*26,771*	*25,056*	*1,715*
2007	*28,108*	*24,948*	*3,160*
2008	*29,513*	*23,814*	*5,699*
Total			***11,874***

Shortcut: *If only asked for "Unpaid Claims Estimates," we can just add up the projected future payment amounts . . . No need to show the Ultimate claims.*

(10) Detail
Looking only at the Projected future payments gives us an *<u>Unpaid</u> Claim Estimate*

	Incremental Paid: Projections only				*Sum of*
Year	***24***	***36***	***48***	***60 or Ult.***	*Projections*
2005				*1,300*	*1,300*
2006			*467*	*+1,248=*	*1,715*
2007		*1,247*	*+521*	*+1,392=*	*3,160*
2008	*2,381*	*+1,310*	*+547*	*+1,462=*	*5,699*
Est. Unpaid Claims using Case Outstanding Dev. Method					*11,874*

Solutions to questions from the 1995 Exam (modified):

51. Use the Case Outstanding Development Technique to estimate ultimate claims by accident year. Assume all claims are closed by 60 months and that the final "Ratio of Incremental Paid Claims to Previous Case Outstanding" is 1.0.

(1) Given

Accident	**Reported Claims as of Months**			
Year	**12**	**24**	**36**	**48**
1990	131,800	189,145	204,764	212,850
1991	136,900	197,635	214,780	
1992	135,000	195,030		
1993	126,500			

(2) Given

Accident	**Paid Claims (cumulative)**			
Year	**12**	**24**	**36**	**48**
1990	52,300	116,800	159,900	196,400
1991	52,500	121,000	166,500	
1992	52,000	119,500		
1993	49,300			

(3) = (1) - (2)

Accident	***Case Outstanding as of Months***			
Year	***12***	***24***	***36***	***48***
1990	*79,500*	*72,345*	*44,864*	*16,450*
1991	*84,400*	*76,635*	*48,280*	
1992	*83,000*	*75,530*		
1993	*77,200*			

(4) = (2) - (2)prior

Accident	***Paid Claims (incremental)***			
Year	***12***	***24***	***36***	***48***
1990	*52,300*	*64,500*	*43,100*	*36,500*
1991	*52,500*	*68,500*	*45,500*	
1992	*52,000*	*67,500*		
1993	*49,300*			

Solutions to questions from the 1995 Exam #51 (continued):

(5) = (4) / (3)prior

Ratio: Paid Claims (incr) to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1990	*n/a*	*81.1%*	*59.6%*	*81.4%*	
1991	*n/a*	*81.2%*	*59.4%*		
1992	*n/a*	*81.3%*			
1993	*n/a*				
Selected		***81.2%***	***59.5%***	***81.4%***	*100%*
Three-Year Simple Averages					*given*

(6) = (5) & projections
where projections
= selected ratio

Complete the square: Ratios with Incremental Paids					*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1990	*n/a*	*81.1%*	*59.6%*	*81.4%*	***100.0%***
1991	*n/a*	*81.2%*	*59.4%*	***81.4%***	***100.0%***
1992	*n/a*	*81.3%*	***59.5%***	***81.4%***	***100.0%***
1993	*n/a*	***81.2%***	***59.5%***	***81.4%***	***100.0%***

CAREFUL: These ratios apply to Case Outstanding, so we also need the Case Outstanding projections before we can actually use these ratios.

(7) = (3) / (3)prior

Ratio: Case Outstanding to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	
1990	*n/a*	*91.0%*	*62.0%*	*36.7%*	
1991	*n/a*	*90.8%*	*63.0%*		
1992	*n/a*	*91.0%*			
1993	*n/a*	*0.0%*			
Selected		***90.9%***	***62.5%***	***36.7%***	*0%*
Three-Year Simple Averages					*definition*

(8) = (7) & projections
where projections
= selected ratio

Complete the square: Ratios Case Outstanding / Prior					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***
1990	*n/a*	*91.0%*	*62.0%*	*36.7%*	***0.0%***
1991	*n/a*	*90.8%*	*63.0%*	***36.7%***	***0.0%***
1992	*n/a*	*91.0%*	***62.5%***	***36.7%***	***0.0%***
1993	*n/a*	***90.9%***	***62.5%***	***36.7%***	***0.0%***

(9) = (3) & projections
where projections
*= (8) * (9) prior*

Complete the square: Case Outstanding & projections					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1990	*79,500*	*72,345*	*44,864*	*16,450*	***0***
1991	*84,400*	*76,635*	*48,280*	***17,703***	***0***
1992	*83,000*	*75,530*	***47,211***	***17,311***	***0***
1993	*77,200*	***70,200***	***43,880***	***16,089***	***0***

Be sure to go out until the is no more case outstanding.
Otherwise, the cumulative paid will not equal ultimate claims.

Solutions to questions from the 1995 Exam #51 (continued):

NOW: We can go use those ratios we found in step (6), and project out the future INCREMENTAL claim payments

(10) = (4) & projected *where projected = (6) * **(9) prior***

Complete the square: Incremental Paid & projections					All paid at
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1990	*52,300*	*64,500*	*43,100*	*36,500*	***16,450***
1991	*52,500*	*68,500*	*45,500*	***39,279***	***17,703***
1992	*52,000*	*67,500*	***44,921***	***38,410***	***17,311***
1993	*49,300*	***62,691***	***41,751***	***35,700***	***16,089***

To get to the Ultimate Claim amounts, we must use CUMULATIVE paid amounts, since Estimated Total Claims Payments are the Estimated Ultimate Claims, by definition.

(11) = Sum across (10)

Year	*Cumulative Paid & Projections at Ultimate*					*Ultimate*
1990	*52,300*	*+ 64,500*	*+ 43,100*	*+ 36,500*	*+ 16,450*	***= 212,850***
1991	*52,500*	*+ 68,500*	*+ 45,500*	*+ 39,279*	*+ 17,703*	***= 223,482***
1992	*52,000*	*+ 67,500*	*+ 44,921*	*+ 38,410*	*+ 17,311*	***= 220,141***
1993	*49,300*	*+ 62,691*	*+ 41,751*	*+ 35,700*	*+ 16,089*	***= 205,531***
Total Estimate of Ultimate Claims using Case Outstanding Dev. Method						***862,004***

Solutions to questions from the 1997 Exam (modified):

9. The selection of a tail factor is not an issue when projecting the "Ratio of Case Outstanding to Previous Case Outstanding" described by Friedland. True, the key ratio in this method is not a "tail factor" but the "Ratio of Incremental Paid Claims to Previous Case Outstanding" factor for the last settlement interval.

Solutions to questions from the 2001 Exam (modified):

32. Based on the Case Outstanding Development Technique, calculate the Ultimate Claim Estimates for report years 1997 through 2000. Show all work.

(1) GIVEN

Report	**Case Outstanding as of Months**			
Year	**12**	**24**	**36**	**48**
1997	200	150	75	25
1998	300	250	150	
1999	350	275		
2000	400			

(2) GIVEN

Report	**Paid Claims (incremental)**			
Year	**12**	**24**	**36**	**48**
1997	100	75	70	50
1998	125	80	100	
1999	175	110		
2000	225			

Solution to questions from the 2001 Exam #32 (continued):

(3) = (2) / (1)prior

Ratio: Paid Claims (incr) to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*n/a*	*37.5%*	*46.7%*	*66.7%*	
1998	*n/a*	*26.7%*	*40.0%*		
1999	*n/a*	*31.4%*			
2000	*n/a*				
Selected		***31.9%***	***43.3%***	***66.7%***	*125%*
Three-Year Simple Averages					*given*

(4) = (3) & projections

Complete the square: Ratios with Incremental Paids					*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*n/a*	*37.5%*	*46.7%*	*66.7%*	***125.0%***
1998	*n/a*	*26.7%*	*40.0%*	***66.7%***	***125.0%***
1999	*n/a*	*31.4%*	***43.3%***	***66.7%***	***125.0%***
2000	*n/a*	***31.9%***	***43.3%***	***66.7%***	***125.0%***

CAREFUL: These ratios apply to Case Outstanding, so we also need the Case Outstanding projections before we can actually use these ratios.

(5) = (1) / (1)prior

Ratio: Case Outstanding to PRIOR Case Outstanding					
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*n/a*	*75.0%*	*50.0%*	*33.3%*	
1998	*n/a*	*83.3%*	*60.0%*		
1999	*n/a*	*78.6%*			
2000	*n/a*	*0.0%*			
Selected		***79.0%***	***55.0%***	***33.3%***	*0%*
Three-Year Simple Averages					*definition*

(6) = (5) & projections

Complete the square: Ratios Case Outstanding / Prior					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*n/a*	*75.0%*	*50.0%*	*33.3%*	***0.0%***
1998	*n/a*	*83.3%*	*60.0%*	***33.3%***	***0.0%***
1999	*n/a*	*78.6%*	***55.0%***	***33.3%***	***0.0%***
2000	*n/a*	***79.0%***	***55.0%***	***33.3%***	***0.0%***

(7) = (1) & projections
where projected
*= (6) * (7)prior*

Complete the square: Case Outstanding & projections					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*200*	*150*	*75*	*25*	*0*
1998	*300*	*250*	*150*	***50***	*0*
1999	*350*	*275*	***151***	***50***	*0*
2000	*400*	***316***	***174***	***58***	*0*

NOW: We can go use those ratios we found in step (4), and project out the future INCREMENTAL claim payments

(8) = (2) & projected
where projected
*= (4) * **(7)prior***

Complete the square: Incremental Paid & projections					*Final Paid*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
1997	*100*	*75*	*70*	*50*	*31*
1998	*125*	*80*	*100*	***100***	*63*
1999	*175*	*110*	***119***	***101***	*63*
2000	*225*	***127***	***137***	***116***	*72*

Solution to questions from the 2001 Exam #32 (continued):

To get to the Ultimate Claim amounts, we must use CUMULATIVE paid amounts, since Estimated Total Claims Payments are the Estimated Ultimate Claims, by definition.

(9) = Sum across (8)

Year	*Cumulative Paid & Projections at Ultimate*					*Ultimate*
1997	*100*	*+ 75*	*+ 70*	*+ 50*	*+ 31*	***= 326***
1998	*125*	*+ 80*	*+ 100*	*+ 100*	*+ 63*	***= 468***
1999	*175*	*+ 110*	*+ 119*	*+ 101*	*+ 63*	***= 568***
2000	*225*	*+ 127*	*+ 137*	*+ 116*	*+ 72*	***= 678***
Total Estimate of Ultimate Claims using Case Outstanding Dev. Method						***2,039***

Solutions to questions from the 2003 Exam (modified):

21. Using the Case Outstanding Development Technique, calculate the ultimate claims for Accident Year 2002.

(1) = Reported - (2)

	Case Outstanding as of Months			
Year	**12**			
2002	13,500,000	= 16,500,000 - 3,000,000		

(2) Given

	Paid Claims (incremental)			
Year	**12**			
2002	3,000,000			

(3) Given

Ratio: Paid Claims (incr) to PRIOR Case Outstanding						*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2002	*n/a*					
Selected		***55.0%***	***55.0%***	***50.0%***	***64%***	***103%***
		given	*given*	*given*	*given*	*given*

CAREFUL: These ratios apply to Case Outstanding, so we also need the Case Outstanding projections before we can actually use these ratios.

(4) Given

Ratio: Case Outstanding to PRIOR Case Outstanding						*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2002	*n/a*					
Selected		***90.0%***	***60.0%***	***55.0%***	***40%***	***0.0%***
		given	*given*	*given*	*given*	*definition*

(5) = (1) & projected, where projected = (4) * (5)prior

Compute the Case Outstanding Projections						*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2002	*13,500,000*	*12,150,000*	*7,290,000*	*4,009,500*	*1,603,800*	*0*

NOW: We can use the ratios we found in step (3), and project out the future INCREMENTAL claim payments

(6) = (2) & projected, where projected = (3)*(5)prior

Compute the Incremental Paid Projections						*Final Paid*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2002	*3,000,000*	*7,425,000*	*6,682,500*	*3,645,000*	*2,566,080*	*1,651,914*

(7) = Sum across (6)

Year	***Calculate the Cumulative Paid Claim Projections at Ultimate***						*Ultimate*
2002	*3,000,000*	*+ 7,425,000*	*+ 6,682,500*	*+ 3,645,000*	*+ 2,566,080*	*+ 1,651,914*	*24,970,494*
Total Estimate of Ultimate Claims using Case Outstanding Dev. Method							***24,970,494***

Solutions to questions from the 2004 Exam (modified):

8. Using the Case Outstanding Development Technique, find ultimate claims for Accident Year 2003:

(1) Given

	Case Outstanding as of Months			
Year	***12***			
2003	*16,000*			

(2) = *Reported minus Case Outstanding*

	Paid Claims (incremental)			
Year	***12***			
2003	*4,000*	*= 20,000 - 16,000*		

(3) Given

Ratio: Paid Claims (incr) to PRIOR Case Outstanding					*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2003	*n/a*				
Selected		***50.0%***	***60.0%***	***48.0%***	***105%***
		given	*given*	*given*	*given*

CAREFUL: These ratios apply to Case Outstanding, so we also need the Case Outstanding projections before we can actually use these ratios.

(4) Given

Ratio: Case Outstanding to PRIOR Case Outstanding					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2003	*n/a*				
Selected		***80.0%***	***70.0%***	***55.0%***	***0%***
		given	*given*	*given*	*definition*

(5) = (1) & projected, where projected = (4) * (5)prior

Compute the Case Outstanding Projections					*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2003	*16,000*	*12,800*	*8,960*	*4,928*	*0*

NOW: We can use the ratios we found in step (3), and project out the future INCREMENTAL claim payments

(6) = (2) & projected, where projected = (3)*(5)prior

Compute the Incremental Paid Projections					*Final Paid*
Year	***12***	***24***	***36***	***48***	***60 or Ult.***
2003	*4,000*	*8,000*	*7,680*	*4,301*	*5,174*

(7) = Sum across (6)

Total Estimate of Ultimate Claims using Case Outstanding Dev. Method					
For 2003:	*4,000*	*+ 8,000*	*+ 7,680*	*+ 4,301*	*+ 5,174*
					29,155

Answer: E

Solutions to questions from the 2005 Exam (modified):

22. Using the Case Outstanding Development Technique, calculate the estimated Total Unpaid Claims.

(1) GIVEN

Report	**Case Outstanding as of Months**				
Year	**12**	**24**	**36**	**48**	**60**
2000	42,000	29,000	16,000	8,000	4,000
2001	45,000	33,000	19,000	9,000	
2002	44,000	30,000	18,000		
2003	45,000	32,000			
2004	39,000				

(2) GIVEN

Report	**Paid Claims (incremental)**				
Year	**12**	**24**	**36**	**48**	**60**
2000	22,000	16,000	13,000	9,000	4,000
2001	24,000	17,000	14,000	10,000	
2002	25,000	19,000	15,000		
2003	27,000	18,000			
2004	24,000				

(3) = (2) / (1)prior

Ratio: Paid Claims (incr) to PRIOR Case Outstanding						*Final Ratio*
Year	***12***	***24***	***36***	***48***	***60***	***72***
2000	*n/a*	*38.1%*	*44.8%*	*56.3%*	*50.0%*	
2001	*n/a*	*37.8%*	*42.4%*	*52.6%*		
2002	*n/a*	*43.2%*	*50.0%*			
2003	*n/a*	*40.0%*				
2004	*n/a*					
Selected		***39.8%***	***45.8%***	***54.4%***	***50%***	***100%***
Three-Year Simple Averages						

(4) = (3) & projections

Complete the square: Ratios with Incremental Paids						*Final Paid*
Year	***12***	***24***	***36***	***48***	***60***	***72***
2004	*n/a*	***39.8%***	***45.8%***	***54.4%***	***50.0%***	***100.0%***

CAREFUL: These ratios apply to Case Outstanding, so we also need the Case Outstanding projections before we can actually use these ratios.

(5) = (1) / (1)prior

Ratio: Case Outstanding to PRIOR Case Outstanding						*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2000	*n/a*	*69.0%*	*55.2%*	*50.0%*	*50.0%*	
2001	*n/a*	*73.3%*	*57.6%*	*47.4%*		
2002	*n/a*	*68.2%*	*60.0%*			
2003	*n/a*	*71.1%*				
2004	*n/a*					
Selected		***70.4%***	***57.6%***	***48.7%***	***50%***	***0%***
Three-Year Simple Averages						*definition*

(6) = (5) & projections (2004 only)

Complete the square: Ratios Case Outstanding / Prior						*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2004	*n/a*	***70.4%***	***57.6%***	***48.7%***	***50.0%***	***0.0%***

(7) = (1) & projections (2004 only) *where projections = (6) * (7)prior*

Complete the square: Case Outstanding & projections						*0 at Ult.*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2004	*39,000*	***27,463***	***15,814***	***7,699***	***3,849***	***0***

Be sure to go out until the is no more case outstanding.
Otherwise, the cumulative paid will not equal ultimate claims.

(8) = (2) & projected (2004 only) *where projections = (4) ** ***(7)prior***

Complete the square: Incremental Paid & projections						*Final Paid*
Year	***12***	***24***	***36***	***48***	***60***	***72 or Ult.***
2004	*24,000*	***15,508***	***12,565***	***8,609***	***3,849***	***3,849***

(9) = Sum across (8) for Unpaid Only (projections) for 2004

*Estimated Unpaid Claims = Sum of all **Projected** Future Payments*						*Unpaid*
Year	*24*	*36*	*48*	*60*	*72 or Ult.*	*Total*
2004	*15,508*	*12,565*	*8,609*	*3,849*	*3,849*	***= 44,381***

Solutions to questions from the 2010 Exam:

2a. (3.5 points) Use Friedland's case outstanding development technique Approach #1 to estimate the paid loss for accident years 2006 through 2009 as of 48 months.

2b. (0.5 point) Explain whether the case outstanding development technique is generally more suitable for accident year or report year analysis.

Question 2 – Model Solution

Step 1: Compute Case Outstanding (O/S) on Previous O/S

AY	12 - 24	24 - 36	36 - 48
2006	1.20	0.97	.79=3565/4500
2007	1.16	0.94	
2008	1.26		
Avg	1.21	0.96	0.79

Step 2: Compute Incremental Paid Claims

AY	12	24	36	48
2006	1,520	1,980	2,950	3,500
2007	2,150	1,610	3,000	
2008	1,790	1,600	=3390-1790	
2009	2,000			

Step 3: Compute Incr. Paid Claims to Previous Case O/S

AY	12 - 24	24 - 36	36 - 48
2006	0.51	0.64	0.78
2007	0.4	0.64	=3000/4680
2008	0.39		
Avg	0.43	0.64	0.78

Step 4: Compute Projected Case Outstanding

AY	12	24	36	48	
2006					
2007					
2008			5,020	=5230 * 0.96	
2009		5,203	4,994	=5203 * 0.96	

Step 5: Projected Incremental Paid Claims

AY	12	24	36	48	
2006					
2007				3,424	
2008			3,347	3,916	=5020 * 0.78
2009		1,849	3,330	3,896	=4994 * 0.78
			=5203 * 0.64		

Paid losses as of 48 Mos

AY		
2006	9,950	(given)
2007	10,184	=6760 + 3424
2008	10,653	=3390 + 3347 + 3916
2009	11,075	=2000 + 1849 + 3330 +3896

b. Report year since there is no Pure IBNR.

b. It's more suitable for reported year since it is more suitable when most losses are reported during the 1st year.

Solutions to questions from the 2011 Exam:

29a. (1 point) Use the case outstanding development technique to estimate the ultimate claims for AY 2009.

29b. (0.25 point) Briefly describe when the case outstanding development technique is appropriate.

Question 29 – Model Solution

Intial comments:

AY 09 ultimate claims = AY 09 incremental paid claims $_{\text{at 12mos}}$ + AY 09 incremental paid claims $_{\text{at 24 mos}}$
+ AY 09 incremental paid claims $_{\text{at 36mos}}$ + AY 09 incremental paid claims $_{\text{at 48 mos}}$

AY 09 incremental paid claims $_{\text{at 36mos}}$ = AY09 Case O/S at 24 mos * Selected ratio of incremental paid claims to previous case outstanding $_{\text{at 36mos}}$

AY 09 Case O/S $_{\text{at 36mos}}$ = AY09 Case O/S $_{\text{at 24 mos}}$ * Selected ratio of case O/S to to previous case O/S $_{\text{at 36mos}}$

AY 09 incremental paid claims $_{\text{at 48mos}}$ = AY09 Case O/$_{\text{S at 36 mos}}$ * Selected ratio of incremental paid claims to previous case outstanding $_{\text{at 48mos}}$

No further closed claim development after 48 months is assumed.

AY 09 incremental paid claims $_{\text{at 36mos}}$ = 1350 x .6 = 810

AY 09 Case O/S $_{\text{at 36mos}}$ = 1350 x .4 = 540

AY 09 incremental paid claims $_{\text{at 48mos}}$ = 540 x 1.05 = 567

a. ULT claims = 1700 + 1200 + 810 + 567 = $\boxed{4277}$

b. Usually used with claims made analysis since there is no pure IBNR

Question 29 – Model Solution 1 – Part b

b. When all you have available is case o/s data, for example due to the acquisition of another company.

Question 29 – Model Solution 2 – Part b

b. When the IBNR is consistently related to reported claims

Question 29 – Model Solution 3 – Part b

b. Appropriate when most of the claims are reported in the first AY period.

Solutions to questions from the 2012 Exam:

19a. (1.5 points) Use the case outstanding development technique to estimate unpaid claims for accident year 2011.
19b.(0.5 point) Briefly describe two assumptions of this technique.

Question 19 – Model Solution 1 (Exam 5B Question 4)

a. Projected case outstanding for 2011 (000s)

	12	24	36	48
AY 2011	1650	**1485** =**1650** x 0.9	**445.5** = 1485 x 0.3	

Paid Claims (000's)

	12	24	36	48
AY 2011	1800	1320 =**1650** x 0.8	891 =**1485** x 0.6	467.78 = **445.5** x 1.05

Unpaid claims for AY 2011 = 1320 + 891 + 467.78 = 2678.78

b. –reported claims to date will continue to develop in a similar manner in future
-IBNR related to claims is consistently related to claims already reported.

Question 19 – Model Solution 2 (Exam 5B Question 4)

- Selected ratio of case outstanding to previous case outstanding:

24 Months	36 Months	48 Months
0.90	0.30	0.00

- Selected ratio of incremental paid claims to previous case outstanding:

24 Months	36 Months	48 Months
0.80	0.60	1.05

Case outstanding$_{12}$ x ratio to paid$_{24}$ + case$_{24}$ x ratio$_{36}$ + case36 x ratio$_{48}$
a. 1000 x 1650 (0.8+0.9(0.6+0.3(1.05))=2678.775 x 1000 = 2,678,775

b. (i) stable payment or claim settlement patterns
(ii) stable case reserving level

Examiner's Comments

a. This part was generally well-answered. Some candidates incorrectly gave the projected ultimate (not unpaid) claims as the answer. Some candidates incorrectly calculated the project unpaid claims for all three years, not just AY 2011.
b. Candidates came up with a wide variety of answers to this question. The candidates did not score the full credits if their answers were too vague or inaccurate. No credit if a candidate used the common uses of the method (such as for lines of insurance for which most of the claims are reported in the first accident period or for claims-made coverages) as the answer since the question was asking the assumptions not the common uses of the method.

1 Introduction 283

Berquist and Sherman developed a methodical actuarial approach for analyzing unpaid claims for insurers who had undergone changes in operations and procedures.

They present two alternatives for the actuary in addressing such situations:

* Treat problem areas through data selection and rearrangement
* Treat problem areas through data adjustment

2 Reacting to a Changing Environment through Data Selection and Rearrangement 283 - 284

Berquist and Sherman (B/S) recommend using data that is unaffected by changes in the insurer's claims and underwriting procedures and operations.

Example:

If the insurer has changed its methods in establishing open case reserves, then the actuary may place greater reliance on paid claims methods that will be unaffected by the changes in case O/S.

B/S suggests several ways for selecting alternative data to respond to potential problems related to a changing environment:

* Using **earned exposures** instead of the ***number of claims*** when claim count data is of questionable accuracy or if there has been a major change in the definition of a claim count.
* Substituting **policy year data** for ***accident year data*** when there has been a significant change in policy limits or deductibles between successive policy years.
* Substituting **report year data** for ***accident year data*** when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the report year than with the accident date.
* Substituting **accident quarter** for ***accident year*** when the rate of growth of earned exposures changes markedly, causing distortions in development factors due to significant shifts in the average accident date within each exposure period.

Other adjustments that can be made to the data:

* Divide the data into more homogeneous groups, which is valuable when there have been changes in the composition of business by jurisdiction, coverage, class, territory, or size of risk.

  When dividing the data into more homogeneous groups, retain sufficient volume of experience within each group to ensure the data is credible.
* Group claims data by size of the claim (see B/S paper).

  A shift in emphasis by the claims department to settle large claims versus small claims is an operational change that could affect many types of data used for estimating unpaid claims.

Examples:

Greater attention to large claims could result in a slowdown in the rate of total claim settlements.

It may also speed-up the settlement of larger claims affecting both paid claims and case O/S triangles; if large claims are settled earlier, then case O/S will no longer be present in the triangle at the later maturities and the payments will appear in the triangles at earlier maturities than in the past.

Also, without appropriate monitoring, smaller claims may become larger claims more quickly than past experience suggests.

3 Treat Problem Areas through Data Adjustment 284 - 290

B/S discuss 2 data adjustment techniques prior to applying traditional development methods.

The same examples discussed in the 1977 B/S paper and described below.

1. A portfolio of U.S. medical malpractice insurance for an experience period of 1969 to 1976 (Berq-Sher Med Mal Insurer).
2. A portfolio of auto bodily injury liability also for an experience period of 1969 to 1976 (Berq-Sher Auto BI Insurer).

1. Detecting Changes in the Adequacy Level of Case O/S and Reducing the Affect of Such Changes on Reported Claims Projections

Exhibit I, Sheets 1 - 10: The analysis for Berq-Sher Med Mal Insurer

Exhibit I, Sheet 1: The unadjusted reported claim development triangle, in which B/S uses a simple average for all years to project ultimate claims.

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet1
Unadjusted Reported Claims

PART 1 - Data Triangle

Accident	Projected Incremental Closed Claim Counts							
Year	12	24	36	48	60	72	84	96
1969	2,897,000	5,160,000	10,714,000	15,228,000	16,611,000	20,899,000	22,892,000	23,506,000
1970	4,828,000	10,707,000	16,907,000	22,840,000	26,211,000	31,970,000	32,216,000	
1971	5,455,000	11,941,000	20,733,000	30,928,000	42,395,000	48,377,000		
1972	8,732,000	18,633,000	32,143,000	57,196,000	61,163,000			
1973	11,228,000	19,967,000	50,143,000	73,733,000				
1974	8,706,000	33,459,000	63,477,000					
1975	12,928,000	48,904,000						
1976	15,791,000							

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	1.781	2.076	1.421	1.091	1.258	1.095	1.027	
1970	2.218	1.579	1.351	1.148	1.220	1.008		
1971	2.189	1.736	1.492	1.371	1.141			
1972	2.134	1.725	1.779	1.069				
1973	1.778	2.511	1.470					
1974	3.843	1.897						
1975	3.783							

PART 3 - Average Age-to-Age Factors

Accident	Averages							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average All Years	2.532	1.921	1.503	1.170	1.206	1.052	1.027	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	2.532	1.921	1.503	1.170	1.206	1.052	1.027	1.000
CDF to Ultimate	11.145	4.402	2.291	1.524	1.303	1.080	1.027	1.000
Percent Reported	9.0%	22.7%	43.6%	65.6%	76.7%	92.6%	97.4%	100.0%

Exhibit I, Sheet 2: The unadjusted paid claim triangle, in which B/S uses the volume-weighted average for all years to project ultimate claims.

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 2
Unadjusted Paid Claims

PART 1 - Data Triangle

Accident Year	Unadjusted Paid Claims as of (months) 12	24	36	48	60	72	84	96
1,969	125,000	406,000	1,443,000	2,986,000	4,467,000	8,179,000	12,638,000	15,815,000
1,970	43,000	529,000	2,016,000	3,641,000	7,523,000	14,295,000	18,983,000	
1,971	295,000	1,147,000	2,479,000	5,071,000	11,399,000	17,707,000		
1,972	50,000	786,000	3,810,000	9,771,000	18,518,000			
1,973	213,000	833,000	3,599,000	11,292,000				
1,974	172,000	1,587,000	6,267,000					
1,975	210,000	1,565,000						
1,976	209,000							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	3.248	3.554	2.069	1.496	1.831	1.545	1.251	
1970	12.302	3.811	1.806	2.066	1.900	1.328		
1971	3.888	2.161	2.046	2.248	1.553			
1972	15.720	4.847	2.565	1.895				
1973	3.911	4.321	3.138					
1974	9.227	3.949						
1975	7.452							

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Volume-weighted Average								
All Years	6.185	3.709	2.455	1.952	1.718	1.407	1.251	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	6.185	3.709	2.455	1.952	1.718	1.407	1.251	1.486
CDF to Ultimate	493.993	79.870	21.534	8.771	4.494	2.616	1.859	1.486
Percent Paid	0.2%	1.3%	4.6%	11.4%	22.3%	38.2%	53.8%	67.3%

Exhibit I, Sheet 3: Project the unadjusted reported and unadjusted paid claims to an ultimate basis.

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 3
Projection of Ultimate Claims Using Development Technique and Unadjusted Data

Accident Year	Age of Acccident Year at 12/31/76	Claims at 12/31/76 Reported	Claims at 12/31/76 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected ultimate Claims Using Dev. Method with Reported	Projected ultimate Claims Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7) = [(3) x (5)]	(8) = [(4) x (6)]]
1969	96	23,506,000	15,815,000	1.000	1.486	23,506,000	23,501,090
1970	84	32,216,000	18,983,000	1.027	1.860	33,085,832	35,308,380
1971	72	48,377,000	17,707,000	1.080	2.616	52,247,160	46,321,512
1972	60	61,163,000	18,518,000	1.303	4.495	79,695,389	83,238,410
1973	48	73,733,000	11,292,000	1.524	8.774	112,369,092	99,076,008
1974	36	63,477,000	6,267,000	2.291	21.536	145,425,807	134,966,112
1975	24	48,904,000	1,565,000	4.402	79.880	215,275,408	125,012,200
1976	12	15,791,000	209,000	11.145	494.058	175,990,695	103,258,122
Total		367,167,000	90,356,000			837,595,383	650,681,834

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) and (4) Based on data from Berq-Sher Med Mal Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Significant differences in these projections exist by AY and in total. The paid claim development method is shown for demonstration purposes, and is not a reliable projection method due to the highly leveraged CDFs for most AYs in the experience period.

1a. Testing the Assumptions of the Reported Claim Development Technique

Assume that the adequacy of the case O/S has not been changing over time. However if it has, then the fundamental assumption of the development method does not hold and the method will not produce reliable results of ultimate claims or unpaid claims.

Approaches to determine if an insurer has sustained changes in case O/S adequacy:

1. Meet with the claims department management to discuss the claims process
2. Calculate various claim development diagnostic tests, including: the ratio of paid-to-reported claims, average case O/S, average reported claim, and average paid claims.

   In their medical malpractice example, B/S compares the ***annual change in the average case O/S*** to the ***annual change in the average paid claims*** to determine a **shift in case O/S adequacy**.

Begin testing the underlying assumptions in Exhibit I, Sheet 4 with a review of the average case O/S triangle.

- Average case O/S triangle is the unadjusted case O/S divided by the open claim counts
- Look down each column, the two latest points are significantly higher than the preceding values at each maturity age (i.e., the latest two diagonals are higher than prior diagonals).

  At 24 months, the average case O/S values for the last two AYs are $22,477 and $32,160 compared to $13,785 and $11,433 for the preceding two AYs.

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet4
Development Triangle - Unadjusted Data

Accident Year	Unadjusted Average Case Outstanding as of (months) 12	24	36	48	60	72	84	96
1969	3,701	5,660	9,262	10,151	11,745	16,627	19,238	21,423
1970	7,250	10,635	12,960	14,221	17,067	23,411	24,551	
1971	5,877	8,122	10,613	14,373	21,706	29,044		
1972	8,324	11,433	15,499	25,040	28,019			
1973	10,124	13,785	30,223	33,266				
1974	8,261	22,477	34,402					
1975	11,176	32,160						
1976	13,028							
Annual Change based on Exponential Regression Analysis of Severities and Accident Year								
	15.62%	29.50%	31.11%	34.17%	32.96%	32.16%	27.62%	
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)								
	79.96%	89.46%	85.79%	94.05%	98.88%	98.31%	100.00%	

Exponential regression is used to determine the annual trend rate in the average case O/S at each age.

- The average case O/S is fit at each maturity age with the AY.
- The fitted trend rate and the R-squared test (goodness of fit) for each age is shown.
- Annual trend rates of 30% for maturity ages 24 months through 72 months with R-squared values of 85% or greater for all of these ages.

Testing the Assumptions of the Reported Claim Development Technique (continued):

Exhibit I, Sheet 5: Ratios of paid-to-reported claims and trend rates in the average paid claim triangle.

- If there has been an increase in the case O/S adequacy level, the ratios of paid-to-reported claims should be decreasing along the latest two diagonals of the triangle.
- Some decreases are seen in this ratio triangle, but there is variability and it is hard to draw definitive conclusions based on this diagnostic.

The test that B/S uses is to compare annual trend rates, using regression, of the average case O/S and the average paid claims on closed counts.

The paid claim triangle can be used with the closed claim counts triangle to approximate the average paid claims on closed counts (since partial payments are not common in Med Mal).

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 5
Development Triangles - Unadjusted Data

Accident Year	Unadjusted Average Paid Claims as of (months) 12	24	36	48	60	72	84	96
1969	402	539	2,971	8,620	9,199	12,669	17,084	16,634
1970	110	919	5,487	9,129	12,403	18,452	19,533	
1971	706	1,115	5,644	4,928	12,994	14,948		
1972	161	862	5,782	9,477	14,085			
1973	724	541	4,003	11,709				
1974	518	1,394	7,635					
1975	517	1,494						
1976	525							
Annual Change based on Exponential Regression Analysis of Severities and Accident Year								
	12.89%	11.98%	11.46%	6.72%	14.16%	8.62%	14.34%	
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)								
	18.31%	35.27%	37.88%	10.14%	84.57%	19.26%	100.00%	

A comparison of annual rates of change between average case O/S and average paid claims:

* The annual trend rate appears to be 30% based on a review of the average case O/S triangle;
* Annual trend rate indications range from 7% to 14% using the average paid claim triangle.

B/S note that the trends for average paid claims are similar to industry benchmarks (at the time), and thus they conclude that the higher trends for average case O/S are indicative of changes in case O/S adequacy.

Mechanics of the Berquist-Sherman Case O/S Adjustment

Two decisions requiring actuarial judgment must be made by the actuary:

1. Choose a diagonal from which all other values of the adjusted average case O/S triangle will be calculated.
   The most common choice is the latest diagonal of the average case O/S triangle, since the latest diagonal of the adjusted reported claim triangle will not change from the unadjusted data triangle.
2. Select an annual severity trend to adjust average case O/S values from the selected diagonal
   B/S selected the latest diagonal as the starting point and a 15% annual severity trend.

Exhibit I, Sheet 6: Derivation of Adjusted Reported Claim Development Triangle

Top section: Adjusted average case O/S triangle.

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 6
Derivation of Adjusted Reported Claim Development Triangle

Accident Year	Adjusted Average Case Outstanding as of (months) 12	24	36	48	60	72	84	96
1969	4,898	13,904	17,104	19,020	18,423	21,961	21,349	21,423
1970	5,633	15,989	19,669	21,873	21,186	25,255	24,551	
1971	6,477	18,387	22,620	25,154	24,364	29,044		
1972	7,449	21,145	26,013	28,927	28,019			
1973	8,566	24,317	29,915	33,266				
1974	9,851	27,965	34,402					
1975	11,329	32,160						
1976	13,028							

- The last diagonal is the same as the one from the unadjusted average case O/S triangle (E1S4)
- All other values are determined by de-trending from the latest diagonal. The calculations within each column start with the latest point and the selected severity trend rate. Examples:
  The 1975 adjusted average case O/S at 12 months is \$11,329 (= \$13,028/1.15^1), representing 1 year of trend.
  The 1970 adjusted average case O/S at 48 months is \$21,873 based on the 1973 average case O/S of \$33,266/1.15^3

The purpose of restating the average case O/S triangle is to have each diagonal in the triangle at the same case O/S adequacy level as the latest diagonal (i.e. latest valuation).

Exhibit I, Sheet 6: Derivation of Adjusted Reported Claim Development Triangle

Adjusted reported claims = adjusted average case O/S * number of open claims + unadjusted paid claims.

Accident	Adjusted Reported Claims as of (months)							
Year	12	24	36	48	60	72	84	96
1969	3,793,504	12,084,942	18,563,821	25,924,316	23,516,364	24,979,245	24,016,864	23,506,000
1970	3,760,482	15,830,500	24,615,996	33,169,802	30,722,141	33,362,729	32,216,000	
1971	5,982,185	25,583,831	41,384,825	50,323,342	46,191,356	48,377,000		
1972	7,819,355	33,794,110	51,361,061	64559286	61,163,000			
1973	9,533,246	34,585,431	49,667,342	73,733,000				
1974	10,348,458	41,241,243	63,477,000					
1975	13,102,479	48,904,000						
1976	15,791,000							

Exhibit I, Sheet 7: Adjusted reported claim triangle and development factor selections

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 7
Adjusted Reported Claims

PART 1 - Data Triangle

Accident	Adjusted Reported Claims as of (months)							
Year	12	24	36	48	60	72	84	96
1969	3,793,504	12,084,942	18,563,821	25,924,316	23,516,364	24,979,245	24,016,864	23,506,000
1970	3,760,482	15,830,500	24,615,996	33,169,802	30,722,141	33,362,729	32,216,000	
1971	5,982,185	25,583,831	41,384,825	50,323,342	46,191,356	48,377,000		
1972	7,819,355	33,794,110	51,361,061	64,559,286	61,163,000			
1973	9,533,246	34,585,431	49,667,342	73,733,000				
1974	10,348,458	41,241,243	63,477,000					
1975	13,102,479	48,904,000						
1976	15,791,000							

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	3.186	1.536	1.396	0.907	1.062	0.961	0.979	
1970	4.210	1.555	1.347	0.926	1.086	0.966		
1971	4.277	1.618	1.216	0.918	1.047			
1972	4.322	1.520	1.257	0.947				
1973	3.628	1.436	1.485					
1974	3.985	1.539						
1975	3.732							

PART 3 - Average Age-to-Age Factors

	Averages							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.906	1.534	1.340	0.925	1.065	0.964	0.979	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96- 108
Unadj Selected	2.532	1.921	1.503	1.170	1.206	1.052	1.027	1.000
Adj Selected	3.906	1.534	1.340	0.925	1.065	0.964	0.979	1.000
CDF to Ultimate	7.465	1.911	1.246	0.930	1.005	0.944	0.979	1.000
Percent Reported	13.40%	52.33%	80.27%	107.56%	99.49%	105.96%	102.15%	100.00%

The selected development factors are lower based on adjusted data than on unadjusted data for all age-to-age maturities except 12-to-24 months.

This is consistent with the belief that the case O/S adequacy had increased and an unadjusted reported claim development projection would overstate future claim development.

Exhibit I, Sheet 8: Projection of Ultimate Claims Using Development Technique and Adjusted Data

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 8
Projection of Ultimate Claims Using Development Technique and Adjusted Data

Accident Year	Age of Accident Year at 12/31/76	Claims at 12/31/76 Reported	Claims at 12/31/76 Paid	Claims at 12/31/76 Adjusted Reported	CDF to Ultimate Reported	CDF to Ultimate Paid	CDF to Ultimate Adjusted Reported	Projected ultimate Claims Using Dev. Method with Reported	Projected ultimate Claims Using Dev. Method with Paid	Projected ultimate Claims Using Dev. Method with Adjusted Reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) = [(3)x(6)]	(10)=[(4)x(7)]	(11)=[(5)x(8)]
1969	96	23,506,000	15,815,000	23,506,000	1.000	1.486	1.000	23,506,000	23,501,090	23,506,000
1970	84	32,216,000	18,983,000	32,216,000	1.027	1.859	0.979	33,085,832	35,289,131	31,539,464
1971	72	48,377,000	17,707,000	48,377,000	1.080	2.616	0.944	52,266,704	46,321,512	45,656,084
1972	60	61,163,000	18,518,000	61,163,000	1.303	4.494	1.005	79,693,384	83,222,528	61,474,940
1973	48	73,733,000	11,292,000	73,733,000	1.524	8.773	0.930	112,403,868	99,064,716	68,550,870
1974	36	63,477,000	6,267,000	63,477,000	2.291	21.538	1.246	145,443,637	134,976,860	79,081,019
1975	24	48,904,000	1,565,000	48,904,000	4.402	79.887	1.911	215,253,430	125,022,648	93,459,963
1976	12	15,791,000	209,000	15,791,000	11.145	494.099	7.465	175,986,370	103,266,710	117,875,378
Total		367,167,000	90,356,000	367,167,000				837,639,227	650,665,195	521,143,718

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) and (4) Based on data from Berq-Sher Med Mal Insurer.
(5) Developed in Exhibit I, Sheet 6.
(6) and (7) Based on CDF from Exhibit I, Sheets 1 and 2.
(8) Based on CDF from Exhibit I, Sheet 7.

- Claim development projections based on unadjusted reported, paid claims and adjusted reported claims are computed.
- Projected ultimate claims based on the adjusted reported claim triangle are significantly less than the ultimate claims produced by the unadjusted data.

Exhibit I, Sheet 9: Estimated IBNR and the total unpaid claim estimate using all three projection methods

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 9
Development of Unpaid Claim Estimate

Accident Year	Claims at 12/31/76 Reported	Claims at 12/31/76 Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Projected Ultimate Claims Using Dev. Method with Adjusted Reported	Case Outstanding at 12/31/76	Unpaid Claim Estimate at 12/31/76: IBNR - Based on Dev. Method with Reported	IBNR Paid	IBNR Adjusted Reported	Total - based on Dev. Method with Reported	Total Paid	Total Adjusted Reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1969	23,506,000	15,815,000	23,506,000	23,501,090	23,506,000	7,691,000	0	-4,910	0	7,691,000	7,686,090	7,691,000
1970	32,216,000	18,983,000	33,085,832	35,289,131	31,539,464	13,233,000	869,832	3,073,131	-676,536	14,102,832	16,306,131	12,556,464
1971	48,377,000	17,707,000	52,266,704	46,321,512	45,656,084	30,670,000	3,889,704	-2,055,488	-2,720,916	34,559,704	28,614,512	27,949,084
1972	61,163,000	18,518,000	79,693,384	83,222,528	61,474,940	42,645,000	18,530,384	22,059,528	311,940	61,175,384	64,704,528	42,956,940
1973	73,733,000	11,292,000	112,403,868	99,064,716	68,550,870	62,441,000	38,670,868	25,331,716	-5,182,130	101,111,868	87,772,716	57,258,870
1974	63,477,000	6,267,000	145,443,637	134,976,860	79,081,019	57,210,000	81,966,637	71,499,860	15,604,019	139,176,637	128,709,860	72,814,019
1975	48,904,000	1,565,000	215,253,430	125,022,648	93,459,963	47,339,000	166,349,430	76,118,648	44,555,963	213,688,430	123,457,648	91,894,963
1976	15,791,000	209,000	175,986,370	103,266,710	117,875,378	15,582,000	160,195,370	87,475,710	102,084,378	175,777,370	103,057,710	117,666,378
Total	367,167,000	90,356,000	837,639,227	650,665,195	521,143,718	276,811,000	470,472,227	283,498,195	153,976,718	747,283,227	560,309,195	430,787,718

Column Notes:
(2) and (3) Based on data from Berq-Sher Med Mal Insurer.
(4) through (6) Developed in Exhibit I, Sheet 8.
(7) = [(2) - (3)].
(8) = [(4) - (2)].
(9) = [(5) - (2)].
(10) = [(6) - (2)].
(11) = [(7) + (8)].
(12) = [(7) + (9).
(13) = [(7) + (10)].

These amounts are summarized in the following table.

Claims Data Type	Estimated IBNR Total All Years ($ millions)	Total Unpaid Claim Estimate Total All Years ($ millions)
Unadjusted Reported	47	74
Unadjusted Paid	28	56
Adjusted Reported	15	43

Conclusion: The dramatically different results suggest that alternative estimation methods be used and additional information be obtained to determine the most appropriate estimate of unpaid claims.

(See Chapter 15 — Evaluation of Techniques for further discussion.)

Potential Difficulty with the Adjustment
In Thorne's review of the B/S paper, he states that the estimation of the underlying trend in severity requires a great deal of care, due to the:

* the sensitivity of the reserve estimates to the selected rate, and
* the substantial judgment needed in selecting the rate

Estimating severity trends for Med Mal is complicated by the following factors:

* Slow claims payments reduces data available by AY (e.g. less than 3% of ultimate claims are paid during the first 24 months and less than 30% during the first 60 months)
* Severity trends are distorted by irregular settlements and variation in the rate of claims closed without payment.

2. Detecting Changes in the Rate of Settlement of Claims and Adjusting Paid Claims for Such Changes

Exhibit II, Sheets 1 - 10: The analysis for Berq-Sher Auto BI Insurer

Exhibit II, Sheet 1: The unadjusted paid claim development triangle, in which B/S uses a volume-weighted average for all years to project ultimate claims.

Test the data to determine if the rate of claims settlement is consistent over the experience period (i.e. the underlying assumption of the paid claim development technique)

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 1
Unadjusted Paid Claims ($000)

PART 1 - Data Triangle

Accident	Paid Claims as of (months)							
Year	12	24	36	48	60	72	84	96
1969	1,904	5,398	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.835	1.389	1.185	1.093	1.037	1.013	1.006	
1970	2.801	1.388	1.202	1.086	1.036	1.024		
1971	3.010	1.451	1.187	1.086	1.035			
1972	3.265	1.445	1.200	1.085				
1973	3.070	1.461	1.200					
1974	3.267	1.498						
1975	3.328							

PART 3 - Average Age-to-Age Factors

	Averages							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.082	1.439	1.195	1.088	1.036	1.018	1.006	
Latest 4	3.233	1.464	1.197	1.088	1.036	1.018	1.006	
Volume-weighted Average								
All Years	3.098	1.444	1.196	1.087	1.036	1.019	1.006	
Latest 4	3.229	1.464	1.197	1.087	1.036	1.019	1.006	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	3.098	1.444	1.196	1.087	1.036	1.019	1.006	1
CDF to Ultimate	6.170	1.991	1.380	1.154	1.062	1.025	1.006	1.000
Percent Reported	16.2%	50.2%	72.5%	86.7%	94.2%	97.6%	99.4%	100.0%

Exhibit II, Sheet 2: Closed and reported claim counts and the ratio of closed-to-reported claim counts.

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 2
Development Triangles - Unadjusted Data

Accident	Closed Claim Counts as of (months)							
Year	12	24	36	48	60	72	84	96
1969	4,079	6,616	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident	Reported Claim Counts as of (months)							
Year	12	24	36	48	60	72	84	96
1969	6,553	7,696	7,770	7,799	7,814	7,819	7,820	7,821
1970	7,277	8,537	8,615	8,661	8,675	8,679	8,682	
1971	8,259	9,765	9,884	9,926	9,940	9,945		
1972	7,858	9,474	9,615	9,664	9,680			
1973	7,808	9,376	9,513	9,562				
1974	6,278	7,614	7,741					
1975	6,446	7,884						
1976	6,115							

Accident	Ratio of Closed to Reported Claim Counts as of (months)							
Year	12	24	36	48	60	72	84	96
1969	0.622	0.860	0.926	0.961	0.982	0.991	0.996	0.998
1970	0.609	0.847	0.917	0.957	0.979	0.992	0.996	
1971	0.595	0.837	0.917	0.959	0.982	0.991		
1972	0.572	0.828	0.910	0.958	0.978			
1973	0.566	0.818	0.910	0.951				
1974	0.555	0.816	0.893					
1975	0.545	0.790						
1976	0.528							

- Looking down each column of the ratio triangle, a steady decrease in the rate of claim settlement over the experience period is seen.
- Thus, the primary assumption of the paid claim development method does not hold, and the method would likely understate the true value required for unpaid claims.

Mechanics of the Berquist-Sherman Paid Claim Development Adjustment

1. Determine the disposal rates by AY and maturity, where the definition of disposal rates is the same as that used in the FS approach of Chapter 11.

   Exhibit II, Sheets 3 and 4: Projected number of ultimate claims based on reported claim counts

Chapter 13 - Berquist-Sherman Techniques
Berq-Sher Auto BI Insurer
Reported Claim Counts

Exhibit II
Sheet 3

PART 1 - Data Triangle

Accident Year	Reported Claim Counts as of (Months) 12	24	36	48	60	72	84	96
1969	6,553	7,696	7,770	7,799	7,814	7,819	7,820	7,821
1970	7,277	8,537	8,615	8,661	8,675	8,679	8,682	
1971	8,259	9,765	9,884	9,926	9,940	9,945		
1972	7,858	9,474	9,615	9,664	9,680			
1973	7,808	9,376	9,513	9,562				
1974	6,278	7,614	7,741					
1975	6,446	7,884						
1976	6,115							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	1.174	1.010	1.004	1.002	1.001	1.000	1.000	
1970	1.173	1.009	1.005	1.002	1.000	1.000		
1971	1.182	1.012	1.004	1.001	1.001			
1972	1.206	1.015	1.005	1.002				
1973	1.201	1.015	1.005					
1974	1.213	1.017						
1975	1.223							

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average All Years	1.196	1.013	1.005	1.002	1.001	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96- 108
Selected	1.196	1.013	1.005	1.002	1.001	1.000	1.000	1.000
CDF to Ultimate	1.221	1.021	1.008	1.003	1.001	1.000	1.000	1.000
Percent Reported	81.9%	97.9%	99.2%	99.7%	99.9%	100.0%	100.0%	100.0%

Berq-Sher Auto BI Insurer
Reported Claim Counts

Exhibit II
Sheet 4

Accident Year	Age of Accident Year at 12/31/76	Reported Claim Counts at 12/31/76	CDF to Ultimate	Projected Ultimate Claim Counts
(1)	(2)	(3)	(4)	(5) = [(3) x (4)]
1969	96	7,821	1.000	7,821
1970	84	8,682	1.000	8,682
1971	72	9,945	1.000	9,945
1972	60	9,680	1.001	9,690
1973	48	9,562	1.003	9,591
1974	36	7,741	1.008	7,803
1975	24	7,884	1.021	8,050
1976	12	6,115	1.221	7,466
Total		67,430		69,047

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) Based on data from Berq-Sher Auto BI Insurer.
(4) Based on CDF from Exhibit II, Sheet 3.

Exhibit II, Sheet 5: Disposal Rate and Development of Adjusted Closed Claim Counts

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 5
Disposal Rate and Development of Adjusted Closed Claim Counts

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96	Projected Ultimate Claim Counts
1969	0.522	0.846	0.920	0.958	0.981	0.991	0.996	0.998	7,821
1970	0.510	0.833	0.910	0.955	0.978	0.991	0.996		8,682
1971	0.494	0.822	0.912	0.957	0.981	0.991			9,945
1972	0.464	0.809	0.903	0.955	0.977				9,690
1973	0.461	0.799	0.903	0.948					9,591
1974	0.447	0.796	0.886						7,803
1975	0.437	0.773							8,050
1976	0.433								7,466

Selected Disposal Rate by Maturity Age

	12	24	36	48	60	72	84	96
	0.433	0.773	0.886	0.948	0.977	0.991	0.996	0.998

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	3,383	6,049	6,932	7,415	7,643	7,750	7,789	7,806
1970	3,756	6,715	7,695	8,231	8,484	8,603	8,647	
1971	4,302	7,692	8,815	9,429	9,719	9,855		
1972	4,192	7,495	8,588	9,187	9,469			
1973	4,149	7,418	8,501	9,093				
1974	3,376	6,035	6,916					
1975	3,482	6,226						
1976	3,230							

Disposal rate equals cumulative closed claim counts for each AY-maturity age cell/ultimate claim counts for a given accident year.

The disposal rates show a decrease in the rate of claims settlement.

B/S select the claims disposal rate along the latest diagonal as the basis for adjusting the closed claim count triangle, since the latest diagonal of the adjusted paid claim triangle will not change from the unadjusted paid claim triangle.

2. Adjusted triangle of closed claim counts equal disposal rate for each maturity * the ultimate number of claims

   Examples:

   For AY 1974 at 12 months, 3,376* (adjusted closed claim counts) equal 0.433 (disposal rate at 12 months) * 7,803 (projected ultimate claim counts for AY 1974)

   For AY 1971at 60 months, 9,719* (adjusted closed claim counts) equal 0.977 (disposal rate at 60 months) * 9,945 (projected ultimate claim counts for AY 1971)

   * Note, slight differences which exist between values in the text and values in the exhibits are due to the fact that the exhibits carry a greater number of decimals than shown.

3. B/S then use regression to identify a formula that approximates the relationship between the cumulative number of closed claims (X) and cumulative paid claims (Y).

   B/S find that a curve of the form Y= $ae^{(bX)}$ fits extremely well.

Exhibit II, Sheet 6: Summary of Regression Analysis

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 6
Summary of Regression Analysis

	Accident Year 1969			Accident Year 1970			Accident Year 1971		
	Cumulative			Cumulative			Cumulative		
Months Development	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(5)	(6)	(7)
12	4,079	1,904	1,851	4,429	2,235	2,185	4,914	2,441	2,404
24	6,616	5,398	5,888	7,230	6,261	6,718	8,174	7,348	7,724
36	7,192	7,496	7,658	7,899	8,691	8,785	9,068	10,662	10,637
48	7,494	8,882	8,789	8,291	10,443	10,280	9,518	12,655	12,496
60	7,670	9,712	9,523	8,494	11,346	11,152	9,761	13,748	13,632
72	7,749	10,071	9,873	8,606	11,754	11,664	9,855	14,235	14,098
84	7,792	10,199	10,068	8,647	12,031	11,858			
96	7,806	10,256	10,133						
R Squared			0.99573			0.99709			0.99866
a			287.918			369.851			414.005
b			0.000456			0.000401			0.000358

- Show the results of the regression for the three oldest AYs (1969, 1970, and 1971), including the R-squared value and the estimated *a* and *b* values.
- Since exponential curves closely approximate the relationship between cumulative closed claim counts and cumulative paid claims, B/S suggest that fitting exponential curves for every pair of two successive points is appropriate as the basis for adjusting paid claims.

Exhibit II, Sheet 7 (left side): Triangles for unadjusted closed claim counts, unadjusted paid claims, and adjusted closed claim counts.

Exhibit II, Sheet 7 (right side): The estimated parameters *a* and *b* for all two-point exponential regressions

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 7
Derivation of Adjusted Paid Claims

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	**4,079**	**6,616**	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident Year	Parameter a for Two-Point Exponential Fit 12	**24**	36	48	60	72	84	96
1969		**356**	124	132	198	286	1,034	459
1970		438	181	***215***	353	778	88	
1971		464	244	337	493	370		
1972		510	337	506	421			
1973		616	468	333				
1974		530	220					
1975		580						
1976								

Accident Year	Paid Claims ($000) as of (months) 12	24	36	48	60	72	84	96
1969	**1,904**	**5,398**	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

Year	Parameter b for Two-Point Exponential Fit 12	**24**	36	48	60	72	84	96
1969		**0.000411**	0.000570	0.000562	0.000508	0.000459	0.000294	0.000398
1970		0.000368	0.000490	***0.000468***	0.000409	0.000315	0.000568	
1971		0.000338	0.000416	0.000381	0.000341	0.000370		
1972		0.000354	0.000407	0.000360	0.000380			
1973		0.000346	0.000381	0.000421				
1974		0.000434	0.000576					
1975		0.000444						
1976								

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	**3,383**	6,048	6,932	7,415	7,643	7,750	7,789	7,806
1970	3,755	6,714	7,695	***8,231***	8,484	8,603	8,647	
1971	4,301	7,691	8,814	9,429	9,719	9,855		
1972	4,191	7,494	8,588	9,187	9,469			
1973	4,148	7,417	8,500	9,093				
1974	3,375	6,035	6,916					
1975	3,482	6,226						
1976	3,230							

Accident Year	Adjusted Paid Claims ($000) as of (months) 12	24	36	48	60	72	84	96
1969	1,430	4,276	6,463	8,497	9,579	10,077	10,191	10,256
1970	1,744	5,180	7,864	10,156	11,301	11,744	12,031	
1971	1,984	6,241	9,594	12,233	13,550	14,235		
1972	2,246	7,225	11,071	13,837	15,383			
1973	2,584	7,997	11,981	15,278				
1974	2,292	7,269	11,771					
1975	2,718	9,182						
1976	2,801							

Example: The exponential regression for AY 1969 between ages 12 and 24, such that *X= (4,079; 6,616) and Y= (1,904; 5,398),* would result in *a = 356* and *b = 0.000411*, which we place in the age 24 cell.

Adjusting the paid claims:

- Paid claims are adjusted based on the modifications that we have made to the closed claim count triangle earlier.
- Three kinds of treatments: no adjustment, interpolation, and extrapolation.
  - * Since adjusted closed claim counts are the same as unadjusted closed claim counts along the latest diagonal, the latest diagonal of the paid claim triangle does not require any adjustment.
  - * If the number of adjusted closed claims is within the range of any regression in its specific accident year, we use ***interpolation***. Example:

    Since AY 1970 at age 48 has 8,231 adjusted closed claims, which is within the range of unadjusted closed claims between ages 36 and 48 (7,899; 8,291), the paid claims for AY 1970 at age 48 would be adjusted based on such regression with *a = 215* and *b = 0.000468*.

    Thus, the adjusted paid claims for AY 1970 at age 48 are equal to {215 x [$e^{(0.000468 \times 8,231)}$] } = 10,156.
  - * If the number of adjusted closed claims is not within the range of all regression in its specific AY, then ***extrapolation*** is used to the regression that has the closest range. Example:

    AY 1969 at age 12 has 3,383 adjusted closed claim counts, in which the regression between ages 12 and 24 has the closest unadjusted closed claim count range (4,079; 6,616) among all regressions in year 1969.

    Thus, adjusted paid claims for year 1969 at age 12 is calculated as {356 x [$e^{(0.000411 \times 3,383)}$]} =1,430.

Exhibit II, Sheet 8: Adjusted Paid Claims ($000)

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 8
Adjusted Paid Claims ($000)

PART 1 - Data Triangle

Accident Year	Adjusted Paid Claims as of (months) 12	24	36	48	60	72	84	96
1969	1,430	4,276	6,463	8,497	9,579	10,077	10,191	10,256
1970	1,744	5,180	7,864	10,156	11,301	11,744	12,031	
1971	1,984	6,241	9,594	12,233	13,550	14,235		
1972	2,246	7,225	11,071	13,837	15,383			
1973	2,584	7,997	11,981	15,278				
1974	2,292	7,269	11,771					
1975	2,718	9,182						
1976	2,801							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.989	1.512	1.315	1.127	1.052	1.011	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.379							

PART 3 - Average Age-to-Age Factors

	Averages 24-Dec	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.138	1.536	1.281	1.115	1.047	1.018	1.006	
Latest 4	3.215	1.547	1.273	1.115	1.047	1.018	1.006	
Volume-weighted Average								
All Years	3.158	1.538	1.277	1.114	1.047	1.018	1.006	
Latest 4	3.219	1.546	1.271	1.114	1.047	1.018	1.006	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96- 108
Unadj Selected	3.098	1.444	1.196	1.087	1.036	1.019	1.006	1.000
Adj Selected	3.158	1.538	1.277	1.114	1.047	1.018	1.006	1.000
CDF to Ultimate	7.418	2.349	1.527	1.195	1.073	1.025	1.006	1.000
Percent Reported	13.5%	42.6%	65.5%	83.7%	93.2%	97.6%	99.4%	100.0%

Analyze the adjusted paid claim development triangle and select age-to-age development factors.

Compare the selected development factors from the unadjusted and adjusted paid claim triangle.

- For both adjusted and unadjusted paid claim triangles, selected factors are based on the volume-weighted average for all years.
- At all age-to-age maturities (except 72-to-84 and 84-to-96 months), selected development factors are *higher based on the adjusted data* than on the unadjusted data. This is consistent with the claims settlement rate decreasing in recent years

Thus, the unadjusted paid claim development projection understates future claim development and the estimate of unpaid claims.

B/S provide alternatives for the derivation of CDFs. Two additional approaches for determining CDFs for the adjusted paid claim triangle are as follows:

1. Exhibit II, Sheet 9: Linear Regression of Development Factors Using Adjusted Paid Claims

   Using a linear regression of the CDFs at each maturity age and AY, the Y intercepts, slope, and *R-squared* values for each maturity age are shown.

Chapter 13 - Berquist-Sherman Techniques — Exhibit II

Berq-Sher Auto BI Insurer — Sheet 9

Linear Regression of Development Factors Using Adjusted Paid Claims

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.989	1.511	1.315	1.127	1.052	1.011	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.378							

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72
Estimated Intercept from Linear Regression Analysis of Age-to-Age Factors and Accident Year	-104.01	-25.08	25.05	11.36	2.42
Estimated Slope from Linear Regression Analysis of Age-to-Age Factors and Accident Year	0.0543	0.0135	-0.0121	-0.0052	-0.0007
Goodness of Fit Test of Linear Regression Analysis (R-Squared)	70.3%	34.4%	63.7%	61.0%	1.0%

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult	CDF to Ultimate
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	1.000	1.000
1970	2.969	1.518	1.291	1.113	1.039	1.024	1.006	1.000	1.006
1971	3.145	1.537	1.275	1.108	1.051	1.018	1.006	1.000	1.024
1972	3.217	1.532	1.25	1.112	1.047	1.018	1.006	1.000	1.073
1973	3.094	1.498	1.275	1.102	1.047	1.018	1.006	1.000	1.182
1974	3.172	1.619	1.245	1.097	1.047	1.018	1.006	1.000	1.471
1975	3.378	1.583	1.233	1.091	1.047	1.018	1.006	1.000	2.329
1976	3.355	1.596	1.221	1.086	1.047	1.018	1.006	1.000	7.815

2. Exhibit II, Sheet 10: Exponential Regression of Development Factors Using Adjusted Paid Claims

   Using an exponential regression of the CDFs at each maturity age and AY, the Y intercepts, slope, and *R-squared* values for each maturity age are shown.

* In both Sheets, the R-squared values are never greater than 75% for any maturity age.
* Extrapolated CDFs are used to complete the age-to-age triangles to derive the ultimate CDF for each AY.

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 10
Exponential Regression of Development Factors Using Adjusted Paid Claims

Accident Year	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96 To	To Ult
	Age-to-Age Factors							
1969	2.989	1.511	1.315	1.127	1.052	1.011	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.378							

	12-24	24 - 36	36 - 48	48 - 60	60 - 72
Estimated Constant from Exponential Regression Analysis of Age-to-Age Factors and Accident Year	0	0	135,483,653	10,606	4
Estimated Growth from Exponential Regression Analysis of Age-to-Age Factors and Accident Year	1.017390463	1.0086231	0.99066952	0.99536201	0.99933607
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)	70.6%	34.0%	63.3%	61.0%	1.0%

Accident Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult	CDF to Ultimate
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	1.000	1.000
1970	2.969	1.518	1.291	1.113	1.039	1.024	1.006	1.000	1.006
1971	3.145	1.537	1.275	1.108	1.051	1.018	1.006	1.000	1.024
1972	3.217	1.532	1.250	1.112	1.047	1.018	1.006	1.000	1.073
1973	3.094	1.498	1.275	1.102	1.047	1.018	1.006	1.000	1.182
1974	3.172	1.619	1.245	1.097	1.047	1.018	1.006	1.000	1.472
1975	3.378	1.582	1.234	1.092	1.047	1.018	1.006	1.000	2.329
1976	3.359	1.596	1.222	1.087	1.047	1.018	1.006	1.000	7.823

Exhibit II, Sheet 11: Projection of Ultimate Claims Using Development Technique on Unadjusted and Adjusted Data ($000)

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 11
Projection of Ultimate Claims Using Development Technique and Adjusted Data ($000)

			CDF to Ultimate				Projected Ultimate Claims Using Dev Method with			
				Adjusted Paid				Adjusted Paid		
	Age of				Regression				Regression	
Accident Year	Accident Year at 12/31/76	Paid Claims at 12/31/76	Unadjusted Pasid	Volume Weighted	Linear	Exponential	Unadjusted Paid	Volume Weighted	Linear	Exponential
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) = [(3) x (4)]	(9) = [(3) x (5)]	(10) = [(3)x(6)]	(11) = [(3)x(7)]
1969	96	10,256	1.000	1.000	1.000	1.000	10,256	10,256	10,256	10,256
1970	84	12,031	1.006	1.006	1.006	1.006	12,103	12,107	12,103	12,103
1971	72	14,235	1.025	1.025	1.024	1.024	14,586	14,589	14,578	14,578
1972	60	15,383	1.062	1.073	1.073	1.073	16,330	16,510	16,500	16,500
1973	48	15,278	1.154	1.195	1.182	1.182	17,629	18,263	18,056	18,058
1974	36	11,771	1.380	1.527	1.471	1.472	16,238	17,972	17,320	17,328
1975	24	9,182	1.991	2.348	2.329	2.329	18,286	21,560	21,387	21,385
1976	12	2,801	6.170	7.416	7.815	7.823	17,281	20,771	21,890	21,913
Total		90,937					122,710	132,028	132,090	132,120

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) Developed in Exhibit II, Sheet 7.
(4) Based on CDF from Exhibit II, Sheet 1.
(5) through (7) Based on CDF from Exhibit II, Sheets 8 through 10, respectively.

For the unadjusted paid claim triangle, the all-year volume-weighted average age-to-age factors are used.

For the adjusted paid claims, the all-year volume-weighted average *as well as* the development factors derived from the linear and exponential regression analyses are used.

Exhibit II, Sheet 12: Development of Unpaid Claim Estimate ($000)

Chapter 13 - Berquist-Sherman Techniques Exhibit II
Berq-Sher Auto BI Insurer Sheet 12
Development of Unpaid Claim Estimate ($000)

		Projected ultimate Claims Usinsg Dev Method with				Unpaid Claim Estimate at 12/31/76			
			Adjusted Paid				Adjusted Paid		
Accident	Paid Claims	Unadjusted	Volume	Regression		Unadjusted	Volume	Regression	
Year	at 12/31/76	Paid	Weighted	Linear	Exponential	Paid	Weighted	Linear	Exponential
(1)	(2)	(3)	(4)	(5)	(6)	(7) = [(3) - (2)]	(8) = [(4) - (2)]	(9) = [(5) - (2)]	(10) = [(6) - (2)]
1969	10,256	10,256	10,256	10,256	10,256	0	0	0	0
1970	12,031	12,103	12,107	12,103	12,103	72	76	72	72
1971	14,235	14,586	14,589	14,578	14,578	351	354	343	343
1972	15,383	16,330	16,510	16,500	16,500	947	1,127	1,117	1,117
1973	15,278	17,629	18,263	18,056	18,058	2,351	2,985	2,778	2,780
1974	11,771	16,238	17,972	17,320	17,328	4,467	6,201	5,549	5,557
1975	9,182	18,286	21,560	21,387	21,385	9,104	12,378	12,205	12,203
1976	2,801	17,281	20,771	21,890	21,913	14,480	17,970	19,089	19,112
Total	90,937	122,710	132,028	132,090	132,120	31,773	41,091	41,153	41,183

Column Notes:
(2) Based on data from Berq-Sher Auto BI Insurer.
(3) through (6) Developed in Exhibit II, Sheet 11.

Unpaid claim estimates based on the results of the unadjusted, adjusted volume weighted, adjusted linear Regression and adjusted exponential regressions are shown:

* The estimated IBNR based on the adjusted paid claims projections are relatively close to one another.
* These estimates are about $10 million greater than those from the unadjusted development technique.

Potential Difficulty with the Adjustment

A key assumption of the B/S paid claims adjustment is that a higher % of closed claim counts relative to ultimate claim counts is associated with a higher % of ultimate claims paid.

In Thorne's review of the B/S paper, he notes: "Lack of recognition of the settlement patterns by size of loss can be an important source of error ... it may be necessary to modify the technique to apply to size of loss categories adjusted for inflation."

* Thorne's detailed example shows the number of small claims (limited to $3,000) steadily decreasing while the number of larger claims (limited to $20,000) is steadily increasing.
* He shows that the % of closed claim counts decreases and yet the % of paid claims increases due to the shift to settling larger claims.
* Thus, he notes that the B/S technique actually adjusts paid claims to be *less comparable among AYs* and *increases the error in the estimate of unpaid claims*.
* The example shows the recent trend toward an increasing proportion of severe, late closing claims.

4 XYZ Insurer 291 - 293

Since the XYZ insurer has be subject to both operational and environmental changes, the B/S adjustments are appropriate. Three sets of projections are made:

1. Adjustment due to changes in case O/S adequacy only
2. Adjustment for changes in settlement rate only
3. Adjustments for both the change in case O/S adequacy and settlement rates

1 Adjustment due to changes in case O/S adequacy only

Exhibit III, Sheet 1: Average Paid Claims - Unadjusted Data

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 1
Average Paid Claims - Unadjusted Data

Accident	Average Paid Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				16,708	18,432	20,208	22,143	23,560	24,695	24,825	24,839
1999			14,375	17,059	19,919	22,482	23,347	23,307	23,669	23,771	
2000		10,020	13,025	16,281	19,762	22,332	24,303	25,810	26,235		
2001	5,064	8,740	13,162	17,041	19,908	22,911	25,887	26,639			
2002	11,417	13,067	16,436	20,290	24,073	27,752	29,178				
2003	9,631	10,163	13,478	18,125	22,896	25,077					
2004	9,452	11,673	17,996	23,455	26,028						
2005	10,315	10,920	16,270	20,569							
2006	11,502	13,000	19,000								
2007	10,726	15,000									
2008	12,351										
Annual Change based on Exponential Regression Analysis of Severities and Accident Year											
	8.1%	5.4%	4.6%	4.3%	5.5%	5.1%	6.8%	4.8%	3.1%	-4.2%	
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)											
	46.4%	54.1%	57.2%	64.2%	85.2%	72.3%	95.1%	83.9%	34.2%	100.0%	

To determine a severity trend rate, unadjusted average paid claims are reviewed and an exponential regression at each maturity age is performed.

Since there were not significant differences in the trend rate by maturity age for ages 24 through 72 months, a 5% severity trend rate for all maturities was selected.

Exhibit III, Sheet 2, top section: Adjusted average case O/S triangle.

The latest diagonal and the selected 5% severity trend rate are used to develop this triangle.

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 2
Derivation of Case Adjusted Reported Claim Development Triangle

Accident	Adjusted Average Case Outstanding as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	12,297	27,075	38,570	49,025	56,951	64,896	99,026	26,699	70,223	35,608	
1999	12,912	28,429	40,498	51,476	59,799	68,141	103,977	28,034	73,734	96,618	
2000	13,557	29,850	42,523	54,050	62,789	71,548	109,176	29,435	77,421		
2001	14,235	31,343	44,649	56,752	65,928	75,126	114,634	30,907			
2002	14,947	32,910	46,882	59,590	69,224	78,882	120,366				
2003	15,694	34,555	49,226	62,570	72,686	82,826					
2004	16,479	36,283	51,687	65,698	76,320						
2005	17,303	38,097	54,271	68,983							
2006	18,168	40,002	56,985								
2007	19,076	42,002									
2008	20,030										

Selected Annual Severity Rate 5%

Exhibit III, Sheet 2, bottom section:

Accident	Case Adjusted Reported Claims ($000) as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				14,600	15,094	15,513	17,104	16,366	16,163	15,835	15,822
1999			23,631	25,296	26,319	26,802	28,293	24,795	25,071	25,107	
2000		27,527	31,913	34,907	36,212	37,153	37,698	37,505	37,246		
2001	15,789	29,145	35,225	39,380	39,749	38,453	39,707	38,798			
2002	19,342	37,781	46,968	49,984	47,313	47,571	48,169				
2003	20,450	40,864	46,599	45,605	43,372	44,373					
2004	30,186	57,792	66,886	69,521	70,288						
2005	33,703	56,945	65,226	70,656							
2006	24,715	41,339	48,804								
2007	19,992	31,732									
2008	18,632										

Adjusted reported claim development triangle, created as follows.
{[(adjusted average case O/S) x (open claim counts)] + (paid claims)}

* This is done for 12 months through 84 months.

* For 96 - 132 months, it is expected that the claims department has complete information and that the case O/S is adequate and therefore the unadjusted reported claim triangle is appropriate without any adjustment.

Exhibit III, Sheet 3: Adjusted reported claim development triangle, is analyzed as follows.

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 3
Case Adjusted Reported Claims ($000)

PART 1 - Data Triangle

Accident	Case Adjusted Reported Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				14,600	15,094	15,513	17,104	16,366	16,163	15,835	15,822
1999			23,630	25,296	26,319	26,802	28,294	24,795	25,071	25,107	
2000		27,527	31,913	34,908	36,211	37,153	37,698	37,505	37,246		
2001	15,789	29,146	35,224	39,380	39,748	38,452	39,706	38,798			
2002	19,342	37,781	46,968	49,984	47,313	47,570	48,169				
2003	20,451	40,865	46,599	45,605	43,373	44,373					
2004	30,186	57,792	66,886	69,522	70,288						
2005	33,704	56,945	65,226	70,655							
2006	24,715	41,339	48,804								
2007	19,992	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.034	1.028	1.103	0.957	0.988	0.980	0.999	
1999			1.071	1.040	1.018	1.056	0.876	1.011	1.001		
2000		1.159	1.094	1.037	1.026	1.015	0.995	0.993			
2001	1.846	1.209	1.118	1.009	0.967	1.033	0.977				
2002	1.953	1.243	1.064	0.947	1.005	1.013					
2003	1.998	1.140	0.979	0.951	1.023						
2004	1.915	1.157	1.039	1.011							
2005	1.690	1.145	1.083								
2006	1.673	1.181									
2007	1.587										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.772	1.173	1.057	0.991	1.008	1.044	0.951	0.997	0.991	0.999	
Latest 3	1.650	1.161	1.034	0.970	0.999	1.020	0.949	0.997	0.991	0.999	
Medial Average											
Latest 5x1	1.759	1.161	1.062	0.990	1.016	1.034	0.967	0.993	0.991	0.999	
Volume-weighted Average											
Latest 5	1.772	1.169	1.055	0.990	1.007	1.033	0.957	0.998	0.993	0.999	
Latest 3	1.658	1.159	1.040	0.975	1.000	1.019	0.956	0.998	0.993	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12- 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
Case Adj Selected	1.658	1.159	1.040	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.997	1.205	1.039	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	50.1%	83.0%	96.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* At the 12-to-24 month interval (and somewhat for the 24-36 interval), a persistent downward trend in the age-to-age factors is observed.

  Is the trend rate appropriate?

  Is there a potential shift in the type of claim that is now closed at 12 and 24 months?

* CDFs are selected based on the volume-weighted 3-year average (recognizing the decreasing age-to-age factors in the most recent diagonals) for ages 12-to-24, 24-to-36, and 36-to-48.

  Comparing these to the ones selected based on the unadjusted reported claim triangle (from Chapter 7):

  i. the age-to-age factors are mostly less than those based on the unadjusted claims (as expected).

  ii. smaller factors are expected since case O/S strengthening has occurred for XYZ Insurer

* A 1.000 factor is judgmentally selected for all remaining intervals to smooth out the remaining variability.

2. Adjustment for changes in settlement rate only

Exhibit III, Sheet 4: Disposal Rate and Development of Adjusted Closed Claim Counts

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 4
Disposal Rate and Development of Adjusted Closed Claim Counts

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96	108	120	132	Proj. Ultimate Reported Claim Counts
1998				0.801	0.859	0.903	0.939	0.961	0.973	0.997	1	637
1999			0.655	0.782	0.869	0.936	0.962	0.989	0.992	0.997		1,047
2000		0.462	0.662	0.778.	0.864	0.918	0.971	0.988	0.996			1,408
2001	0.209	0.468	0.643	0.751	0.842	0.933	0.984	0.994				1,455
2002	0.131	0.391	0.541	0.701	0.854	0.942	0.980					1,554
2003	0.111	0.377	0.577	0.775	0.924	0.962						1,631
2004	0.104	0.375	0.637	0.819	0.897							2,263
2005	0.123	0.466	0.693	0.81								2,402
2006	0.183	0.54	0.716									1,679
2007	0.251	0.605										1,308
2008	0.236											1,172
Selected Disposal Rate by Maturity Age												
	0.236	0.605	0.716	0.81	0.897	0.962	0.980	0.994	0.996	0.997	1	

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	150	385	456	516	571	613	624	633	634	635	637
1999	247	633	750	848	939	1,007	1,026	1,041	1,043	1,044	
2000	332	852	1,008	1,140	1,263	1,354	1,380	1,400	1,402		
2001	343	880	1,042	1,179	1,305	1,400	1,426	1,446			
2002	367	940	1,113	1,259	1,394	1,495	1,523				
2003	385	987	1,168	1,321	1,463	1,568					
2004	534	1,369	1,620	1,833	2,029						
2005	567	1,453	1,720	1,946							
2006	396	1,016	1,201								
2007	309	791									
2008	276										

* Disposal rates are selected based on the last diagonal of [closed counts/projected ultimate reported counts]. (projected ultimate reported claim counts are from Chapter 11)

Exhibits III, Sheets 5 and 6: Derivation of adjusted paid claims
(using the same format as in the previous example).

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 4
Summary of Regression Analysis

	Accident Year 1998			Accident Year 1999			Accident Year 2000		
	Cumulative			Cumulative			Cumulative		
Closed Months of Development	Closed Claim Count X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=-ae^(bX)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(5)	(6)	(7)
12									
24							650	6,513	6,437
36				686	9,861	9,952	932	12,139	12,357
48	510	8,521	8,458	819	13,971	14,066	1,095	17,828	18,013
60	547	10,082	10,208	910	18,127	17,823	1,216	24,030	23,829
72	575	11,620	11,770	980	22,032	21,383	1,292	28,853	28,407
84	598	13,242	13,230	1,007	23,511	22,939	1,367	33,222	33,786
96	612	14,419	14,206	1,036	24,146	24,737	1,391	35,902	35,714
108	620	15,311	14,796	1,039	24,592	24,930	1,402	36,782	36,635
120	635	15,764	15,968	1,044	24,817	25,257			
132	637	15,822	16,131						
R Squared			0.993716946			0.996197864			0.999543256
a			637.3038239			1659.37274			1417.357378
b			0.005084397			0.002601397			0.002312307

Chapter 13 - Berquist-Sherman Techniques
XYZ Insurer - Auto BI
Derivation of Adjusted Paid Claims

Exhibit III
Sheet 6

Accident	Closed Claim Counts as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				510	547	575	598	612	620	635	637
1999			686	819	910	980	1,007	1,036	1,039	1,044	
2000		650	932	1,095	1,216	1,292	1,367	1,391	1,402		
2001	304	681	936	1,092	1,225	1,357	1,432	1,446			
2002	203	607	841	1,089	1,327	1,464	1,523				
2003	181	614	941	1,263	1,507	1,568					
2004	235	848	1,442	1,852	2,029						
2005	295	1,119	1,664	1,946							
2006	307	906	1,201								
2007	329	791									
2008	276										

Accident	Parameter a for Two-Point Exponential Fit										
Year	12	24	36	48	60	72	84	96	108	120	132
1998					838	629	443	349	146	4,588	4,912
1999				1,635	1,341	1,435	2,084	9,319	43	3,706	
2000			1,551	1,348	1,196	1,288	2,543	400	1,680		
2,001		517	853	1,037	2,021	2,561	1,289	734			
2,002		1,249	1,878	2,817	4,090	3,111	4,399				
2,003		1,023	1,647	2,258	2,737	1,369					
2,004		1,252	2,500	4,239	5,625						
2005		1,850	2,386	2,695							
2006		1,904	1,545								
2007		1,488									

Accident	Paid Claims ($000) as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817	
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782		
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519			
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437				
2003	1,743	6,240	12,683	22,892	34,505	39,320					
2004	2,221	9,898	25,950	43,439	52,811						
2005	3,043	12,219	27,073	40,026							
2006	3,531	11,778	22,819								
2007	3,529	11,865									
2008	3,409										

Accident	Parameter b for Two-Point Exponential Fit										
Year	12	24	36	48	60	72	84	96	108	120	132
1998					0.00455	0.0051	0.0057	0.006082	0.0075	0.00194	0.001836
1999				0.0026	0.00286	0.0028	0.0024	0.000919	0.0061	0.00182	
2000			0.0022	0.0024	0.00247	0.0024	0.0019	0.003233	0.0022		
2001		0.0036	0.0029	0.0026	0.00203	0.0018	0.0023	0.002739			
2002		0.003	0.0024	0.0019	0.00155	0.0018	0.0015				
2003		0.0029	0.0022	0.0018	0.00168	0.0021					
2004		0.0024	0.0016	0.0013	0.0011						
2005		0.0017	0.0015	0.0014							
2006		0.002	0.0022								
2007		0.0026									
2008											

Accident	Adjusted Closed Claim Counts as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	150	385	456	516	571	613	624	633	634	635	637
1999	247	633	750	848	939	1,007	1,026	1,041	1,043	1,044	
2000	332	852	1,008	1,140	1,263	1,354	1,380	1,400	1,402		
2001	343	880	1,042	1,179	1,305	1,400	1,426	1,446			
2002	367	940	1,113	1,259	1,394	1,495	1,523				
2003	385	987	1,168	1,321	1,463	1,568					
2004	534	1,369	1,620	1,833	2,029						
2005	567	1,453	1,720	1,946							
2006	396	1,016	1,201								
2007	309	791									
2008	276										

Accident	Adjusted Paid Claims ($000) as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	1,661	4,835	6,669	8,755	11,264	14,075	15,372	16,401	17,065	15,767	15,822
1999	3,123	8,593	11,650	15,076	19,705	23,768	24,614	24,251	25,171	24,817	
2000	3,230	10,170	14,361	19,846	26,983	33,536	34,034	36,908	36,782		
2001	1,773	12,166	16,658	23,395	28,702	33,631	36,543	38,519			
2002	3,816	21,877	26,338	30,460	35,435	42,897	44,437				
2003	3,178	18,707	20,743	25,466	32,044	39,320					
2004	4,604	35,259	34,657	42,416	52,811						
2005	4,814	21,474	29,372	40,026							
2006	4,225	14,688	22,819								
2007	3,346	11,865									
2008	3,409										

Exhibits III, Sheet 7: Adjusted paid claim development triangle

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto B1 Sheet 7
Adjusted Paid Claims ($000)

PART 1 - Data Triangle

Accident	Adjusted Paid Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	1,658	4,830	6,659	8,760	11,401	14,476	15,439	15,705	15,742	15,769	15,822
1999	3,120	8,584	11,634	15,191	19,649	23,499	23,928	24,660	24,751	24,817	
2000	3,225	10,158	14,502	19,957	26,887	32,415	34,638	36,563	36,782		
2001	1,769	10,493	16,264	22,201	28,245	34,318	36,550	38,519			
2002	3,808	16,656	22,893	28,752	35,907	42,543	44,437				
2003	3,171	13,772	19,187	25,242	32,008	39,320					
2004	4,592	23,014	32,407	42,416	52,811						
2005	4,805	19,876	29,202	40,026							
2006	4,218	15,035	22,819								
2007	3,341	11,865									
2008	3,409										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998			1.316	1.301	1.270	1.067	1.017	1.002	1.002	1.003	
1999		1.355	1.306	1.293	1.196	1.018	1.031	1.004	1.003		
2000	3.150	1.428	1.376	1.347	1.206	1.069	1.056	1.006			
2001	5.932	1.550	1.365	1.272	1.215	1.065	1.054				
2002	4.374	1.374	1.256	1.249	1.185	1.045					
2003	4.343	1.393	1.316	1.268	1.228						
2004	5.012	1.408	1.309	1.245							
2005	4.137	1.469	1.371								
2006	3.564	1.518									
2007	3.551										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	4.121	1.433	1.323	1.276	1.206	1.053	1.039	1.004	1.002	1.003	
Latest 3	3.751	1.465	1.332	1.254	1.209	1.059	1.047	1.004	1.002	1.003	
Medial Average											
Latest 5x1	4.015	1.424	1.330	1.263	1.206	1.059	1.042	1.004	1.002	1.003	
Volume-weighted Average											
Latest 5	4.152	1.432	1.322	1.269	1.206	1.053	1.044	1.005	1.002	1.003	
Latest 3	3.783	1.458	1.333	1.252	1.208	1.058	1.049	1.005	1.002	1.003	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	3.349	2.079	1.574	1.316	1.203	1.136	1.059	1.022	1.017	1.004	1.010
Adj Selected	4.152	1.432	1.322	1.269	1.206	1.053	1.044	1.005	1.002	1.003	1.010
CDF to Ultimate	13.490	3.249	2.269	1.716	1.352	1.121	1.065	1.020	1.015	1.013	1.010
Percent Reported	7.4%	30.8%	44.1%	58.3%	73.9%	89.2%	93.9%	98.0%	98.5%	98.7%	99.0%

* Selected CDFs are based on the 5-year volume-weighted average and are compared to the selected factors in Chapter 7 based on the unadjusted paid claim triangle.
* At most ages, the selected factors are less than those based on the unadjusted claims, which is consistent with knowing that the rate of settlement has increased.

3 Adjustments for both the change in case O/S adequacy and settlement rates

* Both the adjusted average paid claim triangle and the adjusted average case O/S triangle are used.
* One new adjusted triangle is needed for projection purposes: the adjusted number of open claims, which equals reported claim counts - adjusted closed claim counts.
* The adjusted reported claim triangle is then equal to:

  {[(adjusted average case O/S) x (adjusted open claim counts)] + (adjusted paid claims)}

Chapter 13 - Berquist-Sherman Techniques
XYZ Insurer - Auto BI
Derivation of Both Adjusted Open and Reported Claims

Exhibit III
Sheet 8

Accident	Adjusted Open Claim Counts as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				118	64	35	13	4	3	2	0
1999			276	191	108	64	27	6	4	3	
2000		502	389	271	147	82	28	8	6		
2001	962	541	407	279	153	84	29	9			
2002	975	574	435	298	155	88	31				
2003	988	629	462	305	166	61					
2004	1,398	799	614	416	229						
2005	1,500	840	647	444							
2006	1,077	629	456								
2007	883	473									
2008	760										

Accident	Both Adjusted Reported Claims ($000) as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				14,546	15,024	16,744	16,701	15,807	15,921	15,837	15,822
1999			22,826	25,019	26,098	27,841	26,729	24,836	25,060	25,107	
2000		25,147	31,038	34,579	36,118	38,258	37,712	36,812	37,247		
2001	15,458	27,441	34,446	38,060	38,323	40,658	39,886	38,797			
2002	18,385	35,541	43,302	46,525	46,641	49,495	48,168				
2003	18,678	35,516	41,939	44,319	44,073	44,372					
2004	27,628	52,000	64,127	69,744	70,288						
2005	30,761	51,870	64,325	70,654							
2006	23,780	40,204	48,804								
2007	20,191	31,732									
2008	18,632										

Exhibit III, Sheet 9: Adjusted reported claim triangle

* The unadjusted selected age to age factors as well as the selected age to age factors from the case O/S only adjustment are included in the review of the age to age factors from this triangle.
* The average age-to-age factors tend to be between these two sets of other two selected development factors.
* Selected age to age factors are based on the 3-year volume-weighted average through 72 months; a 1.00 factor is selected for all remaining intervals, to smooth the indications for the older maturities.

Chapter 13 - Berquist-Sherman Exhibit III
XYZ Insurer - Auto Sheet 9
Both Adjusted Reported Claims ($000)

PART 1 - Data Triangle

Accident	Both Adjusted Reported Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				14,541	15,031	15,934	16,697	16,012	15,878	15,834	15,822
1999			22,847	25,010	26,111	26,443	26,723	25,042	25,018	25,107	
2000		25,164	31,068	34,566	36,137	36,285	37,705	37,385	37,246		
2001	15,467	27,457	34,478	38,046	38,343	38,516	39,877	38,798			
2002	18,395	35,560	43,338	46,509	46,664	47,093	48,169				
2003	18,691	35,545	41,992	44,319	44,123	44,373					
2004	27,647	52,041	64,203	69,745	70,288						
2005	30,780	51,904	64,391	70,655							
2006	23,796	40,240	48,804								
2007	20,202	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.034	1.060	1.048	0.959	0.992	0.997	0.999	
1999			1.095	1.044	1.013	1.011	0.937	0.999	1.004		
2000		1.235	1.113	1.045	1.004	1.039	0.992	0.996			
2001	1.775	1.256	1.103	1.008	1.005	1.035	0.973				
2002	1.933	1.219	1.073	1.003	1.009	1.023					
2003	1.902	1.181	1.055	0.996	1.006						
2004	1.882	1.234	1.086	1.008							
2005	1.686	1.241	1.097								
2006	1.691	1.213									
2007	1.571										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.746	1.217	1.083	1.012	1.007	1.031	0.965	0.996	1.000	0.999	
Latest 3	1.649	1.229	1.080	1.002	1.006	1.032	0.967	0.996	1.000	0.999	
Medial Average											
Latest 5x I	1.753	1.222	1.086	1.006	1.006	1.032	0.966	0.996	1.000	0.999	
Volume-weighted Average											
Latest 5	1.746	1.220	1.084	1.010	1.007	1.030	0.969	0.996	1.001	0.999	
Latest 3	1.657	1.230	1.083	1.003	1.007	1.032	0.970	0.996	1.001	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
Case Adj Selected	1.658	1.159	1.040	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Both Adj Selected	1.657	1.230	1.083	1.003	1.007	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	2.229	1.345	1.093	1.010	1.007	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	44.9%	74.3%	91.5%	99.0%	99.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Exhibit III, Sheets 10 and 11: Projected ultimate claims and computation of the unpaid claims estimates

* A comparison of the above amounts are made among the B/S Adjusted Reported Case, Adjusted Reported Both, and the Adjusted Paid method.
* All three projections are relatively close to one another for all accident years.

Chapter 13 - Berquist-Sherman
XYZ Insurer - Auto
Projection of Ultimate Claims Using Development Technique and Adjusted Data ($000)

Exhibit III
Sheet 10

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08		CDF to Ultimate			Projected Ultimate Claims Using Dev. Method with		
				Adjusted Reported		Adjusted	Adjusted Reported		Adjusted
		Reported	Paid	Case	Both	Paid	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) = [(3)x(5)]	(9) = [(3)x(6)]	(10) = [(4)x(7)]
1998	132	15,822	15,822	1.000	1.000	1.010	15,822	15,822	15,980
1999	120	25,107	24,817	1.000	1.000	1.013	25,107	25,107	25,140
2000	108	37,246	36,782	1.000	1.000	1.015	37,246	37,246	37,334
2001	96	38,798	38,519	1.000	1.000	1.020	38,798	38,798	39,289
2002	84	48,169	44,437	1.000	1.000	1.065	48,169	48,169	47,325
2003	72	44,373	39,320	1.000	1.000	1.121	44,373	44,373	44,078
2004	60	70,288	52,811	1.000	1.007	1.352	70,267	70,780	71,400
2005	48	70,655	40,026	1.000	1.010	1.716	70,634	71,362	68,685
2006	36	48,804	22,819	1.039	1.093	2.269	50,707	53,362	51,776
2007	25	31,732	11,865	1.205	1.345	3.249	38,237	42,680	38,549
2008	12	18,632	3,409	1.997	2.229	13.490	37,208	41,531	45,989
Total		449,626	330,627				476,568	489,229	485,546

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from XYZ Insurer.
(5) through (7) Based on CDF from Exhibit III, Sheets 3, 9 and 7, respectively.

Chapter 13 - Berquist-Sherman
XYZ Insurer - Auto
Development of Unpaid Claim Estimate ($000)

Exhibit III
Sheet 11

Accident Year	Claims at 12/31/08		Projected ultimate Claims Using Dev. Method with			Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08					
							IBNR - Based on Dev. Method with			Total - Based on Dev. Method with		
			Adjusted Reported		Adjusted		Adjusted Reported		Adjusted	Adjusted Reported		Adjusted
	Reported	Paid	Case	Both	Paid		Case	Both	Paid	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)=[(2)-(3)]	(8) = [(4) - (2)]	(9)=[(5)-(2)]	(10) = [(6) - (2)]	(11) = [(7)+(8)]	(12) = [(7) + (9)]	(13) = [(7)+(10)]
1998	15,822	15,822	15,822	15,822	15,980	0	0	0	158	0	0	158
1999	25,107	24,817	25,107	25,107	25,140	290	0	0	33	290	290	323
2000	37,246	36,782	37,246	37,246	37,334	464	0	0	88	464	464	552
2001	38,798	38,519	38,798	38,798	39,289	279	0	0	491	279	279	770
2002	48,169	44,437	48,169	48,169	47,325	3,732	0	0	-844	3,732	3,732	2,888
2003	44,373	39,320	44,373	44,373	44,078	5,053	0	0	-295	5,053	5,053	4,758
2004	70,288	52,811	70,267	70,780	71,400	17,477	-21	492	1,112	17,456	17,969	18,589
2005	70,655	40,026	70,634	71,362	68,685	30,629	-21	707	-1,970	30,608	31,336	28,659
2006	48,804	22,819	50,707	53,362	51,776	25,985	1,903	4,558	2,972	27,888	30,543	28,957
2007	31,732	11,865	38,237	42,680	38,549	19,867	6,505	10,948	6,817	26,372	30,815	26,684
2008	18,632	3,409	37,208	41,531	45,989	15,223	18,576	22,899	27,357	33,799	38,122	42,580
Total	449,626	330,627	476,568	489,229	485,546	118,999	26,942	39,603	35,920	145,941	158,602	154,919

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) through (6) Developed in Exhibit III, Sheet 10.

Exhibit III, Sheets 12 and 13: Projected ultimate claims and Estimated IBNR.

* Compares the results of the B/S projections with all the other techniques presented for XYZ Insurer.
* There are significant differences when comparing the results from the unadjusted development technique to those from the development technique applied to adjusted claims data.

These are summarized in the table below:

($ Millions)	**Estimated IBNR**	**Total Unpaid Claim Estimate**
Unadjusted Reported Claims	65	184
Unadjusted Paid Claims	155	274
Adjusted (Case Only) Reported Claims	27	146
Adjusted (Case and Settlement) Reported Claims	40	159
Adjusted Paid Claims	36	155

In Chapter 15, evaluation and selection of ultimate claims for many of the examples in preceding chapters, including XYZ Insurer, are discussed.

The actuary may wish to consider whether or not the results of the B/S analyses should be reflected in a revised B/F projection for XYZ Insurer.

Specifically, the adjusted reporting and payment patterns could be used in place of the unadjusted reporting and payment patterns, and any changes in the expected claim ratios due to B/S indications could be used in determining initial expected claims.

Sample questions:

1. Friedland explains how Berquist and Sherman approaches can be used for insurers who have undergone changes (operational, procedural, etc.). List the two broad alternatives that may be available to an actuary in these situations.

2. Of the two alternatives listed in 1), which is preferred?

3. Berquist/Sherman suggest two basic procedures for selecting data that is relatively unaffected by a particular data problem. What are these two basic procedures (provide an example of each)?

4. For situations requiring data alterations, describe two types of adjustments that may be made, prior to using a traditional method of estimating unpaid claims.

5. When using a Berquist-Sherman technique to adjust data for changes in Case Outstanding adequacy, what are the two decisions that require an actuary's judgment, according to Friedland?

6. A key part of the Berquist-Sherman process is analyzing the data triangles to see if a change (requiring adjustment) has taken place. When testing for a change in the Rate of Claims Settlement, what is the implication if there appears to be a steady decrease in the rate of claim settlement? If we ignored this test, and applied the Paid Claim Development method, would the Unpaid Claim Estimate likely be high or low?

Questions from the 1994 Exam (modified):

11. True/False: Based on the discussion in Friedland, Berquist and Sherman recommend the substitution of policy year data for accident year data when the rate of growth of exposures changes markedly.

Questions from the 1997 Exam (modified):

37. According to Friedland's discussion of Berquist-Sherman and Thorne's review, which of the following are true?
    1. They recommend substituting Report Year for Accident Year data when there has been a significant change in policy limits between successive years.
    2. Thorne's primary criticism of Berquist-Sherman's method to adjust for changes in claims closure is that it does not recognize the different settlement pattern by policy limit.
    3. Thorne's primary criticism of Berquist-Sherman's method to adjust for changes in reserve strength it that there is too much estimation involved in selecting the claim cost trend.

    A. 1 B. 2 C. 3 D. 1, 2 E. 1, 3

Questions from the 1998 Exam (modified):

53. (3 points) Given the following triangles, identify two trends in the data, and explain the potential impact on the ultimate claim estimate if the data remains unadjusted.

(Incremental) Paid Claims ($000's)

Accident Year	Development Period (months) 12	24	36	48	60	72
1992	100	108	113	73	36	28
1993	110	113	115	69	34	
1994	115	115	116	77		
1995	105	112	120			
1996	115	118				
1997	125					

(Incremental) Reported Claims ($000's)

Accident Year	Development Period (months) 12	24	36	48	60	72
1992	275	166	85	45	27	15
1993	305	186	76	29	16	
1994	315	203	69	21		
1995	325	244	45			
1996	340	256				
1997	355					

(Incremental) Reported Claim Counts

Accident Year	Development Period (months) 12	24	36	48	60	72
1992	200	100	57	10	5	1
1993	195	98	60	8	6	
1994	198	101	58	9		
1995	205	102	55			
1996	202	100				
1997	200					

(Cumulative) Ratio of Closed to Reported Claim Counts

Accident Year	Development Period (months) 12	24	36	48	60	72
1992	15.0%	36.0%	60.0%	75.0%	90.0%	93.0%
1993	18.0%	38.0%	65.0%	78.0%	87.0%	
1994	19.0%	40.0%	62.0%	74.0%		
1995	23.0%	42.0%	63.0%			
1996	23.0%	45.0%				
1997	26.0%					

Hint: Test for changes in the <u>Rate of Claims Settlement</u> and changes in <u>Adequacy of Case Outstanding</u>.

Questions from the 1998 Exam (modified):

49. (3 points) Given the data below, use the Berquist and Sherman method for adjusting for change in claim settlement pattern, as described by Friedland, to calculate the revised cumulative paid claims for accident year 1993 at each evaluation point, i.e., 12, 24, 36, 48, and 60. Assume that the relationship between the incremental number of closed claim counts and the incremental paid claim $ is linear. Show all work.

Accident Year	*Cumulative Claim Counts*					
	Age of Development (Months)					
	12	*24*	*36*	*48*	*60*	*Ultimate*
1993	*4,000*	*7,300*	*8,500*	*9,200*	*10,000*	*10,000*
1994	*4,800*	*8,000*	*10,000*	*11,400*		*12,000*
1995	*5,000*	*9,500*	*11,900*			*14,000*
1996	*5,500*	*10,650*				*15,000*
1997	*6,400*					*16,000*

(Data continues below)

Accident Year	*Cumulative Paid Claims ($000's)*					
	Age of Development (Months)					
	12	*24*	*36*	*48*	*60*	
1993	*20,000*	*35,000*	*45,000*	*52,000*	*56,000*	
1994	*25,000*	*39,000*	*48,000*	*55,000*		
1995	*24,000*	*42,000*	*50,000*			
1996	*31,000*	*50,000*				
1997	*35,000*					

Questions from the 2000 Exam:

60. (3 points) You are given the following information as of December 31, 1999:

Cumulative Incurred Claims ($000)

	Age of Development			
Accident Year	12 mos.	24 mos.	36 mos.	48 mos.
1996	8,450	12,755	30,230	43,390
1997	9,028	30,203	46,625	
1998	11,470	36,300		
1999	12,350			

Paid Claim $ per Closed Claim Count

	Age of Development			
Accident Year	12 mos.	24 mos.	36 mos.	48 mos.
1996	900	1,500	2,000	5,050
1997	990	1,650	2,200	
1998	1,089	1,815		
1999	1,198			

Number of Open Claims (Count)

	Age of Development			
Accident Year	12 mos.	24 mos.	36 mos.	48 mos.
1996	800	400	150	50
1997	900	500	200	
1998	1,000	575		
1999	1,100			

Cumulative Paid Claims ($000)

	Age of Development			
Accident Year	12 mos.	24 mos.	36 mos.	48 mos.
1996	5,000	8,000	24,605	40,890
1997	5,500	15,000	38,425	
1998	6,000	17,900		
1999	5,750			

Friedland illustrates a method by Berquist and Sherman to reduce the impact on reported claim projections due to changes in the adequacy level of Case Outstanding amounts. Using this technique, calculate the adjusted 12-24 reported claim development factor for accident year 1997. Show all work.

Questions from the 2002 Exam:

26. (3 points) You are given the following information for a company that has recently undergone changes affecting its claim settlement rates.

Cumulative Closed Claim Counts					
Accident		Age (in Months)			Projected
Year	12	24	36	48	Ultimate
1998	16,250	35,000	50,000	50,000	50,000
1999	18,375	39,375	52,500		52,500
2000	20,625	44,000			55,000
2001	23,000				57,500

Cumulative Paid Claims ($000)				
Accident		Age (in Months)		
Year	12	24	36	48
1998	121,875	262,500	375,000	375,000
1999	137,813	295,313	393,750	
2000	154,688	330,000		
2001	172,500			

Using the Berquist and Sherman method described by Friedland, calculate an estimate of the ultimate Paid Claims for accident year 2000. Assume that the relationship between the incremental number of closed claim counts (#) and the incremental paid claims ($) is linear. Use all-year simple averages to select ATA factors. Show all work.

Questions from the 2004 Exam (modified):

22. (1 point) Based on Friedland's discussion of Berquist and Sherman, state and briefly describe two problems that can be mitigated by analyzing claim experience by separate size of loss categories.

Questions from the 2004 Exam (modified):

23. (3 points) You are given the following information as of December 31, 2003:

Accident Year	Case Outstanding per Open Claim ($) (Age of Development in Months) 12	24	36
2001	$11,870	$18,840	$12,720
2002	12,580	19,963	
2003	14,234		

Accident Year	Number of Open Claims (Counts) (Age of Development in Months) 12	24	36
2001	100	90	50
2002	100	90	
2003	100		

Data continues below

Accident Year	Paid Claim ($) per Closed Claim Count (Age of Development in Months) 12	24	36
2001	$10,600	$21,200	$26,500
2002	11,236	22,472	
2003	11,910		

Accident Year	Cumulative Paid Claims ($) (Age of Development in Months) 12	24	36
2001	$933,000	$2,332,000	$4,198,000
2002	989,000	2,473,000	
2003	1,049,000		

Selected Reported CDF from 24 months to ultimate is 1.426.

a. (1.5 points) Based on Friedland's explanation of Berquist and Sherman's method, demonstrate why you might conclude that the relative level of Case Outstanding adequacy is different for accident year 2003 as of 12 months than for earlier accident years. Show all work.

b. (1.5 points) Calculate an estimate for Ultimate Reported Claims for accident year 2003 using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy. Show all work.

2005 Exam Questions (modified):

8. (3.5 points) You are given the following information as of December 31, 2004:

Cumulative Paid Claims

Accident Year	12	24	36
	(Age of Development in Months)		
2002	$10,000	$32,800	$59,850
2003	13,125	36,120	
2004	12,673		

Closed Claim Counts

Accident Year	12	24	36
	(Age of Development in Months)		
2002	20	41	57
2003	25	43	
2004	23		

Cumulative Reported Claims

Accident Year	12	24	36
	(Age of Development in Months)		
2002	$18,000	$40,800	$62,250
2003	23,205	42,420	
2004	23,761		

Open Claim Counts

Accident Year	12	24	36
	(Age of Development in Months)		
2002	10	8	2
2003	12	6	
2004	11		

- Select ATA factors using all-years simple averages.
- The selected tail factor for incurred development after 36 months is 1.100.

a. (1.5 points) Based on Berquist and Sherman's method, demonstrate that the relative level of the Case Outstanding adequacy has changed for accident year 2004.

b. (2 points) Using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy, calculate the ultimate reported claims for accident year 2004.

9. (2.5 points) Berquist and Sherman describe an approach to adjust the Paid Claim ($) triangle for distortion.

a. (0.5 point) Identify the distortion for which this adjustment is intended.

b. (2 points) Describe the technique to make the necessary adjustment.

2006 Exam Questions (modified):

20. (1.5 points)

a. (0.5 points) Why is it important for the actuary to engage in discussions with management in business areas, such as claims and underwriting, when estimating Unpaid Claims?

b. (1 point) A review of the claims data for a company reveals that the time it takes to settle a claim once it has been reported has increased over the last six months. Identify two questions that you would ask of claims management of that company to better understand this trend.

21. (2 points) In the course of a reserve analysis, it is observed that the paid claim development triangles are distorted by significant changes in the claims settlement rate. Briefly describe the procedure that Berquist and Sherman propose to address this situation, as described in Friedland.

2007 Exam Questions (modified):

33. (2 points) Given the following data for a certain book of business:

Average Case Reserve ($) Per Open Claim

Accident Year	12	24	36
2004	6,354	12,493	25,192
2005	8,196	17,400	
2006	10,000		

Number of Open Claims

Accident Year	12	24	36
2004	400	250	75
2005	550	325	
2006	450		

Cumulative Paid Losses ($)

Accident Year	12	24	36
2004	1,600,000	2,740,000	4,000,000
2005	1,725,000	2,850,000	
2006	1,775,000		

(Columns: Age of Development in Months)

- The annual severity trend for this book of business is 7%.

Construct the Berquist-Sherman adjusted incurred loss triangle, as explained in Friedland.

34. (1 point) Explain two reasons why using paid claim data to estimate a severity trend can be inappropriate for medical malpractice losses.

2007 Exam Questions (modified):

38. (2.25 points)

a. (0.75 point) Identify three operational changes that could affect the accuracy of Unpaid Claim estimates for a book of business written by an insurance company.

b. (0.75 point) For each change identified in part a. above, briefly describe how it affects the unadjusted chain ladder method (Development Method) for calculating Unpaid Claim estimates.

c. (0.75 point) For each response provided in part b. above, identify an adjustment that would result in a more appropriate Unpaid Claim estimate.

39. (1.5 points)

a. (0.5 point) Identify and explain how a change external to a particular insurance company could affect claim frequency for that company.

b. (0.5 point) Identify and explain how a change external to a particular insurance company could affect claim severity for that company.

c. (0.5 point) Explain why frequency and severity changes cannot be considered independently.

2008 Exam Questions (modified):

4. (Modified) 2.5 points
Given the following data as of December 31, 2007:

Cumulative Paid Loss ($000s)				
AY	12	24	36	48
2004	30,729	103,361	125,237	138,547
2005	24,573	85,337	105,979	
2006	22,567	88,009		
2007	27,761			

Average Case O/S per Open Claim ($000s)				
AY	12	24	36	48
2004	63.500	97.100	342.400	888.700
2005	62.100	115.000	394.200	
2006	66.200	109.200		
2007	79.800			

Number of Open Claims (Counts)

AY	*12*	*24*	*36*	*48*
2004	810	480	115	43
2005	698	387	87	
2006	654	361		
2007	633			

a. (2 points)
Using the method described by Berquist and Sherman to adjust for changes in case reserve adequacy, calculate the ADJUSTED cumulative reported loss triangle, assuming a 5% severity trend.

b. (.5 points)
Using all-year weighted average loss development factors, calculate the Accident Year 2007 ultimate loss based on the ADJUSTED cumulative reported loss triangle, assuming a 48-to-Ult CDF of 1.02.

5. modified (2 points)
When compiling data in preparation for a reserve analysis (estimates of unpaid claims), the actuary must consider changes in the external environment as well as changes internal to the insurance company. For each of a, b, c, and d, below, give an example of a situation in which it would be preferable to use the suggested datasets and provide the rational of each example.

a. (.5 points) Policy year data instead of accident year data
b. (.5 points) Accident quarter data instead of accident year data.
c. (.5 points) Report year data instead of accident year data.
d. (.5 points) Earned exposures instead of claim counts.

2009 Exam Questions

11. (2.5 points) Given the following information:

Accident Year	Cumulative Paid Loss 12 Months	24 Months	36 Months	48 Months
2005	$170,000	$320,000	$450,000	$500,000
2006	220,000	420,000	630,000	
2007	360,000	650,000		
2008	450,000			

Accident Year	Number of Open Claims 12 Months	24 Months	36 Months	48 Months
2005	34	20	15	8
2006	55	35	24	
2007	75	50		
2008	84			

Accident Year	Average Case Reserve 12 Months	24 Months	36 Months	48 Months
2005	$2,500	$5,500	$8,000	$15,000
2006	3,125	6,490	9,440	
2007	3,750	7,528		
2008	4,125			

- Selected case reserve severity trend at all maturities is 5%.
- The 48 month to ultimate incurred loss development factor is 1.020.

a. (2 points) Use the Berquist-Sherman case reserve adjustment method to calculate ultimate losses for accident year 2008.

b. (0.5 point) Briefly describe the purpose of the Berquist-Sherman case reserve adjustment.

2010 Exam Questions

1. (4 points) Given the following loss information as of 12 months maturity for AYs 2006 through 2009:

Accident Year	Paid Claims (S000)	Reported Claims ($000)	Closed Claim Counts	Open Claim Counts
2006	9,688	17,299	2,800	1,522
2007	17,778	38,345	5,000	3,639
2008	25,519	51,836	6,900	4,119
2009	34,093	74,115	8,875	5,544

a. (1.75 points) Test the above data for changes in case reserve adequacy and interpret the results.

b. (0.75 point) Describe the leveraging effect that a change in case reserve adequacy has on the IBNR indicated by the reported loss development method.

c. (1.5 points) Use the Berquist-Sherman technique for case reserve adequacy to calculate the adjusted reported claims for each accident year.

2011 Exam Questions

31. (3.75 points) Given the following data as of December 31, 2010:

Accident	Cumulative Paid Claims (000s)		
Year	12 Months	24 Months	36 Months
2008	$3,816	$9,771	$18,518
2009	$3,600	$11,292	
2010	$6,268		

Accident	Case Outstanding (000s)		
Year	12 Months	24 Months	36 Months
2008	$21,936	$31,920	$27,424
2009	$26,334	$28,648	
2010	$31,042		

Accident	Cumulative Reported Claims (000s)		
Year	12 Months	24 Months	36 Months
2008	$25,752	$41,691	$45,942
2009	$29,934	$39,940	
2010	$37,310		

Accident	Open Claim Counts		
Year	12 Months	24 Months	36 Months
2008	1,828	1,900	1,522
2009	1,540	1,600	
2010	1,660		

- Annual severity trend 10%
- 36-to-ultimate reported tail factor = 1.050
- Use all-year volume-weighted average for development factor selection

a. (2.75 points) Use the Berquist-Sherman technique for case reserve adequacy to estimate the ultimate claims for all accident years.

b. (0.25 point) Briefly describe the purpose of the Berquist-Sherman case reserve adjustment.

c. (0.75 point) Discuss whether changing the annual severity trend given above from 10% to 5% would produce a higher or lower ultimate claims estimate under the Berquist-Sherman technique for case reserve adequacy.

2012 Exam Questions

22. (4.25 points) Given the following data as of December 31, 2011:

Cumulative Reported Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$9,931	$11,583	$13,053
2010	$12,967	$17,391	
2011	$12,924		

Cumulative Paid Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$3,711	$8,747	$12,358
2010	$3,464	$8,996	
2011	$3,128		

Open Claim Counts

Accident Year	12 Months	24 Months	36 Months
2009	345	167	30
2010	499	350	
2011	435		

- Assume no reported or paid development after 36 months.
- The annual severity trend is 8%.

a. (0.75 point) Estimate the ultimate claims for accident year 2011 using the reported development technique.

b. (3 points) Estimate the ultimate claims for accident year 2011 using the Berquist-Sherman case outstanding adjustment technique.

c. (0.5 point) Discuss the difference between the two estimates.

2012 Exam Questions (continued)

24. (3.5 points) Given the following information:

Cumulative Closed Claim Counts

Accident Year	12 Months	24 Months	36 Months
2009	500	1,200	1,695
2010	750	1,325	
2011	825		

Cumulative Paid Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$2,893	$8,727	$12,919
2010	$4,339	$9,636	
2011	$4,773		

Cumulative Reported Claim Counts

Accident Year	12 Months	24 Months	36 Months
2009	1,500	1,900	2,050
2010	1,650	2,100	
2011	1,600		

Case Outstanding Claims ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$8,715'	$9,211	$3,944
2010	$7,844	$10,197	
2011	$6,755		

- There are no partial payments.
- Assume no reported development after 36 months.

a. (2 points) Evaluate whether a Berquist-Sherman Case Outstanding Adjustment would be appropriate.

b. (1.5 points) Use disposal rates to evaluate whether a Berquist-Sherman Paid Claim Development Adjustment would be appropriate.

Solutions to Sample Questions:

1. Friedland explains how Berquist and Sherman approaches can be used for insurers who have undergone changes (operational, procedural, etc.). Explain the two broad alternatives that may be available to an actuary in these situations.
   1) Avoid the problem: through data selection and/or rearrangement
   2) Adjust the data to account for the changes

2. Whenever possible, it is better to avoid the problem by using data that is relatively unaffected by the changes that the insurer faces.

3. Berquist/Sherman suggest two basic procedures for selecting data that is relatively unaffected by a particular data problem. What are these two basic procedures (provide an example of each)?

   Two procedures are described to obtain data that is relatively unaffected by a given problem. These procedures are as follows:
   1) Substitute data (example: using quarterly data in place of annual accident year data when there has been substantial growth in premium volume), or
   2) Subdivide the data (example: separating large claims from small claims).

4. For situations requiring data alterations, describe two types of adjustments that may be made, prior to using a traditional method of estimating unpaid claims.
   1) If there have been changes in the <u>Adequacy of Case Outstanding</u> amounts:
      Below we will see how to test and adjust the Case Outstanding data triangle.
   2) If there have been changes in the <u>Rate of Claims Settlement</u>:
      Below we will see how to test and adjust the Paid Claim data triangle.

5. When using a Berquist-Sherman technique to adjust data for changes in Case Outstanding adequacy, Friedland notes two decisions that require an actuary's judgment:
   1) Must "choose a diagonal from which he or she will calculate all other values of the adjusted average case outstanding triangle."
   2) Must "select an annual severity trend to adjust the (values) from the selected diagonal …"

6. A key part of the Berquist-Sherman process is analyzing the data triangles to see if a change (requiring adjustment) has taken place. When testing for a change in the Rate of Claims Settlement, what is the implication if there appears to be a steady decrease in the rate of claim settlement? If we ignored this test, and applied the Paid Claim Development method, would the Unpaid Claim estimate likely be high or low?

   The primary underlying assumption of the Paid Claim Development Technique would be contradicted. Using this method would likely understate the actual amount needed to reserve for unpaid claims.

Solutions to 1994 Exam questions (modified):

11. True/False: Based on the discussion in Friedland, Berquist and Sherman recommend the substitution of policy year data for accident year data when the rate of growth of exposures changes markedly.
    False, the substitution is accident quarter for accident year.

Solutions to 1997 Exam questions (modified):

37. According to Friedland's discussion of Berquist-Sherman and Thorne's review, which of the following are true?
    1. They recommend substituting Report Year for Accident Year data when there has been a significant change in policy limits between successive years.
        - False, the recommendation would be policy year for accident year.
    2. Thorne's primary criticism of Berquist-Sherman's method to adjust for changes in claims closure is that it does not recognize the different settlement pattern by policy limit.
        - False, the criticism is the failure to reflect changes in settlement pattern by size of claim.
    3. Thorne's primary criticism of Berquist-Sherman's method to adjust for changes in reserve strength it that there is too much estimation involved in selecting the claim cost trend.
        - True, too much judgment is involved.

    A. 1 B. 2 **C. 3** D. 1, 2 E. 1, 3

Solutions to 1998 Exam questions (modified):

53. (3 points) Given the following data:

(A) Given (Incremental) Paid Claims ($000's)

Accident	Development Period (months)					
Year	12	24	36	48	60	72
1992	100	108	113	73	36	28
1993	110	113	115	69	34	
1994	115	115	116	77		
1995	105	112	120			
1996	115	118				
1997	125					

(B) Given (Incremental) Reported Claims ($000's)

Accident	Development Period (months)					
Year	12	24	36	48	60	72
1992	275	166	85	45	27	15
1993	305	186	76	29	16	
1994	315	203	69	21		
1995	325	244	45			
1996	340	256				
1997	355					

(C) Given (Incremental) Reported Claim Counts

Accident	Development Period (months)					
Year	12	24	36	48	60	72
1992	200	100	57	10	5	1
1993	195	98	60	8	6	
1994	198	101	58	9		
1995	205	102	55			
1996	202	100				
1997	200					

(D) Given (Cumulative) Ratio of Closed to Reported Claim Counts

Accident	Development Period (months)					
Year	12	24	36	48	60	72
1992	15.0%	36.0%	60.0%	75.0%	90.0%	93.0%
1993	18.0%	38.0%	65.0%	78.0%	87.0%	
1994	19.0%	40.0%	62.0%	74.0%		
1995	23.0%	42.0%	63.0%			
1996	23.0%	45.0%				
1997	26.0%					

1998 # 53 TEST 1: Test for change in the Rate of Claim Settlement.

TEST 1, first step: Estimate ultimate claim counts using reported claim counts.

(E) From (C) *(Cumulative) Reported Claim Counts*

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	200	300	357	367	372	373
1993	195	293	353	361	367	
1994	198	299	357	366		
1995	205	307	362			
1996	202	302				
1997	200					

(F) From (E) *Age-to-Age Factors for (Cumulative) Reported Claim Counts*

Accident Year	12:24	24:36	36:48	48:60	60:72	Let 72:Ult
	Development Period (months)					
1992	1.500	1.190	1.028	1.014	1.003	
1993	1.503	1.205	1.023	1.017		
1994	1.510	1.194	1.025			
1995	1.498	1.179				
1996	1.495					
3-yr Simple Avg ATA	1.501	1.193	1.025	1.015	1.003	1.000
CDF to Ultimate	1.868	1.245	1.044	1.018	1.003	1.000

(G) *Ultimate Reported Claim Counts = [Latest Diagonal from (D)] * [CDF to Ultimate]*

Accident Year	12	24	36	48	60	72	Ultimate
	Development Period (months)						
1992						**373** x1.00=	373.0
1993					**367**	x1.003=	368.0
1994				**366**		x1.018=	372.5
1995			**362**			x1.044=	377.8
1996		**302**				x1.245=	375.9
1997	**200**					x1.868=	373.6

TEST 1 (cont): Create claim disposed ratios (cumulative closed claims /ultimate claims)

(H) = (D) * (E) *(Cumulative) CLOSED Claim Counts*

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	30.0	108.0	214.2	275.3	334.8	346.9
1993	35.1	111.3	229.5	281.6	319.3	
1994	37.6	119.6	221.3	270.8		
1995	47.2	128.9	228.1			
1996	46.5	135.9				
1997	52.0					

(I) = (H) / (G)ult *Disposal Rates (Cumulative Closed Counts, divided by Ultimate Counts)*

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	0.080	0.290	0.574	0.738	0.898	0.930
1993	0.095	0.303	0.624	0.765	0.868	
1994	0.101	0.321	0.594	0.727		
1995	0.125	0.341	0.604			
1996	0.124	0.362				
1997	0.139					

Test 1 Conclusion: Appears to be a speed up in the Rate of Claim Settlement (down columns).

1998 #53 TEST 2: Test for change in <u>Adequacy of Case Outstanding</u>

TEST 2, first step: Calculate case outstanding amounts.

(J) (Cumulative) Paid Claims ($000's)
From (A)

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	100	208	321	394	430	458
1993	110	223	338	407	441	
1994	115	230	346	423		
1995	105	217	337			
1996	115	233				
1997	125					

(K) (Cumulative) Reported Claims ($000's)
From (B)

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	275	441	526	571	598	613
1993	305	491	567	596	612	
1994	315	518	587	608		
1995	325	569	614			
1996	340	596				
1997	355					

(L) = Case Outstanding = Reported Claims - Paid Claims ($000's)
(K) - (J)

Accident Year	12	24	36	48	60	72
	Development Period (months)					
1992	175	233	205	177	168	155
1993	195	268	229	189	171	
1994	200	288	241	185		
1995	220	352	277			
1996	225	363				
1997	230					

TEST 2 (cont): Calculate Open Claim Counts

(M) = *Open Claim Counts = Cumulative Reported Counts - Cumulative Paid Counts*
(E) - (H)

Accident Year	*12*	*24*	*36*	*48*	*60*	*72*
	Development Period (months)					
1992	*170.0*	*192.0*	*142.8*	*91.8*	*37.2*	*26.1*
1993	*159.9*	*181.7*	*123.6*	*79.4*	*47.7*	
1994	*160.4*	*179.4*	*135.7*	*95.2*		
1995	*157.9*	*178.1*	*133.9*			
1996	*155.5*	*166.1*				
1997	*148.0*					

TEST 2 (cont): Calculate Average Case Outstanding per Open Claim

(N) = 1000* *Average Case Outstanding $ per Open Claim Count (Severity)*
(L) / (M)

Accident Year	*12*	*24*	*36*	*48*	*60*	*72*
	Development Period (months)					
1992	*1,029*	*1,214*	*1,436*	*1,929*	*4,516*	*5,936*
1993	*1,220*	*1,475*	*1,854*	*2,380*	*3,584*	
1994	*1,247*	*1,605*	*1,777*	*1,944*		
1995	*1,394*	*1,977*	*2,068*			
1996	*1,447*	*2,185*				
1997	*1,554*					

Test 2 Conclusion: Appears there may be evidence of <u>Case Outstanding Adequacy</u> strengthening in the earlier development intervals. (Really want to compare growth % indications here against the implied trends from paid data. See more recent exam questions below as better examples.)

Solution to 1998 Exam Question 53 (continued): Final Observations

Test 1 Conclusion: Appears to be a speed up in the Rate of Claim Settlement (down columns).
If paid claims are used as the basis for the estimate of ultimate claims, this could create an overstatement in the ultimate amounts (assuming that more closed claims mean a greater percentage of ultimate claim have been paid).

Test 2 Conclusion: Appears there may be evidence of Case Outstanding Adequacy strengthening in the earlier development intervals. (Really want to compare growth % indications here against the implied trends from paid data. See more recent exam questions below as better examples.)
If reported claims are used as the basis for the estimate of ultimate claims this could create an overstatement in the ultimate amounts for accident years 1995 - 1997.

Note: This question only asks us to **test if** data adjustments are needed.
Below we see how to make the data adjustments, given that they are needed.

Most often the question will require one of the two adjustments (either an adjustment for a change in the rate of claim settlement or an adjustment for a change in the adequacy of case outstanding amounts.)

The 1998 questions are shown to reverse order to present the tests (53) before the actual data adjustments.

Solution to 1998 Exam Question 49 (modified):

Calculate the revised cumulative paid claims for accident year 1993 at each evaluation point:

(A) Given

Accident Year	Cumulative Claim Counts, Age of Development (Months) 12	24	36	48	60	(A) Projected Ultimate
1993	**4,000**	**7,300**	**8,500**	**9,200**	**10,000**	10,000
1994	4,800	8,000	10,000	11,400		12,000
1995	5,000	9,500	11,900			14,000
1996	5,500	10,650				15,000
1997	6,400					16,000

(B) Given

Accident Year	Cumulative Paid Claims ($000's), Age of Development (Months) 12	24	36	48	60	
1993	**20,000**	**35,000**	**45,000**	**52,000**	**56,000**	
1994	25,000	39,000	48,000	55,000		
1995	24,000	42,000	50,000			
1996	31,000	50,000				
1997	35,000					

1) Adjusting for changes in settlement rates … Friedland states:
"Berquist and Sherman select the disposal rate along the latest diagonal as the basis for adjusting the closed claim count triangle." Accordingly, we find this diagonal:

(C) = Values of (A) along diagonal, divided by the corresponding Ultimate values in (A)

Accident Year	Disposal Rates = Cumulative Claim Counts / Ultimate Claims Counts, Age of Development (Months) 12	24	36	48	60	
1993					**100.0%**	=10K/10K
1994				**95.0%**	=11,400/12,000	
1995			**85.0%**	=11,900/14,000		
1996		**71.0%**	=10,650/15,000			
1997	**40.0%**	=6,400/16,000				
Selected	40.0%	71.0%	85.0%	95.0%	100.0%	

2) And use these selected Disposal Rates to restate (adjust) the historical count data:

(D) = Ultimate Counts in (A), multiplied by the selected Disposal Rates in (C)

Accident Year	*ADJUSTED Cumulative Claim Counts*					
	Age of Development (Months)					
	12	*24*	*36*	*48*	*60*	
1993	***4,000***	***7,100***	***8,500***	***9,500***	***10,000***	
1994						
1995						
1996						
1997						

3) To move from adjusted claim counts to adjusted claim dollars, Friedland notes:
The authors "identify a mathematical formula that approximates the relationship … "

*See the text for details on regression analysis, but for this question we are told to to **assume the relationship is linear**, based on the unadjusted data points (by year).*

	Original AY 2003 Data		***ADJUSTED** AY 2003 Data*	
	Counts #	*Claim $000*	*Counts #*	***Claims $000's (Cumulative)***
Age	*From (A)*	*From (B)*	*From (D)*	*Linearly Interpolated from left*
12	*4,000*	*20,000*	*4,000*	***20,000** directly = original data*
24	*7,300*	*35,000*	*7,100*	***34,091** See below*
36	*8,500*	*45,000*	*8,500*	***45,000** directly = original data*
48	*9,200*	*52,000*	*9,500*	***55,000***
60	*10,000*	*56,000*	*10,000*	***56,000** directly = original data*

For example, adjusted paid losses at 24 months are calculated as:

20,000 + (7,100 – 4,000)/(7,300 – 4,000) x (35,000 – 20,000) = 34,091

A similar process could be followed for each accident year, creating entire triangles of adjusted data. This data could then be used with a method for estimating unpaid claims.

Solutions to 2000 Exam questions (modified):

Question 60: Propose a technique to reduce the impact on Reported Claim projections due to changes in the Adequacy Level of Case Outstanding amounts. Using this technique, calculate the adjusted 12-24 reported age-to-age claim development factor for accident year 1997.

Step 1: Compute severity trends in paid losses per closed claim:

AY	12 mos	24 mos	36 mos
96-97	$\frac{990}{900}=1.10$	$\frac{1650}{1500}=1.10$	$\frac{2200}{2000}=1.10$
97-98	$\frac{1089}{990}=1.10$	$\frac{1815}{1650}=1.10$	
98-99	$\frac{1198}{1089}=1.10$		

Based on the above, the severity trend in paid losses per closed claims equals 10%

Step 2: a. Compute "Case Outstanding per Open Claim Count" for the latest diagonal ($000s):

AY	12 mos	24 mos	36 mos
1997			calculation not necessary
1998		$\frac{36,300-17,900}{.575}=32,000$	
1999	$\frac{12,350-5,750}{1.1}=6,000$		

b. Compute the remaining values in the triangle above by de-trending the above values by the severity trend, 10%, determined in Step 1. (numbers in $000s):

AY	12 mos	24 mos
1997	$\frac{5,455}{1.1}=4,959$	$\frac{32,000}{1.1}=29,091$
1998	$\frac{6,000}{1.1}=5,455$	$32,000$
1999	$6,000$	

Step 3: Compute adjusted Reported Claims $ at 12 and 24 months respectively for AY 1997

Adjusted Reported Losses = [Adjusted Case Outstanding as above]*[Open Count#]/1000 + Paid Losses

AY 1997 at 12 mos.: $\frac{4,959*900}{1,000}+5,500=9,963$. AY 1997 at 24 mos.: $\frac{29,091*500}{1,000}+15,000=29,545$.

Step 4: Compute the adjusted 12-24 Reported loss development factor for AY 1997.

The adjusted 12-24 incurred ATA CDF for accident year 1997 = $\frac{29,545}{9,963}=2.965$

Solutions to 2002 Exam questions (modified):

26. (3 points) Calculate an estimate of the ultimate Paid Claims for accident year 2000.

(A) Given

Accident Year	Cumulative Claim Counts (#) Age of Development (Months) 12	24	36	48		(A) Projected Ultimate
1998	16,250	**35,000**	**50,000**	**50,000**		50,000
1999	18,375	**39,375**	**52,500**			52,500
2000	20,625	**44,000**				55,000
2001	23,000					57,500

(B) Given

Accident Year	Cumulative Paid Claims ($000's) Age of Development (Months) 12	24	36	48		
1998	121,875	**262,500**	**375,000**	**375,000**		
1999	137,813	**295,313**	**393,750**			
2000	154,688	**330,000**				
2001	172,500					

1) Adjusting for changes in settlement rates … Friedland states:
"Berquist and Sherman select the disposal rate along the latest diagonal as the basis for adjusting the closed claim count triangle." Accordingly, we find this diagonal:

(C) = Values of (A) along diagonal, divided by the corresponding Ultimate values in (A)

Accident Year	Disposal Rates = Cumulative Claim Counts / Ultimate Claims Counts Age of Development (Months) 12	24	36	48	Calculations
1998				**100.0%**	= 50,000 / 50,000
1999			**100.0%**		= 52,500 / 52,500
2000		**80.0%**			= 44,000 / 55,000
2001	**40.0%**				= 23,000 / 57,500
Selected	**40.0%**	**80.0%**	**100.0%**	**100.0%**	

2) And use these Selected Disposal Rates to restate (adjust) the historical count data:
(D) = Ultimate Counts in (A), multiplied by the selected Disposal Rates in (C)

Accident Year	ADJUSTED Cumulative Claim Counts (#) Age of Development (Months) 12	24	36	48	
1998	20,000	**40,000**	**50,000**	**50,000**	
1999	21,000	**42,000**	**52,500**		
2000	22,000	**44,000**			
2001	23,000				

Solution to 2002 #26 (continued):

3) To move from adjusted claim <u>counts</u> to adjusted claim <u>dollars</u>, Friedland notes:
The authors "identify a mathematical formula that approximates the relationship … "
*We a**ssume the relationship is linear**, based on the unadjusted data points (by year).*

Note: we will only calculate the factors we need for this exam question:
Since we only need an estimate for 2000 AY unpaid, which is at 24 months, we need enough data to develop a CDF from 24 to Ultimate. (1998 and 1999, 24 mo and after)

FOR 1998	Original AY 1998 Data		**ADJUSTED** AY 1998 Data	
	Counts #	Claim $000	Counts #	**Claims $000's (Cumulative)**
Age	From (A)	From (B)	From (D)	Linearly Interpolated from left
24	35,000	262,500	40,000	**300,000** see below
36	50,000	375,000	50,000	**375,000** as for unadjusted
48	50,000	375,000	50,000	**375,000** as for unadjusted

For example, adjusted paid losses at 24 months are calculated as:
262,500 + (40-35)/(50-35) x (375,000-262,500) = 300,000

FOR 1999	Original AY 1999 Data		**ADJUSTED** AY 1999 Data	
	Counts #	Claim $000	Counts #	**Claims $000's (Cumulative)**
Age	From (A)	From (B)	From (D)	Linearly Interpolated from left
24	39,375	295,313	42,000	**315,000** see below
36	52,500	393,750	52,500	**393,750** as for unadjusted

For example, adjusted paid losses at 24 months are calculated as:
295,313 + (42,000-39,375)/(52,500-39,375) x (393,750-295,313) = 315,000

(E) from calculations immediately above, we have ADJUSTED PAID ($) DATA

Accident Year	ADJUSTED Cumulative Paid Claims ($000's) — Age of Development (Months) 12	24	36	48
1998		**300,000**	**375,000**	**375,000**
1999		**315,000**	**393,750**	
2000				

4) Use ADJUSTED PAID LOSS DATA to develop a CDF to apply to AY 2000

(F) Based on the adjusted data in table (E)

ATA calculations	**24 to 36**	**36 to 48**	**48 to Ult.**
1998	1.25	1.00	
1999	1.25	n/a	
Selected (Simple Average)	1.25	1.00	1.00
CDF calculations	**at 24 mo**		
CDF to Ultimate	**1.25**		

5) Apply the CDF to AY 2000

Accident Year	Cumulative Paid Claim $000's — Age of Development (Months) 12	24	36	48	**CDF**	**ANSWER** Projected Ultimate
2000	Latest	**330,000**	multiplied by the selected 1.25 =			**412,500**

Solutions to 2004 Exam questions (modified):

22. (1 point) Based on Berquist and Sherman, state and briefly describe the two problems that can be mitigated by analyzing loss experience by separate size of loss categories.

1. The claims department may have shifted their focus from settling small claims to settling large claims. This could potentially disrupt the assumption that as the rate of closure goes up, the losses paid on those claims goes up.

2. Claim adjusters may change the way they handle small, trivial claims. This change in operations could distort the combined large and small database of claims.

23. a. (1.5 points) Based on Friedland's explanation of Berquist and Sherman's method, demonstrate why you might conclude that the relative level of Case Outstanding adequacy is different for accident year 2003 as of 12 months than for earlier accident years. Show all work.

2004 # 23a : Test for change in <u>Adequacy of Case Outstanding</u>

Given Average Case Outstanding per Open Claim

Average Case Outstanding $ per Open Claim Count (Severity)

(A) given

Accident	*Development Period (months)*					
Year	*12*	*24*	*36*			
2001	$11,870	$18,840	$12,720			
2002	12,580	19,963				
2003	14,234					

Now, compare the growth % indications here to the implied trend %s from <u>paid</u> data.

Friedland says, "Berquist and Sherman note that the observed trends for the average paid claims are similar to industry benchmarks (at the time), and thus they conclude that the (different) trend rates for average case oustanding are indicative of changes in case outsanding adequacy." We make a similar assumption here.

Calculate growth rate % in Average Case Outstanding per Open Claim

Average Case Outstanding $ per Open Claim Count (Severity)

(B) from (A)

Accident	*Development Period (months)*					
Year	*12*	*24*	*36*			
2002	*6.0%*	*6.0%*				
2003	***13.1% *****					
Example: 14,234 / 12,580 - 1 = 13.1%						

Given Average Paid Claim ($) per Closed Claim Count

Average Paid $ per Closed Claim Count (Severity)

(C)

Accident	*Development Period (months)*					
Year	*12*	*24*	*36*			
2001	*10,600*	*21,200*	*26,500*			
2002	*11,236*	*22,472*				
2003	*11,910*					

2004 # 23a : Test for change in Adequacy of Case Outstanding - continued

Calculate trend rate % in Average Paid Claim ($) per Closed Claim Count

Calculation of the Trend Factor we take to be "true"

(D) from (C)	*Accident Year*	*Development Period (months)* 12	24	36			
	2002	*6.00%*	*6.00%*				
	2003	***6.0% *****					

Example: 22,474 / 21,200 - 1 = 6%

Compare growth rate %s in average outstanding data (B) to the trend rate %s in the paid data (D).

*** The average open claim amount has risen from 6% to 13% compared to a 6% increase in average paid severities over time. This demonstrates why we may conclude that the relative level of case outstanding adequacy is changing. ***

Solution to 2004 # 23 b. (1.5 points) Calculate an estimate for Ultimate Reported Claims for accident year 2003 using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy. Show all work.

Step 1: Begin by restating the average open severity using a 6% trend (De-trending)

Average Case Oustanding $ per Open Claim: ADJUSTED
Start with most recent diagonal given in (A) and DE-TREND at 6%

(E)	*Accident Year*	*Development Period (months)* 12	24	36	*Notes on Calculations*
	2001	*12,668*	*18,833*	***12,720***	
	2002	*13,428*	***19,963***		*13,428 = 14,234 / 1.06*
	2003	***14,234***			*12,668 = 13,428 / 1.06*

Step 2: Multiply re-stated averages above by the open counts for re-stated Case Outstanding $

*Re-stated Total $ Case Outstanding = Adjusted Average Case Outstanding * Open Counts (#)*

(F) =	*Accident Year*	*Development Period (months)* 12	24	36	*Notes on Calculations*
*(E) * open counts*	*2001*	*1,266,821*	*1,694,972*	*636,000*	
(given)	*2002*	*1,342,830*	*1,796,670*		*1,342,800 = 13,428 * 100*
	2003	*1,423,400*			

Step 3: Add re-stated case outstanding $ to cumulative paid claim $ for Reported Claims

Adjusted Reported Claims = Re-stated Case Outstanding + Cumulative Paid Claims

(G) =	*Accident Year*	*Development Period (months)* 12	24	36	*Notes on Calculations*
(F) + Paid	*2001*	*2,199,821*	*4,026,972*	*4,834,000*	
(given)	*2002*	*2,331,830*	*4,269,670*		*4,269,670 = 1,796,670 + 2,473,000*
	2003	*2,472,400*			

Solution to 2004 #23 (continued):

2004 # 23b : Example with change <u>Adequacy of Case Outstanding - continued</u>

Step 4: Compute ATA factor for 12-24 months using the adjusted reported claims, and Use the <u>given 24 to ultimate CDF</u> to compute the 12 month age to ultimate CDF

ATA	*Development Period (months)*			
	12:24			
2001	*1.831*			
2002	*1.831*			
Selected	*1.831*	*Reported CDF from 24 months to ultimate is 1.426 (given)*		
Ult CDF	*12-to-ultimate = 1.831 * 1.426 =*	*2.611*		

*Finally, we estimate AY 2003 ultimate claims = 2,472,400 * 2.611 =* ***6,455,436*** **ANSWER**

Solutions to 2005 Exam questions (modified):

8. (3.5 points)
   a. (1.5 points) Based on Berquist and Sherman's method, demonstrate that the relative level of the Case Outstanding adequacy has changed for accident year 2004.

2005 # 8a : Test for change in <u>Adequacy of Case Outstanding</u>

Given Average Case Outstanding per Open Claim

(A) = [Reported $ - Paid $ (cumulative)] / [Open Counts]

Accident	*Development Period (months)*					
Year	*12*	*24*	*36*			
2002	800	1,000	1,200			
2003	840	1,050				
2004	1,008					

Now, compare the growth % indications here to the implied trend %s from <u>paid</u> data.

Friedland says, "Berquist and Sherman note that the observed trends for the average paid claims are similar to industry benchmarks (at the time), and thus they conclude that the (different) trend rates for average case oustanding are indicative of changes in case outsanding adequacy." We make a similar assumption here.

Calculate growth rate % in Average Case Outstanding per Open Claim

Average Case Outstanding $ per Open Claim Count (Severity)

(B) from (A)

Accident	*Development Period (months)*					
Year	*12*	*24*	*36*			
2003	*5.0%*	*5.0%*				
2004	***20.0%*** **					

Example: 1008 / 840 - 1 = 20%

Continues below.

2005 # 8a : Test for change in <u>Adequacy of Case Outstanding - continued</u>

Given Average Paid Claim ($) per Closed Claim Count

Average Paid $ per Closed Claim Count (Severity)

(C)

Accident Year	12	24	36			
2002	*500*	*800*	*1,050*			
2003	*525*	*840*				
2004	*551*					

(Development Period (months) spans columns 12, 24, 36 and following)

Calculate trend rate % in Average Paid Claim ($) per Closed Claim Count

Calculation of the Trend Factor we take to be "true"

(D) from (C)

Accident Year	12	24	36			
2003	*5.00%*	*5.00%*				
2004	***5.0% *****					

(Development Period (months) spans columns 12, 24, 36 and following)

Compare growth rate %s in average outstanding data (B) to the trend rate %s in the paid data (D).

*** The average open claim amount has risen from 5% to 20% compared to a 5% increase in average paid severities over time. This demonstrates why we may conclude that the relative level of case outstanding adequacy is changing. ***

Solution to 2005 8 b. (2 points) Using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy, calculate the ultimate reported claims for accident year 2004.

Step 1: Begin by restating the average open severity using a 5% trend (De-trending)

Average Case Oustanding $ per Open Claim: ADJUSTED
Start with most recent diagonal given in (A) and DE-TREND at 5%

(E)

Accident Year	12	24	36	Example Calculation
2002	*914.3*	*1,000*	***1,200***	*1,008 / 1.05 ^{2} = 914.3*
2003	*960.0*	***1,050***		
2004	***1,008***			

(Development Period (months) spans columns 12, 24, 36)

Step 2: Multiply re-stated averages above by the open counts for re-stated Case Outstanding $

*Re-stated Total $ Case Outstanding = Adjusted Average Case Outstanding * Open Counts (#)*

*(F) = (E) * open counts (given)*

Accident Year	12	24	36	Example Calculation
2002	*9,143*	*8,000*	*2,400*	*914.3 * 10 (given) = 9,143*
2003	*11,520*	*6,300*		
2004	*11,088*			

(Development Period (months) spans columns 12, 24, 36)

Step 3: Add re-stated case outstanding $ to cumulative paid claim $ for Reported Claims

Adjusted Reported Claims = Re-stated Case Outstanding + Cumulative Paid Claims

(G) = (F) + Paid (given)

Accident Year	12	24	36	Example Calculation
2002	*19,143*	*40,800*	*62,250*	*9,143 + 10,000 (given) = 19,143*
2003	*24,645*	*42,420*		
2004	*23,761*			

(Development Period (months) spans columns 12, 24, 36)

***2005 # 8b : Example with change** __Adequacy of Case Outstanding - continued__*

Step 4: Compute ATA factors for 12-36 months using the adjusted reported claims, and Use the __given 36 to ultimate CDF__ to compute the 12 month age to ultimate CDF

ATA	*Development Period (months)*			
	12:24	*12:36*		*Example Calculation*
2002	*2.131*	*1.526*		*40,800 / 19,143 = 2.131*
2003	*1.721*			
Selected (Simple Avg)	*1.926*	*1.526*	*Reported CDF from 36 to ultimate is 1.1(given)*	
CDF to Ultimate	*12-to-ult = 1.926 * 1.526 * 1.1 =*	*3.233*		

*Finally, we estimate AY 2004 ultimate claims = 23,761 * 3.233 =* ***76,819*** **ANSWER**

Solutions to 2005 Exam questions (modified) - continued:

9. (2.5 points) Berquist and Sherman describe an approach to adjust the paid loss triangle for distortion.
   a. (0.5 point) Identify the distortion for which this adjustment is intended.
   b. (2 points) Describe the technique to make the necessary adjustment.

   Question 9 – Based on Model Answer 2

a. Change in Claim Settlement Rate

b. 1. Calculate disposal ratios (cumulative claims closed per ultimate count).
   2. Use the latest diagonal of ratios as a base and restate claims closed triangle based on the disposal rates.
   3. Once all claims are restated to latest diagonal closed claim percentages for each accident year, use linear interpolation to determine amount of cumulative paid claim $ that corresponds to the # of claims closed in each interval.
   4. The result is the adjusted paid triangle.

Solutions to 2006 Exam questions (modified):
Solution to 2006 Question 20 – Based on Model Answer 1

a. It is important to know about any changes made to claims department processes. This will affect claim closure patterns and reserve adequacy among other things.

   It is important to talk with underwriting so that you know about any changes in the mix of business or new exposures. These will also affect loss emergence and loss magnitudes.

b. 1) Has there been a change in priorities as far as settling large claims versus small claims?
   2) Has there been a change in philosophy regarding trivial or very small claims?

Solution to 2006 Question 20 – Based on Model Answer 2

a. Claims handling practices may have changed over the experience period.

   For example: change in priority on small vs. large claims, change in procedures for handling small claims, increase or decrease in number of adjusters, change in amount of assistance from outside claims adjusters. These changes can have an impact on the timing of loss and LAE payments and the ultimate amount of the loss and LAE.

b. Underwriting policies and procedures may have changed over experience period.
   1) Has there been a change in priority in handling small vs. large claims?
   2) Has the caseload per claim department adjuster changed?

Solutions to 2006 Exam questions (modified) - continued:

21. (2 points) In the course of a reserve analysis, it is observed that the paid claim development triangles are distorted by significant changes in the claims settlement rate. Briefly describe the procedure that Berquist and Sherman propose to address this situation, as described in Friedland.

1. If you are given an accident year history of cumulative paid claims ($) and cumulative closed and ultimate claim counts (#), examine ultimate Claims Disposal Rates (cumulative closed claims divided by projected ultimate claims). If shifts in claims disposed ratios are present, **select** appropriate Claims Disposal Rates by age of development.

2. The selected rates from (1) are applied to projected ultimate claims to obtain the number of cumulative closed claim counts which would be equivalent to the indicated claims disposed ratio for that age of development by accident year. These are (**adjusted** or) restated closed claim counts(#).

3. To approximate the **adjusted** cumulative paid claims ($) which correspond to the restated counts, a curve is fit between 2 points (claim count$_X$, cumulative paid claims$_X$) & (claim count$_{X+1}$, cumulative paid claims$_{X+1}$). Although Friedland shows how Berquist & Sherman determined that an exponential curve fit the data well, the instructions in many problems state that one should assume that the relationship is linear.

Solutions to 2007 Exam questions (modified):

Question #33 – Model Solution 1. Note this can be determined in a 2 step process as follows:

Step 1: Construct the Adjusted Average Case Outstanding per open claim triangle by de-trending the latest calendar year diagonal, using the annual paid severity trend.

Adjusted Average Case Outstanding				
Accident Year	12	24	36	Examples
2004	8,734.40	16,261.10	25,192.00	9,345.8 = 10,000/1.07
2005	9,345.80	17,400.00		8,734.4 = 10,000/1.07^2
2006	10,000.00			

Step 2: Construct the Adjusted Reported Claims ($) Triangle by multiplying the above triangle by open claim counts and adding the cumulative Paid Claims:

Adjusted Reported Claims				Examples
Accident Year	12	24	36	5,889,400 = 25,192 x 75 + 4,000,000
2004	5,093,760	6,805,275	5,889,400	6,805,275 =16,261 x 250 + 2,740,000
2005	6,865,190	8,505,000		
2006	6,275,000			

2007 Question #33 – Model Solution 2. Note this can be determined in a 3 step process as follows:

Step 1: De-trend the current diagonal of average Case Outstanding per open claim count by 7% per yr:

AY	12	24	36
04	8,734.39	16,261.68	25,192.00
05	9,345.79	17,400.00	
06	10,000.00		

Note: 16,216.68 = 17,400/1.07   8,734.39 = 10,000/1.07^2 9,345.79=10,000/1.07

Step 2: Multiply each value by the number of open claims (counts) to get adjusted Case Outstanding data:

AY	12	24	36
04	3,493,756	4,065,421	1,889,400
05	5,140,185	5,655,000	
06	4,500,000		

Step 3: Add the above triangle to current paid data to get Adjusted Reported Claims:

AY	12	24	36
04	5,093,756	6,805,421	5,889,400
05	6,865,185	8,505,000	
06	6,275,000		

Solution to 2007 Question 34 – Based on Model Solution 1

1. A slow payment / emergence pattern reduces the utility of available claim experience data, and
2. Irregular payment patterns and the variation of the portion of claims closed without payment distorts trends.

Solution to 2007 Question 34 – Based on Model Solution 2

Estimating severity trends for malpractice claims using paid claims is inappropriate because:

1. The slow payment of claims substantially reduces the experience available by accident year for trending
2. Trends in severity are distorted by irregular settlements and variation in the rate of claims closed without payment.

Solution to 2007 Question #38 – Based on Model Solution 1:

a. 1. An increase in Claims Settlement rate.
   2. An improvement in Case Outstanding adequacy
   3. Writing business with better loss ratios (e.g. this affects the BF, Expected Claims method, etc.)

b. 1. A sudden increase in LDF→this overstates the reserve estimate.
   2. A sudden increase in LDF→this overstates the reserve estimate.
   3. This has no effect since the CL method uses current loss experience to estimate loss reserves.

c. 1. Apply the B&S adjustment – to restate closed claim #s using the current settlement rate percentages.
   2. Apply B&S adjustment – adjust past case outstanding to reflect current level of case outstanding adequacy.
   3. No adjustment is needed for CL, but for the BF method, the expected loss ratio should be adjusted accordingly

Solution to 2007 Question #38 – Based on Model Solution 2:

a. 1. Case Outstanding Adequacy change
2. Claim Settlement Rate change
3. Mix of business change (higher policy limit)

b. 1. case reserve strengthening → chain ladder overstates
2. rate of claim settlement increase →chain ladder overstates
3. people buying higher policy limit→ chain ladder overstates

c. 1. Use Berquist/Sherman approach, detrend average open with appropriate trend and multiply with open to get adj case outstanding, add pd loss to get adj reported claim $ triangle
2. Use Berquist/Sherman approach, calculate disposal rate (= closed claim/ultimate claim) and restate the closed claim # triangle and interpolate to estimate restated paid claims $ triangle
3. Use PY instead of AY, trend loss data and policy limit

Solution to 2007 Question #39 – Based on Model Solution 1:

a. Claims Consciousness increases in a given area. This can increase claim frequency as more people will be more aware of how to sue or file a claim.
b. More liberal awards given out by juries in a given county. If awards for certain juries are more liberal in amounts awarded, larger claim amounts will be submitted and claim severities will increase.
c. They are related to each other. They have a combined impact on pure premiums. For example, an increase in the frequency of certain claims can rapidly impact the severity of those claims.

Solution to 2007 Question #39 – Based on Model Solution 2:

a. A new law that allows claims that were not previously considered such as allowing work stress as a workers comp claim when previously not considered an injury. Frequency would increase.
b. A new judicial ruling that sets a precedent for high environmental damages for pollution that was previously an unheard amount (i.e., the need to clean up to a new degree of "clean" or to compensate people at a further distance around the site than previously considered).
c. The total loss to the company is the average frequency times average severity. By only considering one aspect you are ignoring the compound effect on the aggregate distribution from the correlation between the two. Ex: Two additional small claims have much less of an impact than 2 additional large claims have on total claims.

Solution to 2008 #4 part a (Berquist Sherman, as in Friedland's Chapter 13)

3 STEPS TO ADJUSTING THE DATA (for changes in Case Outstanding adequacy)
1: Begin by restating the average Case O/S per Open using appropriate trend
2: Multiply re-stated averages above by the open counts for re-stated Case O/S $
3: Add re-stated Case Outstanding $ to cumulative Paid Claim $ for Reported Claims
This adjusted Reported Claims triangle will then be used in Part b.

WORKING IN $000's

Step 1: Begin by <u>restating</u> the average Case O/S per Open using appropriate trend

*(A) Start with most **recent diagonal** given in (E) and **DE-TRENDED at** 5% as given*

Accident	*Average Case Outstanding $ per Open Claim: ADJUSTED (de-trended)*				
Year	*12*	*24*	*36*	*48*	***Notes on De-trending***
2004	68.934	99.048	375.429	**888.700**	**** Divide latest by* 1.05^3
2005	72.381	104.000	**394.200**		*** Divide latest by* 1.05^2
2006	76.000	**109.200**			** Divide latest by 1.05*
2007	**79.800**				*Ex: 375.43 = 394.2/1.05*

Starting values are from the latest diagonal given for the Avg Case O/S per open claim.

Step 2: Multiply re-stated averages above by the open counts for re-stated Case O/S $

(B) Recall, given Open Counts

AY	*12*	*24*	*36*	*48*
2004	810	480	115	43
2005	698	387	87	
2006	654	361		
2007	633			

*Then, Re-stated <u>Total</u> $ Case O/S = Adjusted <u>Average</u> Case O/S * Open Counts (#)*
*(C) = (A) * (B)*

(Adjusted) Re-stated Case Outstanding Amounts					Notes
AY	12	24	36	48	Ex: 24-mo calculation
2004	55,837	47,543	43,174	38,214	for AY 2005:
2005	50,522	**40,248**	34,295		*Multiply 387 (# open) by*
2006	49,704	39,421			*adj. Average Case O/S*
2007	50,513				*of 104.00, for **40,248***

Step 3: Add re-stated Case O/S $ to cumulative Paid Claim $ for Reported Claims

(D) Recall, given Cumulative Paid Losses

AY	*12*	*24*	*36*	*48*
2004	30,729	103,361	125,237	138,547
2005	24,573	85,337	105,979	
2006	22,567	88,009		
2007	27,761			

Finally, (E) = (C) + (D)

Adjusted Reported Claims = Re-stated Case Outstanding + Cumulative Paid Claims					
AY	12	24	36	48	Ex: 24-mo calculation
2004	86,566	150,904	168,411	176,761	for AY 2005:
2005	75,095	**125,585**	140,274		*Add the adjusted O/S of*
2006	72,271	127,430			*40,280 to the paid of*
2007	78,274				*85,337 for **125,585***

* Note, latest diagonal here does *not* match the cumulative reported amounts that were given in the actual exam, due to the fact that the cumulative reported amounts that were shown for original exam did NOT = Paid + (Avg Case O/S) * (Number Open). The CAS solution forces the diagonal to match by not showing certain calculations.

Either way, this triangle can now be used to calculate CDF's in part (b) …

Solution to 2008 Exam question #4 (continued):

(b) To estimate the AY 2007 Ultimate Claims, follow 2 steps:

(i) Use the adjusted data triangle to develop ATA and CDFs to ultimate
(ii) Apply the factors to reported claims to estimate Ultimate Claims

(i) We're told to use all-year volume-weighted ATA selections,
and 1.02 as the CDF-to-ult at 48 months, so:

weighted	***12: 24 mo***	***24: 36 mo***	***36: 48 mo***		
ATA	*1.727*	*1.116*	*1.050*		
Ultimate	***at 12 mo***	***at 24 mo***	***at 36 mo***	**at 48 mo**	
CDF	*2.064*	*1.195*	*1.071*	*1.020*	(1.02 given)

Example: weighted ATA factor for 12-to-24:
1.727 = (150,904+125,585+127,430)/(86,566+75,095+72,271) from (a)

(ii) Apply the factors to estimate Ultimate Claims

Accident Year	***Age of Data at 12/31/07***	***Reported Claims at 12/31/07***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***
	(1)	*(2) See note*	*(3) above*	*(4)=(2)*(3)*
2007	*12 months*	78,274	2.064	*161,540*

Comments:
* See note re: reported loss triangle provided on the original exam.
Due to reconcilliation issues, this might not be the best illustration.
$78,294 is the value given as reported for AY 2007.
$78,274 is from the calculated sum of the paid + case O/S
If the amounts reconciled, we'd use $78,294 value given.
Other years differ more and also impact the calculations of CDFs.

As mentioned, the CAS answer forces the latest diagonal to match the values shown in the reported triangle. The sample solution is 161,920.

Solution to 2008 #5 using quotes from first page of Friedland's Chapter 13

Berquist and Sherman recommend that, wherever possible, the actuary should use data that is relatively unaffected by changes in the insurer's claims and underwriting procedures and operations.

a) "Substituting policy year data for accident year data when there has been a significant change in policy limits or deductibles between successive policy years."

b) "Substituting accident quarter for accident year when the rate of growth of earned exposures changes markedly, causing distortions in development factors due to significant shifts in the average accident date within each exposure period. "

c) "Substituting report year data for accident year data when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the report year than with the accident date. "

d) "Using earned exposures instead of the number of claims when claim count data is of questionable accuracy or if there has been a major change in the definition of a claim count."

Solution to 2009 Questions

Question 11 - Model Solution 1

a. Step 1: Compute Adjusted Avg Case Reserves. Use the latest diagonal from the given avg case reserve triangle and compute each value along preceding diagonals as the current diagonal value divided by the given severity trend factor of 1.05 (e.g. 7,170 = 7,528/1.05; 6,828 = 7,170/1.05)

Adjusted Avg Case Reserves				
AY	12	24	36	48
2005	3,563.3301	6,828.1179	8,990.4762	15,000.0000
2006	3,741.4966	7,169.5238	9,440.0000	
2007	3,928.5714	7,528.0000		
2008	4,125.0000			

Step 2: Compute Adjusted Case Reserves=Adjusted Avg Case Reserves × Number of Open Claims (given)

AY	12	24	36	48
2005	121,153.2234	136,562.3580	134,857.1430	120,000.0000
2006	205,782.3130	250,933.3330	226,560.0000	
2007	294,642.8550	376,400.0000		
2008	346,500.0000			

Step 3: Compute Adjusted Reported Loss = Adjusted Case Reserves + Cumulative Paid Loss (given)

AY	12	24	36	48
2005	291,153.2234	456,562.3580	584,857.1430	620,000.0000
2006	425,782.3130	670,933.3330	856,560.0000	
2007	654,642.8550	1,026,400.0000		
2007	**796,500.0000**			

Step 4: Selected Adjusted Reported Loss Link Ratios (using a-t-a ratios along latest diagonal)

12-24	24-36	36-48	48-ult
1.5679	1.2767	1.0601	1.02
LDFs			
2.1645	1.3805	1.0813	1.02

AY2008 Ult Loss = 796,500 × 2.165 = **1,724,024**

b. To adjust for case reserve inadequacy by setting all case reserves to the current calendar year level.

Question 11 - Model Solution 2. A more efficient way to compute Adjusted Incurred triangle = Adjusted Avg Case Reserves × Open Claims Count + Paid Loss

AY	12	24	36	48
5	291,153.2234	456,562.3580	584,857.1430	620,000.0000
6	425,782.3130	670,933.3330	856,560.0000	
7	654,642.8550	1,026,400.0000		
8	796,500.0000			

b. The purpose of the Berq Sher case reserve adjustment is to restate the case incurred triangles as if the same level of case outstanding adequacy had been maintained for all years. Hence we consider the case reserves along the latest diagonal and trend them back for older AY and restate the case incurred losses.

Solution to 2010 Questions

1a. (1.75 points) Test the above data for changes in case reserve adequacy and interpret the results.

1b. (0.75 point) Describe the leveraging effect that a change in case reserve adequacy has on the IBNR indicated by the reported loss development method.

1c. (1.5 points) Use the Berquist-Sherman technique for case reserve adequacy to calculate the adjusted reported claims for each accident year.

Question 1 – Model Solution 1

a)

AY	Average Paid Severity =Paid/Closed Counts	Change from prior AY	Case O/S =Rep. - Paid	Average Case O/S =Case O/S/Open Counts	Change from prior AY
2006	3.4600	---	7,611	5.0007	---
2007	3.5556	1.0276	20,567	5.6518	1.1302
2008	3.6984	1.0402	26,317	6.3892	1.1305
2009	3.8415	1.0387	40,022	7.2190	1.1299

The average case outstanding increases much more rapidly that the average paid severity. This indicates an increase in case outstanding adequacy.

b) Higher case adequacy leads to higher LDFs. Moreover, these higher LDFs are applied to higher reported amounts, thus overestimating both ultimate losses and IBNR.

c) Detrend at 4% per year, consistent with inflation on paid severity

AY	(1) Restated Avg Case O/S	(2) Open Counts	(3) Paid Claims	(1) × (2) + (3) Adjusted Reported	
2006	5.7052	1,522	9,688	18,371.3144	
2007	6.4176	3,639	17,778	41,131.6464	6.4176 = 7.219 / 1.04^2
2008	6.9413	4,119	25,519	54,110.2147	6.9413 = 7.219 / 1.04
2009	7.2190	5,544	34,093	74,115.1360	

Question 1 – Model Solution 2

a) Test the above data for changes in case reserve adequacy and interpret the results.

AY	Average Paid Severity		Trend in Average Paid	
2006	3.4600	2006-2007	2.7630%	= 3.5556 / 3.4600 - 1
2007	3.5556	2007-2008	4.0162%	
2008	3.6984	2008-2009	3.8692%	
2009	3.8415	Selected Average	3.5495%	

AY	Average Case Outstanding			Trend in Average Case Outstanding
2006	5.0007	=(17,299-9,688) / 1,522	2006-2007	13.0202%
2007	5.6518		2007-2008	13.0472%
2008	6.3892		2008-2009	12.9875%
2009	7.2190			

Since average case is increasing 13% per year, but average paid is only increasing 3.5% per year, there is a strengthening of case adequacy.

b) If there is an increasing case reserve adequacy, it will overstate the IBNR using reported development method. This is due to historical LDFs (too high) being applied to reported claims.

c) Use the Berquist-Sherman technique for case reserve adequacy to calculate the adjusted reported claims for each AY

AY	Restated Avg Case		AY	Restated Reported	
2006	6,511.1243		2006	19,597,931.18	
2007	6,739.0137	=6974.8792 / 1.035	2007	42,301,270.85	
2008	6,974.8792	= 7,219 / 1.035	2008	54,248,527.42	=(6974.9 x 4,119) + 25,519 x 1,000
2009	7,219.0000		2009	74,115,136.00	

Solution to 2011 Questions

31a. (2.75 points) Use the Berquist-Sherman technique for case reserve adequacy to estimate the ultimate claims for all accident years.

31b. (0.25 point) Briefly describe the purpose of the Berquist-Sherman case reserve adjustment.

31c. (0.75 point) Discuss whether changing the annual severity trend given above from 10% to 5% would produce a higher or lower ultimate claims estimate under the Berquist-Sherman technique for case reserve adequacy.

Question 31 – Model Solution 1 – part a

Step 1: Compute Avg Case o/s (Case o/s / open claim count)

AY	12	24	36
8	12,000.0000	16,800.0000	18,018.4000
9	17,100.0000	17,905.0000	
10	18,700.0000		

Step 2: Compute Adj. Avg Case o/s (10% Trend)

AY	12	24	36
8	15454.55	16277.27	18018.00
9	17000.00	17905.00	
10	18700.00		

Detrend current diagonal by 10%

Step 3: Compute Adj Reported [(adj Avg Case) x (open count) + (paid)]

AY	12	24	36
8	32,066.92	40,697.81	45,941.40
9	29,780.00	39,940.00	
10	37,310.00		

Selected ATAF (USING weighted avg): Σ(x+12) / Σx

AY	12-24	24-36	36-Ult
Selected	1.3052	1.1288	1.05 (given)
Cum.	1.5469	1.1852	1.05

	(1)	(2)	(3) = (1) x (2)
AY	Reported @	LDF	Ultimate Losses
8	$45,942	1.0500	48,239.10
9	$39,940	1.1852	47,336.89
10	$37,310	1.5469	57,714.84
			153,259,771.00

b. If there has been an increase in reserves, the unadjusted LDF's will overestimate development. The B-S technique adjusts the Avg O/S to avoid this.

Solution to 2011 Questions

31c. (0.75 point) Discuss whether changing the annual severity trend given above from 10% to 5% would produce a higher or lower ultimate claims estimate under the Berquist-Sherman technique for case reserve adequacy.

Question 31 – Model Solution 1 – part c

Compute Adj. Avg Case o/s (using a 5% severity trend factor)

AY	12	24	36
8	16961.45	17052.38	18018.00
9	17809.52	17905.00	
10	18700.00		

17,809.52 = 18,700 / 1.05

Compute Ajd Reported [Adj Avg Case x Open Count + Paid]

AY	12	24	36
8	34821.53	42170.52	45941.40
9	31026.66	39940.00	
10	37310.00		

31,026.66 = 17,809.52 * 1,540/1000 + 3,600

Selected Factors (using weighted avg)

	12-24	24-36	36-48
A-t-A (5%)	1.2492	1.0894	1.05
LDF ult (5%)	1.4290	1.1439	1.05
LDF ult (10%)	1.5469	1.1852	1.05

For ages 12 & 24, the ultimates would be lower using a 5% trend opposed to a 10% trend.

Question 31 – Model Solution 2 – part b

b 1. Trend back from the latest diagonal so like that our case adequacy will all be at the same level.
2. Using the new adjusted avg case o/s calculate the adj reported claims
Avg case o/s x open claim counts + unadj. Paid claims

Question 31 – Model Solution 2 – part c

If we trend at a lower rate, then the avg case o/s will be higher and thus our adjusted rptd claims will be higher for the years we bring to the same adequacy level. Thus our CDF ult will be lower and our ultimate claims will be lower.

Solutions to questions from the 2012 exam

22a. (0.75 point) Estimate the ultimate claims for accident year 2011 using the reported development technique.
22b. (3 points) Estimate the ultimate claims for accident year 2011 using the Berquist-Sherman case outstanding adjustment technique.

Question 22 – Model Solution (Exam 5B Question 7)

(a) => Age-to-age factors for reported claims:

AY	12-24	24-36	Selected	
9	1.1663	1.1269		
10	1.3412		12-24 =	1.1269
			24-36 =	1.2538
			36-ult =	1.0000

Straight avg. = 1.2538, 1.1269
Volume weighted avg. = 1.2654, 1.1269 12-to-ultimate = 1.4129
AY2011 Ultimate claims = 12,924 (1.4129) = 18,260

(b) => Case O/S triangle ($000) = Cumulative Reported- Cumulative Paid AY 12 mths

AY	12 mths	24 mths	36 mths
09	6,220.00	2,836.00	695.00
10	9,503.00	8,395.00	
11	9,796.00		

=> Average Case O/S triangle = Case O/S / open claim counts

AY	12	24	36
09	18,028.99	16,982.04	23,166.67
10	19,044.09	23,985.71	
11	22,519.54		

=> Adjusted average case O/S triangle (using 8% trend and trending back from latest diagonal):

AY	12	24	36
09	19,306.88	22,208.99	23,166.67
10	20,851.43	23,985.71	
11	22,519.54		

=>Adjusted Reported Triangle ($000):=(Adjusted average case O/S * open claim counts) + Cumulative Paid Claims

AY	12	24	36
09	10,371.87	12,455.90	13,053.00
10	13,868.86	17,391.00	
11	12,924.00		

AY	12-24	24-36
9	1.2009	1.0479
10	1.254	
Selected	1.2275	1.0479

Ultimate mate claims ($000) = 12,924 (1.228 x 1.048) = 16,624.11

Solutions to questions from the 2012 exam

22c. (0.5 point) Discuss the difference between the two estimates.

Question 22 – Model Solution (Exam 5B Question 7)

(c) The development method from part (a) overestimates ultimate claims because it does not recognize the increase in case adequacy that can be seen when the annual change in average case O/S is analyzed (at 12 months). That is 18.25% is much greater than 5.63%

AY	12 months	Change
2009	18,028.99	
2010	19,044.09	5.63%
2011	22,519.54	18.25%

The method from part (b) restates historical data at the curr case adequacy level, whereas the development factors in part (a) are too high.

Examiner's Comments

Overall, the candidates did well on this question. For many candidates, only a minor omission in the discussion or a computation error in the methods kept them from achieving full marks.

a. Most candidates appropriately demonstrated the reported development method. The most common errors found were computation errors. A few candidates opted to use the latest 12-24 age-to-age factor rather than some sort of average. Although this exacerbated the problem for the method, this selection was accepted where clearly indicated.

b. The candidates are generally able to demonstrate the Berquist-Sherman method, with computation errors being the most common type of error. Where candidates struggled with the methodology, they generally recognized the method makes adjustments at the average case outstanding level. The struggle is usually with the application of the trend to the average outstanding and with the process to go from the adjusted average case outstanding back to the adjusted reported claims.

c. A common mistake found in the discussion is the claim that the reported development method does not account for trend. This is imprecise. The reported development method is a reasonable method in a stable environment, including stable trends. It is the change in the pattern that causes problems with the reported development method, and some candidates failed to make this distinction. The candidates were expected to highlight the changing patterns and make the connection this causes issues for the reported development method, which the Berquist-Sherman method attempts to address.

Solutions to questions from the 2012 exam

24a. (2 points) Evaluate whether a Berquist-Sherman Case Outstanding Adjustment would be appropriate.

24b. (1.5 points) Use disposal rates to evaluate whether a Berquist-Sherman Paid Claim Development Adjustment would be appropriate.

Question 24 – Model Solution (Exam 5B Question 8)

a.

Open claim count = Reported - Closed			
	12	24	36
09	1,000	700	355
10	900	775	
11	775		

Avg O/S = O/S Claims / Open Count			
	12	24	36
09	8.7150	13.1586	11.1099
10	8.7156	13.1574	
11	8.7161		

Note: Observed trend of close to 0%

Avg Paid over Closed claim count			
	12	24	36
09	5.7860	7.2725	7.6218
10	5.7853	7.2725	
11	5.7855		

Observed trend of close to 0%.

Since both avg paid and avg o/s are stable with similar trend, it does not seem necessary to adjust historical case o/s w/ Berquist Sherman method.

b.

DF on reported claim count		
	12-24	24-36
09	1.2667	1.0789
10	1.2727	
Average	1.2697	1.0789

Ultimate Claim Count		
09	2,050.00	
10	2,265.69	= 2100 * 1.0789
11	2,191.81	= 1600 * 1.2697 * 1.0789

Disposal rate = Closed Count over Ult Claim Count)			
	12	24	36
09	0.2439	0.5854	0.8268
10	0.3310	0.5848	
11	0.3764		

From the disposal rate, there appears to be a speeding up in settlement rate in the first 12 months, so it is appropriate to adjust w/ Berquist Sherman paid claim adj. method.

Examiner's Comments

a. Many candidates correctly calculated case outstanding and observed no trend, but failed to calculate trend in paid severity for comparison. Some candidates calculated both case outstanding and paid severity and to correctly state than no adjustment was needed, but then failed to explain why no adjustment was needed.

b. Candidates who failed to receive full credit commonly did 1 of 3 things:

- Calculated ultimate claims by developing paid claim counts to 36 months
- Calculated disposal rates as (reported claim counts / ultimate claim counts)
- Instead of disposal rates, calculated the ratio of closed claims to reported claims.

1 Salvage, Subrogation, and Collateral Sources 329

Ways in which data is maintained:

1. Detailed data may be maintained for case outstanding estimates and payments for the different types of recoveries (e.g. salvage, subrogation, deductibles, and collateral sources).
2. Claims data may be combined for all types of recoveries.
3. Payments are recorded but estimates of case O/S recoveries may not be recorded.
4. Recoveries may be treated as a negative claim payment (separate data for recoveries is not maintained).

To quantify the potential affect of S&S, the actuary must understand how the insurer processes such recoveries and what data is available for analysis.

The development technique is used to quantify the affect of S&S recoveries on estimates of total unpaid claims (when S&S data is available).

- Salvage is commonly associated with property coverages and tends to be fast reporting and settling.
- Subrogation, associated with liability coverage, can take years to realize, well after claims are paid, resulting in age-to-age factors less than 1.00 for older maturities for some lines of business.

2 Estimating S&S Recoveries-Auto Physical Damage Insurer 329 - 330

Data from Auto Physical Damage Insurer is used to demonstrate two methods to quantify S&S recoveries.
This insurer maintains payment activity and case outstanding estimates for S&S.

1. The Development Method

Exhibit I, Sheets 1 and 2: Reported and Received Salvage and Subrogation ($000)

Comments on the term “received”:

i. The term “paid” S&S is often used instead of “received” S&S.

ii. Paid S&S represents a payment made by a third-party to the insurer.

Both auto physical damage and S&S associated with this coverage have quick reporting patterns.

The reported S&S development factors are stable and indicate an age-to-age factor of 1.068 at 12-to-24 months and less than 1.00 at 24-to-36 months.

The development factors for received S&S are also stable.

Selected factors are based on the latest 5-year volume-weighted average factors.

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance
Auto Physical Damage Insurer Exhibit I
Reported Salvage and Subrogation ($000) Sheet 1

PART 3 Only - Average Age-to-Age Factors

Average	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.067	0.998	1.000	1.000	1.000	1.002	1.000	1.000	1.000	1.000	
Latest 3	1.074	0.997	1.002	1.001	1.001	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.072	0.999	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.068	0.998	1.000	1.000	1.000	1.001	1.000	1.000	1.000	1.000	
Latest 3	1.074	0.997	1.002	1.001	1.001	1.001	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.068	0.998	1.000	1.000	1.000	1.001	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.067	0.999	1.001	1.001	1.001	1.001	1.000	1.000	1.000	1.000	1.000
Percent Reported	93.7%	100.1%	99.9%	99.9%	99.9%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

1. The Development Method (continued):

Exhibit I, Sheet 3: Projection of Ultimate Salvage and Subrogation ($000)

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance Exhibit I
Auto Physical Damage Insurer Sheet 3
Projection of Ultimate Salvage and Subrogation ($000)

Accident Year	Age of Accident Year at 12/31/08	S & S 12/31/2008 Reported	S & S 12/31/2008 Received	CDF to Ultimate Reported	CDF to Ultimate Received	Projected Ultimate S & S Using Dev Method with Reported	Projected Ultimate S & S Using Dev Method with Received
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	793	793	1.000	1.000	793	793
::	::	::	::	::	::	::	::
2006	36	5,715	5,655	1.001	1.006	5,721	5,689
2007	24	6,031	5,957	0.999	1.022	6,025	6,088
2008	12	5,414	2,710	1.067	1.938	5,777	5,252
Total		44,719	41,879			45,097	44,639

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Physical Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) [(3) x (5)]
(8) = [(4) x (6)].

2. The Ratio Method

The first step: Estimate the ultimate claims gross of S&S.

Exhibit I, Sheets 4 – 5: Reported and Paid Claims Gross of S&S based on reported and paid claims.

CDFs are computed based on the 5-year volume-weighted averages

Exhibit I, Sheet 6. Projected ultimate claims Gross of S&S based on reported and paid claims.

Given this fast reporting and settling line of insurance, the projections are very similar, as expected.

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance Exhibit I
Auto Physical Damage Insurer Sheet 6
Projection of Ultimate Claims Gross of S&S Using Reported and Paid Claims ($000)

Accident Year	Age of Accident Year at 12/31/08	S & S 12/31/2008 Reported	S & S 12/31/2008 Received	CDF to Ultimate Reported	CDF to Ultimate Received	Projected Ultimate S & S Using Dev Method with Reported	Projected Ultimate S & S Using Dev Method with Received	Selected Ult. Claims Gross of S&S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	2,864	2,864	1.000	1.000	2,864	2,864	2,864
:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	16,862	16,822	1.001	1.005	16,879	16,906	16,897
2008	12	14,727	12,889	1.115	1.279	16,422	16,485	16,466
Total		129,369	127,456			131,081	131,153	131,149

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Physical Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 4 and 5.
(7) = [(3) x (5)]
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

The second step: Project Ultimate S&S

Exhibit I, Sheet 7: Using the development technique to analyze the ratio of *received* S&S to *paid* claims.

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance Exhibit I
Auto Physical Damage Insurer Sheet 7
Ratio of Received Salvage and Subrogation to Paid Claims

PART 3 - Average Age-to-Age Factors

Average	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.496	1.012	1.000	1.002	1.001	1.005	1.000	1.000	1.000	1.000	
Latest 3	1.474	1.013	0.999	1.003	1.001	0.999	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.485	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.486	1.009	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.499	1.009	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Advantages to using the ratio approach:

1. Development factors are not as highly leveraged as those based on received S&S *dollars*.
2. Relates to selecting ultimate S&S ratio(s) for the most recent year(s) in the experience period.

Exhibit I, Sheet 8: Projection of Ultimate Salvage and Subrogation ($000)

AY 2008 projected ultimate S&S ratio (.315) based on:

.210 (Exhibit I, Sheet 7 ratio of received S&S) * 1.499 (Exhibit I, Sheet 7 CDF)

However, compared to the immediate preceding years, 0.315 seems low.

This may be due to a change in recording S&S or a large claim.

Average ultimate S&S ratios for the last 5 years (ex 2008) is 0.347 and for the last 3 years (ex 2008) is 0.344.

Thus, an ultimate S&S ratio for 2008 of 0.345 is selected.

Ultimate S&S equals selected ultimate claims (Exhibit I, Sheet 6) * selected ultimate S&S ratio (Column (6)).

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance — Exhibit I
Auto Physical Damage Insurer — Sheet 8
Projection of Ultimate Salvage and Subrogation ($000)

Accident Year	Age of Accident Year at 12/31/08	Ratio of Received S&S to Paid Claims at 12/31/08	CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate S&S Ratio	Selected Ultimate Claims Gross of S&S	Projected Ultimate S&S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.277	1.000	0.277	0.277	2,864	793
	:::	:::	:::	:::	:::	:::	:::
2007	24	0.354	1.010	0.357	0.357	16,897	6,039
2008	12	0.210	1.499	0.315	0.345	16,466	5,681
Total						131,149	44,924

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 7.
(4) Based on CDF from Exhibit I, Sheet 7.
(5) = [(3) x (4)].
(6) = (5) for all years except accident year 2008. Judgmentally selected 0.345 for 2008 based on prior years.
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)].

Exhibit I, Sheet 9: Development of Unpaid Claim Estimate ($000)

* Shows the results of all 3 projections (i.e. using dev method with reported and received, and ratio method)
* Shows estimated S&S recoverable equal to projected ultimate S&S minus received S&S.

The estimated S&S recoverable is the reduction to the total estimate of unpaid claims for the insurer.

3 Reinsurance and Aggregate Limits 330 - 332

Estimating unpaid claims can be applied to gross, ceded, or net of reinsurance claims experience using the techniques shown in Chapters 7 – 13.

Approaches to estimating unpaid claims on a net of reinsurance basis:

1. Analyze gross (i.e. direct and assumed) and ceded experience separately;
2. Analyze gross and net experience separately.

Choosing a gross versus net versus ceded analysis may depend upon:

* Data availability, gross versus ceded program characteristics, and the actuary's personal preferences.
  - i. If ceded claims are coded in the same database as gross data, net data is available.
    In this case, the actuary is more likely to conduct *both* gross and net analyses.
  - ii. If ceded claims data are coded to a different system, matching gross and ceded data to derive net claim triangles may be more difficult.
    In this case, the actuary will likely prepare *separate* gross and ceded analyses.
* The volume and quality of the data.

Key: When conducting a net (of reinsurance) or ceded analysis, the actuary needs to be aware of the implied relationships between gross, ceded, and net claims, at all stages of the analysis:

* At the beginning (when the actuary is reviewing and reconciling the data).
* During the analysis (when the actuary uses judgment in developing an unpaid claim estimate).
* At the end of the analysis (when the actuary evaluates projection methods and selects ultimate claims and unpaid claim estimates).

When conducting a net (of reinsurance) or ceded analysis (continued):

1. Checks to conduct at the beginning of the analysis:

Check if net claim and net premium data are equal to or less than the gross data.

i. Reinsurance arrangements are often quota share or excess of loss.
For QS treaties create a development triangle ratio-ing net-to-gross claims to test the Q.S %'s by year.
Confirm that the ratios are consistent with relationships between net and gross premium.

Exhibit II, Sheet 1: Shows 3 triangles for an insurer having a QS for the past four years.

For 2005, the insurer had a 70% SQ, and increased the % to 85% in 2007 and to 90% in 2008.

The gross reported claims, the net reported claims, and the ratio of net to gross reported claims are shown below:

Chapter 14 - Recoveries: S&S and Reinsurance Exhibit II
Impact of Quota Share Reinsurance Sheet 1

Accident Year	Gross Reported Claims ($000) as of (months) 12	24	36	48
2005	35,839	42,290	47,365	49,733
2006	37,452	44,568	49,024	
2007	39,324	46,009		
2008	41,212			

Accident Year	Net Reported Claims ($000) as of (months) 12	24	36	48
2005	25,087	29,603	33,155	34,813
2006	26,216	31,197	34,317	
2007	33,426	39,108		
2008	37,091			

Accident Year	Ratio of Net to Gross Reported Claims as of (months) 12	24	36	48
2005	0.700	0.700	0.700	0.700
2006	0.700	0.700	0.700	
2007	0.850	0.850		
2008	0.900			

ii. For XOL treaties, examine large claims to confirm that retentions and limits for ceded claims by year are consistent with the corresponding XOL reinsurance contracts.

Verifying treatment of large claims helps to ensure that the ceded and/or net claim triangles are correct.

Exhibit II, Sheet 2:

The insurer maintains $1 million excess of loss reinsurance.

In AY 2005, the insurer sustained two large claims in excess of $1 million

In AY 2007, one large claim in excess of $1 million.

Chapter 14 - Recoveries: S&S and Reinsurance Exhibit II
Impact of Excess of Loss Reinsurance Sheet 2

Accident Year	Gross Reported Claims ($000) as of (months) 12	24	36	48
2005	12,199	15,615	18,425	20,268
2006	12,992	16,890	20,267	
2007	13,901	17,655		
2008	14,735			

Accident Year	Net Reported Claims ($000) as of (months) 12	24	36	48
2005	11,752	14,076	16,502	18,056
2006	12,992	16,890	20,267	
2007	13,644	17,303		
2008	14,735			

Accident Year	Ceded Reported Claims ($000) as of (months) 12	24	36	48
2005	447	1,539	1,923	2,212
2006	0	0	0	
2007	257	352		
2008	0			

2. Checks to conduct <u>during</u> of the analysis:

Ensure that key assumptions, and actuarial judgment, are consistent between the gross and net or gross and ceded analyses. Examples:

- the tail factor for net claims should be smaller than for gross claims, since net claims are often capped due to excess or aggregate coverage,
- Net claim development patterns should be less than or equal to gross claim development patterns.

Determine the order in which to conduct the gross or net claim development analyses

- Some actuaries will conduct a gross analysis first since these triangles contain a greater volume of claims experience, and may have greater credibility.

  The gross CDFs may be used as input for the selection of ceded or net CDFs.
- However, gross claims are subject to more random variation due to large claims, and thus a net analysis may be conducted first, and the net selected CDFs can be used as input for the selection of gross CDFs.

Thus, there should be a reasonable relationship between the selected development factors for net and gross claims.

Areas of reasonableness in the net and gross or ceded and gross analyses:

1. Among the trend assumptions as well as expected claim ratios, frequency, and severity assumptions.
2. When selecting ultimate claims, ensuring that the implied relationship between the net and gross claims and resulting estimates of unpaid claims to ceded claims are reasonable,
3. Ensuring net IBNR in each AY is generally not greater than gross IBNR.

   Times when the net IBNR will be greater than the gross IBNR include:

   i. When an estimate of uncollectible reinsurance is included in the net IBNR but not in the gross IBNR and there are significant billed reinsurance amounts for which significant collectibility issues exist.

   ii. For a runoff book with reinsurance disputes for items such as asbestos.

Aggregate or stop-loss coverage

* Used by many insurers to protect their financial results across multiple lines of coverage.

* Can apply on an accident year, policy year, or calendar year basis.

* Critical to understand how the coverage operates, and how the insurer treats prior recoveries from aggregate coverage in the source data used in the analysis of unpaid claims.

  i. Determine whether or not to take stop-loss or aggregate programs into account within the claim development triangles or at a later stage of the analysis.

  ii. Often, the actuary would want data prior to the application of stop-loss or aggregate coverage since the actuary can adjust for such coverage as a final step in the developing the unpaid claim estimate.

Exhibit II, Sheet 3: Self-Insurance Pool with Excess of Loss and Stop Loss Reinsurance

The following is a simple approach to adjust for the affect of excess of loss and stop-loss reinsurance.

- Self-Insurance Pool is a group of self-insured municipalities that has maintained a $500,000 per occurrence excess of loss coverage since the pool inception.
- Stop-loss coverage has varied over time depending on the availability and price of such coverage.

  There was a $4 million combined stop-loss (i.e., the stop-loss limit of $4 million applied to the sum of ultimate claims for policy years 2002-03 through 2004-05).

  The stop-loss limit was $1.5 million for policy years 2005-06 and 2006-07.

  There was no stop-loss coverage purchased for 2007-08.

Exhibit II, Sheet 3: Self-Insurance Pool with Excess of Loss and Stop Loss Reinsurance

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance Exhibit II
Impact of Reinsurance Programs Sheet 3
Self-Insurance Pool with Excess of Loss and Stop Loss Reinsurance

	Ultimate Claims		Net of Excess of Loss, Net of Stop Loss				
Policy	Net of Excess of Loss	Stop Loss	Ultimate	Claims at 12/31/08		Estimated	Unpaid Claim
Year	Gross of Stop Loss	Limit	Claims	Reported	Paid	IBNR	Estimate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2002 - 03	1,184,999						
2003 - 04	1,770,725	[4,000,000]	[4,000,000]	[3,753,248]	[3,253,624]	[246,752]	[746,376]
2004 - 05	1,306,107						
2005 - 06	2,168,077	1,500,000	1,500,000	1,500,000	1,016,783	0	483,217
2006 - 07	1,137,216	1,500,000	1,137,216	914,262	629,296	222,954	507,920
2007 - 08	1,364,048	N/A	1,364,048	432,679	257,877	931,369	1,106,171
Total	8,931,172		8,001,264	6,600,189	5,157,580	1,401,075	2,843,684

Column Notes:
(2) Selected based no review of various projection techniques.
(3) Based on Self-Insurance Pool stop-loss reinsurance program.
(4) = [minimum of (2) and (3)].
(5) and (6) Based on Self-Insurance Pool experience.
(7) = [(4) - (5)]
(8) = [(4) - (6)]

As shown above, the actuary estimates ultimate claims using reported and paid claims limited to the per occurrence retention (i.e. $500,000 per occurrence) in Column (2).

The stop-loss limits are shown in Column (3).

Column (4) ultimate claims take into account both the ultimate excess of loss claims and stop-loss coverages.

Estimated IBNR and the total unpaid claim estimate net of both excess of loss and stop-loss coverage are computed in Columns (7) and (8)

Questions from the 2009 Exam

1. (2 points) Given the following information as of December 31, 2008:

Accident Year	Paid Claims Gross of S&S	Selected Ultimate Claims Gross of S&S	Ratio of Received S&S to Paid Claims	Development Factor to Ultimate for S&S Ratio
2006	$15,513	$17,000	0.361	1.000
2007	15,568	17,250	0.379	1.007
2008	9,441	16,500	0.286	1.300

a. (1.5 points) Use the ratio method to estimate the recoverables for salvage and subrogation (S&S) for accident years 2006 - 2008.

b. (0.5 point) Briefly discuss one advantage in using the ratio method to determine salvage and subrogation recoverables.

Questions from the 2011 Exam

32. (3 points) Given the following data as of December 31, 2010:

Accident	Cumulative Paid Claims Gross of Salvage and Subrogation			
Year	12 months	24 months	36 months	48 months
2007	$12,200	$13,260	$13,280	$13,280
2008	$12,180	$13,300	$13,320	
2009	$12,880	$14,040		
2010	$11,980			

Accident	Cumulative Received Salvage and Subrogation			
Year	12 months	24 months	36 months	48 months
2007	$3,074	$4,670	$4,720	$4,746
2008	$3,098	$4,558	$4,602	
2009	$3,180	$4,732		
2010	$2,858			

- Assume no further development after 48 months.
- Use all-year simple averages for tail factor selections.

Use a ratio approach to estimate ultimate salvage and subrogation recoveries.

Questions from the 2011 Exam

33. (1.5 points) Given the following information:

Accident	Gross Reported Claims (000s)			
Year	12 months	24 months	36 months	48 months
2006	$55,963	$62,679	$66,439	$66,439
2007	$57,584	$62,191	$65,922	$65,922

Accident	Net Reported Claims (000s)			
Year	12 months	24 months	36 months	48 months
2006	$50,367	$50,870	$51,125	$51,125
2007	$37,430	$40,424	$42,849	$42,849

- Insurer has either a quota share reinsurance contract or an excess of loss reinsurance contract in place each accident year.

a. (1 point) Analyze the gross and net reported claims data to determine which type of reinsurance was purchased for each accident year. Explain your reasoning.

b. (0.5 point) Briefly explain how the selection of tail factors for both net and gross reported claims should be impacted by the presence of an excess of loss reinsurance contract.

Questions from the 2012 Exam

25. (1.75 points) Given the following data as of December 31, 2011:

Cumulative Paid Claims Gross of Salvage and Subrogation ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$15,117	$16,953	$16,953
2010	$15,092	$16,862	
2011	$14,727		

Cumulative Received Salvage and Subrogation ($000s)

Accident Year	12 Months	24 Months	36 Months
2009	$2,104	$4,493	$4,605
2010	$1,995	$4,657	
2011	$2,025		

Selected cumulative development factors for ratio of received salvage and subrogation to paid claims:

Age (months)	CDF to Ultimate
36	1.000
24	1.025
12	2.047

Assume no development after 36 months.

Use a ratio approach to estimate the ultimate salvage and subrogation for accident year 2011.

Questions from the 2012 Exam)

26. (1.25 points) Given the following information for a self-insured pool as of December 31, 2011:

Policy Year	Reported Claims Gross of Excess of Loss ($000s)	Reported Claims Net of Excess of Loss ($0005)	Gross Cumulative Development Factors	Net Cumulative Development Factors	Stop Loss Limit ($000s)
2008	$1,635	$634	1.440	1.380	$1,000
2009	$3,109	$625	1.760	1.620	$1,250
2010	$2,358	$728	2.140	1.940	$1,250
2011	$1,897	$674	2.710	2.450	$1,500

- The pool has maintained $1 million per occurrence excess of loss reinsurance since inception.
- The pool has also maintained stop loss coverage over limits that vary over time shown above.

Estimate the pool's ultimate claims net of both excess of loss and stop loss for policy years 2008 through 2011.

Solutions to questions from the 2009 Exam

Question 1 – Model Solution 1

a.

[1] Accident Year	[2] Given Received S&S Paid Claims	[3] Given Dev. Factor to Ult	[4] Ult Rec S&S Ratios	[5] Given Ult Claims	[6] Ult S&S
2006	0.361	1.000	0.3610	17,000	6,137.0000
2007	0.379	1.007	0.3817	17,250	6,584.3250
2008	0.286	1.300	0.3718	16,500	6,134.7000
					18,856.0250
	[7] Given Paid Claims	[8] Paid S&S	[9] S&S Recoverables		
	15,513	5,600.1930	536.8070		
	15,568	5,900.2720	684.0530		
	9,441	2,700.1260	3,434.5740		
			4,655.4340	= S&S Recoverables	

Notes
[4] = [2] × [3]
[6] = [4] × [5]
[8] = [2] × [7]
[9] = [6] - [8]

b. The development factors for the ratio method are less leveraged at early maturities than development factors would be in the reported recoveries or received recoveries development methods.

Question 1 – Model Solution 2

a.

AY	(1)=Given Paid Claims Gross S/S	(2)=Given Selected Ult Gross S/S	(3)=Given Ratio Received S/S Paid Claims	(4)= Given Dev to Ult for Ratio
2006	15,513	17,000	0.361	1.000
2007	15,568	17,250	0.379	1.007
2008	9,441	16,500	0.286	1.300

AY	(5) = (3) x (4) Ultimate S/S	(6) = (1) x (3) Received S/S	(7) = (2) x (5) Ultimate S/S	(8) = (7) – (6) S/S
2006	0.3610	5,600.1930	6,137.0000	536.8070
2007	0.3817	5,900.2720	6,584.3250	684.0530
2008	0.3718	2,700.1260	6,134.7000	3,434.5740
	Total	14,201	18,856	4,655.4340

b.. The ratio method provides Ult S&S ratios to paid claims, which can be used as a diagnostic, so that the actuary may use judgment in selecting a more reasonable S/S ratio for AY's that show odd behavior.

Solutions to questions from the 2011 Exam

32. Use a ratio approach to estimate ultimate salvage and subrogation recoveries.

Question 32

Step 1: Compute ratios of received S&S to paid claims gross of S&S

AY	12 months	24 months	36 months	48 months
07	0.2520	0.3522	0.3554	0.3574
08	0.2544	0.3427	0.3455	
09	0.2469	0.3370		
10	0.2386			

Step 2: Compute age to age and age to ult factors of ratios of received S&S to paid claims gross of S&S

AY	12-24	24-36	36-48	48 - Ult
2007	1.3976	1.0091	1.0056	
2008	1.3471	1.0082		
2009	1.3649			
Selected	1.3699	1.0087	1.0056	1.0000
Age to Ult	1.3895	1.0143	1.0056	1.0000

Step 3: Compute age to age and age to ult paid claims factors

AY	12-24	24-36	36-48	48 - Ult
2007	1.0869	1.0015	1.0000	
2008	1.0920	1.0015		
2009	1.0901			
Selected	1.0901	1.0015	1.0000	1.0000
Age to Ult	1.0917	1.0015	1.0000	1.0000

Step 4: Compute Ultimate S&S Recoveries

AY	Paid Losses (1)	Paid Losses LDF to Ult (2)	Received S&S to Paid (3)	Received S&S LDF to Ult (4)	Ult S&S Recoveries (5)=(1)*(2)*(3)*(4)
2007	13,280	1.0000	0.3574	1.0000	4746.2720
2008	13,320	1.0000	0.3455	1.0056	4627.8315
2009	14,040	1.0015	0.3370	1.0143	4806.3389
2010	11,980	1.0917	0.2386	1.3895	4335.9985

Solutions to questions from the 2011 Exam

- The insurer has either a quota share reinsurance contract or an excess of loss reinsurance contract in place each accident year.

33a. (1 point) Analyze the gross and net reported claims data to determine which type of reinsurance was purchased for each accident year. Explain your reasoning.
33b. (0.5 point) Briefly explain how the selection of tail factors for both net and gross reported claims should be impacted by the presence of an excess of loss reinsurance contract.

Question 33 – Model Solution

a. Compute the ratio of net claims-to-gross claims

	12	24	36	48
2006	0.9000	0.8116	0.7695	0.7695
2007	0.6500	0.6500	0.6500	0.6500

For AY 2006, it's a excess of loss reinsurance since the ratio from one maturity to another are not consistent. The ratio depends of the amount of excess loss that has been ceded.

For AY 2007, it's a quota share. They cede 35% of their business to reinsurance. It's a quota share since the ratios are consistent.

b. The tail factor for the gross reported claims would be chosen as normal. However, for the net reported claims, it would vary from years to years. The net tail factor is less than the gross tail factor.

Solutions to questions from the 2012 Exam

25. Use a ratio approach to estimate the ultimate salvage and subrogation for AY 2011.

Question 25 – Model Solution 1 (Exam 5B Question 10)

Development of Cumulative Paid Claim Gross			
AY	12-24	24-36	36 - ult
2009	1.1215	1.0000	1.0000
2010	1.1173		
Selected	**1.1194**	1.0000	1.0000

1.1215 = $16,953 / $15,117

(2011 cumulative paid gross) x (S+S factor) = 14.727 x 1.1194 = **$16,485.4038**

Ratio of S+S Received to Paid Gross			
AY	12-24	24-36	36 - ult
2009	0.1392	0.265	0.2716
2010	0.1322	0.2762	
2011	**0.1375**		

0.1392 = $2,104 / $15,117

(2011 Ratio of Received to Paid Gross) x (Selected CDF to Ult) x Ultimate Gross
= 0.1375 x 2.047 x Ult gross = **$4,640.0230**

Question 25 – Model Solution 2 (Exam 5B Question 10)

Development of Cumulative Paid Claim Gross			
AY	12-24	24-36	36-ult
2009	1.1215	1.0000	
2010	1.1173		
Simple all-year average.			
ATA	1.1194	1.0000	1.0000
LDF	**1.1194**	1.0000	1.0000

Ratio of S+S Received to Paid Gross			
AY	12	24	36
2009	0.1392	0.2650	0.2716
2010	0.1322	0.2762	
2011	**0.1375**		

AY	(1) Ratio	(2) Ratio CDF	(3) Cumul.	(4) Paid CDF	(5)=(1)(2)(3)(4) Ult S/S
2011	0.1375	2.047	14,727	1.1194	**4,640.0230**

Examiner's Comment

This was a fairly simple and straightforward question. A majority of candidates achieved full credit on this problem. Some candidates failed to project claims to ultimate value and as a result salvage and subrogation (S&S) to ultimate. Other candidates lost credit by taking the average ratio of S&S to paid claims at 12 months, then applying a development factor to that average. This ignored older accident year data and was felt to be inappropriate.

Solutions to questions from the 2012 Exam

Estimate the pool's ultimate claims net of both excess of loss and stop loss for policy years 2008 through 2011.

Question 26 –Model Solution 1 (Exam 5B Question 11)

The pool's ultimate claims net of both excess of loss and stop loss = the minimum of the net ultimate losses and the stop loss limit for each of the policy years under consideration.

PY	(1) Rept Claims net	(2) Net LDF	(3) = 1 x 2 Net Ult	(4) Stop loss	(5) Min((3),(4)) Net Ult final
2008	634	1.38	874.92	1,000	874.92
2009	625	1.62	1,012.50	1,250	1,012.50
2010	728	1.94	1,412.32	1,250	1,250.00
2011	674	2.45	1,651.30	1,500	1,500.00
				Total	4,637.42

4637.42 * 1000 = 4,637,420

Question 26 –Model Solution 2 (Exam 5B Question 11)

Compute net ultimate loss and then select the minimum of the net ultimate loss and the stop loss

634 * 1.38 = **874.92** — ’08 Net Ultimate

1012.5 <1250 — ’09 Stop Loss Limit

1412 > **1250** — PY 2010

1651 > **1500** — PY 2011

Total = *4,637.42*

Question 26 –Model Solution 3 (Exam 5B Question 11)

Assume stop loss applies to each PY independently. Assume stop loss applies to loss net of XOL.

PY	(1) Ult Loss Of XOL	(2) Stop Loss	(3) Stop Loss Cessions	(4) Loss Net XOL & Stop Loss
2008	874.92	1,000	0.00	874.92
2009	1,012.50	1,250	0.00	1,012.50
2010	1,412.32	1,250	162.32	1,250.00
2011	1,651.30	1,500	151.30	1,500.00
Total	4951.04		313.62	4,637.42

(1) = Rpt Loss Net XOL
(3) = (1) – min[(1),(2)]
(4) = (1) – (3)

Examiner’s Comments

A little over half of the candidates received full credit and about a third received no credit, most of which completely skipped the question. Those who received partial credit received some credit for demonstrating some understanding of reserving and reinsurance, but did not apply stop gap correctly, did not use reported claims net of XOL and net development factors, and/or made math errors.

1 Introduction 345 - 346

The methods used for estimating unpaid claims presented in Chapters 7 through 14 are reviewed.

Actuaries should use more than one method when analyzing unpaid claims, since no single method can produce the best estimate in all situations.

Berquist and Sherman:

- recommend that where possible, an analysis of unpaid claims should use methods that incorporate the following:
  - * Projections of reported claims
  - * Projections of paid claims
  - * Projections of ultimate reported claim counts and severities
  - * Estimates of the number and average amount of outstanding claims
  - * Claim ratio estimates
- further recommend that wherever possible, the concepts of credibility, regression analysis, and data smoothing be incorporated into the actuarial methods used.

  At times credibility maybe used in the selection process, while at other times actuarial judgment will prevail.

  When incorporating regression analysis into a method, used some measure of the goodness-of-fit to evaluate the appropriateness of that method's projections.
- state: "The methods applied should range from those which are highly stable (i.e. representative of the average of experience over several years) to those which are highly responsive to trends and to more recent experience."

Selection of the most appropriate estimate of unpaid claims is the actuary's responsibility.

Patrik (in Reinsurance):

- There is no single right method.
- Use as many legitimate methods and compare and contrast the estimates from these methods.
- Review the spread of estimates to better understand the range and distribution of possibilities, and the sensitivity of our answers to varying assumptions and estimation methods.
- Testing the method retroactively is one method to evaluate a particular technique by determining the historical accuracy of the method and whether or not the particular method is free from bias in projecting future results.

Ronald Wiser (in "Loss Reserving"):
- explain significant differences between the projections of various methods, typically due to changes in company procedures or to changes in the external environment.
- while attempting to reconcile a number of different estimates is difficult, it often yields new insights for the actuary.

Calculate claim ratios, severities, pure premiums, and claim frequencies as a final check in the selection of ultimate claims (especially for the most recent years)
- ultimate amounts can be evaluated in contexts outside their original analysis.
- if exposures are not available, compare ultimate claim counts with premiums as a proxy for frequency.

Calculate also the implied average case outstanding on open and unreported claims.

Review these statistics:
- for reasonableness from the perspective of year-to-year changes,
- with knowledge gained from meetings with management, and
- with knowledge of the industry in general.

Such a review should give the actuary greater confidence in the unpaid claim estimate or lead to seeking additional information before reaching a conclusion.

2 U. S. Industry Auto 346

The results of the projection techniques are all consistent given the volume of business.

	Estimated Unpaid Claims as of 12/31/07	
$ Billions	**IBNR**	**Total**
Development — Reported	26	71
Development — Paid	29	74
Expected Claims	26	71
Bornhuetter-Ferguson — Reported	26	71
Bornhuetter-Ferguson — Paid	27	73
Cape Cod	27	73
Case Outstanding Development	24	70

In total and by AY, the methods produce unpaid claims that are similar to one another.

3 XYZ Insurer 347 - 348

We expect to see significant differences in the various estimates of unpaid claims in results for XYZ Insurer, since we know that the underlying assumptions of some of the methods do not hold true, due to recent changes in both its internal operations as well as the external environment.

Exhibit I, Sheet 1: Projected ultimate claims from the following methods (including the influence of the B/S adjustments on the projected ultimate claims):

* Reported and paid claim development techniques based on unadjusted reported and paid claims
* BF technique based on unadjusted reported and paid claim development patterns
* Cape Cod method based on unadjusted reported claim development pattern

Adjusted projections based on the following:

* Reported and paid claim development techniques incorporating B/S adjustments to case outstanding only, paid claims only, as well as to both case outstanding and paid claims
* BF based on adjusted reported and paid claim development patterns as well as revised expected claim ratios

Chapter 15 - Evaluation of Techniques Exhibit I
XYZ Insurer - Auto BI Sheet 1
Summary of Ultimate Claims ($000)

	Unajusted projections for Ultimate Claims					Adjusted projections for Ultimate Claims				
Accident	Development Method		B-F Method		Cape Cod	Development Method			B-F Method	
Year	Reported	Paid	Reported	Paid	Method	Case Rptd	Both Rptd	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	15,822	15,980	15,822	15,977	15,822	15,822	15,822	15,980	15,822	15,975
1999	25,082	25,164	25,107	25,158	25,107	25,107	25,107	25,140	25,107	25,128
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	47,979	77,941	45,221	45,636	43,307	38,237	42,680	38,549	40,300	34,988
2008	47,530	74,995	42,607	41,049	39,199	37,227	41,531	45,989	36,842	33,988
Total	514,929	605,028	513,207	554,469	504,298	476,636	489,258	485,546	482,909	484,647

Column Notes:
(2) and (3) Developed in Chapter 7, Exhibit II, Sheet 3.
(4) and (5) Developed in Chapter 9, Exhibit II, Sheet 1.
(6) Developed in Chapter 10, Exhibit II, Sheet 2.
(7) through (9) Developed in Chapter 13, Exhibit III, Sheet 10.
(10) and (11) Developed using projected ultimate claims in (8) as the new intial expected claims estimates.

Note: Calculations for the revised BF incorporating the B/S adjustments on development patterns and the expected claim ratio are not included, but the user is encouraged to reproduce these calculations to ensure a greater understanding of the mechanics of each method.

Next: Removed from consideration are:

- the first 3 techniques, because using unadjusted data does not satisfy the underlying assumptions for these techniques.
- the B/S adjustment for case outstanding only since this projection does not reflect the changes observed in settlement rates.

Exhibit I, Sheets 2 through 6: Exhibits used to assist in selecting ultimate claims by accident year.

* Exhibit I, Sheet 2 — Summary of Ultimate Claims
* Exhibit I, Sheet 3 — Comparison of Estimated Ultimate Claim Ratios
* Exhibit I, Sheet 4 — Comparison of Estimated Ultimate Severities
* Exhibit I, Sheet 5 — Comparison of Estimated Average Case Outstanding and Unreported Claims
* Exhibit I, Sheet 6 — Comparison of Estimated IBNR

Each exhibit contains details by AY.

- For the frequency-severity approaches (#2 and #3), only ultimate claims for the recent AYs are estimated.
- For other techniques, projected ultimate claims for all AYS in the experience period (i.e. 1998 through 2008) are shown.

Exhibit I, Sheets 2 – 6: Summarized results for the following methods:

* Reported and paid claim development techniques incorporating B/S adjustments to paid claims only as well as to both case outstanding and paid claims
* BF based on adjusted reported and paid claim development patterns as well as revised expected claim ratios
* All three frequency-severity projections (from Chapter 11)

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Summary of Ultimate Claims ($000)

Exhibit I
Sheet 2

Accident Year	Claims as of 12/31/08 Reported	Paid	Adjusted Projections for Ultimate Claims: Development Method Both Rptd	Paid	B-F Method Reported	Paid	Projections for Ultimate Claims: Frequency-Severity			Selected Ultimate Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	15,822	15,822	15,822	15,980	15,822	15,975	15,822	0	0	15,822
1999	25,107	24,817	25,107	25,140	25,107	25,128	25,084	0	0	25,107
::	::	::	::	::	::	::	::	::	::	::
2007	31,732	11,865	42,680	38,549	40,300	34,988	58,527	30,487	11,865	40,300
2008	18,632	3,409	41,531	45,989	36,842	33,988	59,214	30,172	3,409	33,507
Total	449,626	330,627	489,258	485,546	482,909	484,647	551,117			483,796

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 13, Exhibit III, Sheet 10.
(6) and (7) Developed using projected ultimate claims in (4) as the new intial expected claims estimates.
(8) Developed in Chapter 11, Exhibit II, Sheet 6.
(9) Developed in Chapter 11, Exhibit IV, Sheet 3.
(10) Developed in Chapter 11, Exhibit VI, Sheet 8.
(11) = (4) for accident years 2004 and prior; (11) = [Average of (6) and (7) for 2005 and 2006]; (11) = (6) for 2007; (11) = [Average of (6) and (9)] for 2008.

FS Method # 1 (from Chapter 11):

- Incorporating closed claim counts into the selection of ultimate claim counts may overstate the true value of projected ultimate claims.
- Column (8) estimate of total ultimate claims for all AYs combined is $551,155;
  Total ultimate claims for all other methods are less than $490,000.

Thus, FS Method # 1 is excluded from further consideration.

For the oldest seven years (1998 - 2004), the results are consistent results from the various projection methods. However, beginning in 2005, the differences become more substantial.

The selection of ultimate claims can be assisted by a review of the estimated ultimate claim ratios and ultimate severities as well as the estimated IBNR.

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Comparison of Estimated Ultimate Claim Ratios

Exhibit I
Sheet 3

Accident Year	Earned Premium	Estimated Ultimate Claim Ratios Based on: Development Method Both Rptd	Paid	B-F Method Reported	Paid	Frequency - Severity Method 1	Method 2	Method 3	Selected Ult Claims Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	20,000	79.1%	79.9%	79.1%	79.9%	79.1%			79.1%
1999	31,500	79.7%	79.8%	79.7%	79.8%	79.6%			79.7%
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	62,438	68.4%	61.7%	64.5%	56.0%	93.7%	48.8%	19.0%	64.5%
2008	47,797	86.9%	96.2%	77.1%	71.1%	123.9%	63.1%	7.1%	70.1%
Total	732,144	66.8%	66.3%	66.0%	66.2%	75.3%			66.1%

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) / (2)].

Chapter 15 - Evaluation of Techniques Exhibit I
XYZ Insurer - Auto BI Sheet 4
Comparison of Estimated Ultimate Claim Ratios

		Estimated Ultimate Severites Based On							Selected
Accident	Ultimate	Development Method		B-F Method		Frequency-Severity			Ultimate
Year	Claim Counts	Paid	Reported	Reported	Paid	Method 1	Method 2	Method 3	Severities
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	637	24,838	25,087	24,838	25,078	24,839			24,838
1999	1,047	23,978	24,010	23,978	23,998	23,956			23,978
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	1,556	27,424	24,770	25,895	22,482	37,607	19,590	7,624	25,895
2008	1,425	29,138	32,266	25,848	23,846	41,545	21,169	2,392	23,509
Total	17,378	28,154	27,940	27,788	27,888	31,713			27,840

Column Notes:
(2) Developed in Chapter 11, Exhibit II, Sheet 3.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) x 1000 / (2)].

Chapter 15 - Evaluation of Techniques Exhibit I
XYZ Insurer - Auto BI Sheet 6
Comparison of Estimated IBNR

	Case	Estimated IBNR Based On							
Accident	Outstanding	Development Method		B-F Method		Frequency-Severity			Selected
Year	at 12/31/08	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method 3	IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	0	0	158	0	157	0			0
1999	290	0	42	0	42	-23			0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	19,867	10,948	6,817	8,568	3,256	26,795	-1,245	-19,867	8,568
2008	15,223	22,899	27,357	18,210	15,356	40,582	11,540	-15,223	14,875
Total	118,997	39,632	35,920	33,283	35,021	101,491			34,170

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) - ((2) in Exhibit I, Sheet 2)].

Estimated average case outstanding and unreported claim on open and IBNR claims is another valuable statistic.

Chapter 15 - Evaluation of Techniques Exhibit I
XYZ Insurer - Auto BI Sheet 5
Comparison of Estimated Average Case Outstanding and Unreported Claims

	Open	Estimated Average Case Outstanding and Unreported Claims Based on							Selected
Accident	IBNR Counts	Development Method		B-F Method		Frequency-Severity			ultimate
Year	at 12/31/08	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method3	Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	0	-	-	-	-	-			-
1999	3	96,667	107,540	96,667	103,667	88,845	0	0	96,667
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	765	40,280	34,882	37,170	30,226	60,996	24,343	0	37,170
2008	1,150	33,149	37,026	29,072	26,590	48,526	23,272	0	26,172
Total	3,515	530,573	542,227	524,635	554,689	631,163			529,352

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = { [(estimated IBNR in Exhibit I, Sheet 6) + ((2) in Exhibit I, Sheet 6)] x 1000 / (2)}.

Acceptable ways to select ultimate claims:

- Select one method and use it for all years.
  The B/S adjusted reported claim (both case and paid adjustments) method may be a reasonable selection for all years for XYZ Insurer.
- Select different methods for different AYs. For example, select the B/S adjusted reported claim method for AY 1998 - 2006 and the BF method for 2007 and 2008.
- Use a weighted average based on assigned weights to the various methods; these weights may be consistent for all years or may vary by AY.

Recall that there is no single "right" way for the actuary to select ultimate claims, and thus unpaid claims.

- Review the results of the various techniques, diagnostic tests (e.g. implied claim ratios and severities), and information gained during the unpaid claims estimation process.
- Retroactive tests are also valuable when selecting which methods to rely on for selecting ultimate claims.

In the example above, selected ultimate claims were based on:

- the B/S adjusted reported claim for AYs 1998 - 2004;
- the average of the adjusted reported and paid BF techniques for AYs 2005 and 2006;
- the adjusted reported BF technique for AY 2007; and
- the average of the adjusted reported BF technique and FS approach #2 for AY 2008.

The key statistics in selections by AY are the estimated IBNR, the estimated ultimate severities, and the estimated claim ratios.

4 Changing Conditions - Changes in Claim Ratios and Case Outstanding Adequacy and Changes in Product Mix 349

Chapters 7 – 10: Four scenarios regarding the U.S. private passenger automobile example are given.

#1. U.S. PP Auto Steady-State: All techniques produced an accurate estimate of unpaid claims.

2 U.S. PP Auto Increasing Claim Ratios, # 3 U.S. PP Auto Increasing Case Outstanding Strength, and # 4 U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength; the techniques varied in their ability to accurately respond to the changing conditions.

#5 U.S. Auto Steady-State (a combined PP and commercial auto portfolio) produce the actual IBNR value. However, when the product mix changes, the methods respond differently to the changing conditions.

The following table summarizes the estimated IBNR for each of the projection techniques

Estimated IBNR ($000)				
Estimation Technique	**Increasing Claim Ratios**	**Increasing Case Outstanding Strength**	**Increasing Ratios and Case outstanding Strength**	**Changing Product Mix**
True IBNR	602	253	348	2,391
Development – Reported	602	501	694	2,153
Development – Paid	602	253	348	1,723
Expected Claims	-843	253	-1,097	2,167
Bornhuetter-Ferguson – Reported	439	458	460	2,168
Bornhuetter-Ferguson – Paid	159	253	-96	1,991
Benktander – Reported	573	492	648	2,159
Benktander – Paid	406	253	151	1,893
Cape Cod	506	470	546	2,168

For each of these scenarios:

- there is considerable variability between the methods in total and by AY.
- it is important to understand what the drivers are for the differences between methods (may need more information from management as well as further quantitative analysis to determine which method is most appropriate).
- the availability of claim counts and the ability to test the estimated ultimate severities could prove valuable to the actuary.

5 Berq–Sher Insurers 350

Exhibit II: Summarized results of the various projection methods for Berq-Sher Med Mal Insurer

XYZ Insurer - Auto BI
Comparison of Estimated IBNR

Exhibit II

			Projected Ultimate Claims			Estimated IBNR Based on		
Accident	Claims as of 12/31/76		Development Method		Berq-Sher	Development Method		Berq-Sher
Year	Reported	Paid	Reported	Paid	Adj Rptd	Reported	Paid	Adj Rptd
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1969	23,506,000	15,815,000	23,506,000	23,501,090	23,506,000	0	-4,910	0
:::	:::	:::	:::	:::	:::	:::	:::	:::
1975	48,904,000	1,565,000	215,253,430	125,022,648	93,459,963	166,349,430	76,118,648	44,555,963
1976	15,791,000	209,000	175,986,370	103,266,710	117,875,378	160,195,370	87,475,710	102,084,378
Total	367,167,000	90,356,000	837,639,227	650,665,195	521,143,718	470,472,227	283,498,195	153,976,718

Column Notes:
(2) and (3) Based on medical malpractice insurance experience.
(4) through (6) Developed in Chapter 13, Exhibit I, Sheet 8.
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) - (2)].

Ultimate claims are estimated using:

- the development technique applied to unadjusted reported and paid claims, and
- adjusted reported claims (claims adjusted to reflect changes in case outstanding adequacy).

Note: the diagnostics that can be performed is limited for both the B/S examples since complete claim count data is not available.

Observations:

- An increase in case outstanding strength has occurred during the experience period.

  Thus, the development method based on unadjusted reported claims is not appropriate since its underlying assumption is not valid (i.e. case O/S adequacy has not remained constant)
- Since the unadjusted paid claim development and adjusted reported claim development methods produce significant differences, the actuary should seek additional information, including the use of other methods, before making a final determination as to ultimate claims and thus the unpaid claim estimate.

Exhibit III: Summarized the results for Berg-Sher Auto BI Insurer.

XYZ Insurer - Auto BI Exhibit III
Summary of Ultimate Claims and Estimated Ultimate Severities

			Projected Ultimate Claims				Estimated Ultimate Severities Based on			
	Paid		Berquist-Sherman Adjusted Paid					Berquist-Sherman Adjusted Paid		
Accident	Claims	Paid Claims				Ultimate	Paid Claims			
Year	as 12/31/76	Dev Method	Dev Method	Lin Reg	Exp Reg	Claim Counts	Dev Method	Dev Method	Lin Reg	Exp Reg
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1969	10,256	10,256	10,256	10,256	10,256	7,821	1,311	1,311	1,311	1,311
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
1975	9,182	18,286	21,560	21,387	21,385	8,050	2,272	2,678	2,657	2,657
1976	2,801	17,281	20,771	21,890	21,913	7,466	2,315	2,782	2,932	2,935
Total	90,937	122,710	132,028	132,090	132,120	69,047	1,777	1,912	1,913	1,913

Column Notes: #DIV/0!
(2) Based on automobile bodily injurty experience.
(3) through (6) Developed in Chapter 13, Exhibit II, Sheet 11.
(7) Developed in Chapter 13, Exhibit II, Sheet 4.
(8) = [(3) x 1000 / (7)].
(9) = [(4) x 1000 / (7)].
(10) = [(5) x 1000 / (7)].
(11) = [(6) x 1000 / (7)].

Four estimates of ultimate claims using the development technique are developed.

1. Project ultimate claims based on unadjusted paid claims data.
2. Adjust the paid claims data for changes in the rate of claims settlement and develop three alternative sets of claim development factors.
3. Summarize ultimate claims and estimated ultimate severities for each of the four projections.

Observations:

All three projections based on the adjusted paid claims are similar to one another, in total and by AY.

Note: These projections are not necessarily independent since they are based on the same source data. Incorporate other techniques to verify the results of the B/S adjusted paid claims methodology.

The results of the B/S adjustment are consistent with our expectations regarding a decrease in the rate of claims settlement.

6 Monitoring and Interim Techniques for Unpaid Claim Estimates 350 - 353

The final part of Wiser's four-phase approach to estimating unpaid claims is to monitor projections of the development of unpaid claims over subsequent calendar periods.

- Deviations of actual development from projected development of claims or claim counts are useful to evaluate the accuracy of the unpaid claim estimate.
- Comparing actual-to-expected claims helps the actuary to evaluate the appropriateness of prior selections and make revisions as necessary if actual claims do not emerge as expected.

Monitoring unpaid claims is useful:

- from a financial reporting perspective,
- for budgeting and planning purposes,
- for pricing and other strategic decision-making, and
- for planning for the next complete analysis of unpaid claims.

Comparing actual and expected claims by AY and between successive annual valuations is shown in Exhibit IV.

For DC Insurer, ultimate claims at 12/31/2007 are derived based on the reported claim development technique.

DC Insurer Exhibit IV
Reported Claims ($000) Sheet 1

PART 3 - Average Age-to-Age Factors

					Averages							
	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	30-33	33-36	To Ult
Simple Average												
All Years	1.830	1.487	1.339	1.094	1.002	1.003	1.001	1.000	1.000	1.000	1.000	
Latest 7	1.888	1.503	1.347	1.119	1.006	1.004	1.002	1.001	1.000	1.000	1.000	
Latest 5	1.898	1.470	1.311	1.119	1.008	1.005	1.002	1.001	1.001	1.000	1.000	
Medial Average												
Latest 5x1	1.896	1.474	1.322	1.126	1.007	1.005	1.002	1.001	1.001	1.000	1.000	
Volume-weighted Average												
All Years	1.838	1.480	1.326	1.091	1.003	1.003	1.001	1.000	1.001	1.000	1.000	
Latest 7	1.889	1.485	1.335	1.119	1.006	1.004	1.002	1.001	1.000	1.000	1.000	
Latest 5	1.895	1.464	1.309	1.118	1.008	1.005	1.002	1.001	1.001	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

			Development Factor Selection									
	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	30-33	33-36	To Ult
Selected	1.895	1.464	1.309	1.118	1.008	1.005	1.002	1.001	1.000	1.000	1.000	1.000
CDF to Ultimate	4.125	2.177	1.487	1.136	1.016	1.008	1.003	1.001	1.000	1.000	1.000	1.000
Percent Reported	24.2%	45.9%	67.2%	88.0%	98.4%	99.2%	99.7%	99.9%	100.0%	100.0%	100.0%	100.0%

DC Insurer Exhibit IV
Projection Ultimate Claims Using Reported Claims ($000) Sheet 2

Accident Year	Age of Accident Year at 12/31/07	Reported Claims at 12/31/07	CDF to Ultimate	Projected Ultimate Claims
(1)	(2)	(3)	(4)	(5)
1997	132	3,376	1.000	3,376
:::	:::	:::	:::	:::
2005	36	2,814	1.000	2,814
2006	24	2,949	1.001	2,952
2007	12	2,463	1.136	2,798
Total		28,575		28,913

Column Notes:
(2) Age of accident year in (1) at December 31, 2007.
(3) Based on data from DC Insurer.
(4) Based on selected CDF in Exhibit IV, Sheet 1.
(5) = [(3) x (4)].

Exhibit IV, Sheet 3: Use selected ultimate claims and the selected reporting pattern to compare actual reported claims one year later (i.e. 12/31/2008) with our expected claims for the year.

DC Insurer Exhibit IV

Annual Monitoring Test ($000) Sheet 3

Accident Year	Selected Ultimate Claims	Expected % Reported at 12/31/2007	Expected % Reported at 12/31/2008	Reported Claims at 12/31/2007	Reported Claims at 12/31/2008	Claims Reported Between 12/31/07 and 12/313/08 Actual	Expected	Difference
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1997	3,376	100.0%	100.0%	3,376	3,376	0	0	0
1998	2,788	100.0%	100.0%	2,788	2,788	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::
2006	2,952	99.9%	100.0%	2,949	3,030	81	3	78
2007	2,798	88.0%	99.9%	2,463	2,733	270	332	-62
Total	28,913			28,575	28,983	408	335	73

Column Notes:
(2) Developed in Exhibit IV, Sheet 2.
(3) and (4) Based on selected CDF in Exhibit IV, Sheet 1.
(5) and (6) Based on data from DC Insurer.
(8) = [(6) - (5)].
(7) = {[(2) - (5)] / [1.0 - (3)] x [(4) - (3)]}.
(9) = [(7) - (8)].

For each AY, expected reported claims in the calendar year are equal to:

[(ultimate claims selected at 12/31/2007 - actual reported claims at 12/31/2007) / (% unreported at 12/31/2007)] x (% reported at 12/31/2008 - % reported at 12/31/2007)]

The % unreported is computed as [1.00 - (1.00 / cumulative claim development factor)].

Examples:

The expected reported claims for accident year 2007 during calendar year 2008 are equal to:

AY_{07} Expected Claim_{CY08} = {[($2,798 - $2,463) / (1 - 0.880)] x (0.999 - 0.880)} = $332

The expected reported claims for accident year 2006 during calendar year 2008 are equal to:

AY_{06} Expected Claim_{CY08} = {[($2,952 - $2,949) / (1- 0.999)] x (1.000 - 0.999)} = $3

Actuaries often rely on techniques other than the development technique to select ultimate claims.

A method often used to derive payment patterns is to compare the historical paid claim development triangle to the final value of selected ultimate claims, as shown in Exhibit V, Sheet 1.

Exhibit V
Sheet 1

XYZ Insurer - Auto BI
Ratio of Paid Claims to Selected Ultimate Claims ($000)

PART 1 - Data Triangle

Accident	Paid Claims as of (months)											Selected
Year	12	24	36	48	60	72	84	96	108	120	132	Ultimate
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817		25,107
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782			37,246
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519				38,798
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437					48,169
2003	1,743	6,240	12,683	22,892	34,505	39,320						44,373
2004	2,221	9,898	25,950	43,439	52,811							70,780
2005	3,043	12,219	27,073	40,026								74,726
2006	3,531	11,778	22,819									54,968
2007	3,529	11,865										40,300
2008	3,409											33,491

PART 2 - Ratios

Accident	Ratio of Paid Cliams to Selected Ultimate Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998			0.399	0.539	0.637	0.734	0.837	0.911	0.968	0.996	1.000
1999		0.186	0.393	0.556	0.722	0.878	0.936	0.962	0.979	0.988	
2000	0.035	0.175	0.326	0.479	0.645	0.775	0.892	0.964	0.988		
2001	0.040	0.153	0.318	0.480	0.629	0.801	0.955	0.993			
2002	0.048	0.165	0.287	0.459	0.663	0.843	0.923				
2003	0.039	0.141	0.286	0.516	0.778	0.886					
2004	0.031	0.140	0.367	0.614	0.746						
2005	0.041	0.164	0.362	0.536							
2006	0.064	0.214	0.415								
2007	0.088	0.294									
2008	0.102										

PART 3 - Average Age-to-Age Factors

	Average										
	12	24	36	48	60	72	84	96	108	120	132
Simple Average											
Latest 5	0.065	0.191	0.343	0.521	0.692	0.837	0.909	0.957	0.978	0.992	1.000
Latest 3	0.085	0.224	0.381	0.555	0.729	0.844	0.923	0.973	0.978	0.992	1.000
Latest 2	0.095	0.254	0.389	0.575	0.762	0.865	0.939	0.978	0.984	0.992	1.000
Medial Average											
Latest 5x1	0.064	0.173	0.339	0.510	0.685	0.841	0.917	0.963	0.979	0.992	1.000

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12-24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	0.085	0.224	0.381	0.555	0.729	0.844	0.923	0.973	0.978	0.992	1.000

Various averages of the % paid at each maturity are calculated and a payment pattern is selected.

Similar calculations for the reporting pattern are shown in Exhibit V, Sheet 2.

Shown below are the implied payment and reporting patterns based on the unadjusted development patterns, the development patterns after B/S adjustments, and the final selections from Exhibit V, Sheets 1 and 2.

Comparison of Reporting and Payment Patterns

	Reporting			**Payment**		
Maturity Age	**Unadjusted CDF**	**Adjusted CDF**	**Selected**	**Unadjusted CDF**	**Adjusted CDF**	**Selected**
12	39.2%	44.9%	51.1%	4.5%	7.4%	8.5%
24	66.1%	74.3%	75.8%	15.2%	30.8%	22.4%
36	83.6%	91.4%	88.7%	31.6%	44.1%	38.1%
48	92.2%	99.0%	95.8%	49.8%	58.3%	55.5%
60	94.0%	99.3%	97.1%	65.6%	74.0%	72.9%
72	98.7%	100.0%	98.9%	78.9%	89.2%	84.4%

It can be challenging to develop a system for quarterly or monthly monitoring given an estimation process that focuses only on annual CDF.

- Some insurers maintain claim development data on a quarterly basis. For these organizations, development factors are readily available for quarterly analyses, and linear interpolation between quarters is likely sufficient for monthly monitoring purposes.
- For insurers who only have annual claim development data, linear interpolation of annual development patterns is not appropriate, particularly for the most immature AYs.

According to B/F In the paper "The Actuary and IBNR":

In the absence of data, it might be reasonable to assume that the:

i. cumulative distribution of development by quarter for the most recent AY is skewed say 40% at 3 months, 70% at 6 months, 85% at 9 months, 100% at 12 months, and that the

ii. distribution for prior AYs is uniform: 25%, 50%, 75%, 100%.

Upon further study, the authors found that their data revealed prior year's development were also skewed; approximate distribution: 33%, 60%, 80%, 100%. The data reviewed were excess of loss and it is recognized that distributions observed may not be typical of ordinary business.

DC Insurer has the systems capability to capture claim development data on a quarterly basis, and built a model for monthly claims monitoring based on linear interpolation of the quarterly CDFs.

Exhibit IV, Sheet 4: A template for January and February 2008.

DC Insurer Exhibit IV
Monthly Monitoring Test ($000) Sheet 4

Accident Year	Selected Ultimate Claims	Expected % Reported at			Actual Reported Claims at			Claims Reported Between 12/31/07 and 12/31/08			Claims Reported Between 01/31/08 and 02/29/08		
		12/31/2007	1/31/2008	2/29/2008	12/31/2007	1/31/2008	2/29/2008	Actual	Expected	Difference	Actual	Expected	Difference
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1997	3,376	100.0%	100.0%	100.0%	3,376	3,376	3,376	0	0	0	0	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2006	2,952	99.9%	99.9%	100.0%	2,949	2,951	2,986	2	0	2	35	3	32
2007	2,798	88.0%	91.5%	95.0%	2,463	2,473	2,538	10	97	-87	65	98	-33
Total	28,913				28,575	28,616	28,727	41	98	-57	111	100	11

Column Notes:
(2) Developed in Exhibit IV, Sheet 2.
(3) Based on selected CDF in Exhibit IV, Sheet 1.
(4) and (5) Based on linear interpolation of selected CDF in Exhibit IV, Sheet 1.
(6) through (8) Based on data from DC Insurer.
(9) = [(7) - (6)]
(10) = {[(2) - (6)] / [1.0 - (3)] x [(4) - (3)11.
(11) = [(9) - (10)].
(12) = [(8) - (7)].
(13) = {[(2) - (6)] / [1.0 - (3)] x [(5) - (4)1}.
(14) = [(12) - (13)].

In his review of the B/F paper "The Actuary and IBNR", Hugh White offered a problem that is still relevant for actuaries monitoring unpaid claims today. Mr. White stated:

> You are trying to establish the reserve for commercial auto BI and the reported proportion of expected losses as of statement date for the current AY is 8% higher than it should be. Do you:
>
> 1. Reduce the bulk (i.e. IBNR) reserve a corresponding amount (because you sense an acceleration in the rate of reporting)?;
> 2. Leave the bulk reserve at the same % level of expected losses (because you sense a random fluctuation such as a large loss)?; or
> 3. Increase the bulk reserve in proportion to the increase of actual reported over expected reported (because you don't have 100% confidence in your "expected losses")?
>
> None of these suggested "answers" is satisfactory without further extensive investigation, and yet, all are reasonable.

The actuary must obtain a comprehensive understanding of the situation, achieved through meetings with management and other parties who understand the situation and through detailed analyses of the claims and claims experience.

Sample Questions:

1. Chapter 15 expands on the last two steps in a four-phase approach to the process of estimating unpaid claims described by Wiser. List the four steps, as shown in Friedland's Introduction to Part 2.

2. In the discussion of Monitoring and Interim Techniques, Friedland emphasizes the importance of comparing the difference between actual and expected claims reported (or paid) in period of time (such as a month or quarter). She states that these comparisons are important "so that the actuary can understand the appropriateness of prior selections and make revisions as necessary if actual claims do not emerge as expected." Define the term emergence.

3. Given the following data as of 12/31/07 (taken from Friedland's Exhibit IV, Sheets 2 & 3):

CDF to Ultimate at 12 months	1.136
CDF to Ultimate at 24 months	1.001
Reported Claims to date for AY 07	2,463
Est. Ultimate Claims for AY 07	2,798

Calculate the expected reported claims (emergence) for AY 2007 during Calendar Year 2008.

1994 Exam Questions (modified):

53. You are given the following data:

Reported CDF to Ult. at 12 months	4.00
Reported CDF to Ult. at 24 months	2.00
Reported CDF to Ult. at 36 months	1.50
<u>Accident Year 1994 data:</u>	
Reported Claims as of 12/31/94	130,000
Earned Premium	1,000,000
Expected Claims Ratio	65%

Assuming the Bornhuetter-Ferguson method is used to estimate ultimate claims, calculate the following amounts for Accident Year 1994:

a. (.5 point) The estimate of IBNR as of 12/31/94.
b. (1 point) The amount of IBNR expected to emerge in 1995.

1995 Exam Questions (modified):

44. (Continued from Chapter 9 question)

You are given the following information (amounts are in $000s):

		Reported Claims including ALAE ($000's omitted) as of				
Earned Premium	Accident Year	12 mo, Report 1	24 mo, Report 2	36 mo, Report 3	48 mo, Report 4	60 mo, Report 5
4,500	1990	2,000	2,600	2,990	3,283	3,283
5,000	1991	2,102	2,638	3,086	3,343	
5,200	1992	2,234	2,938	3,408		
5,300	1993	2,339	2,985			
5,700	1994	2,482				

Also given Cumulative Distribution of development by quarter, WITHIN a calendar year:

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Most recent prior Accident Year	40%	65%	85%	100%
Earlier Accident Years	35%	60%	80%	100%

Assume that all claims reach ultimate settlement at 60 months, and the expected claim ratio is 75%. For purposes of allocating expected development, use distribution of development by quarter.

a. See Chapter 9 for illustration of B-F method.
b. See Chapter 7 for illustration of Development method.
c. (1.5 points) Using Estimated IBNR developed using the B-F method at 12/31/94, determine the expected IBNR balance as of **6/30/95** for accident years 1994 and prior. Show all work.

1996 Exam Questions (modified):

48. (1 point) What are the two important considerations discussed by Friedland with respect to the review of IBNR estimates at the close of interim accounting periods?

List three reasons an Insurance Company may be interested in monitoring its Unpaid Claims Estimates at various times throughout a year.

1997 Exam Questions (modified):

52. You are given the following information:

"AY" Accident Year	Reported Claims & ALAE	"EP" Earned Premium
1993	5,000,000	9,000,000
1994	7,000,000	9,450,000
1995	6,000,000	9,922,500
1996	8,000,000	10,418,625

Ultimate Claim Development Factors (CDFs) by development age	
48 to Ultimate	1.05
36 to Ultimate	1.15
24 to Ultimate	1.30
12 to Ultimate	1.75

<u>Expense Assumptions (as a % of Earned Premium):</u>

General Expense		5%
Acquisition Expense		10%
Taxes, Licenses, Fees	3%	
Underwriting Profit Load	0%	

<u>Other Assumptions:</u>

Earned premium is growing at 5% per year.

There is no expected claim development beyond 60 months.

Calculate the following, using the Bornhuetter and Ferguson methodology outlined by Friedland:

a. (1 point) The expected claims to be reported for accident years 1993 to 1996 (including detail by AY) during calendar year 1997.

b. (1 point) An estimate of expected IBNR as of **12/31/97**.

Show all work.

2000 Exam Questions (modified):

54. (1 point) According to Friedland, what are two reasons for reviewing estimates of Unpaid Claims (reserves) between annual calculations?

2002 Exam Questions (modified): (Continued from Chapter 7 & 9)

22. You are given the following information:

Accident *Year*	Earned Premium ($000's)	Reported Claims at 12-31-01 ($000's)	Expected Claim Ratio
1998	200	100	80%
1999	1,000	1,000	80%
2000	1,500	900	80%
2001	1,500	600	80%

Selected Age-to-Age reported claim development factors:

12 - 24 months	1.250
24 - 36 months	1.100
36 - 48 months	1.050
48 - 60 months	1.080

No further development after 60 months

a,b,c. See Chapter 7 & 9

d. (1 point) Using the Bornhuetter-Ferguson method, calculate the amount of claim development to be expected during Calendar Year 2002, on Accident Years 1998 through 2001. Show all work.

2003 Exam Questions (modified):

2. You are given the following information:

Accident Year	Selected Ultimate Claims
2000	$310,000
2001	290,000
2002	300,000

Age in Months	Reported CDF to Ultimate
12	2.10
24	1.55
36	1.25
48	1.10
60	1.05

What is the total dollars of claims expected to be reported (emerge) during calendar year 2003, on accident years 2000 through 2002?

A. < $120,000
B. $\geq$ $120,000 but < $140,000
C. $\geq$ $140,000 but < $160,000
D. $\geq$ $160,000 but < $180,000
E. $\geq$ $180,000

2004 Exam Questions (modified):

2. You are given the following accident year Age-to-Age claim development factors:

ATA Factors by Months of Development

12 to 24	24 to 36	36 to 48	48. to 60	60 to Ultimate
1.60	1.30	1.10	1.05	1.00

What percentage of the IBNR at 12 months will be expected to emerge (be reported) during the following calendar year?

A. < 25% B. > 25% but < 35% C. > 35% but < 45%
D. > 45% but < 55% E. > 55%

2005 Exam Questions (modified):

10. You are given the following information:

Accident	Earned	Reported Claims (Age of Development in Months)			
Year	Premium	12	24	36	48
2001	$19,000	$4,850	$ 9,700	$14,100	$16,200
2002	20,000	5,150	10,300	14,900	
2003	21,000	5,400	10,800		
2004	22,000	7,200			

- Expected Claim Ratio = 0.90.
- Assume no development past 48 months.

a. & b. See chapters 7 & 9.

c. (1 point) Using the Bornhuetter-Ferguson method, calculate the expected IBNR for Accident Year 2004 expected to be reported (emerge) during calendar year 2005.

d. (0.5 point) State two possible causes for reported claims at 12 months for accident year 2004 being approximately 25% higher than would have been expected, based solely on premium growth.

e. (1 point) For each possible cause you identified in part d. above, how would you adjust your estimate of the expected IBNR emergence for accident year 2004 during calendar year 2005?

2008 Exam Questions (modified):

Question 2 (1.50 points).

Given the following for policy year 2006 for a line of business:

Premium	1,600,000
Expected loss emerged at 24 months	68%
Expected loss emerged at 36 months	82%
Reported loss as of December 31, 2007	800,000
Bornhuetter-Ferguson estimate of ultimate loss	1,133,000

a. (0.5 point)
See chapter 9.

b. (0.5 point)
See chapter 7.

c. (0.5 point)
Calculate the expected calendar year 2008 development for policy year 2006 based on the Bornhuetter-Ferguson Method.

Question 11 (1.50 points).

The loss ratio for a book of business is improving. There have been no changes in either claim emergence patterns or the company's claim reserving practices. IBNR has been estimated based on two different methods, and is summarized as follows:

Loss Development Method	24,000,000
Bornhuetter-Ferguson Method	31,000,000

a. (.75 points)
Discuss the issues surrounding the expected accuracy of each of the methods, given the situation.

b. (.75 point)
After the period of improvement, the loss ratio stabilizes. Briefly describe the adjustments, if any, that should be made to the methods used to estimate IBNR, to arrive at an accurate estimate.

2008 Exam Questions (modified):

Question 27 (2.0 points).

Given the following to be used in a Review of Unpaid Claim Estimates:

Accident Year	Reported Claims as of 12-31-06	Selected IBNR as of 12-31-06	Reported Claims as of 12-31-07
2004	4,500,000	1,100,000	4,750,000
2005	4,300,000	2,300,000	5,200,000
2006	3,700,000	4,800,000	5,000,000

Age (mo.)	Reported CDF to Ultimate
12	2.222
24	1.538
36	1.250
48	1.176

a. (1.5 points)

Calculate the expected claim emergence during calendar year 2007 for accident years 2004 - 2006, based on the selected IBNR at 12-31-06.

b. (.5 point)

Using numerical support, describe the conclusion that should be drawn regarding the accuracy of the IBNR reserving process used at 12-31-06, based on a comparison of actual versus expected claim emergence during calendar year 2007.

2009 Exam Questions

15. (3.25 points) Given the following information as of December 31, 2008:

Accident Year	Claims Reported ($000)	Claims Paid ($000)	Earned Premium ($000)	Estimated Ultimate Claim Counts	Open and IBNR Counts
2006	51,450	24,150	113,400	1,890	630
2007	33,600	12,600	65,100	1,680	840
2008	19,950	4,200	50,400	1,470	1,260

Ultimate claims estimates ($000) resulting from four different development methods:

Accident Year	Unadjusted Reported Development	Unadjusted Paid Development	Both Case and Payment-Rate Adjusted Reported Development	Payment-Rate Adjusted Paid Development
2006	55,100	72,000	55,650	54,600
2007	45,600	85,800	45,150	40,950
2008	51,700	82,500	45,580	46,200

The claims department implemented a new program in 2007, which resulted in the adjusters paying claims faster.

a. (0.5 point) Taking into account the new claims program, identify which one of the above development methods should be rejected and explain why.

b. (2.25 points) For each of the remaining three methods, calculate the ultimate claims ratio, ultimate severity and unpaid severity tests for accident year 2008.

c. (0.5 point) Describe a course of action that the reserving actuary might take in light of the results of the diagnostic tests in part b. above.

2009 Exam Questions (cont'd)

16. (2.5 points) Given the following information as of December 31, 2007:

Accident Year	Reported Claims ($000)	Selected Ultimate ($000)
2005	1,200	1,200
2006	1,113	1,325
2007	1,166	1,446

Selected cumulative development factors:		
12-Ultimate	24-Ultimate	36-Ultimate
1.212	1.154	1.010

Accident year 2007 reported claims ($000) as of December 31, 2008 total 1,250.

a. (1 point) Based on the data and selections as of December 31, 2007, calculate the difference between the actual reported claims versus the expected claims emergence in calendar year 2008 for accident year 2007.

b. (1 point) Using linear interpolation of the given development pattern, project the expected emerged claims for accident year 2007 from January 1, 2008 through May 31, 2008.

c. (0.5 point) Identify whether using linear interpolation in part b. above will overestimate or underestimate the projection and explain why.

2010 Exam Questions:

12. (2 points) Given the following information as of December 31, 2009:

Accident Year	On-Level Earned Premium	Reported Claims	Expected Percentage Unreported
2006	$100,000	$62,000	0%
2007	120,000	60,000	10%
2008	140,000	50,000	X%
2009	160,000	40,000	40%
Total	520,000	212,000	

- The expected claim ratio is 65%.
- The projected ultimate claims using the Bornhuetter-Ferguson technique is $279,600 for all years combined.

Calculate X, the expected percentage unreported for accident year 2008.

2011 Exam Questions

30. (2.5 points) Given the following data for a line of business as of December 31, 2010:

Accident	Average Case Reserves on Open Claims				
Year	12 Months 24	24 Months	36 Months	48 Months 48	60 Months
2006	$10,000	$12,000	$15,000	$22,000	$35,000
2007	$10,300	$12,360	$15,450	$28,600	
2008	$10,609	$12,731	$20,085		
2009	$10,927	$16,550			
2010	$14,205				

Accident	Average Cumulative Paid on Closed Claims				
Year	12 Months 24	24 Months	36 Months	48 Months 48	60 Months
2006	$5,000	$6,000	$7,500	$11,000	$16,000
2007	$5,150	$6,180	$7,725	$11,330	
2008	$5,305	$6,365	$7,957		
2009	$5,464	$6,556			
2010	$5,628				

a. (1 point) Fully discuss whether the reported claim development technique is appropriate to estimate unpaid claims for this line of business.

b. (1 point) Fully discuss whether the paid claim development technique is appropriate to estimate unpaid claims for this line of business.

c. (0.5 point) Discuss whether the expected claim technique is appropriate to estimate unpaid claims for this line of business.

37. (1.75 points) The following table summarizes the estimated IBNR from various estimation techniques for four different books of business.

Estimation Technique	Book A	Book B	Book C	Book D
Development – Reported	$610	$495	$450	$806
Development – Paid	$610	$250	$923	$645
Expected Claims	$14	$250	$450	$811
Bornhuetter-Ferguson – Reported	$445	$453	$450	$809
Bornhuetter-Ferguson – Paid	$161	$250	$781	$745

a. (0.5 point) The true IBNR for Book A is $610. Based on the estimated IBNR for each method shown, discuss a change in Book A that would explain the discrepancies between the estimates and the true IBNR.

b. (0.5 point) The true IBNR for Book B is $250. Based on the estimated IBNR for each method shown, discuss a change in Book B that would explain the discrepancies between the estimates and the true IBNR.

c. (0.5 point) The true IBNR for Book C is $450. Based on the estimated IBNR for each method shown, discuss a change in Book C that would explain the discrepancies between the estimates and the true IBNR.

d. (0.25 point) For Book D, briefly discuss a next step the actuary should take to understand the difference in results.

2012 Exam Questions

29. (1 point) Given the following accident year 2011 information as of December 31, 2011:

Initial Expected Losses	$50,000,000
Reported Losses	$10,000,000
Paid Losses	$2,000,000
Selected 12-Ult Reported Development Factor	10.000
Selected 12-Ult Paid Development Factor	22.500

Technique	Unpaid Claim Estimate
Development – Reported	$98,000,000
Development – Paid	$43,000,000
Expected Claims	$48,000,000
Bornheutter-Ferguson – Reported	$53,000,000
Bornheutter-Ferguson – Paid	$47,777,778

- According to the claims department, an extraordinarily large claim has been reported but not yet paid.

Determine and fully justify a reasonable unpaid claim estimate for accident year 2011 claims as of December 31, 2011.

30. (1.5 points) Given the following information as of December 31, 2010:

Cumulative Reported Claims ($000s)

Accident Year	12 Months	24 Months	36 Months	48 Months	60 Months
2006					$147,194
2007				$148,459	
2008			$135,337		
2009		$140,800			
2010	$115,050				

Reported Claim Development Factors

	12-Ult	24-Ult	36-Ult	48-Ult
Pattern I	1.502	1.155	1.050	1.000
Pattern II	1.452	1.134	1.060	1.000

The following claims are reported during calendar year 2011 ($000s):

Claims Reported in Calendar Year 2011 ($000s)

	Accident Year					
	CY 2011	2010	2009	2008	2007	Total
CY 2011	$114,800	$34,200	$10,100	$8,104	$1,000	$168,204

Determine which of the two reported claim development patterns shown above best reflect the actual emergence of claims. Justify your selection.

Solutions to Sample Questions:

1. Friedland's Chapter 15 expands on the last two steps in a four-phase approach to the process of estimating unpaid claims, as described by Wiser. The four steps, as in the Introduction to Part 2:

   - Exploring the data to identify its key characteristics and possible anomalies. Balancing data to other verified sources should be undertaken at this time.
   - Applying appropriate techniques for estimating unpaid claims.
   - Evaluating the conflicting results of the various methods used, with an attempt to reconcile or explain the different outcomes. At this point, the projected ultimate amounts are evaluated in contexts outside their original frame of analysis.
   - Monitoring projections of claim development over subsequent calendar periods. Deviations of actual development from projected development of counts or amounts are one of the most useful diagnostic tools in evaluating the accuracy of unpaid claim estimates.

2. Define the term emergence:

   Emergence refers to the reporting or development of claims and/or claim counts over time.

   Note: In Friedland's Monitoring Tests, she compares Actual Claims Reported (Emergence) against Expected Claims Reported (Emergence) based on the selected ultimate claim estimates.

3. Calculate the expected reported claims (emergence) for AY 2007 during Calendar Year 2008.

Step 1: Calculate the expected percent to be reported in the interim period:
*Since the Percent (of total Ultimate Claims) Reported = Inverse of Ultimate CDF ***
The expected Percent Reported at 12 months = 1/1.136= 0.8803
& expected Percent Reported at 24 months = 1/1.001= 0.9990
Then the expected percent reported between ages 12 and 24 months = 11.87%

*** Don't forget to work with inverses (%), instead of the CDFs directly*

Proceeding the safe way:
We need a factor for the Unreported part of Ultimate Claims, not total Ultimate Claims.
That is, we must make this % conditional upon the development remaining, so we divide by (1 - Percent Reported at beginning of Interval) = (1 - .8803) = 0.1197.
Thus, the factor we apply to IBNR (broadly defined) = .1187/.1197 = 99.2%
to give the percent of IBNR expected to emerge in period between 12 and 24 months.

Step 2: Apply the appropriate percent to the estimated IBNR

IBNR (broadly defined) = Estimated Ultimate Claims - Reported Claims =	
Estimated IBNR = 2,798 - 2,463 =	335
x Expected emergence of IBNR	x 99.2%
	332

Note: Friedland shows this calculation, using notation:

AY_{07} *Expected Claims* $_{CY08}$ = *{ [($2,798 - $2,463) / (1 - .880)] * (.999 - .880) } = $332*

Continues below:

Solution to sample question 3 (continued):

OR, proceeding for SPECIAL CASES only:
When the CDFs are established AND applied such that the Estimated Ultimate Claims exactly mimic the actual Reported Claims, we can use a shortcut:
Step 2: Apply the (unconditional) percent to the estimated Ultimate Claims

Estimated Ultimate Claims =	2,798
x Expected emergence of Ultimate	x 11.87%
	332

Another special case is the B-F method, but we need to replace "Estimated Ultimate Claims" with the "A-Priori Expected Claims" since under the B-F method, IBNR exactly follows this a-priori expected amount. And then apply the unconditional percent.

Solutions to 1994 Exam Questions (modified):

53. Calculate the following amounts for accident year 1994:

a. (.5 point) The estimate of IBNR as of 12/31/94
$1,000,000 * .65 * (1-1/4.00) = $487,500

b. (1 point) The amount of IBNR expected to emerge in 1995
$1,000,000 * .65 * [(1-1/4.00) - (1-1/2.00] = $162,500

Extra detail shown below, for illustrative purposes:

a) Recall, for the B-F method:
*IBNR = (A-priori Expected Claims) * (Percent Unreported)*

Accident Year	*Age of Data at 12/31/94*	*Reported CDF to Ultimate*	*Percent Reported 12/31/94*	*Percent Unreport 12/31/94*
	(1)	*(2) given*	*(3)=1.0/(2)*	*(4)=1.-(3)*
1994	*12 months*	*4.00*	*25.0%*	*75.0%*
Total				

Note: The Percent Unreported = 1 minus inverse of Ult. CDF

Accident Year	*Earned Premium*	*A priori Expected Claim Ratio*	*A priori Expected Claims*	*"IBNR" Expected Unreport*	***Or** Shortcut using Expected Claims * Percent Unreported*	***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*		*(8)=(1M)*(65%)*[1.0-1.0/4.00]*
1994	*1,000,000*	*65.0%*	*650,000*	*487,500*		*487,500*

Continues below:

Solutions to 1994 Exam Question #53 (continued):

b)

Step 1: Calculate the expected percent to be reported in the interim period:

*Since the Percent (<u>of total Ultimate Claims</u>) Reported = Inverse of Ultimate CDF ***

The expected Percent Reported at 12 months = 1 / 4.00 = *0.2500*

& expected Percent Reported at 24 months = 1 / 2.00 = *0.5000*

Then the expected percent reported between ages 12 and 24 months = *25.00%*

*** Don't forget to work with inverses (%), instead of the CDFs directly*

Proceeding the safe way:

We need a factor for the <u>Unreported</u> part of Ultimate Claims, not total Ultimate Claims.
That is, we must make this % <u>conditional</u> upon the development remaining, so we
divide by (1 - Percent Reported at beginning of Interval) = (1 - .25) = *0.7500.*
Thus, the factor we apply to IBNR (broadly defined) = .25 / .75 = 33.3%
to give the percent of IBNR expected to emerge in period between 12 and 24 months.

Step 2: Apply the appropriate percent to the estimated IBNR

IBNR (broadly defined) = Estimated Ultimate Claims - Reported Claims =

Estimated IBNR from a =	487,500
x Expected emergence of IBNR	x 33.3%
	162,500

OR, proceeding for SPECIAL CASES only, a shortcut:

A special case is the B-F method, where we use "A-Priori Expected Claims" since
under the B-F method, IBNR exactly follows this a-priori expected amount.
And then apply the unconditional percent:

Step 2: Apply the (unconditional) percent to the estimated Ultimate Claims

A-priori Expected Claims =	650,000
x Expected emergence of Ultimate	x 25.00%
	162,500

Solutions to 1995 Exam Questions (modified):

44. Continued (from chapter 9)

c. Using Estimated IBNR developed using the B-F method at 12/31/94, determine the expected IBNR balance as of **6/30/95** for accident years 1994 and prior. Show all work.

Initial Comments:

Part c is asking us to take 6 months of expected emergence out of the IBNR estimates we found in part a. Those IBNR estimates were calculated in Chapter 9, but are repeated below for convenience.

Step 1: Start by finding the percent of emergence expected for an annual period, as in the questions above.
Step 2: Multiply by the IBNR estimates for each year.
Step 3: Pro-rate those amounts to 6 mo., using the development patterns we are given for within each year.
Step 4: For the balance, we subtract the 6 mo. emerged IBNR estimates from the 12/31/94 IBNR amounts.

Solution to 1995 Exam Question # 44 (continued):

Preliminary Info for 1995 # 44 Recall B-F IBNR estimates from part a (see chapter 9):

Accident Year	Age of Data at 12/31/94	Reported CDF to Ultimate	Percent Reported 12/31/94	Percent Unreport 12/31/94	Note: The Percent Unreported = 1 minus inverse of Ult. CDF
	(1)	(2) above	(3)=1.0/(2)	(4)=1.-(3)	
1990	60 months	1.0000	100.0000%	0.0000%	
1991	48 months	1.0000	100.0000%	0.0000%	
1992	36 months	1.0905	91.7011%	8.2989%	
1993	24 months	1.2650	79.0514%	20.9486%	
1994	12 months	1.6224	61.6371%	38.3629%	

Accident Year	Earned Premium	A priori Expected Claim Ratio	A priori Expected Claims	"IBNR" Expected Unreport	Or shortcut using Est. Expected Claims x Percent Unreported	IBNR (broadly defined)
	(5) given	(6) given	(7)=(5)*(6)	(8)=(7)*(4)		(8)=(7)*[1.0-1.0/CDF]
1990	4,500	75.0%	3,375	0.0000		0.0000
1991	5,000	75.0%	3,750	0.0000		0.0000
1992	5,200	75.0%	3,900	323.6571		323.6571
1993	5,300	75.0%	3,975	832.7069		832.7069
1994	5,700	75.0%	4,275	1,640.0140		1,640.0140
Total				**2,796.3780**		**2,796.3780**

Steps 1 and 2 produce the expected emergence in the next **annual** period, as in the questions above.

	Step 1						Step 2
Acc Year	**Estimated IBNR at 12/31/94**	**Ages in NEXT yr (CY 1995)**	**Percent Reported at 1/1/95**	**Percent Reported at 12/31/95**	**Percent Unreported at 1/1/95**	**Percent of current IBNR expected to emerge between 1/1 - 12/31/95**	**Est. IBNR to emerge during '95**
	(8) above	(9) FYI	(10) See (3)	(11) see(3)	(12)= 1-(10)	(13) = [(11)-(10)] / (12)	(14)=(8)*(13)
1992	323.6571	36 to 48	91.7011%	100.0000%	8.2989%	100.0000%	323.6571
1993	832.7069	24 to 36	79.0514%	91.7011%	20.9486%	60.3845%	502.8259
1994	1,640.0140	12 to 24	61.6371%	79.0514%	38.3629%	45.3936%	744.4614
Total	2,796.3780						**1,570.9444**

* Here the period we evaluate for emerged losses is the **year** immediately following our original estimate

Note, as an ALTERNATIVE, we could use short-cut using a prior Expected Claims since we're using B-F

Acc Year	A-Priori Expected Claims		Percent Reported at 1/1/95	Percent Reported at 12/31/95	Percent of Ultimate expected to emerge between 1/1 - 12/31/95	Est. IBNR to emerge during '95
	(7) above		(10) See (3)	(11) see(3)	(13') = [(11)-(10)]	(14)=(7)*(13')
1992	3,900		91.7011%	100.0000%	8.2989%	323.6571
1993	3,975		79.0514%	91.7011%	12.6497%	502.8256
1994	4,275		61.6371%	79.0514%	17.4143%	744.4613
Total	12,150					**1,570.9440**

Continues on next page.

Solution to 1995 Exam Question # 44 (continued):

Step 1: Start by finding the percent of emergence expected for an annual period, as in the questions above.
Step 2: Multiply by the IBNR estimates for each year.
Step 3: Pro-rate those amounts to 6 mo., using the development patterns we are given for within each year.
Step 4: For the balance, we subtract the 6 mo. emerged IBNR estimates from the 12/31/94 IBNR amounts.

Step 3				Step 4	
Relevant Accident Years	*Amount of IBNR expected to emerge between 1/1 - 12/31/95 (14)*	*Pro-ration for 6 mo. within yr. (15)*	*Amount of IBNR expected to emerge between 1/1 - 6/30/95 (16) = (14) * (15)*	*Estimated IBNR at 12/31/94 (17) above*	*Estimated IBNR at 6/30/95 (18)=(17)-(16)*
1992	*323.6571*	*60%*	*194.1943*	*323.6571*	*129.4628*
1993	*502.8256*	*60%*	*301.6954*	*832.7069*	*531.0115*
1994	*744.4613*	***65%***	*483.8998*	*1,640.0140*	*1,156.1142*
Total	*1,570.9440*		*979.7895*	*2,796.3780*	***1,816.5885***

Note: these types of questions intentionally exclude new loss occurrences.
So, claims occurring in the first half accident year 1995 are excluded, to compare "apples-to-apples."

Solutions to 1996 Exam Questions (modified):

48. (1 point) What are the two important considerations discussed by Friedland with respect to the review of IBNR estimates at the close of interim accounting periods?

CAS answer (pre-Friedland)

1. The need to compare actual with expected claim emergence. If there are material differences, adjustments to the Unpaid Claims Estimates (reserve) may have to be made.
2. The need to consider material changes in exposures or premium rate adequacy.

Related Friedland quotes:

"In addition to measuring changes in claims for historical periods, the actuary must incorporate the effect of changes in the exposure for the current period …"

"Monitoring unpaid claims can be important for insurers from a financial reporting perspective, for budgeting and planning purposes, for pricing and other strategic decision-making, and for planning for the next complete analysis of unpaid claims."

Solutions to 1997 Exam Questions (modified):

52 Calculate the following, using the Bornhuetter and Ferguson methodology outlined by Friedland:

a. (1 point) The expected claims to be reported for accident years 1993 to 1996 (including detail by AY) during calendar year 1997.

b. (1 point) An estimate of expected IBNR as of **12/31/97**.

a.

Preliminary Comments:

To find the Expected Claims Ratio to use in our A-Priori B-F values, we use 1 - (Expenses & Profit Load)

A-priori Expected Claims Ratio = 100% - 5% - 10% - 3% - 0% = 82% to apply to Earned Premium (EP)

	Step 1 (using shortcut described above for B-F special case)					Step 2
Accident Year	***A-Priori Expected Claims***	***Ages in NEXT yr (CY 1997)***	***Percent Reported at 1/1/97***	***Percent Reported at 12/31/97***	***Percent of Ultimate expected to emerge in the '97 Calendar Year***	***Est. IBNR to emerge during '97***
	*(1)=.82*EP*	*(2) FYI*	*(3)=1/CDF*	*(4)*	*(5) = [(4) - (3)]*	*(6)=(1)*(5)*
1993	*7,380,000.0*	*48 to 60*	*95.2381%*	*100.0000%*	*4.7619%*	*351,428.2200*
1994	*7,749,000.0*	*36 to 48*	*86.9565%*	*95.2381%*	*8.2816%*	*641,741.1840*
1995	*8,136,450.0*	*24 to 36*	*76.9231%*	*86.9565%*	*10.0334%*	*816,362.5743*
1996	*8,543,272.5*	*12 to 24*	*57.1429%*	*76.9231%*	*19.7802%*	*1,689,876.3870*
Total						***3,499,408.3653***
						answer a.

Note: these types of questions intentionally exclude new loss occurrences.

So, claims occurring in accident year 1997 are excluded in part a., to compare "apples-to-apples."

However, part b. of this question asks us to look at AY 1997 claims as well . . .

b.

	Start with activity for AY's '96 and prior		*+ New for AY 1997*	*= Combined for All AY's*
AY	*Estimated IBNR at end of THIS period (that is, at 12/31/96) (7) = (1) * [1.0 - (3)]*	*IBNR from 12/31/96 expected to emerge in '97 (so, for AY's '96 and prior) (8) from (6) above*	*Estimated IBNR at end of NEXT period (97)* ***for AY '97 claims only*** *(9) See calculation below*	*Estimated IBNR at 12/31/97 (10) = (7) minus (8) + (9)*
1993	*351,428.2200*	*351,428.2200*	*n/a*	*0.0000*
1994	*1,010,740.8150*	*641,741.1840*	*n/a*	*368,999.6310*
1995	*1,877,640.4301*	*816,362.5743*	*n/a*	*1,061,277.8558*
1996	*3,661,398.8386*	*1,689,876.3870*	*n/a*	*1,971,522.4516*
1997	***not applicable***	*8,543,272.5 * [1-57.1429%] * 1.05 growth =*	*3,844,468.7805*	*3,844,468.7805*
Total			***answer to b.***	***7,246,268.7189***

Solutions to 2000 Exam Questions (modified):

54. (1 point) According to Friedland, what are two reasons for reviewing estimates for Unpaid Claims (reserves) between annual calculations?

CAS answer (pre-Friedland)

1. To see if claims are emerging as had been expected.
2. To see if a change in Estimated Unpaid Claims is necessitated by a change in exposures.

See also Friedland comments included above with 1996 # 48.

Solutions to 2002 Exam Questions (modified):

#22. Given the following information:

Accident Year	Earned Premium	Reported Claims at 12-31-01	Expected Claim Ratio
1998	200	100	80%
1999	1,000	1,000	80%
2000	1,500	900	80%
2001	1,500	600	80%

Selected Age-to-Age reported claim development factors:

12 - 24 months	1.250
24 - 36 months	1.100
36 - 48 months	1.050
48 - 60 months	1.080

d. Using the Bornhuetter-Ferguson method, calculate the amount of claim development to be expected during calendar year 2002 on accident years 1998 through 2001. Show all work.

Note: See Chapter 9 for part b calculations. Results shown in column (1) below.

$000's	*Step 1 (proceeding the safe way, using our answer to part b in Ch 9)*						*Step 2*
Acc Year	***Estimated IBNR at 12/31/01***	***Ages in NEXT yr (CY 2002)***	***Percent Reported at 1/1/02***	***Percent Reported at 12/31/02***	***Percent Unreported at 1/1/02***	***Percent of current IBNR expected to emerge between 1/1 - 12/31/02***	***Est. IBNR to emerge during '02***
	(1) from b	*(2) FYI*	*(3)=1/CDF*	*(4)=1/CDF*	*(5)=1.0-(3)*	*(6) = [(4)-(3)] / (5)*	*(7)=(1)*(6)*
1998	*11.8518*	*48 to 60*	*92.5926%*	*100.0000%*	*7.4074%*	*100.0000%*	*11.8518*
1999	*94.5328*	*36 to 48*	*88.1834%*	*92.5926%*	*11.8166%*	*37.3136%*	*35.2736*
2000	*237.9996*	*24 to 36*	*80.1667%*	*88.1834%*	*19.8333%*	*40.4204%*	*96.2004*
2001	*430.4244*	*12 to 24*	*64.1313%*	*80.1667%*	*35.8687%*	*44.7058%*	*192.4247*
Total	*774.8086*						*335.7505*
Note: these types of questions intentionally exclude new loss occurrences.							x 1000 =
So, claims occurring in accident year 2002 are excluded, to compare "apples-to-apples."							***335,750.5***

OR, an alternative solution:

$000's	*Step 1 (using shortcut described above for B-F special case)*				*Step 2*
Accident Year	***A-Priori Expected Claims***	***Percent Reported at 1/1/02***	***Percent Reported at 12/31/02***	***Percent of Ultimate expected to emerge in the '02 Calendar Year***	***Est. IBNR to emerge during '02***
	*(1)=.80*EP*	*(3)=1/CDF*	*(4)=1/CDF*	*(5') = [(4) - (3)]*	*(6)=(1)*(5')*
1998	*160*	*92.5926%*	*100.0000%*	*7.4074%*	*11.8518*
1999	*800*	*88.1834%*	*92.5926%*	*4.4092%*	*35.2736*
2000	*1,200*	*80.1667%*	*88.1834%*	*8.0167%*	*96.2004*
2001	*1,200*	*64.1313%*	*80.1667%*	*16.0354%*	*192.4248*
Total					***335.7506***
					x 1000 =
					335,750.6

Solutions to 2003 Exam Questions (modified):

2. You are given the following information:

Accident Year	Selected Ultimate Claims
2000	$310,000
2001	290,000
2002	300,000

Age in Months	Reported CDF to Ultimate
12	2.10
24	1.55
36	1.25
48	1.10
60	1.05

What is the total amount of incurred claims that is expected to emerge during calendar year 2003 on accident years 2000 through 2002?

A. < $120,000 B. ≥ $120,000 but < $140,000 C . ≥ $140,000 but < $160,000
D. ≥ $160,000, but < $180,000 E. ≥ $180,000

Preliminary Comments:

2003 # 2 does not specify the methodology used to select ultimate claim estimates, nor does it specify the reported claims as of 12/31/02. The expected emergence depends on the methodology used. For example, if the B-F technique were used, the percents below would be applied to the A-Prior Expected Claims, which are not equal to the Selected Ultimate Claims (generally). However, the most reasonable answer using the data given is below:

$000's	*Step 1 (using method applied to selected Ultimate Loss estimates)*					*Step 2*
Accident Year	*Selected Ultimate Claims*	*Ages in NEXT period ('03)*	*Percent Reported at 1/1/03*	*Percent Reported at 12/31/03*	*Percent of Ultimate expected to emerge in the '03 Calendar Year*	*Estimated Emergence during '03*
	(1) given	*(2) FYI*	*(3)=1/CDF*	*(4)=1/CDF*	*(5) = [(4) - (3)]*	*(6)=(1)*(5)*
2000	*310,000*	*36 to 48*	*80.0000%*	*90.91% ***	*10.9091%*	*33,818.21*
2001	*290,000*	*24 to 36*	*64.5161%*	*80.0000%*	*15.4839%*	*44,903.31*
2002	*300,000*	*12 to 24*	*47.6190%*	*64.5161%*	*16.8971%*	*50,691.30*
Total						***129,412.82***

*** Example: 2000 AY will be 48 months old at 12/31/03. 48-to-ult CDF = 1.1 and 1/1.1 = 90.91%*

Answer B.

Solutions to 2004 Exam Questions (modified):

2. You are given the following accident year age-to-age claim development factors:

Months of Development				
12 to 24	24 to 36	36 to 48	48. to 60	60 to Ultimate
1.60	1.30	1.10	1.05	1.00

What percentage of the IBNR estimate at 12 months will be expected to emerge during the following calendar year? C. > 35% but < 45% **Answer: C**

	Months of Development				
	12 to 24	24 to 36	36 to 48	48. to 60	60 to Ultimate
ATA	1.6	1.3	1.1	1.05	1
	12	**24**	36	48	60
CDF to Ult	**2.4024**	**1.5015**	1.155	1.05	1

Calculate the expected percent to be reported in the interim period:

*Since the Percent (of total Ultimate Claims) Reported = Inverse of Ultimate CDF ***

The expected Percent Reported at 12 months = 1 / 2.4024 = *0.4163*

& expected Percent Reported at 24 months = 1 / 1.5015 = *0.6660*

Then the expected percent reported between ages 12 and 24 months = *24.97%*

And normalize, since the question asks for an IBNR factor:

We need a factor for the Unreported part of Ultimate Claims, not total Ultimate Claims.
That is, we must make this % conditional upon the development remaining, so we
divide by (1 - Percent Reported at beginning of Interval) = (1 - .4163) = *0.5837.*
Thus, the factor we apply to IBNR (broadly defined) = .2497/.5837= ***42.78%***
to give the percent of IBNR expected to emerge in period between 12 and 24 months.

*** Don't forget to work with inverses (%), instead of the CDFs directly*

Solutions to 2005 Exam Questions (modified):

2005 #10 continued from Chapters 7 and 9, where we are given the following data:

Accident Year	Selected Ultimate Claims
2000	$310,000
2001	290,000
2002	300,000

Age in Months	Reported CDF to Ultimate
12	2.10
24	1.55
36	1.25
48	1.10
60	1.05

Solution to 2005 Exam Question #10 (continued):

c. (1 point) Using the Bornhuetter-Ferguson method, calculate the expected IBNR emergence for accident year 2004 case incurred claims during calendar year 2005. **… continued below**

Preliminary Info for 2005 # 10 Recall B-F IBNR estimates from part b (see chapter 9):						
	Selected ATA factors (1)		*Reported Ultimate CDF (2) = product of (1)*		*Exp. % Unreported (3) = 1.0 - 1.0 / (2)*	*Accident Year*
Tail at 48 months	*1.0000*	*at 48 mo.*		*1.0000*	*0.0000%*	*2001*
36 - 48 months	*1.1489*	*at 36 mo.*		*1.1489*	*12.9602%*	*2002*
24 - 36 months	*1.4501*	*at 24 mo.*		*1.6660*	*39.9760%*	*2003*
12 - 24 months	*2.0000*	*at 12 mo.*		*3.3320*	*69.9880%*	*2004*
(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF						

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(4) given	*(5) given*	*(6)=(4)*(5)*	*(7)=(6)*(3)*		*(7)=(3)*(4)*[1.0-1.0/CDF]*
2001	*19,000*	*90.0000%*	*17,100*	*0.0000*		*0.0000*
2002	*20,000*	*90.0000%*	*18,000*	*2,332.8360*		*2,332.8360*
2003	*21,000*	*90.0000%*	*18,900*	*7,555.4640*		*7,555.4640*
2004	*22,000*	*90.0000%*	*19,800*	*13,857.6240*		*13,857.6240*
Total				*23,745.9240*		*23,745.9240*
					Note: Only the calculations for Accident Year 2004 are required:	
					*22,000 * 90% * (1 - 1/3.33) = 19,800 * 70% =*	***13,857.6240***

c) Details shown for completeness

Acc Year	***Estimated IBNR***	***Ages in NEXT yr (CY 2005)***	***Percent Reported at 1/1/05***	***Percent Reported at 12/31/05***	***Percent Unreported at 1/1/05***	***Percent of current IBNR expected to emerge between 1/1 - 12/31/05***	***Est. IBNR to emerge during '05***
	(7)	*(8) FYI*	*(9) See (3)*	*(10) see(3)*	*(11)= 1-(9)*	*(12) = [(10)-(9)] / (11)*	*(13)=(7)*(12)*
2001	*0.0000*	*48 to 60*	*100.0000%*	*100.0000%*	*0.0000%*	*n/a*	*0.0000*
2002	*2,332.8360*	*36 to 48*	*87.0398%*	*100.0000%*	*12.9602%*	*100.0000%*	*2,332.8360*
2003	*7,555.4640*	*24 to 36*	*60.0240%*	*87.0398%*	*39.9760%*	*67.5800%*	*5,105.9862*
2004	*13,857.6240*	*12 to 24*	*30.0120%*	*60.0240%*	*69.9880%*	*42.8816%*	***5,942.3760***
Total							*13,381.1982*

** Here the period we evaluate for emerged losses is the year immediately following our original estimate*

But, for exam purposes:	***Only the calculations for Accident Year 2004 are required:***	
Solution to c:	*13,858 * (60.02% - 30.01%) / (1 - 30.01%) =*	***5,942.3760***
	OR since B-F, can also use shortcut with A-prior Expected Claims for AY 2004:	
	*19,800 * (60.02% - 30.01%) =*	**5,942.3760**

Solution to 2005 Exam Question #10 (continued):

2005 #10 d. (0.5 point) State two possible causes for case incurred claims at 12 months for accident year 2004 being approximately 25% higher than would have been expected based solely on premium growth.

Question 10 – Based on Model Solution 1:

1. An increase in the rate of claim reporting
2. An unexpected large claim being reported

Question 10 – Based on Model Solution 2:

1. Reserve (Allowance for Unpaid Claims) Strengthening
2. Deterioration of Expected Claim Ratio

2005 #10 e. (1 point) For each possible cause you identified in part d. above, how would you adjust your estimate of the expected IBNR emergence for accident year 2004 during calendar year 2005?

Question 10 – Based on Model Solution 1:

1. Reduce IBNR since there is an expectation of fewer claims to occur in the future.
2. No change needs to be made to IBNR since there is no expectation of large claims occurring again in the future.

Question 10 – Based on Model Solution 2:

1. If reserves have been strengthened, lower than expected IBNR emergence would be anticipated.
2. If the Expected Claims Ratio has deteriorated, greater than expected IBNR emergence would be anticipated.

Solution to 2008 Exam Question

Question 2, Solution

a) See chapter 9.
b) See chapter 7.
c) Finding Expected emergence in CY 2008, for policy year 2006 only, using B-F method:

Using "the safe way" … FOR POLICY YEAR 2006 ONLY: Step 1					Step 2
Estimated IBNR at 12/31/07	*Percent Reported* at 1/1/08	*Percent Reported* at 12/31/08	*Percent Unreported* at 1/1/08	*Percent of current IBNR expected to emerge between 1/1 - 12/31/08*	*Est. IBNR to emerge during '08*
(1) note	*(2) given*	*(3) given*	*(4)= 1-(2)*	*(5) = [(3)-(2)] / (4)*	*(6)=(1)*(5)*
332,800	*68.00%*	*82.00%*	*32.00%*	0.4375	*145,600*

Note: B-F expected IBNR = (1,600,000)(65%)*[1.0-.68] = 332,800*

OR, we could use short-cut using a prior Expected Claims since we're using the B-F method

FOR POLICY YEAR 2006 ONLY: Step 1					Step 2
A-Priori Expected Claims	*Percent Reported* at 1/1/08	*Percent Reported* at 12/31/08		*Percent of Ultimate expected to emerge between 1/1 - 12/31/08*	*Est. IBNR to emerge during '08*
(1') note	*(2) given*	*(3) given*		*(5') = [(3)-(2)]*	*(6)=(1')*(5')*
1,040,000	*68.00%*	*82.00%*		0.14	*145,600*

*Note: B-F a-priori Expected Claims = Premium * ECR = (1,600,000)*(65%) = 1,040,000*

Solution to 2008 Exam Question

Question 11, Solution

a. Given an improving Loss Ratio with no change in reporting/settlement/payment patterns

(i) Loss Development Method

OK, since the development patterns will accurately reflect the emerging experience

(ii) Bornhuetter-Ferguson Method

Would overstate IBNR if B-F method is applied without adjustment

(since emerging experience would be better than reflected in B-F a priori claim ratio)

b. After the experience stabilizes at the new (lower loss ratio) levels:

(i) Loss Development Method

OK, since the development patterns have accurately reflected the emerging experience

(ii) Bornhuetter-Ferguson Method

The a-priori expected claim ratio would need to be selected to reflect the new outlook

(that is, lower than the original ratio selected based on older years with worse experience)

Solution to 2008 Exam Question

Question 27, Solution

Part a) Projecting Expected Emergence during CY 2007, as if it's 12-31-06 **(in $000s)**

Step 1: Find the one-year claim emergence EXPECTED based on IBNR estimates at 12/31/06						
Accident Year	Estimated IBNR at 12/31/06	Percent Reported at 1/1/07 (inverse of CDFs given)	Percent Reported at 12/31/07 (inverse of CDFs given)	Percent Unreported at 1/1/07	Expected % of IBNR expected to emerge in CY 2007	$ of EXPECTED IBNR to emerge in CY 2007
	(1) given	(2) by age	(3) by age+1	(4)= 1-(2)	(5) = [(3)-(2)] / (4)	(6)=(1)*(5)
2004	1,100	80.0000%	85.0340%	20.0000%	25.1700%	276.8700
2005	2,300	65.0195%	80.0000%	34.9805%	42.8253%	984.9819
2006	4,800	45.0045%	65.0195%	54.9955%	36.3939%	1,746.9072
			Answer to (a)		Sum of EXPECTED	3,008.7591

Part b) A retrospective look at CY 2007, given it's 12-31-07 **(in $000s)**

Step 2: Calculate IBNR that was ACTUALLY reported in CY 2007				Step 3: Compare
Accident Year	Amounts Reported at 12/31/06	Amounts Reported at 12/31/07	ACTUAL IBNR that emerged in CY 2007	ACTUAL development minus EXPECTED development
	(7) given	(8) given	(9)= (8)-(7)	(10) = (9)-(6)
2004	4,500	4,750	250	-26.8700
2005	4,300	5,200	900	-84.9819
2006	3,700	5,000	1,300	-446.9072
Sum of ACTUAL			2,450	Difference = -558.7591

When the "actual" emergence is significantly less than the "expected" emergence,
the methodology used to estimate Ultimate Claims may be overstating the IBNR (esp AY '06).
The actuary may conclude that other methods should be considered and tested.

Solutions to 2009 Exam Questions

Question 15 - Model Solution 1

a. Unadjusted paid development because the old LDFs assume more is paid later so older LDFs will be too since the new is in place, overestimating ultimate losses.

b. Ultimate claim ratio (relative to EP), Ultimate severity (relative to ultimate claim counts), Unpaid severity (relative to open and IBNR counts)

1. Unadjusted reported development:
   - i. Ultimate claim ratio = 51,700 / 50,400 = 102.58%
   - ii. Ultimate severity = 51,700,000 / 1,470 = 35,170
   - iii. Unpaid severity = (51,700 – 4,200) × 1,000 / 1,260 = 37,698

2. Case & payment rate adjusted reported development
   - i. Ultimate claim ratio = 45,580 / 50,400 = 90.44%
   - ii. Ultimate severity = 45,580,000 / 1,470 = 31,007
   - iii. Unpaid severity = (45,580 – 4,200) × 1,000 / 1,260 = 32,841

3. Payment rate adjusted paid development
   - i. Ultimate claim ratio = 46,200 / 50,400 = 91.67%
   - ii. Ultimate severity = 46,200,000 / 1,470 = 31,429
   - iii. Unpaid severity = (46,200 – 4,200) × 1,000 / 1,260 = 33,333

c. Since unadjusted reported development estimates are high compared to the other methods, might talk to claims department about if there were any changes in case outstanding adequacy as well.

Question 15 - Model Solution 2

a. The unadjusted paid development since the claims settlement practices of the company have changed from 2007 and the historical settlement patterns will no longer be able to project future claims activity accurately.

b.

1. Ultimate claims ratio for AY 2008
   - i. unadjusted reported development: 51,700 / 50,400 = 102.58%
   - ii. both case and payment rate adjusted reported development: 45,580 / 50,400 = 90.4%
   - iii. payment rate adjusted paid development: 46,200 / 50,400 = 91.67%
2. Ultimate severity = [ultimate loss for each method] / [ultimate claim count]
   - i. 51,700 ×1,000 /1,470 = 35,170
   - ii. 45,580 ×1,000 /1,470 = 31,007
   - iii. 46,200 ×1,000 /1,470 = 31,429
3. Unpaid severity = [unpaid under each method] / [open claim count]
   - i. [ultimate loss estimate – paid loss] / [open claims] = (51,700 – 4,200) / 1,260 × 1,000 = 37,698
   - ii. (45,580– 4,200) /1,260 ×1,000 = 32,841
   - iii. (46,250– 4,200) /1,260 ×1,000 = 33,333

c. The unadjusted reported development appears to be overstated given the limited information.

Actuary may prefer to use average of the case and payment rate adjusted reported and payment rate adjusted paid estimates.

Solutions to 2009 Exam Questions

Question 16 - Model Solution 1

a. AY 2007 in CY 2008:

Actual = AY 2007 reported claims ($000) as of 12/31/2008 – AY 2007 reported claims ($000) as of 12/31/2007
= 1,250 - 1,166 = 84

Expected = (Ult – Reptd) / % Unreptd × (% Reptd at 2008 - % Reptd at 2007)
= (1,446-1,166) × (1/1.154 - 1/1.212)/(1.0 - 1/1.212) = 66.38

Actual – Expected = 84 – 66.38 = $\boxed{17.62}$

b. 17-Ult = 1.212 - [(17-12)/12 × (1.212 – 1.154)] =1.188 (linear interpolation on the given 12-ult and 24-ult LDFs)

Expected Reported Losses = (1,446-1,166) × (1/1.188 - 1/1.212)/(1 - 1/1.212)= $\boxed{26.68}$

c. Likely to underestimate.

Because the "to-ult" factor calculated based on lin. interp is likely overstated because development tends to slow down overtime, more losses should be reported during first half of year, which means a smaller dev-to-ult factor than linear interp suggests.

Question 16 - Model Solution 2

a. Expected emergence = (Ult–Rptd)/% Unrptd*(% Rptd at '08 - % Rptd at '07) = 280/.1749 ×.041 = 66.39

actual 1,250 – 1,166 = 84

Diff = 84 - 66.39 = $\boxed{17.61}$

b. Expect 66.39 over the year. (66.39) × (5/12) = $\boxed{27.66}$

c. Linear interpolation assumes that the claims will emerge evenly throughout the year.

However, claims are usually reported earlier. Since there will be less dev in the future, we could expect more emergence earlier in the year. Use of linear interpolation would underestimate the projection.

Solutions to 2010 Exam Questions

12. The projected ultimate claims using the Bornhuetter-Ferguson technique is $279,600 for all years combined. Calculate X, the expected percentage unreported for accident year 2008.

Question 12 – Solution 1

	(1)	(2)	(3)	(4)	(5)
				65% × (1)	(2) + (3) × (4)
AY	On-Level EP ($000)	Rpt Claims ($000)	Exp % Unrprted	Expected Claims	Projected Ult. Claims
2006	100	62	0%	65	62
2007	120	60	10%	78	62.8
2008	140	50	X%	91	50 + 91X%
2009	160	40	40%	104	81.6
Total	520	212		338	261.4 + 91X%

261,400 + 91,000X% = 279,600

X% = 20%

Solutions to 2011 Exam Questions

30a. (1 point) Fully discuss whether the reported claim development technique is appropriate to estimate unpaid claims for this line of business.

30b. (1 point) Fully discuss whether the paid claim development technique is appropriate to estimate unpaid claims for this line of business.

30c. (0.5 point) Discuss whether the expected claim technique is appropriate to estimate unpaid claims for this line of business.

Question 30 – Model Solution 1

Avg Case Trend	Avg paid/closed	AtA for Pd	AtA for Pd
12 mon	12mon	12-24	24-26
06: 3%	3%	1.2	1.25
07: 3%	3%	1.2	1.25
08: 3%	3%	1.2	1.25
09: 14,205/10,927 = 1.3 $\boxed{30\%}$	3%	1.2	
10			

a. Reported claims are not appropriate without a case reserve adjustment. Avg cases reserves trending higher as they did from 09 to 10 is a clue that case reserves have been strengthened. If not accounted for, this would overstate losses.

b. Paid claim development is appropriate. The reserve changes will not show up in the paid estimates. Also, the development factors are very stable.

c. Since there appears to be a good volume of paid data and the development factors are consistent, I would not use the expected claims technique which is best when actual losses are not reliable.

Question 30 – Model Solution 2

a. Check the trend in O/S average reserves.

10,000

➢ +3%

10,300

>+ 3%

10,609

> +3%

10,927

> +30% ←increase in trend, unadjusted development technique is not appropriate.

14,205

b. Check trend in avg. paid claims

5000 %	6000 +3%
5150 >+3%	6180 +3%
5305 >+3%	6365 +3%
5464 >+3%	6556 +3%
5625 > +2.9%	

Trend is consistent, no change in settlement patterns in evident. It is appropriate to use the paid claim development technique.

c. Expected claims technique is appropriate to use since the technique is not affected by changes in reserve adequacy.

2011 Exam

Question 37

a. (0.5 point) The true IBNR for Book A is $610. Based on the estimated IBNR for each method shown, discuss a change in Book A that would explain the discrepancies between the estimates and the true IBNR.

b. (0.5 point) The true IBNR for Book B is $250. Based on the estimated IBNR for each method shown, discuss a change in Book B that would explain the discrepancies between the estimates and the true IBNR.

c. (0.5 point) The true IBNR for Book C is $450. Based on the estimated IBNR for each method shown, discuss a change in Book C that would explain the discrepancies between the estimates and the true IBNR.

d. (0.25 point) For Book D, briefly discuss a next step the actuary should take to understand the difference in results.

Question 37 – Model Solution 1

a. A deteriorating LR will cause the Rpt Dev, Paid Dev, methods to estimate correct IBNR and Exp claims, BF methods to understate b/c ELR will be too low for most recent years.

b. Case Reserve Strengthening. Paid methods are not affected by changing case reserve adequacy and Exp. Claims does not depend on experience. Reported methods will overstate IBNR.

c. Change in Claim Closure Rate. If rate is increasing, paid methods will overstate IBNR.

d. Meet with Claims Dept, UW, and management to discuss any internal changes that may be causing the difference b/w methods.

Question 37 – Model Solution 2

a. A change in claim ratio ie. Increased claim ratios will cause expected claims method to underestimate IBNR. Development (reported and paid) are accurate. The Bornhuetter-Ferguson methods underestimate but not as much as the expected claims technique as it weights expected claims method with development technique.

b. A change in case reserving methods ie. Case strengthening. The reported Development and B-F Methods over-state as the CDFs calculated are too high and these high CDFs are applied to high reported claims. So only the paid development, BF paid and expected claims are accurate. BF reported is less over-stated than Rpt Development as it weighs in the expected claims method which is accurate.

c. A change in claim settlement rates, ie. Increased claim closure rates. The paid development and B-F paid techniques over-state as the CDFs selected are high and these CDFs are applied to high paid claims. BF-paid is less over-stated because it weighs in the expected claims technique.

d. Should calculate loss ratios, pure premiums, average paid and average case outstanding, etc. bearing in mind the year-to-year changes and pick the most appropriate reserve, knowledge from the management and knowledge of the industry.

Solutions to 2012 Exam Questions

29. Determine and fully justify a reasonable unpaid claim estimate for AY 2011 claims as of 12/31/ 2011.

Question 29 – Model Solution 1 (Exam 5B Question 14)

Given our expected loses and reported LDF, our expected reported claims at 12m would be $50m /10,000 = $5m. that implies the impact of the large claim is also $5m (10-5 = 5). Therefore a reasonable approach would be to separate the large claim impact and apply it to a paid claim based development method

Since the paid IDF is so highly leveraged, the BF paid method would probably be more suitable.
Therefore BF paid estimate + impact of large claim = unpaid estimate $47,777,778 + $5m = <u>52,777,778</u>

Question 29 – Model Solution 2 (Exam 5B Question 14)

This extraordinary large claim will skew any method relying on reported claims without proper removal and separate handling. So we will not use reported development or B/F reported.

The paid development factor is 22.5, which is very leveraged and it is sensitive to initial paid losses. Se we will not use paid development.

The remaining methods are expected claims and B/F-paid. Since B/F-paid is not sensitive to volatility in early maturities, I think it is appropriate to use it since it is essentially a credibility weighting of paid development and expected claims. I believe this to be slightly preferable to the expected claims method, which is not sensitive to changing conditions. Also, our volume of data seems high enough to obtain some weight.

Select B/F-paid $47,777,778

Question 29 – Model Solution 3 (Exam 5B Question 14)

Use the reported BF technique, estimate is $53M.

Paid development is not appropriate because the large claim is not in the data. Also has highly leveraged factor for 12-ult.

Reported development is not appropriate because the extraordinarily large claim is in reported data, but should not be expected to have similar claims throughout the year, so reported experience @ 12 mos. is not predictive of unreported claims.

Expected claims tech. doesn't account for the large claim, nor does paid B-F. REPORTED B-F accounts for the large claim, but uses expected claims to determine the unreported portion, which is a reasonable estimate of unreported claims.

Examiner's Comments

Candidates who understood the theory of each of the reserving methods tended to score well on this question as they were able to structure their answers to provide pros and/or cons of each method to support their final selection. A small number of candidates proposed an alternative method to the five methods presented in the question and were awarded credit based on the support provided for their proposal.

Candidates sometimes failed to: address the impact of the large loss, address all of the methods presented in the question, fully support an alternately proposed method.

Candidates sometimes incorrectly stated that: the large loss would distort the loss development factors used in the paid and/or reported development methods, highly leveraged loss development factors were a reason not to use the Bornhuetter-Ferguson methods, or the large loss would distort the a priori loss ratio used in the Bornhuetter-Ferguson methods.

Solutions to 2012 Exam Questions

30. Determine which of the two reported claim development patterns shown above best reflect the actual emergence of claims. Justify your selection.

Question 30 – Model Solution 1 (Exam 5B Question 15)

Expected emergence:

			Difference from actual	
CY	Pattern 2	Pattern 1	Patt 1	Patt 2
2007	0	0	-1000	-1000
2008	8,120	6,767	-1337	16
2009	9,829	14,080	3980	-271
2010	32,263	34,365	365	-1937
Total			2,008	-3,192

I would select pattern 1, since it is closer to actual emergence overall.

Question 30 – Model Solution 2 (Exam 5B Question 15)

Expected emergence = IBNR (%rept – prior % rept/starting % unrept)

	Patt 1 % rept	Patt 2 % rept	IBNR patt 1	IBNR patt 2
06	100%	100%	0	0
07	100%	100%	0	0
08	95.2%	94.3%	6767	8120
09	86.6%	88.2%	21824	18867
10	66.6%	68.9%	57755	52003
		↑		↑
		1/1.452		0.452* 115,050

	Patt 1 emergence	Patt 2 exp'd emergence
06	0	0
07	0	0
08	6767	8120
09	14006	9753 = 18867*(0.943-0.882)/(1-0.882)
10	34584	
Total	55357	50145

Actual emergence was 53,404. Pattern 1 was much better at predicting most recent but worse for other periods. To be conservative and since it was a bit closer to actual estimate, choose pattern 1.

Solutions to 2012 Exam Questions
Question 30 – Model Solution 3 (Exam 5B Question 15)

	Pattern 1 IBNR	2011 emergence	Pattern 2 IBNR	2011 emergence
06	0	0	0	0
07	0	0	0	0
08	6769	6769	8120	8120
09	21,824	14,080	18,867	9,829
10	57,775	34,565	52,003	32,263

Pattern 2 is more predictably closer to actual claim emergence. 1 is too erratic.

Pattern	2010	2009	2008	2007	2006
1	34,565	14,080	6769	0	0
2	32,263	9,829	8,120	0	0
Actual	34,200	10,100	8,104	1000	0
Diff					
1	+1.07%	+39.4%	-16.5%		
2	-5.7%	-2.7%	-2%		

Examiner's Comments

The majority of candidates were able to put the expected and/or actual values in a comparable form, and make a valid selection based on those values with some justification. Candidates lost points for:

- Using the wrong formula for the loss emergence % or applying it incorrectly to ultimate IBNR, ultimate loss or cumulative reported loss
- Describing the selected method as "closer" without supplying numeric justification for the response
- Including 2011 in the total expected loss emergence when comparing to actual
- Only compared the emergence for 1 or 2 accident years to draw the conclusion

1 Introduction 371

ALAE vs. ULAE

- ALAE are costs the insurer can assign to a particular claim (e.g. legal and expert witness expenses)
- ULAE cannot be allocated to a specific claim (e.g. salaries, rent, and computer expenses for the claims department of an insurer).

Actuaries in Canada still separate LAE into ALAE and ULAE (a.k.a. internal loss adjusting expense, or ILAE).

In 1998, the NAIC promulgated two new categories of claim adjustment expenses for U.S. insurers reporting on Schedule P of the P&C statutory Annual Statement:

- Defense and cost containment (DCC) which includes all defense litigation and medical cost containment expenses regardless of whether internal or external to the insurer.
- Adjusting and other (A&O), includes all claims adjusting expenses, whether internal or external to the insurer.

The authors choose to use the term ALAE in this chapter and state that the development methods presented in this chapter can also be used for DCC. Key factors include whether expenses:

* can be organized by accident year (policy, underwriting, or report year)

* tend to track AY, PY, U/W Y, or RY or are more dependent on CY.

While ALAE often demonstrate a close relationship with claims experience, ULAE or A&O are often related to the size of the insurer's claims department.

2 Example – Auto Property Damage Insurer 371 – 374

Auto Property Damage Insurer is used to demonstrate four projection techniques for ALAE.

Techniques to develop ALAE:

1. The development technique using paid ALAE.
2. The development technique using reported ALAE (when case O/S for ALAE exists), which for Auto Property Damage Insurer maintains.
3. The development of the ratio of paid ALAE-to-paid claims only.

Exhibit I, Sheets 1 – 3: The ALAE development method for reported and paid ALAE.

Exhibit I, Sheets 4 – 8: The development method applied to the ratio of paid ALAE-to-paid claims.

Exhibit I, Sheets 9 – 10: The projection of ultimate ALAE, using ratio of paid ALAE-to-paid claims, but using additive development factors instead of multiplicative factors to project ultimate ALAE.

In "Loss Reserving," Wiser notes: "If the ratios are very small at early maturities, the additive approach seems to be more stable."

All assumptions underlying the development technique (see Chapter 7) apply to the following example for ALAE.

Begin with the projection of reported and paid ALAE in Exhibit I, Sheets 1 and 2.

- Notice the increasing reported and paid ALAE for AYs 2006 - 2008.
- Looking down the age-to-age factors columns for reported ALAE, we see a changing pattern of development at 12-to-24 months and 24-to-36 months. The age-to-age factors are smaller for the more recent AY compared to the earlier AYs.

Auto Property Damage Insurer Exhibit I
Reported ALAE ($000) Sheet I

PART 1 - Data Triangle

Accident	Reported ALAE as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	684	953	1,031	1,062	1,080	1,084	1,089	1,092	1,092	1,092	1,092
1999	625	929	1,006	1,033	1,041	1,046	1,049	1,051	1,051	1,051	
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::		

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
1998	1.393	1.082	1.030	1.017	1.004	1.005	1.003	1.000	1.000	1.000	
1999	1.486	1.083	1.027	1.008	1.005	1.003	1.002	1.000	1.000		
2000	1.350	1.065	1.028	1.017	1.003	1.001	1.000	1.000			
2001	1.421	1.055	1.041	1.015	1.005	1.001	1.004				
2002	1.411	1.092	1.056	1.028	1.058	1.016					
2003	1.252	1.092	1.055	1.003	1.044						
2004	1.231	1.067	1.026	1.031							
2005	1.202	1.056	1.031								
2006	1.154	1.051									
2007	1.162										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.200	1.071	1.042	1.019	1.023	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.173	1.058	1.037	1.021	1.036	1.006	1.002	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.198	1.071	1.042	1.020	1.018	1.003	1.002	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.193	1.070	1.042	1.018	1.024	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.170	1.057	1.038	1.020	1.036	1.006	1.002	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.170	1.057	1.038	1.020	1.036	1.006	1.002	1.000	1.000	1.000	1.000
CDF to Ultimate	1.367	1.169	1.106	1.066	1.045	1.008	1.002	1.000	1.000	1.000	1.000
Percent Reported	73.1%	85.5%	90.4%	93.8%	95.7%	99.2%	99.8%	100.0%	100.0%	100.0%	100.0%

These observations lead us ask the following:

- Is ALAE increasing because the portfolio of insureds is increasing?
- Were there operational/policy changes over the experience period impacting ALAE case O/S (since the same magnitude of change is not evident when looking down columns of the age-to-age factors for paid ALAE)?

Age-to-Age and tail factor selections:

- Age-to-age factors are selected based on the 3-year volume-weighted average (for both reported ALAE and paid ALAE) to reflect the most recent experience.
- A tail factor of 1.00 for reported ALAE is selected since there is no further development beyond 96 months.
- A tail factor of 1.005 for paid ALAE is selected based on a review of the ratios of reported ALAE-to-paid ALAE from 96 months to 132 months and paid development during this period.

Exhibit I, Sheet 3: Projection of Ultimate ALAE ($000)

Auto Property Damage Insurer Exhibit I
Projection of Ultimate ALAE ($000) Sheet 3

Accident Year	Age of Accident Year at 12/31/08	ALAE at 12/31/08 Reported	ALAE at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate ALAE Using Dev Method with Reported	Projected Ultimate ALAE Using Dev Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	1,092	1,084	1.000	1.005	1,092	1,089
1999	120	1,051	1,045	1.000	1.005	1,051	1,050
:::	:::	:::	:::	:::	:::	:::	:::
2006	36	1,198	1,132	1.106	1.155	1,325	1,307
2007	24	1,596	1,454	1.169	1.241	1,866	1,804
2008	12	1,556	952	1.367	2.138	2,128	2,035
Total		12,679	11,685			13,774	13,516

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Property Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7)= [(3) x (5)]
(8)= [(4) x (6)].

Key Observations:

- The reported and paid ALAE projections are similar.
- There is a significant increase in the ultimate ALAE for AYs 2006 - 2008.

The second approach for ultimate ALAE projection is shown in Exhibit I, Sheets 4 - 8.

- The approach uses the development technique applied to the ratio of paid ALAE-to-paid claims only.
- The first step is to estimate ultimate claims, shown in Exhibit I, Sheets 4 and 5, based on reported claims only and paid claims only, respectively.

Auto Property Damage Insurer Exhibit I
Reported Claims Only ($000) Sheet 4

PART 1 - Data Triangle

Accident Year	Reported Claims Only as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	109,286	111,832	110,648	109,174	108,849	108,779	108,786	108,646	108,736	108,735	108,732
1999	120,639	119,607	116,924	116,482	116,332	116,230	116,236	116,161	116,160	116,125	
2000	115,422	119,143	118,641	117,008	116,782	116,919	116,860	116,825	116,472		
2001	129,430	139,925	138,161	137,395	137,269	137,033	136,998	137,056			
2002	134,190	143,852	143,093	142,360	142,004	141,715	141,627				
2003	152,678	166,131	166,015	165,579	165,229	163,508					
2004	144,595	154,830	154,295	154,228	153,750						
2005	137,791	154,230	154,307	153,981							
2006	159,818	178,399	179,384								
2007	162,205	178,425									
2008	176,030										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
1998	1.023	0.989	0.987	0.997	0.999	1.000	0.999	1.001	1.000	1.000	
1999	0.991	0.978	0.996	0.999	0.999	1.000	0.999	1.000	1.000		
2000	1.032	0.996	0.986	0.998	1.001	0.999	1.000	0.997			
2001	1.081	0.987	0.994	0.999	0.998	1.000	1.000				
2002	1.072	0.995	0.995	0.997	0.998	0.999					
2003	1.088	0.999	0.997	0.998	0.990						
2004	1.071	0.997	1.000	0.997							
2005	1.119	1.000	0.998								
2006	1.116	1.006									
2007	1.100										
2008											

There is some evidence of an increasing volume of claims, but it is not as significant as the increase in ALAE.

- Notice the age-to-age factors that are less than 1.00 (a.k.a. downward or negative development) for reported claims only.
- Auto Property Damage Insurer does not consider S&S when setting case O/S, given that large recoveries due to S&S are common for this line of business.

Next: Compare the development patterns for ALAE and claims only.

	Reported ALAE		Reported Claims Only	
Age (Months)	**CDF**	**Implied% Reported**	**CDF**	**Implied% Reported**
12	1.367	73.2%	1.101	90.8%
24	1.169	85.5%	0.990	101.0%
36	1.106	90.4%	0.989	101.1%
48	1.066	93.8%	0.991	100.9%
60	1.045	95.7%	0.993	100.7%
72	1.008	99.2%	0.998	100.2%
84	1.002	99.8%	0.999	100.1%
96	1.000	100.0%	0.999	100.1%
108			1.000	100.0%

	Paid ALAE		Paid claims Only	
Age (Months)	**CDF**	**Implied% Reported**	**CDF**	**Implied% Reported**
12	2.138	46.8%	1.584	63.1%
24	1.241	80.6%	1.029	97.2%
36	1.155	86.6%	1.007	99.3%
48	1.096	91.2%	1.004	99.6%
60	1.058	94.5%	1.002	99.8%
72	1.028	97.3%	1.001	99.9%
84	1.013	98.7%	1.001	99.9%
96	1.009	99.1%	1.001	99.9%
108	1.007	99.3%	1.000	100.0%
120	1.005	99.5%		
132	1.005	99.5%		

Note that ALAE reported and paid patterns lag the claims only patterns, which could be related to the S&S and the expenses incurred in obtaining these recoveries.

Again, the 3-year volume-weighted averages are used to reflect the most recent experience.

Exhibit I, Sheet 6: Projection of Ultimate Claims Using Reported and Paid Claims Only ($000)

Auto Property Damage Insurer
Projection of Ultimate Claims Using Reported and Paid Claims Only ($000)

Exhibit I
Sheet 6

Accident Year	Age of Accident Year at 12/31/08	Claims only at 12/31/08 Reported	Claims only at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev Method with Reported	Projected Ultimate Claims Using Dev Method with Paid	Selected Ultimate Claims Only
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	108,732	108,730	1.000	1.000	108,732	108,730	108,731
1999	120	116,125	116,033	1.000	1.000	116,125	116,033	116,079
2000	108	116,472	116,807	1.000	1.000	116,472	116,807	116,640
2001	96	137,056	136,995	0.999	1.001	136,919	137,132	137,025
2002	84	141,627	141,461	0.999	1.001	141,485	141,602	141,544
2003	72	163,508	163,257	0.998	1.001	163,181	163,420	163,301
2004	60	153,750	152,613	0.993	1.002	152,675	152,918	152,797
2005	48	153,981	153,154	0.991	1.004	152,599	153,767	153,183
2006	36	179,384	175,602	0.989	1.007	177,418	176,834	177,126
2007	24	178,425	171,505	0.990	1.029	176,646	176,508	176,577
2008	12	176,030	124,470	1.101	1.584	193,794	197,147	195,471
Total		1,625,090	1,560,627			1,636,048	1,640,900	1,638,474

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Property Damage Insurer
(5) and (6) Based on CDF from Exhibit I, Sheets 4 and 5.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Note: The reported and paid claims only projections are similar for this stable, short-tail line of insurance.

In Exhibit I, Sheet 7, the development technique is used to analyze the ratio of paid ALAE-to-paid claims only.

- An important assumption is that the relationship between ALAE and claims only is stable over the experience period.
- Confirm this assumption during the data gathering process and discussions with management.
- A change in defense strategy or a new policy with respect to the use of external versus internal defense counsel limit the use of historical relationships to project future ALAE experience.

Auto Property Damage Insurer Exhibit I
Ratio of Paid ALAE to Paid Claims Only Sheet 7

PART 1 - Ratio Triangle

Accident	Ratio of Paid ALAE to Paid Claims Only as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	0.0066	0.0081	0.0088	0.0093	0.0097	0.0098	0.0099	0.0099	0.0100	0.0100	0.0100
1999	0.0065	0.0077	0.0083	0.0085	0.0088	0.0088	0.0089	0.0090	0.0090	0.0090	
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::		

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
1998	1.227	1.086	1.057	1.043	1.010	1.010	1.000	1.010	1.000	1.000	
1999	1.185	1.078	1.024	1.035	1.000	1.011	1.011	1.000	1.000		
2000	1.125	1.079	1.029	1.043	1.000	1.000	1.014	1.000			
2001	1.154	1.083	1.062	1.029	1.014	1.014	1.000				
2002	1.163	1.105	1.079	1.044	1.056	1.040					
2003	1.078	1.091	1.067	1.031	1.000						
2004	1.057	1.089	1.033	1.032							
2005	1.035	1.051	1.032								
2006	1.051	1.032									
2007	1.250										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.094	1.074	1.055	1.036	1.014	1.015	1.006	1.003	1.000	1.000	
Latest 3	1.112	1.057	1.044	1.036	1.023	1.018	1.008	1.003	1.000	1.000	
Medial Average											
Latest 5x1	1.062	1.077	1.054	1.035	1.005	1.012	1.006	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.109	1.054	1.049	1.035	1.028	1.014	1.004	1.001	1.002	1.000	1.000
CDF to Ultimate	1.332	1.201	1.140	1.086	1.050	1.021	1.007	1.003	1.002	1.000	1.000

Note: Selected factors differ than those appearing in Exhibit I, Sheet 7, in order to replicate CDF to Ultimate's factors

Advantages and Disadvantages to using the ratio method:

Advantages:

1. It recognizes the relationship between ALAE and claims only.
2. The ratio development factors are not as highly leveraged as those based on paid ALAE dollars.

   Age-to-age factors based on the simple average of the latest 3 years are selected.

   A tail factor of 1.00 for the ratio of paid ALAE-to-paid claims is selected based on the absence of development at 108-to-120 months.

   This method produces projected ultimate ALAE less than the reported and paid ALAE projections (a key reason for this is the absence of a tail factor).

   Note that paid ALAE lagged paid claims only, and if these implied patterns are correct, then there should be a tail factor for the ratio of paid ALAE-to-paid claims only.
3. The ability to interject actuarial judgment in the projection analysis, especially for the selection of the ultimate ALAE ratio for the most recent year(s) in the experience period.

Disadvantages:

1. Any error in the estimate of ultimate claims only could affect the estimate of ultimate ALAE.
2. When large amounts of ALAE are spent on claims that ultimately settle with no claim payment, the projection process is distorted.

   This suggests reviewing large claims and projecting estimates of unpaid large claims separately.

   This also applies to the analysis of unpaid ALAE with respect to large expenses as for large claims.

Exhibit I, Sheet 8: Ratio of Paid ALAE to Paid Claims Only

Auto Property Damage Insurer Exhibit I
Ratio of Paid ALAE to Paid Claims Only Sheet 8

Accident Year	Age of Accident Year at 12/31/08	Ratio of Paid ALAE to Paid Claims Only at 12/31/08	CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate Paid-to-Paid Ratio	Selected Ultimate Claims Only	Projected Ultimate Paid ALAE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.0100	1.000	0.0100	0.0100	108,731	1,087
1999	120	0.0090	1.000	0.0090	0.0090	116,079	1,045
:::	:::	:::	:::	:::	:::	:::	:::
2006	36	0.0064	1.140	0.0073	0.0073	177,126	1,292
2007	24	0.0085	1.201	0.0102	0.0077	176,577	1,360
2008	12	0.0076	1.332	0.0102	0.0077	195,471	1,505
Total						1,638,474	12,477

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 7.
(4) Based on CDF from Exhibit I, Sheet 7.
(5) = [(3) x (4)].
(6) = (5), except for 2007 and 2008 which are judgmentally selected based on review of prior years.
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)].

The development technique is used to project an initial estimate of the ALAE ratio to claim amount of 0.0102 for AYs 2007 and 2008.

- However, 0.0102 seems high (compared to the immediate preceding years), and may be due to a change in procedures for recording ALAE or unusually large expenses.

  The average of the ultimate ALAE ratios for all the years up to 2006 is .0077, and the average for the latest three years excluding 2007 and 2008 is 0.0071.
- An ultimate ALAE ratio for 2007 and 2008 of 0.0077 is selected (based on the average for all years).
- Ultimate ALAE is based on selected ultimate claims (from Exhibit I, Sheet 6) times ultimate ALAE ratio (from Column (6)).

A third approach is to use additive rather than multiplicative development factors to ultimate.

In Exhibit I, Sheets 9: Ratio of Paid ALAE to Paid Claims Only - Additive Method

In Exhibit I, Sheets 10: Projection of Ultimate ALAE ($000) - Additive Method

Exhibit 1, Sheet 9, Top section: The ratio of paid ALAE-to-paid claims only is shown.

Exhibit 1, Sheet 9, Middle section: Age-to-age factors based on the difference between ratios of paid ALAE-to-paid claims only at successive ages are shown.

Auto Property Damage Insurer Exhibit I
Ratio of Paid ALAE to Paid Claims Only - Additive Method Sheet 9

PART 1 - Ratio Triangle

Accident Year	Ratio of Paid ALAE to Paid Claims Only as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	0.0066	0.0081	0.0088	0.0093	0.0097	0.0098	0.0099	0.0099	0.0100	0.0100	0.0100
1999	0.0065	0.0077	0.0083	0.0085	0.0088	0.0088	0.0089	0.0090	0.0090	0.0090	
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::		
2007	0.0068	0.0085									
2008	0.0076										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors - Additive 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
1998	0.0015	0.0007	0.0005	0.0004	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	
1999	0.0012	0.0006	0.0002	0.0003	0.0000	0.0001	0.0001	0.0000	0.0000		
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::		
2007	0.0017										
2008											

Examples:

the 12-to-24 month factor for AY 1998 is equal to .0015 = the paid ratio of 0.0081 at 24 months minus the paid ratio of 0.0066 at 12 months.

the 36-to-48 month factor for AY 2002 is equal to 0.0005 = the paid ratio at 48 months of 0.0068 less the paid ratio at 36 months of 0.0063, or 0.0005.

Exhibit 1, Sheet 9, Bottom section: average age-to-age factors are calculated.

- Additive age-to-age factors based on the simple average for the latest 3 years are selected.
- The age-to-ultimate factor is based on ***cumulative addition*** (not multiplication) beginning with the selected factor for the oldest age.

PART 3 - Average Age-to-Age Factors

	Averages - Additive 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	0.0006	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	
Latest 3	0.0007	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	
Medial Average											
Latest 5x1	0.0003	0.0004	0.0003	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection - Additive 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	0.0007	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
CDF to Ultimate	0.0019	0.0012	0.0009	0.0006	0.0004	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000

Exhibit 1, Sheet 10: Projection of Ultimate ALAE ($000) - Additive Method

Auto Property Damage Insurer Exhibit I
Projection of Ultimate ALAE ($000) - Additive Method Sheet 10

Accident Year	Age of Accident Year at 12/31/08	Ratio of Paid ALAE to Paid Claims Only at 12/31/08	Additive CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate Paid-to-Paid Ratio	Selected Ultimate Claims Only	Projected Ultimate Paid ALAE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.0100	0.0000	0.0100	0.0100	108,731	1,087
1999	120	0.0090	0.0000	0.0090	0.0090	116,079	1,045
:::	:::	:::	:::	:::	:::	:::	:::
2007	24	0.0085	0.0012	0.0097	0.0097	176,577	1,719
2008	12	0.0076	0.0019	0.0095	0.0095	195,471	1,863
Total						1,638,474	13,241

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 9.
(4) Based on additive CDF from Exhibit I, Sheet 9.
(5) = [(3) + (4)]
(6) = (5)
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)]

The only difference between this projection and the projection in Exhibit I, Sheet 8, is that we ***add the paid ALAE ratio from the latest diagonal of the triangle to the CDF*** instead of multiplying by the CDF.

Note: In Exhibit I, Sheet 9, we do not modify the ALAE ratio for the latest years, but allow the initial projected ratio values for 2007 and 2008 to be used to project ultimate ALAE.

Exhibit I, Sheet 11: The results of the 4 projections are shown.

Auto Property Damage Insurer Exhibit I
Development of Estimated Unpaid ALAE ($000) Sheet 11

Accident Year	Age of Accident Year at 12/31/08	Paid ALAE at 12/31/08	Projected Ultimate ALAE Using Dev Method with Reported	Projected Ultimate ALAE Using Dev Method with Paid	Projected Ultimate ALAE Using Ratio Method with Mult.	Projected Ultimate ALAE Using Ratio Method with Additive	Estimated Unpaid ALAE Using Dev Method with Reported	Estimated Unpaid ALAE Using Dev Method with Paid	Estimated Unpaid ALAE Using Ratio Method with Mult.	Estimated Unpaid ALAE Using Ratio Method with Additive
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	132	1,084	1,092	1,089	1,087	1,087	8	5	3	3
1999	120	1,045	1,051	1,050	1,045	1,045	6	5	0	0
:::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::
2007	24	1,454	1,866	1,804	1,360	1,719	412	350	-94	265
2008	12	952	2,128	2,035	1,505	1,863	1,176	1,083	553	911
Total		11,685	13,774	13,516	12,477	13,241	2,089	1,831	792	1,556

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) Based on data from Auto Property Damage Insurer.
(4) and (5) Developed in Exhibit I, Sheet 3.
(6) Developed in Exhibit I, Sheet 8.
(7) Developed in Exhibit I, Sheet 10.
(8) = [(4) - (3)]. (9) = [(5) - (3)]. (10) = [(6) - (3)]. (11) = [(7) - (3)].

Estimated unpaid ALAE = total unpaid ALAE (including both case O/S for ALAE and ALAE IBNR).

Notes: Without a tail factor, projected ALAE, based on the standard development technique, applied to the ratio of paid ALAE-to-paid claims only appears low.

This method is not sufficient, even if the tail factor is changed to 1.005.

The challenge is in selecting the ultimate ALAE ratio for the most recent two AYs, and with a selected ratio of 0.0077, the estimate of unpaid ALAE is negative for AY 2007.

This does not seem correct based on knowledge of the property damage line of insurance and the operations of XYZ Insurer.

Conduct similar evaluation analyses (Chapter 15) in selecting which method is appropriate for each AY.

3 Choosing a Technique for Estimating Unpaid ALAE 374

The choice of a technique to estimate unpaid ALAE depends upon:

- types of data available,
- the credibility of the data, and an
- understanding as to how the insurer's environment affects the various projection techniques.

These comments that apply for ALAE are similar to those that apply for claims with respect to when the various estimation techniques work and when they do not.

Sample Questions:

1. In Chapter 1, Friedland briefly describes the NAIC's requirements for U.S. insurers to report their Claim Adjustment Expenses in Schedule P of the P&C statutory Annual Statement, using two separate expense groupings. Name and explain the 2 categories.

2. In the Introduction to Part 4, Friedland explains that, despite the NAIC groupings used to split Claims Adjustment Expenses for the purpose of statutory filings, it is common for U.S. insurers to use an "ALAE and ULAE categorization" for the purpose of determining Unpaid Claims Adjustment Expense estimates.

   Define ALAE and ULAE, and provide examples of each.

3. Friedland points out that, in many cases, ALAE data is simply combined with claims data when estimating unpaid amounts, such that the term "claims" often refers to "claims *and* ALAE." Why is ULAE not typically combined in the same way?

4. In Chapter 16, Friedland shows methods of estimating Unpaid ALAE for instances when ALAE is *not* simply combined with claims. (In these cases, estimates of Unpaid Claims will have been developed separately.)

   List the 4 techniques that Friedland demonstrates in Chapter 16.

2000 Exam Questions (modified):

39. (2 points) You have developed an estimate of Unpaid Claims, and are now estimating Unpaid ALAE.

You are given the following triangle of paid ALAE per $100 of paid claims, and additional data below.

Development Month	Cumulative Paid ALAE per $100 of Cumulative Paid Claims Accident Year				
	1995	1996	1997	1998	1999
12	2.45	2.50	2.40	2.20	2.10
24	2.80	2.90	2.77	2.60	
36	2.96	3.10	2.95		
48	3.00	3.16			
60	3.00				
Paid Claims at December 31, 1999	$100,000,000	$110,000,000	$115,000,000	$120,000,000	$100,000,000
Ultimate Claims Estimate	$100,00,000	$110,000,000	$120,000,000	$150,000,000	$200,000,000

There is no development beyond 48 months.

Using the Additive Approach described by Friedland, what is the estimate of Unpaid ALAE as of December 31, 1999? Show all work.

2003 Exam Questions (modified):

20. (3 points) You are given the following information:

Accident Year	Cumulative Paid Claims (excluding ALAE) Age of Development in Months 12	24	36	48	Selected Ultimate Claims
1998		$9,200	$9,300	$9,300	$9,300
1999	$8,000	8,900	9,060	9,060	9,060
2000	9,200	9,900	9,980		9,980
2001	8,300	9,400			9,520
2002	9,500				10,680

Accident Year	Cumulative Paid ALAE Age of Development in Months 12	24	36	48
1998		$690	$753	$764
1999	$500	760	853	861
2000	550	650	710	
2001	555	770		
2002	630			

- Use a simple all-years average to select ATA factors.
- Assume there is no further development of claims or ALAE after 48 months.

Using the Development Method applied to Ratio of Paid-ALAE-to-Paid-Claims described by Friedland, estimate the Unpaid ALAE for accident year 2002 as of December 31, 2002. Show all work.

2006 Exam Questions (modified):

17. (1.5 points) Historically, an insurance company's only method of estimating unpaid ALAE was utilizing development factors based on combined claim and ALAE data. It has been discovered that the claims department of that company implemented a revised strategy two years ago to use outside counsel earlier in the claim settlement process in hopes of lowering claim payments.

a. (1 point) Briefly describe two techniques for estimating unpaid ALAE that would address the new claims-handling strategy.

b. (0.5 points) Explain why these techniques may or may not be appropriate.

2007 Exam Questions (modified):

47. (1.5 points) Given the following information for an insurance company as of December 31, 2006:

Accident Year	Ultimate Claims	Paid DCC
2003	$65,000	$3,000
2004	62,500	2,100
2005	66,000	1,200
2006	64,500	500

Ratio of Cumulative Paid DCC to Cumulative Paid Claims

Accident Year	12	24	36	Ultimate
	Age of Development in Months			
2003	2.4%	3.0%	4.0%	4.8%
2004	2.0%	2.5%	3.7%	
2005	2.0%	2.6%		
2006	2.2%			

Estimate the Unpaid Defense and Cost Containment (DCC) for accident years 2003 through 2006. State any assumptions.

2009 Exam Questions

13. (2 points) Given the following information:

Accident Year	Ratio of Paid ALAE to Paid Claims Only 12 Months	24 Months	36 Months	Ultimate
2005	0.0060	0.0077	0.0080	0.0080
2006	0.0070	0.0081	0.0090	
2007	0.0065	0.0079		
2008	0.0062			

Estimated Ultimate Claims Only ($000)

Accident Year	Ultimate Claims Only
2005	210,000
2006	218,400
2007	227,140
2008	236,220

a. (1 point) Using the multiplicative paid ALAE-to-paid claims only method, and using all-year, simple average age-to-age development factors, estimate ultimate ALAE for accident year 2008.

b. (1 point) Briefly describe one advantage and one disadvantage of the multiplicative paid ALAE-to-paid claims only method.

2010 Exam Questions

7. (2 points) Given the following information as of December 31, 2009:

Accident Year	Reported Claims Only	Reported ALAE
2007	$163,900	$1,253
2008	179,200	1,490
2009	176,300	1,567

Cumulative Development Factors to Ultimate

Age	Reported Claims Only	Reported ALAE	Ratio of Reported ALAE to Reported Claims
36	1.000	1.003	1.003
24	0.998	1.103	1.106
12	1.103	1.469	1.332

a. (1.5 points) Use the development method applied to the reported ALAE-to-reported claims ratio to calculate the expected unreported ALAE for each accident year as of December 31, 2009

b. (0.5 point) Briefly describe one advantage and one disadvantage of the method used in part a. above.

2011 Exam Questions

34. (1.75 points) Given the following data as of December 31, 2010:

Paid Claims Only (excludes expense)

Accident Year	12 months	24 months	36 months	48 months
2007	$55,683	$68,489	$76,486	$77,685
2008	$62,489	$75,495	$82,168	
2009	$69,791	$80,489		
2010	$75,187			

Paid ALAE

	12 months	24 months	36 months	48 months
2007	$2,985	$4,288	$5,217	$5,609
2008	$3,581	$4,968	$5,908	
2009	$3,979	$5,289		
2010	$4,315			

- Accident year 2010 ultimate paid claims estimate = $101,535
- Assume no further development after 48 months.
- Use all-year simple averages for all factor selections.

a. (1.5 points) Use the paid ALAE-to-paid claims only additive method to estimate ultimate ALAE for AY 2010.
b. (0.25 point) Briefly describe an advantage of using a ratio approach to estimate ultimate ALAE.

2012 Exam Questions

27. (2 points) Given the following information for a line of business as of December 31, 2011:

Ratio of Paid ALAE to Paid Claims Only

Accident Year	12 Months	24 Months	36 Months	48 Months
2008	0.0052	0.0057	0.0061	0.0064
2009	0.0054	0.0058	0.0061	
2010	0.0068	0.0074		
2011	0.0074			

Accident Year	Ultimate Claims Only (000s)
2008	$152
2009	$160
2010	$170
2011	$185

- Assume no development after 48 months.

Estimate the ultimate ALAE for accident year 2011.

Solutions to Sample Questions:

1. In Chapter 1, Friedland briefly describes the NAIC's requirements for U.S. insurers to report their Claim Adjustment Expenses in Schedule P of the P&C statutory Annual Statement, using two separate expense groupings. Name and explain the 2 categories.

   (1) DCC: Defense and Cost Containment expenses, including <u>all</u> defense litigation and medical cost containment expenses

   (2) A&O: Adjusting and Other expenses, including <u>all</u> claims-adjusting expenses

2. In the Introduction to Part 4, Friedland explains that, despite the NAIC groupings used to split Claims Adjustment Expenses for the purpose of statutory filings, it is common for U.S. insurers to use an "ALAE and ULAE categorization" for the purpose of determining unpaid claims adjustment expenses.

   Define ALAE and ULAE, and provide examples of each.

   (1) ALAE: Allocated Loss Adjustment Expenses include the costs that an insurer is able to <u>allocate to a particular claim</u>, such as lawyers/legal fees and expert witness expenses (aligns more closely to DCC)

   (2) ULAE: Unallocated expenses include amounts not easily allocated to a specific claim, such as payroll of claims adjusters and rent & computer expenses of claims department (aligns more closely to A&O)

3. Friedland points out that, in many cases, ALAE is simply combined with the claims data when estimating unpaid amounts, so the term "claims" often refers to "claims and ALAE." Why is ULAE not typically combined in the same way?

   ALAE amounts (which can be allocated to specific claims) are often closely related to the claims amounts. On the other hand, **ULAE amounts are usually less closely related to the claims amounts**, and more closely related to the size the insurance company's claims department (since salaries and office rent for claims adjusters are unallocated).

   Note: The methods for estimating Unpaid ULAE can therefore be quite different than the methods for estimating Unpaid Claims and/or ALAE. (ULAE methods will be covered in Chapter 17). See also Conger on ULAE.

4. In Chapter 16, Friedland shows methods of estimating Unpaid ALAE for instances when ALAE is not simply combined with claims. List the 4 techniques that Friedland demonstrates in Chapter 16.

   (1) Development method applied to reported ALAE $ (as in analogous version for claims in chapter 7)

   (2) Development method applied to paid ALAE $ (as in analogous version for claims in chapter 7)

   (3) Development method applied to RATIO of paid ALAE, to paid claims ("the ratio approach")

   Example: See prior exam question 2003 #20

   (4) Additive development approach applied to ratio of paid ALAE to paid claims ("the additive approach")

   Example: See prior exam question 2000 #39

Solutions to 2000 Exam questions (modified):

Question 39. Using the Additive Approach described by Friedland, what is the estimate of Unpaid ALAE as of December 31, 1999?

Step 1: Write an equation to estimate the Unpaid ALAE:

Estimated Unpaid ALAE = Ultimate ALAE – Paid ALAE to date

Step 2: Compute "additive increments".

Since there is no development beyond 48 months, only years 97 – 99 are needed.

To determine the additive increment, compute a 3 year average of the difference in cumulative paid ALAE per $100. Add the additive increment to cumulative paid ALAE per $100 Claims to date to compute ultimate ALAE ratios.

Month developed to	3 year (if possible) average of the difference in cumulative paid ALAE
24	$\frac{[(2.6-2.2)+(2.77-2.40)+(2.9-2.5)]}{3}=.39$
36	$\frac{[(2.95-2.77)+(3.10-2.90)+(2.96-2.80)]}{3}=.18$
48	$\frac{[(3.16-3.10)+(3.00-2.96)]}{2}=.05$

	1997	1998	1999
Ultimate ALAE Ratios	2.95 + **(.05)**	2.60 + **(.18 + .05)**	2.10 + **(.39 + .18 + .05)**
	= 3.0	= 2.83	= 2.72

Step 3: Compute Ultimate ALAE (by AY) and Paid ALAE to date (by AY)

Ultimate ALAE = Ultimate ALAE ratio * Ultimate Claims

Paid ALAE = Paid ALAE ratio * Paid Claims

	1997	1998	1999
1. Ultimate ALAE	$3.0*\frac{[120M]}{100}=3.6M$	$2.83*\frac{[150M]}{100}=4.245M$	$2.72*\frac{[200M]}{100}=5.44M$
2. Paid ALAE	$2.95*\frac{[115M]}{100}=3.3925M$	$2.60*\frac{[120M]}{100}=3.12M$	$2.10*\frac{[100M]}{100}=2.1M$
3. Unpaid ALAE = (1. – 2.)	207,500	1,125,000	3,340,000

So, Total Estimated Unpaid ALAE as of 12/31/99 = 207,500 + 1,125,000 + 3,340,000 = 4,672,500

Solutions to 2003 Exam questions (modified):

20. (3 points) Using the Development Method applied to Ratio of Paid-ALAE-to-Paid-Claims described by Friedland, estimate the unpaid ALAE for accident year 2002 as of December 31, 2002. Show all work.

Step 1: Compute RATIOS of Paid ALAE to Paid Claim amounts

Accident	*RATIO by development age*			
Year	*12*	*24*	*36*	*48*
1998		*0.0750*	*0.0810*	*0.0822*
1999	*0.0625*	*0.0854*	*0.0942*	*0.0950*
2000	*0.0598*	*0.0657*	*0.0711*	
2001	*0.0669*	*0.0819*		
2002	*0.0663*	*= 630 / 9500, for example*		

Note: Rounded to 4 digits

Step 2: Compute and select ATA factors, using the ratios above

Accident	***ATA** Factors by development age*			
Year	*12:24*	*24:36*	*36:48*	*48:ult*
1998		*1.0800*	*1.0148*	*1.0000*
1999	*1.3664*	*1.1030*	*1.0085*	*(given)*
2000	*1.0987*	*1.0822*		
2001	*1.2242*	*= .0819 /.0669, for example*		
All-yr Avg	*1.2298*	*1.0884*	*1.0117*	*1.0000*
***CDF** to Ult*	*1.3541*	*1.1011*	*1.0117*	*1.0000*

Step 3: Compute projected ULTIMATE RATIO (of paid ALAE to Paid Claims) for AY 2002
… Do not forget this step!

Accident Year 2002 Projection of Ultimate Ratio:
*Ultimate RATIO = (2002 RATIO at 12 mo.) * (Ultimate CDF)* *Ultimate RATIO = (.0663) * (1.3541) = .0898*

Step 4: Apply this ultimate ratio to ultimate claims to estimate the ultimate ALAE and unpaid ALAE:

Accident Year	*Ultimate Paid-to-Paid Ratio*	*Estimated Ultimate Claims*	*Estimated Ultimate ALAE*	*Paid ALAE*	*Estimated Unpaid ALAE*
	(1) above	*(2) given*	*(3)=(1)*(2)*	*(4) given*	*(5)=(3)-(4)*
2002	*0.0898*	*10,680*	*959*	*630*	*329*

Solutions to 2006 Exam questions (modified):

17. (1.5 points) Historically, an insurance company's only method of estimating unpaid ALAE was utilizing development factors based on combined claim and ALAE data. It has been discovered that the claims department of that company implemented a revised strategy two years ago to use outside counsel earlier in the claim settlement process in hopes of lowering claim payments.

a. (1 point) Briefly describe two techniques for estimating unpaid ALAE that would address the new claims handling strategy.

b. (0.5 points) Explain why these techniques may or may not be appropriate.

Solution Based on CAS Model Solution 1, with additional comments from the Friedland text:

a1. Use paid-ALAE-to-Paid-Claim development ratios to develop the ultimate paid ALAE to paid loss ratios, then apply these ratios to the ultimate claims to project unpaid ALAE estimates.

Note: This if the technique Friedland refers to as the Ratio method (%).

a2. Develop ALAE separately by triangle method.

Note: This if the technique Friedland calls the Development method, applied to ALAE dollars ($).

b1. Developing Paid-ALAE-to-Paid-Claim ratios could be appropriate since it recognizes the relationship between the two, and also uses the paid ALAE data. The issue that should be emphasized is if ultimate claims projection has an error, then the ALAE projection will be in error too.

Notes: Other <u>advantages</u> of this Ratio Method include “the ability to easily interject actuarial judgment in the projection analysis, particularly for the selection of the ultimate ALAE ratio for the most recent year(s)” and the fact that “ratio development factors tend not to be as highly leveraged as the development factors based on paid ALAE dollars,” according to Friedland (pg 373).

Another <u>potential challenge</u> of the Ratio Method “exists for some lines of business where large amounts of ALAE may be spent on claims that ultimately settle with no claims payment.”

b2. Developing ALAE separately may not be appropriate, since the ALAE payments are generally closely related to paid claims, and using this type of development method would not reflect this relationship.

Solutions to 2007 Exam questions (modified):

47. Estimate the Unpaid Defense and Cost Containment (DCC) for accident years 2003 through 2006.

Accident Year	Ultimate Loss	Paid DCC
2003	$65,000	$3,000
2004	62,500	2,100
2005	66,000	1,200
2006	64,500	500

Ratio of Cumulative Paid DCC to Cumulative Paid Loss				
Accident	Age of Development in Months			
Year	12	24	36	Ultimate
2003	2.4%	3.0%	4.0%	4.8%
2004	2.0%	2.5%	3.7%	
2005	2.0%	2.6%		
2006	2.2%			

Preliminary note: Friedland notes "while we choose to use the term ALAE in this chapter, we point out that the development methods presented in Chapter 16 can also be used for DCC."

Based on Model Solution 1

Initial comments: The "Ratio Approach" in this model solution uses Paid-DCC-to-Paid-Claim development ratios to compute ultimate DCC-to-Paid-Claim ratios. These ratios are then applied to ultimate claims to determine ultimate DCC, from which Paid DCC is subtracted to estimate the unpaid DCC.

Age to Age Factors			
AY	12-24	24-36	36-ult
03	1.25	1.333	1.2
04	1.25	1.480	
05	1.3		
Simple average	1.267	1.407	1.2
CDF to ultimate	**2.139**	**1.688**	**1.2**

AY	Paid DCC to Paid Claims Ratio (1) given*	CDF to Ultimate (2) above	Ult Paid to Paid ratio (3)=(1)*(2)	Ultimate Claims * Ult Pd to Pd ratio (4) see note	Paid DCC (5) given	Est. Unpaid DCC (6) = (4)-(5)
03	4.8	1.000	4.80	3,120	3,000	120
04	3.7	1.200	4.44	2,775	2,100	675
05	2.6	1.688	4.39	2,897.4	1,200	1,697.4
06	2.2	2.139	4.71	3,037.95	500	2,537.95
* See latest diagonal of ratios in the triangle of ratios provided.						**5,030.35**

(4) = (3) * ultimate losses given in the problem.

Solutions to 2007 Exam questions (modified) – continued with an alternative solution.

Preliminary note: This question does not specify the method to use, so different answers were accepted.

Question #47 – Model Solution 2 (continued)

Initial comments: The approach used in this model solution is to use the "Additive Approach" to estimate the Unpaid DCC. To determine the additive increment, compute a 3 year average of the difference in cumulative paid ALAE per $100. Add the additive increment to cumulative paid ALAE per $100 to date to compute ultimate ALAE ratios. These ratios are then applied to ultimate claims to determine ultimate DCC from which Paid DCC is subtracted to estimate the Unpaid DCC.

Additive Development of DCC-to-Claims Ratio Method:

AY	12-24	24-36	36-ult
03	0.6%=(3-2.4)	1%	0.8%
04	0.5%	1.2%	
05	0.6%		
Selected	0.57%	1.1%	0.8%
Ultimate	**2.47%**	**1.9%**	**0.8%**

Note: Selected DCC-to-Claims ratios are based on a straight average

AY	Ult Loss (1) given	Ult. DCC To Claims Ratio (2) see note	Ult DCC (3) = (1)*(2)	Pd DCC (4) given	DCC Reserve (5) = (3)-(4)
03	65,000	4.8%	3,120	3,000	120
04	62,500	4.5%=3.7+**.8**	2,812.50	2,100	712.59
05	66,000	4.5%=2.6+**1.9**	2,970	1,200	1,770
06	64,500	4.67% = 2.2+**2.47**	3,012.15	500	2,512.15
					5,114.74

(2) Based on data given in the problem and DCC to claims ratios computed above.

Solutions to 2009 Exam questions

Question 13 - Model Solution 1

a. (1 point) Using the multiplicative paid ALAE-to-paid claims only method, and using all-year, simple average age-to-age development factors, estimate ultimate ALAE for accident year 2008.

Step 1: Estimated ultimate ALAE for AY 2008 = Estimated ult pd ALAE to pd Loss ratio * ultimate losses

Step 2: Calculate pd ALAE to pd Loss link ratios

AY	12-24	24-36	36-Ult
05	1.2833	1.0389	1.000
06	1.157	1.1111	
07	1.215		
08	--		

Step 3: Calculate the all year simplage average pd ALAE to pd Loss link ratios

* All year simple avg age to age link ratio: 12-24: 1.21850 24-36: 1.07495
* LDF to ultimate: 12–ult = 1.21850 * 1.07495 = 1.3099 24 – ult = 1.07495

(24-ult was computed but not needed to solve the problem)

Step 4: Using the equation in Step 1, the results from Step 3 and the given data in the problem, estimate ultimate ALAE for AY 2008

	A (given)	B	C=A×B	D (given)	E = CxD
AY	Pd to Pd Ratio	Ult LDF	Ult Ratio	Ult Loss	Ult ALAE
2008	.0062	1.3099	.00812	236,220,000	1,918,106

b. (1 point) Briefly describe one advantage and one disadvantage of the multiplicative paid ALAE-to-paid claims only method.

Adv: Development factors are usually not as highly leveraged for the development as dollar development

Disadv: If ultimate loss estimates are not accurate, the ultimate ALAE estimates will be inaccurate as well.

Question 13 - Model Solution 2

a. Note: This is a more efficient solution (shown to demonstrate the minimum needed to obtain full credit)

	Development Factors			
	12	24	36	Ult
Age-Age	1.219	1.075	1.000	1.000
Cumulative	1.310	1.075	1.000	1.000

AY 2008 Ultimate ALAE =.0062 x 1.310 x 236,220,000 = 1,918,579

b. Note: No advantage given in this model solution (perhaps because it was the same as that stated in model solution 1)?

Disadv: The analysis is distorted when large amounts of ALAE are spent on claims that ultimately settle with no pymt to the claimant.

Solutions to 2010 Exam questions

7a. (1.5 points) Use the development method applied to the reported ALAE-to-reported claims ratio to calculate the expected unreported ALAE for each accident year as of December 31, 2009

7b. (0.5 point) Briefly describe one advantage and one disadvantage of the method used in part a. above.

Question 7 – Model Solution 1

a.

	(1) Ratio	(2) CDF to Ultimate	(3) = (1) × (2) Ultimate Ratio	(4) Reported to Ultimate	(5) Ultimate Claims	(6) = (3) x (5) Ultimate ALAE	(7) Reported ALAE	(8) = (6) - (7) Unreported ALAE
1253/163,900=	0.0076	1.003	0.0077	1.000	163,900	1,257	1,253	4
1490/179,200=	0.0083	1.106	0.0092	0.998	178,842	1,645	1,490	155
1567/176,300=	0.0089	1.332	0.0118	1.103	194,459	2,302	1,567	735
							Total	894

(1) = Reported ALAE / Reported Claims
(5) = Reported Claims in $ x (4)

b. Advantage: Development factors of ALAE to claims are less leveraged for reported ALAE only

Disadvantage: There may be claims with zero reported indemnity but substantial ALAE payments - ie for defense expenses

Question 7 – Model Solution 2

a.

(1) AY	(2) Reported	(3) Reported Claim ATU	(4) = (2) x (3) Ultimated Claims	(5) Reported ALAE	(6) = (5) / (2) Reported ALAE -to-claim ratio	(7) Reported ALAE to Reported Claims	(8) = (6) × (7) Ultimate ALAE to Claim Ratio	(9) = (4) × (8) Ultimate ALAE	(10) = (9) - (5) Unreported ALAE
2007	163,900	1.000	163,900	$1,253	0.7645%	1.003	0.7668%	1,257	$4
2008	179,200	0.998	178,842	$1,490	0.8315%	1.106	0.9196%	1,645	$155
2009	176,300	1.103	194,459	$1,567	0.8888%	1.332	1.1839%	2,302	$735
								Total	$894

b. Advantage - allows for interjection of actuarial judgment in selection of ultimate ALAE to reported claim ratio to reflect operational or judicial/external changes

Disadvantage - an error in the estimation of ultimate claim will lead to an error in the estimation of ultimate ALAE to reported claim ratio to reflect operational or judicial/external changes

Solutions to 2011 Exam questions

34a. (1.5 points) Use the paid ALAE-to-paid claims only additive method to estimate ultimate ALAE for accident year 2010.

34b. (0.25 point) Briefly describe an advantage of using a ratio approach to estimate ultimate ALAE.

Question 34 – Model Solution 1

Compute the ratio or Paid ALAE to Paid Claims

Accident	*RATIO by development age*			
Year	*12*	*24*	*36*	*48*
2007	*0.0536*	*0.0626*	*0.0682*	*0.0722*
2008	*0.0573*	*0.0658*	*0.0719*	
2009	*0.0570*	*0.0657*		
2010	*0.0574 = 4,315/ 75,187 for example*			

Compute Additive age to age factors

Accident	***Additive ATA*** *Factors by development age*			
Year	*12:24*	*24:36*	*36:48*	*48:ult*
2007	*0.0090*	*0.0056*	*0.0040*	*0.0000*
2008	*0.0085*	*0.0061*		*(given)*
2009	*0.0087 = .0657 - .0570, for example*			
All-yr Avg	*0.0087*	*0.0058*	*0.0040*	*0.0000*
CDF *to Ult*	*0.0186*	*0.0098*	*0.0040*	*0.0000*

Note: .0186=.0087+.0098 .0098=0.0058+0.004

Accident Year 2010 Projection of Ultimate Ratio:
Ultimate RATIO = (2010 RATIO at 12 mo.)+ (Ult CDF)
Ultimate RATIO = (.0574) + (.0186) = 0.076

Accident Year	*Ultimate Paid-to-Paid Ratio*	*Estimated Ultimate Claims*	*Estimated Ultimate ALAE*	*Paid ALAE*	*Estimated Unpaid ALAE*
	(1) above	*(2) given*	*(3)=(1)*(2)*	*(4) given*	*(5)=(3)-(4)*
2010	*0.0760*	*101,535*	***$7,717***	*$4,315*	*$3,402*

Answer is **7,713**. (4) and (5) shown for information purposes only

b. Using a ratio instead of a straight dollar development method reduces the chance of highly leverages CDFs at early maturities.

Solutions to 2011 Exam questions

34b. (0.25 point) Briefly describe an advantage of using a ratio approach to estimate ultimate ALAE.

Question 34 – Model Solution 2 – Part b

Less leveraged LDFs

Question 34 – Model Solution 3 – Part b

An advantage is that the development factors are more stable when compared to the factors that result from the ALAE only data.

Question 34 – Model Solution 4 – Part b

Advantage : recognizes the inherent relationship between claims only and ALAE.

Question 34 – Model Solution 4 – Part b

Allows actuary to interject opinion and selections directly into the reserving process

Solutions to 2012 Exam questions

Question 27 - Model Solution 1 (Exam 5B Question 12)

Ratios

	12-24	24-36	36-48
08	1.096	1.070	1.049
09	1.074	1.052	
0	1.088		
Avg.	1.086	1.061	1.049
CDF to Ult	1.209	1.113	1.049

Ult 2011 ratio = (.0074)(1.209) = .0089

Ult 2011 ALAE = Ult ratio*Ult claims = (.0089)(185,000) = 1,646.5

Question 27 - Model Solution 2 (Exam 5B Question 12)

Using the additive approach: Additive ALAE a-t-a factors

AY	12-24	24-36	36-48	
2008	0.0005	0.0004	0.0003	= .0064 - .0061
2009	0.0004	0.0003		
2010	0.0006			

Simple Avg			
Selection	0.0005	0.00035	0.0003
Cumulative factors	0.00115	0.00065	0.0003
	=0.0005 + 0.00065		

AY 2011 ultimate ALAE = (0.0074 + 0.00115) * 185,000 = <u>1,581.75</u>

Examiner's Comments

Most candidates used the development of the paid ALAE to paid claims only approach to arrive at a reasonable answer. Of those candidates who attempted the problem, the most common error involved simple calculation mistakes.

Chapter17 – Estimating Unpaid ULAE

1 Introduction 386

ULAE refer to general overhead expenses associated with claims-handling (e.g. the costs of investigating, handling, paying, and resolving claims)

- ALAE: costs that can be assigned to a specific claim (e.g. legal fees, the cost of expert witnesses, police reports, engineering reports, and independent adjusters if assigned to a particular claim)
- ULAE: costs that cannot be assigned to a unique claim (e.g. costs associated with operating the claims department, including rent, technology, salaries, as well as management and administrative expenses).

Two broad techniques for estimating unpaid ULAE: dollar-based and count based methods.

While these techniques rely on different assumptions, and vary significantly in the amount of data and calculations required, they may produce similar results.

They are used for an entire population of claims, and need to be correct only for the "average" claim being reported, handled, paid, or closed during a time period (not for each individual claim).

ULAE liabilities have a "market value" in the fees that a third-party claims administrator (TPA) would require to manage the book of claims.

Self-insurers use such market values to determine the unpaid ULAE for financial reporting purposes.

2 Dollar-Based Techniques 387-402

Dollar-based techniques assume that ULAE track with claim dollars with regards to both timing and relative amount. This assumption:

- means that the timing of ULAE expenditures follows the timing of the reporting or payment of claim dollars.
- implies that a $1,000 claim requires ten times as much ULAE as a $100 claim.

4 commonly used dollar-based techniques:

1. Classical (a.k.a. traditional)
2. Kittel refinement
3. Conger and Nolibos method – generalized Kittel approach
4. Mango-Allen refinement

Dollar Based Techniques:

1. Classical (or Traditional) Technique

Unpaid ULAE is estimated using a CY paid ULAE-to-CY paid claims ratio.

Key Assumptions of Classical Technique

- The insurer's ULAE-to-claim relationship has reached a steady-state so that the ratio of paid ULAE-to-paid claims approximates ultimate ULAE-to-ultimate claims.
- The volume and cost of future claims management on not-yet-reported claims and reported-but-not-yet-closed claims will be proportional to IBNR and case O/S, respectively.

Assume that ½ of ULAE are sustained when opening a claim and ½ is sustained when closing the claim. Thus,

i. 50% of the ULAE ratio is applied to case O/S (since for known claims, ½ of the unallocated work was already completed at the time of opening);

ii. 100% of the ULAE ratio is applied to IBNR, since all unallocated work remains to be completed (i.e. the work associated with opening and closing the claims).

Mechanics of Classical Technique

4 steps in the classical technique for estimating unpaid ULAE:

1. Calculate ratios of historical CY paid ULAE-to-CY paid claims
2. Review historical paid ULAE-to-paid claims ratios for trends or patterns
3. Select a ratio of ULAE-to-claims applicable to future claims payments
4. Apply 50% of the selected ULAE ratio to case O/S and 100% of the selected ULAE ratio to IBNR

Calendar Year	Paid ULAE	Paid Claims	Ratio of Paid ULAE to Paid Claims
(1)	(2)	(3)	(4)
2004	14,352,000	333,000,000	0.043
2005	15,321,000	358,000,000	0.043
2006	16,870,000	334,000,000	0.051
2007	17,112,000	347,000,000	0.049
2008	17,331,000	391,000,000	0.044
Total	80,986,000	1,763,000,000	0.046

(5) Selected ULAE Ratio	0.045
(6) Case Outstanding at 12/31/08	603,000,000
(7) Total IBNR at 12/31/08	316,000,000
(8) Pure IBNR at 12/31/08	19,000,000
(9) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	27,787,500
(10) Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR	21,105,000

Column and Line Notes:

(2) and (3) Based on data from XYZ Insurer.

(4) = [(2) / (3)].

(5) Selected based on ULAE ratios in (4).

(6) Based on data from XYZ Insurer.

(7) Based on actuarial analysis at 12/31/08 for all lines combined.

(8) Estimated assuming pure IBNR is equal to 5% of accident year 2008 ultimate claims
Ultimate claims for all lines combined for accident year 2008 are $380 million for XYZ Insurer.

(9) = {[(5) x 50% x (6)] + [(5) x 100% x (7)]}.

(10) = {[(5) x 50% x ((6) + (7) - (8))] + [(5) x 100% x (8)]}.

Exhibit 1 comments:

- In estimating unpaid ULAE, the experience for the insurer as a whole (i.e. all lines of coverage combined) is used.
- It is good to have five years of complete and accurate data.
- It is surprising to see relatively stable ULAE ratios given all the changes we know transpired at XYZ Insurer during the experience period.
- A ULAE ratio of 0.045 is selected based on a review of the historical experience as well as discussions with company management regarding future expectations.

  These discussions include expectations regarding claims department caseload, the relationship between claim and salary inflation, as well as management's expectations of the future use of independent adjusters and TPAs.

For XYZ Insurer, case O/S at 12/31/ 2006 is \$603 million and selected IBNR is \$316 million.

Using the classical technique, we estimate unpaid ULAE at 12/31/2008 to be

$27.8 million = [(0.045 x 50% x $603 million) + (0.045 x 100% x $316 million)]

Challenges of the Classical Technique

One challenge: "closing" a claim and "paying" a claim do not necessarily mean the same thing. Examples:

- For glass coverage, a single payment is the norm, and payment represents settlement (i.e. closure) of the claim, and therefore the end of the claims handling activity.
- For WC, a claim payment and closing of the claim often differ, since regular payments can replace lost wages for an extended period of time.

Address this challenge by adjusting the %'s applied to the case O/S and the IBNR. Example:

For an insurer with a portfolio of long-tail professional liability coverage, with substantial claims-handling work during the life of the claim, unpaid ULAE ratios of 25% are applied to case O/S and 75% to IBNR (assumes a greater % of expenses are related to closing the claims rather than opening claims).

Another challenge is the definition of IBNR.

The broad definition of IBNR includes liability for both claims that are not yet reported as well as future case development on known claims.

The narrow definition of IBNR is incurred but not yet reported (IBNYR, a.k.a. pure IBNR), while future case development on known claims is referred to as incurred but not enough reported (IBNER).

Using the classical technique, apply 100% of the ULAE ratio to IBNYR (pure IBNR) and 50% of the ULAE ratio to the sum of case reserves and IBNER.

Pure IBNR maybe estimated as a % of total IBNR or a % of the selected ultimate claims for the latest AY(s). Assume:

- pure IBNR for XYZ Insurer is equal to 5% of the latest AYs (2008) ultimate claims.
- ultimate claims for AY 2008 of \$380 million

Calculate the unpaid ULAE for XYZ Insurer as follows:

Unpd ULAE = [(ULAE ratio x 50% x unpd known claims) + (ULAE ratio x 100% x Pure IBNR)]

= [(0.045 x 50% x (case outstanding + IBNER)) + (0.045 x 100% x IBNYR)]

Calculate: IBNYR claims of \$19 million (0.05 x \$380 million) and derive the IBNER claims as total IBNR less IBNYR or \$297 million (\$316 million - \$19 million).

Calculate: Estimated unpaid ULAE for XYZ Insurer as follows:

Unpd ULAE = [(0.045 x 50% x (\$603 million + \$297 million)) + (0.045 x 100% x \$19 million)] = \$21.1 million

This estimate of unpaid ULAE is significantly less than the initial estimate of \$27.8 million for XYZ insurer.

Comments:

Most actuaries assume 5% of the most recent AY ultimate claims approximates pure IBNR.

Test this assumption by calculating the pure IBNR claims and determine the ratio to total unpaid claims.

First estimate the number of IBNR claim counts (projected ultimate claim counts - reported claim counts).

Multiply IBNR counts for each AY by an ultimate severity value for each AY to estimate ultimate claims associated with pure IBNR.

Perform the analysis for each line of business, and the total ultimate claims associated with pure IBNR can be compared to total ultimate claims for both IBNR and reported claim counts for the latest AY.

When the Classical Technique Works and When it Does Not

In "Determination of Outstanding Liabilities for ULAE," Wendy Johnson states that the classical technique "will only give good results for very short-tailed, stable lines of business."

Kay Kellogg Rahardjo in "A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation" states:

- The paid to paid method assumes that claims incur expenses only when initially opened and when closed, which is not true for liability claims.
- The paid to paid ratio itself is subject to distortion when a company is growing or shrinking or when a line of business is in "transition" (e.g. consider WC in the early 1990s as many large customers moved to deductible policies or towards self-insurance).

Additional challenges include

* Choosing between the use of:
  - paid claims or closed claims and
  - total IBNR or pure IBNR.

* Assuming that 50% of ULAE payments are sustained when a claim is opened and 50% when a claim is closed may not accurately describe an insurer's application of resources to the life cycle of its claims.

* Use of the classical technique leading to inaccurate results when the volume of claims is growing.

Mango and Allen in "Two Alternative Methods for Calculating the Unallocated Loss Adjustment Expense Reserve", note that:

i. the numerator in the ratio (i.e. CY paid ULAE) tends to react relatively quickly to an increase in exposure or an increase in the number of claims being reported.

ii. the denominator (i.e. paid claims) reflects claim payments made on claims reported at the former, lower, exposure base and will not be as responsive to the growth in volume.

Thus, the resulting paid ULAE-to-paid claims ratio may misrepresent the true situation.

A similar mismatch between paid ULAE and paid claims can occur if the volume is decreasing.

* Inflation can also create distortions in the classical technique.

In his 1973 paper "Unallocated Loss Adjustment Expense Reserves in an Inflationary Economic Environment," Kittel notes that the classical technique does include an inflation adjustment to the degree that total unpaid claims take inflation into account.

i. if the costs underlying ULAE inflate at the same rate as claim costs, then inflation is accounted for.

ii. however, if different rates of inflation underlie the claims experience and ULAE, the estimated unpaid ULAE may not be predictive of future experience.

Mango and Allen expand on this point:

"... the paid-to-paid ratio is distorted upwardly under inflationary conditions because the impact of inflation on the denominator of the ratio lags its impact on the numerator. This lag is due to the fact that most of the losses paid in a CY were incurred in a prior year, and thus are largely unaffected by the most recent inflation."

In summary, the classical technique may not be appropriate for:

1. Long-tail lines of business
2. Times of changing inflationary forces, either in the past or expected in the future
3. When an insurer is experiencing a rapid change in volume (either expansion or decrease in the size of its portfolio)
4. Where the 50/50 assumption is not an appropriate representation of the claims handling workflow

<u>Kittel Refinement</u>

Kittel describes a weakness in the classical technique:

The Loss Department doesn't just close claims but it also opens them.

Paid losses don't accurately represent the work done by the Loss Department since they do not take into account claims opened during the year which remain open at year end.

This can be significant when loss reserves vary from year to year (e.g. a growing line with rapidly inflating loss costs could have loss reserves increase at 30% - 40% per year).

Key Assumptions of Kittel Refinement to the Classical Technique:

- ULAE is sustained as claims are reported even if no claim payments are made.
- ULAE payments for a specific calendar year are related to both the reporting and payment of claims.

Thus, Kittel's refinement is the use of the ratio of paid ULAE-to-the average of paid claims and incurred (as a reasonable approximation of the relationship of ultimate ULAE- to-ultimate claims).

CY incurred claims = CY paid claims + change in total claim liabilities (including both case O/S and IBNR).

Derivation of Kittel's formula:

Use the 50/50 assumption, ignore partial payments, the loss dollars processed with the CY paid ULAE are:

½ unit of work	x	payments on prior outstanding reserves
1 complete unit	x	losses opened and paid during the year
½ unit of work	x	losses opened remaining open

If reserves are accurate, CY incurred = AY incurred = losses opened and paid + opened remaining open.

So,

Calendar paid = opened and paid + paid on prior O/S reserves

Calendar incurred = opened and paid + opened remaining opened

½ (calendar paid + incurred) = Losses opened and paid
+ ½ payments on prior O/S
+ ½ losses opened remaining open

Kittel accepts the second key assumption of the classical technique as valid for the Kittel refinement (i.e. ½ of expenses are sustained when opening a claim and ½ of expenses when closing a claim).

Mechanics of the Kittel Refinement

Kittel's refinement to the classical technique is shown in Exhibit II. The four steps in this technique are:

1. Develop ratio of historical CY paid ULAE-to-average of CY paid and CY incurred claims
2. Review historical ratios for trends or patterns
3. Select a ratio of ULAE-to-claims applicable to future claims payments
4. Apply 50% of the selected ULAE ratio to case outstanding and 100% of the selected ULAE ratio to IBNR (identical to the classical technique)

Kittel's Refinement Exhibit 2

Calendar Year	Paid ULAE	Paid Claims	Incurred Claims	Average Paid and Inc. Claims	ULAE Ratio Paid Claims	Paid ULAE to Avg Paid and Inc. Claims
(1)	(2)	(3)	(4)	(5)	(6)	('7)
2004	14,352,000	333,000,000	535,213,000	434,106,500	0.043	0.033
2005	15,321,000	358,000,000	492,265,000	425,132,500	0.043	0.036
2006	16,870,000	334,000,000	435,985,000	384,992,500	0.051	0.044
2007	17,112,000	347,000,000	432,966,000	389,983,000	0.049	0.044
2008	17,331,000	391,000,000	475,300,000	433,150,000	0.044	0.040
Total	80,986,000	1,763,000,000	2,371,729,000	2,067,364,500	0.046	0.039

(8) Selected ULAE Ratio	0.04
(9) Case Outstanding at 12/31/08	603,000,000
(10) Total IBNR at 12/31/08	316,000,000
(11) Pure IBNR at 12/31/08	19,000,000
(12) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	24,700,000
(13) Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR	18,760,000

(2) through (4) Based on data from XYZ Insurer.
(5) = [Average of (3) and (4)].
(6) = [(2) / (3)].
(7) = [(2) / (5)].
(8) Selected based on ULAE ratios in (7).
(9) Based on data from XYZ Insurer.
(10) Based on actuarial analysis at 12/31/08 for all lines combined.
11) Estimated assuming pure IBNR is equal to 5% of accident year 2008 ultimate claims.
Ultimate claims for all lines combined for accident year 2008 are $380 million for XYZ Insurer.
(12) = {[(8) x 50% x (9)] + [(8) x 100% x (10)]}.
(13) = {[(8) x 50% x ((9) + (10) - (11))] + [(8) x 100% x (11)]}.

Using Kittel's refinement, we observe lower ULAE ratios than with the classical technique (traditional paid-to-paid approach).

- This is expected when incurred claims are greater than paid claims on a CY basis.
- Based on Kittel's refinement, a ULAE ratio of 0.040 is selected.

Using Kittel's refined technique, estimate unpaid ULAE for XYZ Insurer to be $24.7 million using the formula with total IBNR and $18.8 million using the formula with an adjustment to determine pure IBNR.

$24.7 million = [(0.04 x 50% x $603 million) + (0.04 x 100% x $316 million)]

$18.8 million = [(0.04 x 50% x ($603 million + $297 million)) + (0.04 x 100% x $19 million)]

The Kittel refinement address the challenge in the classical technique related to sustaining ULAE for activities beyond simply paying a claim.

However, the refinement does not explicitly address the issue associated with the definition of IBNR (i.e. modifying the formula to differentiate between IBNYR and IBNER).

Problems associated with the Kittel Refinement

- The use of traditional 50/50 assumption regarding ULAE expenditures does not allow for allocation of ULAE costs between opening, maintaining, and closing claims which may vary from insurer to insurer.
- There is no potential for using different rates of inflation between ULAE and claims.

<u>Conger and Nolibos Method – Generalized Kittel Approach</u>

Conger and Nolibos sought to define a procedure to estimate unpaid ULAE that would:

a. Recognize an insurer's rapid growth
b. Be consistent with patterns of the insurer's ULAE expenditures over the life of a claim
c. Reproduce key concepts underlying the Johnson technique
d. Use commonly available and reliable aggregate payment and unpaid claims data
e. Include an extension to the Kittel refinement which would allow for alternatives to the 50/50 rule

The generalized approach uses weighted claims, which recognizes that claims use up different amounts of ULAE at different stages of their life cycle, from opening to closing.

- Newly opened, open, and newly closed claims are each given different weights when determining the claims basis to which ULAE payments during a past or future calendar period are related.
- Since handling costlier claims warrants more resources than handling smaller claims, they use <u>claim dollars</u> instead of claim counts in their generalized approach.

The claim basis for a particular time period is defined to be the weighted average of the:

- ***Ultimate cost of claims reported*** during the period (ultimate includes reported amounts and future development on known claims)
- ***Ultimate cost of claims closed*** during the period (includes any future payment made after the claim closing)
- ***Claims paid*** during the period

Compare:

Kittel's weights are fixed at 50% for incurred claims and 50% for paid claims.

The generalized method introduces a 3^{rd} claim measure that allows distinguishing the cost of maintenance from the cost of closing.

Key Assumptions of Generalized Approach

- Expenditure of ULAE resources is proportional to the dollars of claims being handled (in contrast to Johnson's assumption that ULAE costs are independent of claim size and nature).
- ULAE amounts spent <u>opening</u> claims are proportional to the ultimate cost of claims being reported.
- ULAE amounts spent <u>maintaining</u> claims are proportional to payments made.
- ULAE amounts spent <u>closing</u> claims are proportional to the ultimate cost of claims being closed.

Mechanics of Generalized Approach

Conger and Nolibos define $U_1 + U_2 + U_3 = 100\%$, where:

- U_1 is the % of ultimate ULAE spent opening claims
- U_2 is the % of ultimate ULAE spent maintaining claims
- U_3 is the % of ultimate ULAE spent closing claims

Determine reasonable ranges for U_1, U_2, and U_3 and test the sensitivity of the final estimate of unpaid ULAE to variations within those ranges.

The values of U_1, U_2, and U_3 could vary significantly from insurer to insurer and between lines of business.

- For a litigation-intense liability book of business, a strong concentration of activity close to the time of claim settlement and payment exists.
- For WC, greater front-end costs exist.

For time period T, Conger and Nolibos define M, the total amount spent on ULAE during a time period T, to be

$M = (U_1 \times R \times W) + (U_2 \times P \times W) + (U_3 \times C \times W)$, where

- R is the ultimate cost of claims <u>reported</u> during T
- P is the claims <u>paid</u> during T
- C is the ultimate cost of claims <u>closed</u> during T
- W is the ratio of ultimate ULAE to ultimate claims (L)

* T could be activity between t_1 and t_2 related to an AY or for all AYs, where t_1 and t_2 are points in time.
* Algebraically derive the ratio W = M/B by defining B, ***the claims basis*** for the time period T to be:

$B = (U_1 \times R) + (U_2 \times P) + (U_3 \times C)$

Thus, M = B x W, and W = M/B.

Each component of the claims basis is a value of the claims underlying the ULAE payments. Thus,

- $U_1 \times R$: the claims basis for ULAE spent setting up new claims
- $U_2 \times P$: the claims basis for ULAE spent maintaining open claims
- $U_3 \times C$: the claims basis for ULAE spent closing existing claims

Insurers measure and report M, the ULAE payments during a period, on a CY basis.

- Once U_1, U_2, and U_3 are estimated or selected, the claims basis B can be calculated from claim amounts R, P, and C, that can be determined from data underlying an analysis for estimating unpaid claims.
- M (total ULAE payments) and B (claim basis) can be calculated for historical calendar periods. By computing the ratio W (= M/B, where both M and B are expressed on a CY basis), we obtain ratios of ULAE to claims by CY.
- Select an overall ratio of ULAE-to-claims, W*, which is used to estimate future ULAE payments.

Ultimate ULAE (U) for a group of AYs can be estimated as:

$U = W^* \times L$, where

- W* is the selected ultimate ULAE-to-claims ratio
- L is the independently estimated ultimate claims for the same group of AY

3 ways to estimate unpaid ULAE for a group of AYs.

1. Compute Unpaid ULAE by subtracting ULAE already paid (M) from the estimate of ultimate ULAE (U).
Unpaid ULAE = $(W^* \times L) - M$

Practical and Conceptual Problems with this Method:

- Practically, it may be difficult to quantify the historical paid ULAE that corresponds only to the AYs claims represented by L.
- Conceptually, this shares the potential distortions of an expected claims ratio approach to estimating unpaid claims (unpaid claims equal a predetermined expected claims ratio time earned premium less claims paid to date). The unpaid claim estimate is distorted if actual paid claims do not approach expected ultimate claims.

2. Conger and Nolibos Preferred Method:

The method is similar to a BF technique in that an a priori provision of unpaid ULAE is calculated.

Unpaid ULAE = W* x (L - B)

Deriving the estimate (for a group of AYs). Assume that

R(t) – ultimate cost of claims known at time t

P(t) – total amount paid at time t

C(t) – ultimate cost of claims closed at time t

Compute Unpaid ULAE = W* x {U_1 x [L – R(t)] + U_2 x [L – P(t)] + U_3 x [L – C(t)]},

Each component of the unpaid ULAE formula represents a provision for the ULAE associated with:

- Opening claims not yet reported
- Making payments on currently active claims and on those claims that will be reported in the future
- Closing "unclosed" claims (i.e. those claims that are open at time t and those claims that will be reported and opened in the future)

Rearranging the equation, one obtains:

Unpaid ULAE = W* x (L - B)

This method assumes that the amount of ULAE paid to date and the unpaid ULAE are not directly related, except to the extent that these payments influence the selection of the ratio W*.

This is similar to the assumption underlying the BF technique.

3. Compute Unpaid ULAE in a similar way to the claims development method.

Unpaid ULAE could be estimated by the following formula:

Unpaid ULAE = M x (L/B – 1.00)

This implies that unpaid ULAE are proportional to paid amounts reported to date.

Practical problems and concerns:

- The practical difficulty of establishing the ULAE amounts paid that correspond to accidents occurring during a particular period
- This method may be overly responsive to random fluctuations in ULAE emergence.

Application of Generalized Approach to Claim Counts

The formula for a claim count basis used in the determination of unpaid ULAE is:

$b = (v_1 \times r) + (v_2 \times o) + (v_3 \times c)$, where

- r represents reported claim counts
- o represents open claim counts
- c represents closed claim counts
- v_1 is the estimate of the relative cost of handling the reporting of a claim (for one year)
- v_2 is the estimate of the relative cost of managing an open claim (for one year)
- v_3 is the estimate of the relative cost of closing a claim (for one year)

It is not necessary to determine the actual costs of the various claim activities but instead their relative magnitudes.

Example: Johnson assumes that $v_1 = 2$, $v_2 = 1$, and $v_3 = 0$.

Using estimated v_1, v_2, and v_3, select w*, the ratio of ULAE to the claim count basis, based on the historical data w = M/b, where M still represents ULAE payments.

After selecting w* (or a series of w^*_i which reflect future inflation adjustments),

Compute: Unpaid ULAE = $\Sigma\ w^*_i \times [(v_1 \times r_i) + (v_2 \times o_i) + (v_3 \times c_i)]$, where

- r_i represents the number of claims to be reported in each CY i
- o_i represents the number of open claims at the end of CY i
- c_i represents the claims to be closed during CY i
- i represents the series of future CY-ends until all claims are closed

Comments:

- Only claims occurring on or before the valuation date should be considered.
- A claim that stays open for a number of years is counted multiple times in the summation, and is consistent with the assumption that there are ULAE payments each year as long as a claim stays open.
- The formula could be adapted to reflect the Rahardjo and Mango-Allen concepts of cost varying over time by stratifying the claims activities more finely than just reporting, opening, and closing.

Simplification of Generalized Approach

The estimation of R (ultimate cost of reported claims) and C (ultimate cost of closed claims) may not be easy.

R can be computed as the ultimate for the accident period ending on that date - pure IBNR amounts, which represent the ultimate cost of not yet reported claims.

C represents the final cost of claims closed as of the valuation date including any subsequent payments (i.e. paid on closed if the line of business does not have subsequent payments.)

Consider a simplification where estimates of R and C are not required.

1. Estimate ultimate claims for the AY as a proxy for the ultimate costs of claims reported in the CY.

   The CY amount equals the sum of the corresponding AY ultimate claims + pure IBNR at the beginning of the year - pure IBNR at the end of the year.

   The error in this approximation is based on a review of changes in exposures between AYs and the characteristics of the coverage being analyzed to make adjustments based on judgment.

2. Assume $U_3 = 0$, if no additional effort is required to close an existing claim

   This assumption is not appropriate for professional liability or employment practices liability are lines of business where a significant portion of the claims-related expenses will be incurred with its settlement.

If it is ok to assume that $U_3 = 0$, then $U_1 + U_2 = 100\%$, and compute B, the claims basis for each CY as

Est. B = $(U_1 \times A) + (U_2 \times P)$, where A represents the ultimate claims for the AY.

Then calculate observed W values for each year as W = M/Est. B

After a review of the observed ULAE ratios, select an appropriate ratio W* for estimating unpaid ULAE.

Next, estimate pure IBNR (perhaps by analyzing claim reporting patterns and ultimate severities) and deduct this estimate from L to obtain an estimate of the ultimate costs of claims reported to date (R).

Finally, compute ULAE is either of two ways:

Unpaid ULAE = $W^* \times \{L – [(U_1 \times R) + (U_2 \times P)]\}$, which can be expressed as

Unpaid ULAE = $W^* \times [U_1 \times (L – R) + U_2 \times (L – P)\}$

Practical Difficulties with the Generalized Approach

- The estimation of R and C, the ultimate cost of reported and closed claims, is not simple.
- It is not known about the relative accuracy of the generalized method (as compared to other dollar-based methods) in an inflationary environment.
- The effect of reopened claims on the accuracy of the estimates of unpaid ULAE is not known.
- How to modify the approach to properly reflect the change over time in the quantity or cost of resources dedicated to the handling of a claim, as that claim ages is not known.

Mango-Allen Variation of the Kittel Refinement to the Classical Technique

- Their variation applies when working with a line of business where the actual historical calendar period claims are volatile, due to random reporting or settlement of large claims (i.e. for lines of business with a relatively small number of claims of widely varying sizes).
- They suggest replacing actual calendar period claims with *expected* (by applying selected reporting and payment patterns to a set of AY estimated ultimate claims) claims for those historical calendar periods.
- They explain that the actuary can estimate the expected paid claims by applying selected reporting and payment patterns to a set of accident year estimated ultimate claims.

Key Assumptions of Mango-Allen Refinement to the Classical Technique

- An insurer's ULAE-to-claim relationship is derived based on a review of the ratio of paid ULAE-to-expected paid claims (vs. the classical technique where paid ULAE is compared to actual paid claims).
- Uses the second key assumption of the classical technique (i.e. one-half of expenses are sustained when opening a claim and one-half of expenses when closing a claim).

Mechanics of Mango-Allen Refinement to the Classical Technique

Shown in Exhibit III for New Small Insurer, a new insurer specializing in lawyers' professional liability coverage. 5 steps in this technique:

1. Estimate calendar year expected paid claims
2. Develop ratio of historical calendar year paid ULAE-to-expected calendar year paid claims
3. Review historical ratios for trends or patterns
4. Select a ratio of ULAE-to-claims applicable to future claims payments
5. Apply 50% of the selected ULAE ratio to case outstanding and 100% of the selected ULAE ratio to IBNR

1. Begin the analysis by estimating expected paid claims for each of the four CYs in the experience period.
   * Expected CY payments are based on EP * an expected claims ratio * the percentage expected to be paid in each year.
   * Since New Small Insurer is a new company without credible historical claims experience, rely on the claims ratio underlying the pricing analyses as well as insurance industry benchmark payment patterns.

Exhibit III, Sheet 1

Accident Year	Direct Earned Premium	Expected Claims Ratio	Expected Claims	Expected Payment Percentage in Calendar Year 2005	2006	2007	2008	Expected Claims Paid in Calendar Year 2005	2006	2007	2008
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2005	4,300,000	55%	2,365,000	12%	15%	15%	15%	283,800	354,750	354,750	354,750
2006	4,250,000	55%	2,337,500		12%	15%	15%		280,500	350,625	350,625
2007	4,420,000	55%	2,431,000			12%	15%			291,720	364,650
2008	3,985,000	55%	2,191,750				12%				263,010
Total	16,995,000		9,325,250					283,800	635,250	997,095	1,333,035

Column Notes:
(2) Based on information provided by New Small Insurer.
(3) Based on actuarial analysis conducted for pricing purposes.
(4) = [(2) x (3)].
(5) through (8) Based on actuarial analysis of insurance industry benchmark paid claims development experience.
(9) = [(4) x (5)].
(10) = [(4) x (6)].
(11) = [(4) x (7)].
(12) = [(4) x (8)].

2. Proceeds in a similar fashion as the classical technique (See Exhibit III, Sheet 2.)

Calendar Year	Paid ULAE	Paid Claims Actual	Paid Claims Expected	ULAE Ratio Paid ULAE-to-Paid Claims Actual	ULAE Ratio Paid ULAE-to-Paid Claims Expected
(1)	(2)	(3)	(4)	(5)	(6)
2005	55,000	1,253,450	283,800	0.044	0.194
2006	62,500	86,000	635,250	0.727	0.098
2007	70,000	410,650	997,095	0.170	0.070
2008	80,000	309,600	1,333,035	0.258	0.060
Total	267,500	2,059,700	3,249,180	0.130	0.082

(7) Selected ULAE Ratio	0.07
(8) Case Outstanding at 12/31/08	225,000
(9) Total IBNR at 12/31/08	6,430,000
(10) Pure IBNR at 12/31/08	109,588
(11) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	457,975
(12) Estimated Unpaid ULAE at 12/31/al Using Pure IBNR	236,761

(2) and (3) Based on data from New Small Insurer.
(4) Developed in Exhibit III, Sheet 1.
(5) = [(2) / (3)].
(6) = [(2) / (4)].
(7) Selected based on ULAE ratios in (6) and input of New Small Insurer Mgt.
(8) Based on claims data from New Small Insurer.
(9) Based on actuarial analysis at 12/31/08.
(10) Estimated assuming pure IBNR is equal to 5% of AY expected claims.
(11) = {[(7) x 50% x (8)] + [(7) x 100% x (9)]}.
(12) = {[(7) x 50% x ((8) + (9) - (10))] + [(7) x 100% x (10)]}.

Observe that:

- the ratios of paid ULAE-to-actual paid claims are much more volatile than the ratios of paid ULAE-to-expected paid claims.
- a pronounced downward trend in the paid ULAE-to-expected paid claims ratios.

Understanding the reasons behind this trend

i. reviewing the assumptions underlying the development of expected paid claims
ii. discuss with management about actual paid ULAE.

Possible explanations:

* The industry-based payments pattern for developing expected paid claims may be too fast for the insurer.

* The variability and downward trends could be related to large claims (from a review of claims data that there are several open claims for the most recent AYs in litigation with large case O/S and small payments to date).

After discussion with management about its expectations for the upcoming years, and a review of current claims data, we select a ratio of 0.07 for estimating unpaid ULAE.

Estimated unpaid ULAE at 12/31/08 of $457,975 using total IBNR and $236,761 using pure IBNR is as follows:

$457,975 = [(0.070 x 50% x $225,000) + (0.070 x 100% x $6,430,000)]

$236,761 = {[0.070 x 50% x ($225,000 + (6,430,000 – 109,588))] + [0.070 x 100% x $109,588]}

When the Mango-Allen Refinement Works and When it Does Not

- The Mango-Allen refinement is a good alternative for insurers with limited or highly volatile claims experience.
- However, for insurers with a large volume of paid claims experience, the additional calculations to estimate expected paid claims to improve the accuracy of projected unpaid ULAE may not justify the time and costs involved.

3 Count Based Techniques 402-406

2 drawbacks to the use of claims (vs. claim counts) as a base for estimating unpaid ULAE.

1. ULAE is not solely dependent on the magnitude of its accompanying claim dollars. ULAE is also dependent on the average claim size. For example,
   i. the ULAE required to settle a one million-dollar claim is less than the ULAE required to settle ten $100,000 claims.
   ii. However, the classical technique with its use of a paid-to-paid ratio does not recognize this difference.

2. The estimate of unpaid ULAE becomes a “rider” on the estimate of unpaid claims, responding to whatever volatility is present in the estimate of ultimate claims.
   Unpaid ULAE is not expected to respond fully to fluctuations in claim amounts. If there is a sudden drop in claim counts or in the value of claims, we would not expect an immediate drop in the overhead expenses or the number of claims management personnel.

Key assumptions in count-based techniques:

- is that the same kind of transaction costs the same amount of ULAE regardless of the claim size.
- a claim that stays open longer will cost proportionately more than a quick-closing claim, with respect to some component of ULAE.

<u>Early Count Techniques</u>

R.E. Brian suggested breaking the ULAE process into five kinds of transactions:

1. Setting up new claims
2. Maintaining outstanding claims
3. Making a single payment
4. Closing a claim
5. Reopening a claim

In the Brian technique:

- the actuary projects the future number of each type of transaction.
- each of these transactions would carry a similar cost, and suggested estimating the cost per transaction using ratios of historical ULAE expenditures to the number of claim transactions occurring during the same calendar periods.

Assumptions and Weaknesses of the technique:

* The primary assumption (which Conger and Nolibos identify as a weakness) is that each of the five kinds of claims transactions requires similar ULAE resources and expenditures.

  However, the weakness could easily be remedied by refining the formula to allow for different costs for the different types of transactions.
* A more significant weakness of this technique is the difficulty in estimating both the number of future transactions and the average cost of each transaction.

  Reliable and consistent claim count and claim transaction data supporting these projections is often not readily available.

Wendy Johnson Technique (similar to Brian's approach)

Wendy Johnson's approach focuses on two key transactions: reporting and maintenance.

- Johnson then projects the future number of newly reported claims, as well as the number of claims that will be in a pending status each year (i.e. will require maintenance work during the year).
- Johnson then estimates the cost of each transaction by comparing historical aggregate ULAE expenditures to the number of transactions occurring in the same time period.
- Johnson's technique allows for an explicit differential in the amount of ULAE cost required for different types of claim transactions (e.g. opening a claim costs $x and maintaining existing claims costs an additional $x).

The benefit of Johnson's approach is that it only requires the actuary to estimate the *relative* amount of resources for each transaction type (detailed time-and-motion studies to calculate the actual cash cost of each transaction type are not needed).

Mango-Allen Claim Staffing Technique (in response to shortcomings in Johnson's method)

The technique is a "transaction-based method", using future claim staff workload levels and a new projection base, equal to the sum of calendar year opened, closed, and pending claims (OCP claims).

The following four components are computed

1. Future CY OCP claims
2. Future CY claim staff workloads, which are expressed as OCP claims per staff member
3. Future CY claim staff count
4. Future CY ULAE per claim staff member

Future CY ULAE payments = (future claim staff count)*(future ULAE per claim staff member), and consider inflation.

Estimated unpaid ULAE is the sum of future CY ULAE payments.

3 characteristics of OCP claims that make their use as a base for the claim staffing method appealing:

1. *It is a reasonable proxy for claims department activity* (i.e. directly proportional to levels of claim activity, especially number of staff and workload levels of the staff).
2. *It is claim count based.* Claims counts (if case complexity issues are addressed) bear a more direct relationship to claim staff activity.
3. *It is derivable from typical reserve study information*. Projected opened, closed and pending claims are derivable from ultimate claim counts, a claim reporting pattern and a claim closing pattern.

Conger and Nolibos note:

- that the estimate of unpaid ULAE is likely to be sensitive to the magnitude of the selected parameters.
- the estimates will be influenced by parameters not explicitly considered in the article (e.g. the implicit assumption that equal amounts of ULAE resources are required to open, close, and handle one average claim for a year).

Rahardjo

Kay Kellogg Rahardjo:

- discusses the different levels of work effort required for handling claims in the first 30 days than for claims that have been open for five years.
- focuses on the length of time for which WC claims remain open, which she defines to be the "duration." She states: "As duration increases, so does the expense of handling the claim for the remainder of the claim's life."

Spalla

Joanne Spalla asserts:

- that manual time-and-motion studies are not needed to determine the costs of claim-related activities and transactions.
- the use of modern claim department information systems to track time spent on individual claims by level of employee since many claims-related activities are computer-supported.
- these average claim costs, loaded for overhead and other costs that are not captured by the computerized tracking systems, can be applied within frameworks as described by Rahardjo and Mango-Allen (claim staffing technique).

A benefit of working with the underlying cost data is that it allows for more detailed analysis of the claim activity costs, to determine which types of claim transactions and which stages of the claim life cycle have relatively similar (or different) costs.

Conger and Nolibos suggest when Spalla's method, consider evaluating a 'reality check': if the selected costs per transaction were applied to the numbers of transactions that were undertaken last year, would the result match that period's actual total ULAE expenditures?"

While Spalla describes determining the actual cost, the approach could also be used to quantify the relative amount of cost per transaction compared to the cost of other kinds of claim transactions.

- This relativity is less subject to annual change than the dollar cost per transaction or per activity.
- With relativities, the actuary could use the general approaches described in Rahardjo and Mango-Allen, but now with some quantitative basis for the magnitude of the parameters.

4 Triangle-Based Techniques 406

1. Actuaries can estimate ULAE using triangle-based development techniques.

   To analyze ULAE in triangular format, a method used to assign ULAE to individual cells (AY by evaluation year) of the triangle is needed.

   Since "actual" ULAE by AY is not observable, at least not for all categories of ULAE, the actuary will need to form assumptions for the creation of the paid ULAE triangle. ULAE payments are usually allocated using the pattern of claim payments.

   Note: AY triangles of ULAE may be distorted if either the method of allocating calendar ULAE to accident years changes over time or if the claims payment patterns change.

2. R.S. Slifka suggests using a time-and-motion study to estimate the claim department's allocation of resources/costs between current AY claims and prior AY claims.

   For example, assume that a time and motion study suggests that:

   - 60% of the current accident year's ULAE remains unpaid
   - 15% of the prior accident year's ULAE remains unpaid
   - 5% of the second prior accident year's ULAE remains unpaid

   Total unpaid ULAE is estimated as 80% (60% + 15% + 5%) of a typical CYs ULAE payment.

   This technique presumes a steady state, and can be refined to reflect volume growth as well as the effects of inflation.

3. Construct paid ULAE triangles based on time and motion studies.

   For example, assume that time and motion studies suggest that 50% of ULAE is paid at the time a claim is reported and the remaining 50% is paid in proportion to claim payments.

   An actuary can then assign historical calendar ULAE to accident year-calendar year cohorts:

   i. 50% according to the distribution of reported claims across current AY, prior AY, second prior AY, and so on; and

   ii. 50% according to the distribution of paid claims, as indicated by an appropriate AY claims payment pattern.

   Once the ULAE triangle is constructed, apply the traditional development technique to estimate ultimate ULAE and indicated unpaid ULAE.

In practice, ULAE triangle projections are rarely used by actuaries.

5 Comparison Example 407

Conger and Nolibos provide an example of a U.S. WC insurer who has been in operations for 6 years. In Exhibit IV, Sheet 1, CY and AY experience data from their example is shown for PQR Insurer.

Chapter 17 - Unallocated Loss Adjustment Expenses **Exhibit IV**
PQR Insurer **Sheet 1**
Summary of Input Parameters ($000)

	Calendar Year			Ult on	Accident Year		
Year	Paid ULAE	Paid Claims	Reported Claims	Reported in Calendar	Ultimate Claims	IBNR at 12/31/2008	Reported Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2003	1,978	4,590	19,534	27,200	28,600	257	28,343
2004	4,820	14,600	57,125	76,700	79,200	1,742	77,458
2005	8,558	38,390	85,521	106,900	108,400	5,095	103,305
2006	12,039	58,297	128,672	154,300	156,700	16,140	140,560
2007	13,143	86,074	145,070	163,100	163,400	34,477	128,923
2008	15,286	105,466	163,626	176,400	177,100	56,141	120,959
Total	55,824	307,417	599,548	704,600	713,400	113,852	599,548

Note: Claims include allocated claim adjustment expenses.
Column Notes:
(2) through (4) Based on data from PQR Insurer. Reported claims represent paid claims, case outstanding, and estimated IBNR. (5) through (7) Based on actuarial analysis at year-end 2008.
(8) Based on data from PQR Insurer. Includes paid claims, case outstanding, and estimated IBNR.

Exhibit IV, Sheet 2:

- Over the six years of operations, paid ULAE averaged about 18% of claims, and given the downward trend in the paid-to-paid ratios in Column (6), a ULAE ratio of 16% may be selected.
- Based on the above, an actuary using the:
  i. traditional technique would derive estimated unpaid ULAE of $41.6 million.
- ii. Kittel refinement, and a 11.5% ULAE ratio would derive estimated unpaid ULAE of $29.9 million (see (7).

Chapter 17 - Unallocated Loss Adjustment Expenses **Exhibit IV**
PQR Insurer **Sheet 2**
Classical and Kittel Techniques ($000)

					ULAE Ratio- Paid ULAE to	
Calendar Year	Paid ULAE	Paid Claims	Reported Claims	Average of Paid and Claims	Paid Claims Traditional	Avg Paid & Rptd Claims Kittel
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2003	1,978	4,590	19,534	12,062	0.431	0.164
2004	4,820	14,600	57,125	35,863	0.33	0.134
2005	8,558	38,390	85,521	61,956	0.223	0.138
2006	12,039	58,297	128,672	93,485	0.207	0.129
2007	13,143	86,074	145,070	115,572	0.153	0.114
2008	15,286	105,466	163,626	134,546	0.145	0.114
Total	55,824	307,417	599,548	453,484	0.182	0.123

(8) Selected ULAE Ratio	0.16	0.115
(9) Case Outstanding at 12/31/08	292,130	292,130
(10) IBNR at 12/31/08	113,853	113,853
(11) Estimated Unpaid ULAE at 12/31/08	41,587	29,891

Column and Line Notes:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = [Average of (3) and (4)].
(6) = [(2) / (3)].
(7) = [(2) / (5)].
(8) Selected based on ULAE ratios in (6) and (7).
(9) Based on data from PQR Insurer.
(10) Based on actuarial analysis at 12/31/08 for all lines combined.
(11) = {[(8) x 50% x (9)] + [(8) x 100% x (10)]}.

For PQR Insurer, Conger and Nolibos found that:

- ULAE expenditures are concentrated more heavily towards the front end of the claim than are the claim payments.
- the growth of PQR Insurer will result in an overstatement of the estimated unpaid ULAE using the traditional technique.
- discussions with PQR management and examination of the flows of work and allocation of resources in the claims department suggest 60% to 70% of the work for a claim is concentrated at the time the claim is reported, and 30% to 40% of the work is spread over the remaining life of the claim.
- no particular extra degree of effort is required to close the claim.

Since ULAE expenses are heavier at the beginning of the claim's life cycle, the estimated unpaid ULAE using the Kittel refinement results in a lower estimate of unpaid ULAE ($29.9 million) than the traditional technique ($41.6 million).

Exhibit IV, Sheet 3, shows the Conger and Nolibos generalized method with U_1= 60%, U_2= 40%, and U_3 = 0%

Chapter 17 - Unallocated Loss Adjustment Expenses **Sheet 3**
PQR Insurer **Exhibit IV**
Conger and Nolibos Generalized Approach - 60/40 Assumption ($000)

Calendar Year (1)	Paid ULAE (2)	Ult on Claims Reported in Calendar Year (3)	Paid Claims (4)	Claims Basis (5)	ULAE Ratio (6)
2003	1,978	27,200	4,590	18,156	0.109
2004	4,820	76,700	14,600	51,860	0.093
2005	8,558	106,900	38,390	79,496	0.108
2006	12,039	154,300	58,297	115,899	0.104
2007	13,143	163,100	86,074	132,290	0.099
2008	15,286	176,400	105,466	148,026	0.103
Total	55,824	704,600	307,417	545,727	0.102

(7) Selected ULAE Ratio	0.100
(8) Ultimate Claims	713,400
(9) Indicated Unpaid ULAE Using:	
(a) Expected Claim Method	15,516
(b) Bornhuetter-Ferguson Method	16,767
(c) Development Method	17,152

<u>Column and Line Notes</u>:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = {[(3) x 60%] + [(4) x 40%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(8) From Exhibit IV, Sheet 1.
(9a) = {[(7) x (8)] - (Total in (2))}.
(9b) = {(7) x [(8) - (Total in (5))]}.
(9c) = {{[(8) / (Total in (5))] - 1.00} x (Total in (2))}.

The claims basis in Column (5) is equal to 60% of the ultimate on claims reported in the year (R) and 40% of paid claims (C). A ULAE ratio of 10% is selected based on a review of the historical experience by year.

The estimated unpaid ULAE in Line (9) is computed using the 3 approaches described in the previous section:

- Expected claim method = [(selected ULAE ratio x ultimate claims) – total paid ULAE to date]
- Bornhuetter-Ferguson method = [selected ULAE ratio x (ultimate claims – total claims basis)]
- Development method = {[(ultimate claims / total claims basis) – 1.00] x total paid ULAE to date}

Exhibit IV, Sheet 4, shows the Conger and Nolibos generalized method with U_1= 70%, U_2= 30%, and U_3 = 0%

Exhibit IV, Sheet 5 presents the Conger and Nolibos simplified generalized approach.

Shown is a range of estimated unpaid ULAE assuming pure IBNR = 4% of the latest AY ultimate claims or 6% of the latest AY ultimate claims.

Chapter 17 - Unallocated Loss Adjustment Expenses **Exhibit IV**
PQR Insurer **Sheet 5**
Conger and Nolibos Simplified Generalized Approach - 60/40 Assumption ($000)

Year	Cal Year Paid ULAE	Acc Year Ultimate Claims	Cal Year Paid Claims	Claims Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)
2003	1,978	28,600	4,590	18,996	0.104
2004	4,820	79,200	14,600	53,360	0.090
2005	8,558	108,400	38,390	80,396	0.106
2006	12,039	156,700	58,297	117,339	0.103
2007	13,143	163,400	86,074	132,470	0.099
2008	15,286	177,100	105,466	148,446	0.103
Total	55,824	713,400	307,417	551,007	0.101

(7) Selected ULAE Ratio	0.10
(8) Ultimate Claims	713,400
(9) Estimated Pure IBNR Based on	
(a) 4% of Latest Accident Year Ultimate Claims	7,084
(b) 6% of Latest Accident Year Ultimate Claims	10,626
(10) Indicated Unpaid ULAE Using	
(a) 4% of Latest Accident Year Ultimate Claims	16,664
(b) 6% of Latest Accident Year Ultimate Claims	16,877

Column and Line Notes:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = {[(3) x 60%] + [(4) x 40%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(8) From Exhibit IV, Sheet 1.
(9a) = [4% x (accident year 2008 ultimate claims in (3))].
(9b) = [6% x (accident year 2008 ultimate claims in (3))].
(10a) = {(7) x [60% x (9a)] + {40% x [(8) - (Total in (4))]}}.
(10b) = {(7) x [60% x (9b)] + {40% x [(8) - (Total in (4))]}}.

Many actuaries only use one method to estimate unpaid ULAE.

When determining which method to use, a selection criterion for assessing alternative methods should be used.

- One approach is to evaluate the results in terms of the number of years of payments indicated by the unpaid estimate.
- The expected number of future year payments will vary depending on the types of insurance in insurer's portfolio. For example:
  i. for short-tail lines of insurance, the actuary may expect the estimate of unpaid ULAE to represent 1-2 years of additional CY payments.
  ii. for long-tail lines of coverage, the estimated unpaid ULAE may be expected to represent 3-4 years of payments.

Chapter17 – Estimating Unpaid ULAE

`Note: With the release of the 2011 CAS Exam 6 syllabus, "Unallocated Loss Adjustment Expense Reserves in an Inflationary Environment " by Kittel and "Determination of Outstanding Liabilities for Unallocated Loss Adjustment Expenses" by Johnson are no longer part of the required syllabus readings. These articles have been replaced by "Estimating Unpaid ULAE Liabilities " by Friedland.

However, in the article by Friedland, numerous references (and numerical examples) are made to the articles authored by Kittel and Johnson. Therefore, the following past CAS questions drawn from the content within the Kittel and Johnson paper have been provided (with cautions noted *).

1994 Exam Questions:

58.You are given the following information:

Item	Amount
Calendar year 1993 paid losses	900,000
Total loss reserves @12/31/92	9,000,000
Total loss reserves @12/31/93	10,000,000
IBNR for losses @12/31/92	3,600,000
IBNR for losses @12/31/93	4,000,000
Calendar year 1993 paid ULAE	90,000
Calendar year 1993 incurred ULAE	210,000

a. (1 point) Compute the 12/31/93 ULAE reserve using the traditional paid-to-paid ratio. Show all work.

b. (1 point) Compute the 12/31/93 ULAE reserve using the Kittel method. Show all work.

** Conger shows Kittel's Refined Method to use "B" = 50% (Paid Loss) + 50% (Reported Loss).*

Instead of using reported loss, this old exam solution will use incurred.

1996 Exam Questions:

30. According to Johnson in 'Determination of Outstanding Liabilities for ULAE,' which of the following statements are <u>FALSE?</u>
    1. Johnson's method is based on the assumption that ULAE have little or nothing to do with the nature of particular claims.
    2. Johnson's method assumes that the ULAE payments are proportional to the loss payments.

1999 Exam Questions:

13. T/F Johnson's ULAE Model assumes that unallocated loss adjustment expenses have a direct correlation to the nature of particular claims.

Questions from the 2004 Exam:

5. You are given the following information:

   2003 calendar year paid loss = $15,000

   Total loss reserves as of December 31, 2003 = $20,000

   Total loss reserves as of December 31, 2002 = $18,000

   IBNR reserve as of December 31, 2003 = $3,000

   2003 calendar year paid ULAE = $1,000

   50% of the ULAE occurs when the claim is reported and 50% when it is closed

   Using Kittel's paid to paid/incurred method, what is the ULAE reserve at December 31, 2003?

A. < $450 B. > $450 but < $575 C. > $575 but < $700 D. > $700 but < $825 E. > $825

Note: This question is not consistent with the way Conger presents Kittel's Refined Method.

Questions from the 2005 Exam:

2. You are given the following information:
   - Calendar year 2004 paid ULAE = $25,000
   - Loss reserve at December 31, 2003 = $1,000,000
   - Calendar year 2004 loss payments = $250,000
   - Calendar year 2004 incurred losses = $500,000
   - IBNR percentage of loss reserve at December 31, 2004 = 20%
   - 60% of a clairn's ULAE expense is paid when opened with the remaining expense paid at closing.

Using the paid ULAE to paid loss method, what is the ULAE reserve as of December 31, 2004?

A. < $55,000 B. $\geq$ $55,000, but < $62,500 C. $\geq$ $62,500 but < $70,000
D. $\geq$ $70,000, but < $77,500 E. $\geq$ $77,500

** Wiser's discussion of the paid-to-paid method shows an adaption away from the 50-50 assumption. Accordingly, when applying the ratio, we'd use the 60% for opening % (and 40% at closing), as given.*

But, Conger shows Traditional Method and Kittel's Refined Methods to use the "50-50" assumption. So, if the question asked for the "Traditional" Method or "Kittel's Refined Method" as in Conger, Then, to be consistent with Conger's Exhibits B or C, the solution would not use the 60% given.

Questions from the 2006 Exam:

18. (2.5 points) Given the following information:

2005 Calendar Year Paid Loss	$ 2,000,000
Outstanding Case Reserves as of December 31, 2005	12,000,000
IBNR Reserve as of December 31, 2005	4,000,000
2005 Calendar Year Paid ULAE	90,000
Outstanding Case Reserves as of December 31, 2004	10,000,000
IBNR Reserve as of December 31, 2004	3,600,000

- Estimated percentage of work at closing 70%
- Estimated percentage of work at opening 30%

a. (0.5 points) Compute the ULAE reserve at December 31, 2005 using the traditional paid-to-paid ratio.

**Conger shows Traditional Method and Kittel's Refined Methods to use the "50-50" assumption. To be consistent with Conger's Exhibit B, this question would be solved ignoring the 30% & 70% given. But, Wiser's discussion of the paid-to-paid method shows an adaption away from the 50-50 assumption. So, under Wiser, we could use the 30% for opening % (and 70% at closing), as given.*

b. (1 point) Compute the ULAE reserve at December 31, 2005 using the method described by Kittel.

** Conger shows Kittel's Refined Method to use "B" = 50% (Paid Loss) + 50% (Reported Loss). Instead of Reported Loss, the old exam solution will use Incurred. The difference is the IBNYR. Additionally, as in part a), Conger's example of Kittel's Refined method uses the "50-50" assumption. To be consistent with Conger's Exhibit C, this question would be solved ignoring the 70% & 30% given.*

c. (1 point) Identify two problems with the ULAE reserving methods that use calendar year paid-to-paid loss ratios as a starting point.

Questions from the 2008 Exam:

16. (1 point)

a. (0.25 point) Identify the fundamental assumption underlying a dollar-based approach to estimating ULAE liabilities.

b. (0.25 point Identify the fundamental assumption underlying a count-based approach to estimating ULAE liabilities.

c. (0.5 point) Identify two considerations that could influence an actuary's decision to choose a dollar-based versus a count-based approach when estimating ULAE liabilities.

Questions from the 2009 Exam:

14. (4 points) Given the following information:

Calendar Year	Paid ULAE	Paid Loss & ALAE	Reported Loss & ALAE	Estimated Ultimate Loss & ALAE on Claims Reported in Calendar Year
2006	$11,000	$60,000	$134,000	$159,000
2007	14,000	90,000	152,000	170,000
2008	16,000	110,000	170,000	183,000

Estimates as of December 31, 2008 for all accident years combined:

- Case reserves $293,000
- IBNR $114,000
- Ultimate Loss & ALAE $667,000

The claims department indicates that 60% of its work is expended when the claim is reported, and 40% of its work is spread over the life of the claim. No additional work is expended in closing the claim.

a. (1 point) Use the traditional paid-to-paid method to calculate the ULAE reserve as of Dec. 31, 2008.

b. (1 point) Use Kittel's refinement to the traditional paid-to-paid method to calculate the ULAE reserve as of December 31, 2008.

c. (1 point) Use the Bornhuetter-Ferguson method applied to Conger's generalized approach to calculate the ULAE reserve as of December 31, 2008.

d. (1 point) Describe two issues with other methods that led Conger to develop the generalized approach.

Questions from the 2011 Exam:

35. (2 points) Given the following information as of December 31, 2010:

Calendar Year	Paid ULAE	Ultimate Reported Claims	Paid Claims
2007	$2,000	$21,000	$2,100
2008	$2,750	$21,500	$12,650
2009	$4,500	$35,000	$22,650
2010	$5,500	$40,000	$30,100

- 40% of ultimate ULAE is spent on maintaining claims.
- 60% of ultimate ULAE is spent on opening claims.
- Ultimate value of claims for 2007 through 2010 = $117,500

Use the Conger-Nolibos expected claim method to estimate the unpaid ULAE.

Questions from the 2012 Exam:

28. (1.5 points) Given the following data:

Calendar Year	Paid ULAE ($000s)	Paid Claims ($000s)	Reported Claims ($000s)
2009	$11,000	$56,000	$125,600
2010	$12,000	$85,500	$145,000
2011	$14,000	$102,000	$162,500

- The case outstanding as of December 31, 2011 is $150,000,000
- The IBNR estimate as of December 31, 2011 is $50,000,000

Use the Kittel technique to estimate unpaid unallocated loss adjustment expenses (ULAE).

Solutions to 1994 Exam Questions:

58. a.(1 point) Compute the 12/31/93 ULAE reserve using the traditional paid-to-paid ratio. Show all work.

	Paid-to-paid method	
(1a)	Calendar year 1993 paid losses	900,000
(1b)	Calendar year 1993 paid ULAE	90,000
(1c)=(1b)/(1a)	Paid-to-paid ratio	10.0%
(1d)	Case loss reserves @12/31/93	6,000,000
(1e)	IBNR loss reserves	4,000,000
(1f)=(1c)x(1e)+(1c)x(1d)/2	Estimated ULAE reserve	700,000

b. (1 point) Compute the 12/31/93 ULAE reserve using the Kittel method. Show all work.

	Kittel method	
(2a)	Calendar year 1993 paid losses	900,000
(2b)	Calendar year 1993 incurred losses	1,900,000
(2c)=avg(2a,2b)	Average of paid and incurred losses	1,400,000
(2d)	Calendar year 1993 paid ULAE	90,000
(2e)=(2d)/(2c)	Kittel ratio	6.43%
(2f)=(1d)	Case loss reserves @12/31/93	6,000,000
(2g)=(1e)	IBNR loss reserves	4,000,000
(2h)=(2e)x(2g)+(2e)x(2f)/2	Estimated ULAE reserve	450,000

Solutions to 1996 Exam Questions:

30. According to Johnson, which of the following statements are FALSE?
    1. Johnson's method is based on the assumption that ULAE have little or nothing to do with the nature of particular claims. True
    2. Johnson's method assumes that the ULAE payments are proportional to the loss payments. **False**

Solutions to 1999 Exam Questions:

13. T/F Johnson's ULAE Model assumes that unallocated loss adjustment expenses have a direct correlation to the nature of particular claims.
    False, Johnson assumes no correlation.

Solutions to questions from the 2004 Exam:

5. You are given the following information:

   2003 calendar year paid loss = $15,000
   Total loss reserves as of December 31, 2003 = $20,000
   Total loss reserves as of December 31, 2002 = $18,000
   IBNR reserve as of December 31, 2003 = $3,000
   2003 calendar year paid ULAE = $1,000
   50% of the ULAE occurs when the claim is reported and 50% when it is closed

   Using Kittel's paid to paid/incurred method, what is the ULAE reserve at December 31, 2003?

   A. < $450 B. > $450 but < $575 C. > $575 but < $700 D. > $700 but < $825 E. > $825

Step 1: Compute the "Paid to Paid" ratio under the "alternative method" (e.g. paid/incurred method) and write equations to determine the CY 2003 incurred losses and the ULAE reserve.

	Alternative (paid to paid/incurred) method
Paid to Paid ratio	$\frac{CY\ \ Paid\ \ ULAE}{.50*[CY\ \ Paid\ +\text{CY Incurred}\ Loss]}$

CY 2003 Incurred losses equals CY 2003 Paid Loss + [2003 Total Reserves - 2002 Total Reserves]
= 15,000 + 20,000 – 18,000 = 17,000

ULAE Reserves = .50 * Paid to Paid Ratio * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves)
= .50 * Paid to Paid Ratio * [(Total Reserves) + (IBNR Reserves)]

Step 2: Using the formulas in Step 1 and the values provided in the problem, solve for the absolute value of the difference between these two estimates:

	Alternative (paid to paid/incurred) method
Paid to Paid ratio	$\frac{1{,}000}{.50*[15{,}000+17{,}000]} = .0625$
2003 ULAE Reserve	.50 * .0625 * [20,000 + 3,000] = 718.75 **Answer: D**

Solutions to questions from the 2005 Exam:

2. You are given the following information:
   - Calendar year 2004 paid ULAE = $25,000
   - Loss reserve at December 31, 2003 = $1,000,000
   - Calendar year 2004 loss payments = $250,000
   - Calendar year 2004 incurred losses = $500,000
   - IBNR percentage of loss reserve at December 31, 2004 = 20%
   - 60% of a claim's ULAE expense is paid when opened with the remaining expense paid at closing.

Using the paid ULAE to paid loss method, what is the ULAE reserve as of December 31, 2004?

A. < $55,000 B. $\geq$ $55,000, but < $62,500 C. $\geq$ $62,500 but < $70,000
D. $\geq$ $70,000, but < $77,500 E. $\geq$ $77,500

Step 1: Write an equation to determine the ULAE reserve as of December 31, 2004, using the paid ULAE to paid loss method.

ULAE Reserves = Paid to Paid Ratio * AF * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves), where, AF is the adjustment factor, which is equal to 1.0 - % of a claim's ULAE expense is paid when opened with the remaining expense paid at closing. Since 60% of a claim's ULAE expense is paid when opened with the remaining expense paid at closing, AF = 1.0 – 0.60 = 0.40.

Step 2: Write equations to determine case reserves at 12/13/2004, total reserves at 12/31/2004, IBNR reserves at 12/31/2004, and solve for each.

Case reserves at 12/31/2004 = Total reserves at 12/31/2004 – IBNR at 12/31/2004

CY 2004 incurred losses = [CY 2004 loss payments + Total reserves at 12/31/2004
- Total reserves at 12/31/2003]

500,000 = 250,000 + [Total reserves at 12/31/2004 – 1,000,000]

Thus, total reserves at 12/31/2004 = 500,000 – 250,000 + 1,000,000 = 1,250,000

IBNR reserves at 12/31/2004 = .20 * 1,250,000 = 250,000

Case reserves at 12/31/2004 = 1,250,000 - .20 * 1,250,000 = 1,000,000

Step 3: Using the equation in Step 1, the data given in the problem, and the results from Step 2, compute the ULAE reserve as of December 31, 2004, using the paid ULAE to paid loss method.

ULAE Reserves = Paid to Paid Ratio * AF* (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves),

= 25,000/250,000 * 0.40 * 1,000,000 + 25,000/250,000 * 250,000

= 40,000 + 25,000 = 65,000

Answer C $\geq$ $62,500 but < $70,000

Solutions to questions from the 2006 Exam:

18. (2.5 points) Given the following information:

2005 Calendar Year Paid Loss	$2,000,000
Outstanding Case Reserves as of December 31, 2005	12,000,000
IBNR Reserve as of December 31, 2005	4,000,000
2005 Calendar Year Paid ULAE	90,000
Outstanding Case Reserves as of December 31, 2004	10,000,000
IBNR Reserve as of December 31, 2004	3,600,000

Estimated percentage of work at closing 70%
Estimated percentage of work at opening 30%

a. (0.5 points) Compute the ULAE reserve at December 31, 2005 using the traditional paid-to-paid ratio.
b. (1 point) Compute the ULAE reserve at December 31, 2005 using the method described by Kittel.
c. (1 point) Identify two problems with the ULAE reserving methods that use calendar year paid-to-paid loss ratios as a starting point.

a. Write an equation to determine the ULAE reserve as of December 31, 2005, using the paid ULAE to paid loss method.

ULAE Reserve = Paid to Paid Ratio * % at closing * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves)
Paid to Paid ratio = paid ULAE/paid loss = 90,000 / 2,000,000 = .045
ULAE Reserve =.045 * .70 * ($12,000,000) + .045 * ($4,000,000) = $ 558,000

b. Write an equation to determine the ULAE reserve as of December 31, 2005, using the Kittel method.

ULAE Reserve = Paid to Paid Ratio * % at closing * (Case Reserves) + Paid to Paid Ratio*(IBNR Reserves)
Paid to Paid ratio = paid ULAE/(paid loss + % at opening (change in total reserves))
Change in reserves = (12M + 4M) – (10M + 3.6M) = 2,400,000
Paid to Paid ratio = 90,000/(2,000,000 + .3* 2,400,000) = .033
ULAE Reserve =.033 * .70 * ($12,000,000) + .033 * ($4,000,000) = $409,200

Question 18 - Model answer 1

c1. It doesn’t take into consideration open claims at the end of the year
c2. It will overstate reserves if the company is growing.

Question 18 - Model answer 2

c1. When the company is growing, using the paid to paid ratio to estimate ULAE will over estimate the ULAE ratio
c2. If the claim department changes its claim settlement pattern, the paid to paid ratio will change. Thus, the estimate of ULAE based on historical paid to paid will not be accurate.

Solutions to questions from the 2008 Exam:

16a. (0.25 point) Identify the fundamental assumption underlying a dollar-based approach to estimating ULAE liabilities.

16b. (0.25 point Identify the fundamental assumption underlying a count-based approach to estimating ULAE liabilities.

16c. (0.5 point) Identify two considerations that could influence an actuary's decision to choose a dollar-based versus a count-based approach when estimating ULAE liabilities.

Question 16 - Model answer 1

a. Dollar-based – ULAE payments follow the paid losses & ALAE.

b. Count-based – ULAE payment for some type of transaction will be same irrespective of claim size and nature.

c. (1)If there is enough data (claims paid, transactions done) to identify the cost associate with each transaction type to make the count-based method reliable. That is, if the ULAE paid is large enough to warrant a detailed analysis of transactions/cost-based operation.

   (2) If the ULAE to paid loss ratio is stable then better to use a dollar-based system.

Question 16 - Model answer 2

a. ULAE dollars track with claim dollars i.e., a $1000 claim has 10 times as much ULAE as a $100 claim.

b. ULAE dollars track with the type of transaction regardless of dollars, so similar types of transactions have same ULAE expenditures.

c. (1) Whether the volume of losses is growing considerably.

   (2) The application of the company's resources to various stages of the life of a claim.

Solutions to questions from the 2009 Exam:

Question 14 - Model Solution 1

a. ULAE Ratio estimate = CY paid ULAE/[CY paid loss + ALAE]

= (11,000+14,000+16,000)/(60,000+90,000+110,000) = (41,000)/260,000 = 0.158

ULAE Reserve = 0.158 × (IBNR + ½ Case Reserve)

= 0.158 × (114,000 + ½ × 293,000) **= 41,159**

b. Use Kittel ULAE Ratio = (CY paid ULAE) / [½ ×(CY paid + CY reported)]

= 41,000 / [½ × (260,000 +456,000)] = 0.115

ULAE Reserve = 0.1115 × (114,000 + ½ × 293,000) = **29,834**

c. $B = u_1 \times R + u_2 \times P$, where R = Sum of estimated ultimate loss & ALAE on claims reported in CY

u_1 = 60 %, u_2 = 40%, where u_1 = % of work expended when the claim is reported. $u_2 = 1.0 - u_1$

B = 0.6 × 512,000 + 0.4 × 260,000; B = 411,200

W = M/B = 41,000/411,200 = 0.0997

By B-F approach, ULAE reserve = W × (L-B), where L = ultimate loss & ALAE for all years as of 12/31/08

ULAE Reserve = 0.0997 × (667,000 – 411,200) = **25,503**

d1. estimates may be distorted if book is growing

d2. 50-50 assumption may not be true

Solutions to questions from the 2009 Exam (continued):

Question 14 - Model Solution 2

The difference in Solution 1 vs. Solution 2 lies in the assumption made by the candidate answering this question, which is stated in part a. below.

a. As a historical matter, the traditional and Kittle refinement used a 50/50 split between opened and remainder, we will calculate our answers based on the 60/40 split specified.

	(1)	(2)	(3) = (1) / (2)	
	Paid ULAE	Paid Loss & ALAE	Paid-Paid	
06	11,000	60,000	0.183	
07	14,000	90,000	0.156	
08	16,000	110,000	0.145	
	41,000	260,000	0.158	selected ratio

R_{ULAE} = (ratio)* (IBNR + (.4) Case) = (.158) (114,000+ (.4) (293,000)) = 36,530

b.

	(4)	(5) = 1/2 [(2) + (4)]	(6) = (1) / (5)	
	Reported Loss & ALAE	Kittle basis	ratio	
06	134,000	97,000	0.113	
07	152,000	121,000	0.116	
08	170,000	140,000	0.114	
		358,000	0.115	selected ratio

R_{ULAE} = (ratio) (IBNR + (.4) Case) = (.115) (114,000+ (.4) (293,000)) = 26,588

c. Note: This solution is the same as shown in Solution 1 (only rounding differences exist: 0.0997 vs 0.100)

	(7)	(8) = (.6) × (7) +		
	Ult on CY reported	(.4) × (2)	(9) = (1) / (8)	
		Conger Basis	ratio	
06	159,000	119,400	0.092	
07	170,000	138,000	0.101	
08	183,000	153,800	0.104	
		411,200	0.100	selected ratio

"B-F" method: R_{ULAE} = (ratio)(Ult L+ALAE for all years as of 12/31/08 – Conger Basis)
= (.100)(667,000 - 411,200) = 25,580

d1. When business is growing, the paid-paid method is inaccurate due to the mismatch between ULAE payments and their associated claims.

d2. The traditional 50-50 split between cost to open and cost to maintain-and-close may not hold. The generalized method allows separation of cost to maintain and cost to close.

Solutions to questions from the 2011 Exam:

35. Use the Conger-Nolibos expected claim method to estimate the unpaid ULAE.
Intial comments

Conger and Nolibos define $U_1 + U_2 + U_3 = 100\%$, where:

- U_1 is the % of ultimate ULAE spent opening claims
- U_2 is the % of ultimate ULAE spent maintaining claims
- U_3 is the % of ultimate ULAE spent closing claims

For time period T, Conger and Nolibos define M, the total amount spent on ULAE during a time period T, to be

$M = (U_1 \times R \times W) + (U_2 \times P \times W) + (U_3 \times C \times W)$, where

- R is the ultimate cost of claims reported during T
- P is the claims paid during T
- C is the ultimate cost of claims closed during T
- W is the ratio of ultimate ULAE (U) to ultimate claims (L)

* T could be activity between t_1 and t_2 related to an AY or for all AYs, where t_1 and t_2 are points in time.

* Algebraically derive the ratio W = M/B by defining B, **the claims basis** for the time period T to be:

$B = (U_1 \times R) + (U_2 \times P) + (U_3 \times C)$

Thus, M = B x W, and W = M/B.

Ultimate ULAE (U) for a group of AYs can be estimated as:

U = W* x L, where

- W* is the selected ultimate ULAE-to-claims ratio
- L is the independently estimated ultimate claims for the same group of AY

Compute Unpaid ULAE by subtracting ULAE already paid (M) from the estimate of ultimate ULAE (U).

Unpaid ULAE = (W* x L) - M

Note: Calculations involving U_3 or C are not needed in solving this problem since U_3 or C is not given.

Question 35 - Model Solution 1

Compute W*

CY	B	M (given)	W = M/B
07	13440	2000	0.1488
08	17,960=0.60*$21,500+0.40*$12,650	2750	0.1531
09	30060	4500	0.1497
10	36040	5500	0.1526
	97,500	14,750	0.1513

Selected W* = 0.15

ULAE Ratio = W = M / B = M / [(u_1 x r) + (u_2 x p)], where $u_1 = 0.60$, $u_2 = 0.40$

Ult ULAE = W xL = 0.15(117,500) = 17,625

Unpaid ULAE = Ult ULAE – Paid ULAE = 17,625 – 14,750 = **2875**

Question 35 - Model Solution 2

B = [117.5 x 60% + 67.5 x 40%] = 97,500; M = 14,750 (given)

W = M / B = 15.13%

L = 117,500 (given)

Unpaid ULAE = W x L – M

= 15.13% x 117,500 – 14,750 = **3027.75**

Solutions to questions from the 2012 Exam:

28..Use the Kittel technique to estimate unpaid unallocated loss adjustment expenses (ULAE).

Question 28 – Model Solution (Exam 5B Question 13)

Ratio of paid ULAE to avg. (rept. + paid)

	Pd ULAE	Avg pd + rept	Ratio
09	11,000	90,800	.1211
10	12,000	115,250	.1041
11	14,000	132,250	.1059
Total	37,000	338,300	.1094 ← Selected – not enough data to say that there is a clear downward trend

ULAE = Ratio * [.50 * Case o/s + IBNR)] = (0.1094)[(.5)(150,000,000) + (50,000,000)] = 13,675,000

Examiner's Comments

Most candidates that attempted the question received full credit.

The most common deductions were for candidates that incorrectly calculated the ULAE ratio (did not recognize that the ratio should be Paid ULAE/avg [paid claims, reported claims]),

or that calculated the unpaid ULAE but treated it in the wrong fashion, for example as total ULAE and then subtracted paid ULAE.

Unpaid Claim Estimates

ASOP 43

1 Purpose and Scope 1

1.1 Purpose—This actuarial standard of practice (ASOP) provides guidance to actuaries estimating loss and loss adjustment expense for unpaid claims for P&C coverages.

Any reference to "unpaid claims" includes unpaid claim adjustment expense

1.2 Scope—This standard applies to:

- developing unpaid claim estimates only for events that have already occurred or will have occurred, as of an accounting date (exclusive of estimates developed solely for ratemaking purposes).
- estimating unpaid claims for all classes of entities, including self-insureds, insurance companies, reinsurers, and governmental entities.
- estimates of gross amounts before recoverables (e.g. deductibles, ceded reinsurance, and salvage and subrogation)
- estimates of amounts after such recoverables, and
- estimates of amounts of such recoverables.

The actuary should comply with this standard except to the extent it may conflict with applicable law (statutes, regulations, and other legally binding authority).

2 Definitions 2-3

Definitions of certain terms below used in this actuarial standard of practice.

Actuarial Central Estimate—An estimate of the expected value over the range of reasonably possible outcomes.

Claim Adjustment Expense—The costs of administering, determining coverage for, settling, or defending claims even if it is ultimately determined that the claim is invalid.

Event—The incident or activity that triggers potential for claim or claim adjustment expense payment.

Model Risk—The risk that the methods are not appropriate to the circumstances or the models, are not representative of the specified phenomenon.

Parameter Risk— The risk that the parameters used in the methods or models are not representative of future outcomes.

Process Risk— The risk associated with the projection of future contingencies that are inherently variable, even when the parameters are known with certainty.

Principal— The actuary's client or employer. Where the actuary has both a client and an employer, as is common for consulting actuaries, the facts and circumstances will determine whether the client or the employer (or both) is the principal with respect to any portion of this standard.

Unpaid Claim Estimate— The actuary's estimate of the obligation for future payment resulting from claims due to past events.

Unpaid Claim Estimate Analysis— The process of developing an unpaid claim estimate.

3 Analysis of Issues and Recommended Practices 3-8

3.1 Purpose or Use of the Unpaid Claim Estimate

Potential purposes or uses of unpaid claim estimates include establishing liability estimates for

- external financial reporting
- internal management reporting
- various special purpose uses (e.g. appraisal work and scenario analyses).

3.2 Constraints on the Unpaid Claim Estimate Analysis

At times constraints exist in performing an actuarial analysis, such as those due to limited data, staff, time or other resources. When constraints create a significant risk that a more in-depth analysis would produce a materially different result, the actuary should notify the principal of that risk and communicate the constraints on the analysis to the principal.

3.3 Scope of the Unpaid Claim Estimate - the actuary should identify the following:

a. the intended measure of the unpaid claim estimate

1. Examples of types of measures for the unpaid claim estimate include high estimate, low estimate, median, mean, mode, actuarial central estimate, mean plus risk margin, actuarial central estimate plus risk margin, or specified percentile.

   An actuarial central estimate may or may not be the result of the use of a probability distribution or a statistical analysis (which is meant to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean).

   The terms "best estimate" and "actuarial estimate" are <u>not</u> sufficient descriptions of the intended measure, since they describe the source or the quality of the estimate but not the objective of the estimate.

2. The actuary should consider whether the intended measure is appropriate to the intended purpose or use of the unpaid claim estimate.

3. The description of the intended measure should include whether any amounts are discounted.

b. whether the unpaid claim estimate is to be gross or net of recoverables;

c. whether collectibility risk is to be considered when the unpaid claim estimate is affected by recoverables;

d. the specific types of unpaid claim adjustment expenses covered in the unpaid claim estimate (e.g. coverage dispute costs, defense costs, and adjusting costs);

e. the claims to be covered by the unpaid claim estimate (e.g. type of loss, line of business, year, and state); and

f. any other items that, in the actuary's professional judgment, are needed to describe the scope sufficiently.

3.4 Materiality — Should be evaluated based on professional judgment, taking into account the requirements of applicable law and the intended purpose of the unpaid claim estimate.

3.5 Nature of Unpaid Claims — Aspects of unpaid claims (including any material trends) that may require an understanding include:

a. coverage;
b. conditions or circumstances that make a claim more or less likely or the cost more or less severe;
c. the underlying claim adjustment process; and
d. potential recoverables.

3.6 Unpaid Claim Estimate Analysis—

The actuary should consider the following items when performing the unpaid claim estimate analysis:

3.6.1 Methods and Models

The actuary should select specific methods or models, modify such methods or models, or develop new methods or models based on relevant factors including the following:

a. the nature of the claims and underlying exposures;
b. the development characteristics associated with these claims;
c. the characteristics of the data;
d. the applicability of methods or models to the available data; and
e. the reasonableness of the assumptions underlying each method or model.

The actuary should consider:

a. whether a method or model is appropriate in light of the purpose, constraints, and scope of the assignment.

   For example, while an unpaid claim estimate produced by a simple method may be appropriate for an immediate internal use, it may not be for external financial reporting purposes.

b. whether different methods or models should be used for different components of the unpaid claim estimate. For example, different coverages within a line of business may require different methods.
c. the use of multiple methods or models appropriate to the purpose, nature and scope of the assignment and the characteristics of the claims unless, in the actuary's professional judgment, reliance upon a single method or model is reasonable given the circumstances.

3.6.2 Assumptions — The actuary should:

a. consider the reasonableness of the assumptions underlying each method or model used.

   Assumptions involve professional judgment as to the appropriateness of the methods and models used and the parameters underlying the application of such methods and models. Assumptions may be implicit or explicit and may involve interpreting past data or projecting future trends.

b. use assumptions that have no known significant bias to underestimation or overestimation of the identified intended measure.
c. The actuary should consider the sensitivity of the unpaid claim estimates to reasonable alternative assumptions.

3.6.3 Data — The actuary should refer to ASOP No. 23, Data Quality, with respect to the selection of data to be used, relying on data supplied by others, reviewing data, and using data.

3.6.4 Recoverables—Consider interaction among the different types of recoverables and adjust the analysis of unpaid claims to reflect that interaction in a manner the actuary deems appropriate.

3.6.5 Gross vs. Net— Consider the facts and circumstances of the assignment when choosing which components (the gross estimate, the estimated recoverables, and the net estimate) to estimate.

3.6.6 External Conditions— Consider external conditions (e.g. potential economic changes, regulatory actions, judicial decisions, or political or social forces) that are known by qualified actuaries in the same practice area and that are likely to have a material effect on the actuary's unpaid claim estimate analysis.

3.6.7 Changing Conditions— Consider changes in conditions with regard to claims, losses, or exposures, that are likely to be insufficiently reflected in the experience data or in the assumptions used to estimate the unpaid claims.

Examples include reinsurance program changes and changes in the practices by the entity's claims personnel to the extent such changes are likely to have a material effect on the results of the actuary's unpaid claim estimate analysis.

Consider obtaining supporting information from the principal or the principal's duly authorized representative and may rely upon their representations unless, in the actuary's professional judgment, they appear to be unreasonable.

3.6.8 Uncertainty— The actuary should consider:

a. the uncertainty associated with the unpaid claim estimate analysis.

   Note: The standard does not require or prohibit the actuary from measuring this uncertainty.

b. the purpose and use of the unpaid claim estimate in deciding whether or not to measure this uncertainty.

   when measuring uncertainty, consider the types and sources of uncertainty being measured and choose the methods, models, and assumptions that are appropriate for the measurement of such uncertainty.

   for example, when measuring the variability of an unpaid claim estimate covering multiple components, consider whether the components are independent of each other or whether they are correlated.

   types and sources of uncertainty surrounding unpaid claim estimates include uncertainty due to model risk, parameter risk, and process risk.

3.7 Unpaid Claim Estimate—Take into account the following with respect to the unpaid claim estimate:

3.7.1 Reasonableness— the reasonableness of the unpaid claim estimate:

i. includes using appropriate indicators or tests that, in the actuary's professional judgment, provide a validation that the unpaid claim estimate is reasonable.

ii. should be determined based on facts known to, and circumstances known to or reasonably foreseeable by, the actuary at the time of estimation.

3.7.2 Multiple Components — When the actuary's unpaid claim estimate comprises multiple components, consider whether the estimates of the multiple components are reasonably consistent.

3.7.3 Presentation—The unpaid claim estimate may be presented in a variety of ways (e.g. as a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the unpaid claim amount.)

4 Communications and Disclosures 9-10

4.1 Actuarial Communication—the actuary should disclose the following in an appropriate actuarial communication:

a. the intended purpose(s) or use(s) of the unpaid claim estimate, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses (as described in section 3.1)

b. significant limitations, if any, which constrained the actuary's unpaid claim estimate analysis such that, in the actuary's professional judgment, there is a significant risk that a more in-depth analysis would produce a materially different result (as described in section 3.2)

c. the scope of the unpaid claim estimate (as described in section 3.3)

d. the following dates:

(1) the accounting date of the unpaid claim estimate, which is the date used to separate paid versus unpaid claim amounts;

(2) the valuation date of the unpaid claim estimate, which is the date through which transactions are included in the data used in the unpaid claim estimate analysis; and

(3) the review date of the unpaid claim estimate, which is the cutoff date for including information known to the actuary in the unpaid claim estimate analysis, if appropriate.

An example is as follows: "This unpaid claim estimate as of 12/31/2005 was based on data evaluated as of 11/30/2005 and additional information provided to me through 1/17/2006."

e. specific significant risks and uncertainties, if any, with respect to whether actual results may vary from the unpaid claim estimate; and

f. significant events, assumptions, or reliances, if any, underlying the unpaid claim estimate that, in the actuary's professional judgment, have a material effect on the unpaid claim estimate, including assumptions provided by the actuary's principal or an outside party or assumptions regarding the accounting basis or application of an accounting rule.

If the actuary depends upon a material assumption, method, or model that the actuary does not believe is reasonable or cannot determine to be reasonable, the actuary should disclose the dependency of the estimate on that assumption/method/model and the source of that assumption/method/model.

4.2 Additional Disclosures—In certain cases, the actuary may need to make the following disclosures in addition to those in section 4.1:

a. In the case when the actuary specifies a range of estimates, the actuary should disclose the:

i. basis of the range provided, for example, a range of estimates of the intended measure (each of such estimates considered to be a reasonable estimate on a stand-alone basis);

ii. a range representing a confidence interval within the range of outcomes produced by a particular model or models; or

iii. a range representing a confidence interval reflecting certain risks, such as process risk and parameter risk.

b. In the case when the unpaid claim estimate is an update of a previous estimate, the actuary should disclose changes in assumptions, procedures, methods or models that the actuary believes to have a material impact on the unpaid claim estimate and the reasons for such changes to the extent known by the actuary.

This standard does not require the actuary to measure or quantify the impact of such changes.

4.3 Prescribed Statement of Actuarial Opinion—This ASOP does not require a prescribed statement of actuarial opinion as described in the Qualification Standards for Prescribed Statements of Actuarial Opinion promulgated by the American Academy of Actuaries.

4.4 Deviation from Standard—If, in the actuary's professional judgment, the actuary has deviated materially from the guidance set forth elsewhere in this standard, the actuary can still comply with this standard by applying the following sections as appropriate:

4.4.1 Material Deviations to Comply with Applicable Law—If compliance with applicable law requires the actuary to deviate materially from the guidance set forth in this standard, the actuary should disclose that the assignment was prepared in compliance with applicable law, and the actuary should disclose the specific purpose of the assignment and indicate that the work product may not be appropriate for other purposes.

4.4.2 Other Material Deviations—The actuary's communication should disclose any other material deviation from the guidance set forth in this standard.

The actuary should:

i. consider whether, in the actuary's professional judgment, it would be appropriate and practical to provide the reasons for, or to quantify the expected impact of, such deviation.

ii. be prepared to explain the deviation to a principal, another actuary, or other intended users of the actuary's communication.

iii. be prepared to justify the deviation to the actuarial profession's disciplinary bodies.

Statement of Principles: Loss and LAE Reserves

CAS

The purpose of the CAS Statement of Principles is to present essential ***guidelines*** for any comprehensive and systematic approach to testing the adequacy of loss reserves.

1. Definitions:

Five elements of a <u>total loss reserve</u>:

1. Case reserves assigned to specific claims.
2. A provision for future development on known claims.
3. A provision for claims that re-open after they have been closed.
4. A provision for <u>claims that have occurred but have not yet been reported</u> to the insurer.
5. A provision for <u>claims that have been reported to the insurer but have not yet been recorded</u>.

Differing loss reserve categories and definitions

Category 1: The reserve for **known claims:**

a. is the amount that will be required for future payments of claims that have already been reported to the insurer.

b. is equal to (1) + (2) + (3)

Category 2: The reserve for **unknown claims (a.k.a. IBNR reserve)**

a. (4) is also known as "pure" IBNR claims while (5) is known as claims in transit.

b. in practice, (2) + (3) + (4) + (5) are often called IBNR.

Dates are important in the loss reserve estimation process. The 5 key dates are:

1. **Accident Date:** the date the loss occurred.
2. **Report Date**: the date the loss is first reported to an insurer.
3. **Recorded Date**: the date the loss is first recorded on the insurer's books.
4. **Accounting Date**: the "as of" date for the loss reserve estimate.
   It is generally a date when a financial statement is prepared (e.g. month end, quarter end or year end).
5. **Valuation Date**: the date the evaluation of the loss liability is made.
   The valuation date can be before, after or the same as the accounting date.

Loss reserve terminology:

1. The **required loss reserve** as of a given accounting date:
   a. is the amount that must be paid to settle all claim liabilities.
   b. can only be known when all claims have been settled.
   c. is a <u>fixed number that does not change</u> at different valuation dates.
2. The **indicated loss reserve:**
   a. results from an actuarial analysis of a reserve inventory as of a given accounting date conducted as of a certain valuation date.
   b. is the analyst's opinion of the amount of the required loss reserve.
   c. <u>changes at different valuation dates</u> and will converge to the required loss reserve
3. The **carried loss reserve:** the amount of unpaid claim liability shown in financial statements.
4. The **loss reserve margin:** = the carried reserve - the required reserve.
   Since the required reserve is unknown, we only have an indicated margin.
   Thus, the **indicated loss reserve margin** = the carried loss reserve - the indicated loss reserve.

2. **Principles.** While there are four 'stated' principles, there are 3 unique principles in that principle 1 and principle 2 are identical, with the exception that principle 1 applies to loss reserves while principle 2 applies to LAE reserves.

1. "An actuarially sound loss reserve for a defined group of claims as of a given valuation date is a provision, based on estimates derived from reasonable assumptions and appropriate actuarial methods for the unpaid amount required to settle all claims, whether reported or not, for which liability exists on a particular accounting date."
2. "An actuarially sound loss adjustment expense reserve for a defined group of claims as of a given valuation date is a provision, … for the unpaid amount required to investigate, defend, and effect the settlement of all claims… for which loss adjustment expense liability exists on a particular accounting date."
3. The uncertainty inherent in the estimation of required provisions… implies that a range of reserves can be actuarially sound. The true value of the liability for losses or loss adjustment expenses at any accounting date can be known only when all attendant claims have been settled.
4. The most appropriate reserve within a range of actuarially sound estimates depends on both the relative likelihood of estimates within the range and the financial reporting context in which the reserve will be presented.

3. **Considerations.**

The CAS Statement of Principles provides the following summarized list of these "considerations"

(1) Data Organization

Five key dates relative to data organization:

1.	Accident Date
2.	Report Date
3.	Recorded Date
4.	Accounting Date (AD)
5.	Valuation Date (VD)

(2) Homogeneity

Subdivide experience into groups exhibiting similar characteristics, such as:

- Loss development patterns, and
- Size of loss distributions.

(3) Credibility

Credibility is a measure of the predictive value that an actuary attaches to a body of data. Credibility is generally increased by:

- Making groups more homogenous, and
- Increasing the amount of the experience within a homogenous group. [Larger insurers can therefore refine/partition their data in finer detail than smaller insurers.]

(4) Data Availability

- Data should meet requirements for proper reserve evaluation.
- Data should reconcile to financial statements (now a required "part" of the Actuarial Opinion).

(5) Emergence Patterns

Delay between occurrence and reporting of a claim.

(6) Settlement Pattern

Length of time between report and settlement of a claim.

(7) Loss Development Pattern

Should be carefully reviewed. Insurer's claim practices affect the manner in which claims develop.

(8) Frequency/Severity

High frequency/low severity versus low frequency/high severity exposures.

(9) Reopened Claim Potential

Tendency for claims to reopen varies by line of business. Workers' compensation claims are generally the most likely to reopen.

(10) Claims-Made Coverages

Eliminates "pure" IBNR claim potential. Only "pipeline" IBNR.

(11) Aggregate Limits

Use data modeling techniques to estimate their impact.

(12) Salvage/Subrogation

Need to be considered for proper evaluation of reserves on a GAAP basis. Optional on a statutory basis.

(13) GAAP

Different from statutory accounting. For example, reserves are reduced by anticipated salvage/subrogation under GAAP.

(14) Reinsurance

- Evaluate impact of changes in net retention.
- Analyze direct and ceded experience separately.
- Recoverability of ceded amounts is generally evaluated separately (now "part" of the Actuarial Opinion).

(15) Portfolio Transactions, Commutations, Structured Settlements

- These transactions generally recognize the time value of money.
- Their impact on loss reserves and development patterns should be evaluated.

(16) Pools and Associations

Consider the appropriateness of reserves reported by pools and associations.

(17) Operational Changes

- Examples include:
  1. New computer system
  2. Accounting change
  3. Reorganization of claims department
- Reserve computation should reflect impact of these changes.

(18) Changes in Contracts

- Examples include:
  1. Policy limits
  2. Deductibles
  3. Coverage attachment points
- These changes may alter the frequency/severity of claims.

(19) External Influences Examples include:

1. Judicial environment
2. Regulation
3. Legislative changes
4. Residual market
5. Economic variables

(20)Discounting

Always perform reserve analysis on an undiscounted basis, then apply the effect of discounting.

(21)Provision for Uncertainty

- When a reserve is carried at full-value it may include an implicit provision for uncertainty.
- A reserve carried at present-value may require an explicit provision for uncertainty.
- A reserve with a high degree of variability, even if carried at full-value, may require an explicit provision for uncertainty.

(22)Reasonableness

- Incurred losses implied by the reserves should be measured for reasonableness against relevant indicators such as premiums, exposures, frequency/severities, or number of policies.
- Material departures from expected results should be explained.

(23)Loss-Related Balance Sheet Items

Examples include:

- Contingent commissions
- Retrospective premium adjustments
- Policyholder dividends
- Premium deficiency reserves
- Statutory reserves
- Provision for reinsurance

(24)Loss Reserving Methods

- The actuary has the responsibility for the selection of the most appropriate reserving methods.
- Generally the actuary should examine the reserve indications of more than one method.

(25)Standards of Practice

This is technically the 25th consideration.

Sample Questions:

1. Which of the following is a consideration in the estimation of loss and LAE reserves according to the CAS Statement of Principles?

   ❶ Reasonableness

   ❷ Salvage and Subrogation

   ❸ Claim settlement patterns

   ❹ Risk margins for loss and LAE reserves

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

2. Which of the following is/are true?

   ❶ Subdividing loss experience into more homogeneous categories tends to increase the credibility of the loss experience.

   ❷ The date a claim is recorded in the insurance company's financial systems is one of the five key dates mentioned in the Statement of Principles regarding Loss and LAE reserves.

   ❸ Evaluating reserves for high frequency/low severity lines of insurance generally requires more detailed and extensive analysis than the evaluation of reserves for low frequency/high severity lines of insurance.

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

3. Which of the following is not a consideration cited in the "Statement of Principles?"

   ❶ The impact of reinsurance plans and retentions

   ❷ The impact of commutations and structured settlements

   ❸ The impact of higher rates of economic inflation

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,or 3

4. Which of the following are principles of reserving identified by the CAS?

   ❶ A range of reserves

   ❷ An actuarially sound loss reserve

   ❸ Provision for uncertainty

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸ 5. Neither 1,2,3 or 4

5. What are the five key dates identified in the Statement of Principles for the organization of a reserving database?

6. Which of the following is a key criteria to recognize when accumulating data for actuarial analysis according to Wiser?

   ❶ Policy limit

   ❷ Claim frequency

   ❸ Claim severity

   ❹ Loss development pattern

   1. ❶ 2. ❷ 3. ❶, ❷ 4. ❶, ❷, ❸,❹ 5. Neither 1,2,3 or 4

Questions from the 1994 Exam:

4. True/False: According to the CAS Statement of Principles, data used in the analysis of reserves must reconcile to the insurer's financial records.

Questions from the 1998 Exam:

61. (1 point) Based on the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the most appropriate reserve within a range of actuarially sound estimates depends on two considerations. List these two considerations.

Questions from the 1999 Exam:

9. True/False. According to the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," if reserves in a data triangle have been established at present values, the development history should be restated to remove the effect of discounting.

Questions from the 2000 Exam:

7. True/False. According to the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the provision for claims in transit is an element of the IBNR reserve.

8. True/False. According to the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," a valuation date must be coincident with or subsequent to the accounting date.

Questions from the 2001 Exam:

4. According to CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the five elements of a total loss reserve should be individually quantified.

Questions from the 2002 and 2003 Exams:

There were no questions drawn from this article appearing on the above referenced exams

Questions from the 2004 Exam:

28. (2 points) What are the four principles of loss and LAE reserving contained in "Statement of Principles Regarding Property and Casualty Loss & Loss Adjustment Expense Reserves"?

Questions from the 2005 Exam:

There were no questions drawn from this article appearing on the above referenced exam.

Questions from the 2006 Exam:

22. (1.5 points) Although paid losses are an objective measure of past losses, the projection of future payment patterns from past ones may be subject to distortions from a number of sources.

    Identify and briefly describe three such sources of distortion.

Questions from the 2007 Exam:

There were no questions drawn from the content within this article appearing on the above referenced exam.

Questions from the 2008 Exam:

1. (1 point) A company's reserving actuary observes that one segment for a particular line of business has much higher severity and a longer-tailed settlement pattern than the remaining segments. Exposures in the high-severity, longer-tailed segment are growing faster than in the other segments.
   a. (0.5 point) Explain how the guidance provided by the Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves applies to this situation.
   b. (0.5 point) Describe a potential bias that could result if the actuary analyzes these segments on a combined basis.

Questions from the 2009 Exam:

There were no questions drawn from the content within this article appearing on the above referenced exam.

Questions from the 2010 Exam:

6. (2 points) According to the Casualty Actuarial Society's "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves":
   a. (1 point) Identify four broad categories of operational changes within an insurance company that could affect an unpaid claim estimate.
   b. (1 point) Provide a specific example for each broad category of operational changes identified in part a. above.

Solutions to sample questions:

1. All are considerations

   1. ❶   2. ❷   3. ❶, ❷   4. ❶, ❷, ❸   **5. Neither 1,2,3 or 4**

2. Which of the following is/are true?

   ❶ Subdividing loss experience into more homogeneous categories tends to increase the credibility of the loss experience. True.

   ❷ The date a claim is recorded in the insurance company's financial systems is one of the five key dates mentioned in the Statement of Principles regarding Loss and LAE reserves. True.

   ❸ Evaluating reserves for high frequency/low severity lines of insurance generally requires more detailed and extensive analysis than the evaluation of reserves for low frequency/high severity lines of insurance. False, just the opposite.

   1. ❶   2. ❷   **3. ❶, ❷**   4. ❶, ❷, ❸   5. Neither 1,2,3 or 4

3. Which of the following is **not** a consideration cited in the "Statement of Principles"

   ❶ The impact of reinsurance plans and retentions

   ❷ The impact of commutations and structured settlements

   ❸ The impact of higher rates of economic inflation

   All are considerations

   1. ❶   2. ❷   3. ❶, ❷   4. ❶, ❷, ❸   **5. Neither 1,2,or 3**

4. Which of the following are principles of reserving identified by the CAS?

   ❶ A range of reserves

   This is a principle of reserving

   ❷ An actuarially sound loss reserve

   This is a principle of reserving

   ❸ Provision for uncertainty

   This is **not** a principle of reserving, it is a consideration.

   1. ❶   2. ❷   **3. ❶, ❷**   4. ❶, ❷, ❸   5. Neither 1,2,3 or 4

5. What are the five key dates identified in the Statement of Principles for the organization of a reserving database?

1.	Accident Date
2.	Report Date
3.	Recorded Date
4.	Accounting Date
5.	Valuation Date

Solutions to sample questions: (continued)

6. Which of the following is a key criteria to recognize when accumulating data for actuarial analysis according to Wiser?

   To answer this question, without reading Wiser, remember that Wiser basically rehashes the entire CAS statement of principles. In particular, he describes the "considerations" relevant to data used for actuarial analysis.

   ❶ Policy limit — This is a CAS consideration
   ❷ Claim frequency — This is a CAS consideration
   ❸ Claim severity — This is a CAS consideration
   ❹ Loss development pattern — This is also a CAS consideration

   1. ❶ 2. ❷ 3. ❶, ❷ **4. ❶, ❷, ❸,❹** 5. Neither 1,2,3 or 4

   Similar to question on 1993, Part 7, exam

Solutions to questions from the 1994 Exam:

4. True/False: According to the CAS Statement of Principles, data used in the analysis of reserves must reconcile to the insurer's financial records.

   True, recall that this is also required in the Statement of Actuarial Opinion.

Solutions to questions from the 1998 Exam:

61. (1 point) Based on the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the most appropriate reserve within a range of actuarially sound estimates depends on two considerations. List these two considerations.

    The most appropriate reserve within a range of actuarially sound estimates depends on both the:

    - Relative likelihood of estimates within the range, and
    - Financial reporting context in which the reserve will be presented.

Solutions to questions from the 1999 Exam:

9. True, since the "unwinding" of discount as claims move closer to their ultimate settlement date produces the appearance of loss development in a development triangle.

Solutions to questions from the 2000 Exam:

7. True/False. According to the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the provision for claims in transit is an element of the IBNR reserve. True. See page 57.

8. True/False. According to the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," a valuation date must be coincident with or subsequent to the accounting date. False. A valuation date may be prior to, coincident with or subsequent to the accounting date. See page 57.

Solutions to questions from the 2001 Exam:

4. According to CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," the five elements of a total loss reserve should be individually quantified. False. Although a total loss reserve is composed on five elements, the five elements may not necessarily be individually quantified. See page 57.

Solutions to questions from the 2002 and 2003 Exams:

There were no questions drawn from this article appearing on the above referenced Exams

Solutions to questions from the 2004 Exam:

28. (2 points) What are the four principles of loss and LAE reserving contained in "Statement of Principles Regarding Property and Casualty Loss & Loss Adjustment Expense Reserves"?

Question 28 – Model Solution 1:

1. An actuarially sound loss reserves, for a given group of claims as of a valuation date, is a provision, based on reasonable assumptions and appropriate actuarial techniques, for the unpaid amount to settle all claims, whether reported or not, for which liability exists as of an accounting date.
2. An actuarially sound loss adjustment expenses reserves, for a given group of claims as of a valuation date, is a provision, based on reasonable assumptions and appropriate actuarial techniques, for the unpaid amount to investigate, influence or adjust the loss amount of all claims, whether reported or not, for which liability exists as of an accounting date.
3. The inherent uncertainty of the reserving process implies that a range or reserves may be actuarially sound.
4. The most appropriate actuarially sound reserve amount within a range depends on:
   a. The relative likelihood of the reserves in the range
   b. The financial context the reserves is to be presented.

Question 28 – Model Solution 2:

1. An actuarially sound loss reserve for a defined group of claims as of a given valuation date, is a provision base on reasonable assumptions and appropriate actuarial methods for the unpaid amount required to settle all claims, whether reported or not for which a liability exists on a particular accounting date.
2. An actuarially sound LAE reserve, for a defined group of claims on a given valuation date, is a provision based on reasonable assumption and appropriate actuarial methods, for the unpaid amount needed to investigate, defend, and effect the settlement of all claims, whether reported or not for which liability exists on a particular accounting date.
3. The uncertainty inherent in the loss reserving process implies that a range of estimates can be actuarially sound. The ultimate value the amounts unpaid cannot be known until all attendant claims are settled.
4. The most appropriate loss reserve from a range of reasonable estimates will depend on the relative likelihood of the estimates within the range and the financial reporting context in which the reserves will be presented.

Solutions to questions from the 2005 Exam:

There were no questions drawn from this article appearing on the above referenced exam.

Solutions to questions from the 2006 Exam:

22. (1.5 points) Although paid losses are an objective measure of past losses, the projection of future payment patterns from past ones may be subject to distortions from a number of sources. Identify and briefly describe three such sources of distortion.

Question 22 – Model Answer 1

Model Answer #1

1. The claims department may have had a backup of claims after a catastrophe or major event. One would not want to project this pattern into the future
2. A new type of claim may emerge that was not present in the past (for example, asbestos). You would not want to use older year settlement patterns in the future
3. A large loss could impact one year's losses. This one loss should not be used to project into the future.

Question 22 – Model Answer 2

1. Legal environment changes. Juries may start awarding larger payments to the claimant.
2. Claims department philosophy changes. Larger claims may be settled first, slowed down or sped up.
3. Changes in exposures. If the type of exposures underlying the losses are different than historical

Additional comments:

Review the concepts of Data Homogeneity, Frequency and Severity, Operational changes and External influences as they apply to claims department practices, shifts in types of business/exposures being underwritten, frequency and severity in types of claims that arise and the impact of the judicial environment. Also review the Bouska paper on PEBLEs, and the section on "When Triangles Fail".

Solutions to questions from the 2007 Exam:

There were no questions drawn from the content within this article appearing on the above referenced exam.

Solutions to questions from the 2008 Exam:

1. A company's reserving actuary observes that one segment for a particular line of business has much higher severity and a longer-tailed settlement pattern than the remaining segments. Exposures in the high-severity, longer-tailed segment are growing faster than in the other segments.
   a. (0.5 point) Explain how the guidance provided by the Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves applies to this situation.
   b. (0.5 point) Describe a potential bias that could result if the actuary analyzes these segments on a combined basis.

Question 1 – Model Answer 1

a. The statement of principles says that both severity and development patterns can be used to identify homogeneous lines of business. Thus, this high-severity, long-tailed line can be analyzed separately from other lines.
b. If the actuary analyzes these segments together, the analysis implicitly assumes growth is the same across all lines. This will lead to inadequate IBNR for the longer-tailed line. There is a bias to understate IBNR.

Question 1 – Model Answer 2

a. The statement offers guidance on when to analyze business segments separately vs. when to combine them. In this case the higher severity, longer tailed line should be analyzed separately as long as there is enough data in the two groups (long & short tailed) to have credible analyses.
b. Because the longer-tailed line is growing faster, it should have more weight in future loss payment patterns than it had in past ones. A bias could result in the analysis that assumes the past development patterns are predictive of future patterns. This would be a downward bias.

Solutions to questions from the 2010 Exam:

Question 6 - Solution 1

a) Change in underwriting guidelines;
Change in reinsurance structure;
Change in claims handling philosophy;
Change in information technology.

b) Write more large risks;
Change reinsurance limit and attachment point;
Change in settlement rate;
Change in accounting process because of new technology implementation.

Solution 2

a) Underwriting;
Marketing;
Reserving;
Information technology.

b) May loose underwriting standards causing a deteriorating loss ratio;
May emphasize a specific product causing a change in the mix of business;
May decide to strengthen case reserves;
May implement a new database causing temporary lags while employees get used to the new system.

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Actuarial Notes for the Spring 2014 CAS Exam 5A and Exam 5B

5A - Basic Techniques for Ratemaking

5B – Estimating Claim Liabilities

Volume 3

Independently Authored and Modified Past CAS Tests
Multiple Choice Questions

and

Independently Authored Preparatory Tests
Computational and Essay Based Questions

Exam 5 – Independently Authored and Modified Past CAS Questions
T/F and Multiple Choice Questions - Preparatory Test 1

General information about this exam

- This practice test contains 20 questions consisting of true/false and multiple choice questions.
- This practice test contains past CAS questions that have been modified (or completely re-written), because the content of past CAS questions asked are no longer applicable to the content covered by the Werner/Modlin text.
- This practice test should be taken after working all past CAS questions associated with the articles shown below, to demonstrate your understanding of the content covered in the chapters/articles listed below.
- After answering the multiple choice questions in this test, candidates should consider how such questions can be re-written in essay based format, since essay based questions will constitute approximately 25-30% of all questions appearing on the exam.

Articles covered on this exam:

Article	Author	Syllabus Section
A. Chapter 4: Exposures	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 5: Premium	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 8: Overall Indication	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Statement of Principles Re PC Ins Ratemaking	CAS	A. Basic Techniques for Ratemaking
A. Actuarial Standard No. 13 – Trending Proc.	CAS	A. Basic Techniques for Ratemaking
A. Chapter 9: Traditional Risk Classification	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 12: Credibility	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 13: Other Considerations	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 14: Implementation	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 15: Commercial Lines Rating Mech	Modlin, Werner	A. Basic Techniques for Ratemaking

Exam 5A – Modified Past CAS Questions - Test 1

Question 1

Based on the "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following are examples of biases or distortions which should be considered when examining historical insurance data for trend?

1. The impact of school vacations on automobile miles driven.
2. An automatic insurance to value program at policy renewal.
3. The introduction of higher policy limits.

1	2	3	1, 2	1, 2, 3

Question 2

(1 point) According to Werner and Modlin in "Basic Ratemaking", which of the following statements regarding the pure premium ratemaking method are true?

1. The pure premium method would be preferable to the loss ratio method for developing rates for a new Homeowners endorsement covering sewer backup.
2. The pure premium method requires the calculation of on-level factors.
3. The pure premium method produces indicated rate changes.

1	2	1, 2	1, 3	1, 2, 3

Question 3

(1 point) According to Werner and Modlin in "Basic Ratemaking", which of the following are true?

1. Most states have statutes that require that rates shall not be inadequate, excessive or unfairly discriminatory between risks of like kind and quality.
2. Some states' statutes may require certain rates to be "actuarially sound."
3. The description of the goal of the ratemaking process does not consider generating a reasonable-return on funds provided by investors.

1	3	1, 3	1, 2	1, 2, 3

Question 4

(1 point) According to Werner and Modlin in "Basic Ratemaking", actuarial criteria are used to achieve which of the following goals when establishing a classification system?

1. Causality
2. Homogeneity
3. Affordability

1	2	3	1, 2	1, 3

Question 5

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. Based on the criterion that the exposure base should be the factor most directly proportional to the expected loss, number of house years is the preferred exposure base, and amount of insurance should be used as a rating variable.
2. For products liability, the exposure base that is intuitively the most proportional to expected loss is the number of products currently in use, and is the exposure base currently used.
3. Workers compensation has historically used hours worked as an exposure base.

1 only	3 only	1, 2 only	2, 3 only	1, 2, 3

Question 6

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. If there is a more accurate or practical exposure base than the one currently in use, the actuary should take steps to implement it.
2. Amount of Insurance Coverage is the typical exposure base for homeowners insurance.
3. In composite rating, the premium is initially calculated using estimates for each exposure measure along with relevant rating algorithms for each coverage.

3	1, 2	1, 3	2, 3	1, 2, 3

Question 7

According to Werner and Modlin in “Basic Ratemaking”, which of the following should exist for an exposure base to be practical.

1. It should be objective
2. It should be relatively easy to use and
3. It should be inexpensive to obtain and verify.

3 only	1 only	1, 3 only	2, 3 only	None of the given answer choices

Question 8

(1 point) According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following are true?

1. Informed actuarial judgment should not be used in ratemaking, unless there is a lack of credible data.
2. Consideration should be given in ratemaking to the effects of subrogation and salvage.
3. A rate is an estimate of the expected value of present costs.

1	2	1, 3	2, 3	1, 2, 3

Question 9

(1 point) According to the CAS Committee on Ratemaking Principles, "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," which of the following are NOT stated principles?

1. A rate provides for all costs associated with the transfer of risk.
2. A rate is an estimate of the expected value of future costs.
3. A rate provides for the costs associated with an individual risk transfer.

1	1, 2	1, 3	2, 3	None of the given answer choices

Question 10

(1 point) According to the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking", which of the following are true?

1. The cost of reinsurance should be considered in the ratemaking process
2. Changes in the underwriting process should be considered in the ratemaking process.
3. Affordability is specifically stated as an important factor that should be considered in the ratemaking process.

1 only   1, 2 only   3 only   2, 3 only   1, 2, 3

Question 11

According to the Statement of Principles Regarding Property and Casualty Insurance Ratemaking, which of the following are false?

1. Credibility is increased either by making groups more homogeneous or by decreasing the size of the group analyzed.
2. When considering trends, consideration should only be given to past changes in claims costs, claim frequencies, exposures expenses and premiums.
3. When an individual risk's experience is sufficiently credible, the premium for that risk should be modified to reflect the individual experience.

1   3   1, 2   1, 3   1, 2, 3

Question 12

The CAS Statement of Principles on Ratemaking describes a number of considerations that commonly apply to any ratemaking methodology. In its discussion of "Risk", the Statement distinguishes between (i) the charge for the risk of random variation from expected costs and (ii) the charge for any systematic variation of the estimated costs from expected costs.

Which of the following statements apply to the charge for any systematic variation of the estimated costs from expected costs?

1. It should influence the underwriting profit provision.
2. It should be reflected in the determination of the total return.
3. It should be reflected in the contingency provision.

1 only   1   3 only   1, 3   2, 3   None of the given answer choices

Question 13

According to Werner and Modlin in “Basic Ratemaking”, which are examples that can cause changes in the average premium level?

1. A rating characteristic can cause average premium to change.
2. Moving all existing insureds to a higher deductible
3. Acquiring the entire portfolio of another insurer writing higher policy limits.

2   3   1, 3   2, 3   1, 2, 3

Question 14

According to the "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," which of the following are true?

1. It is inappropriate to analyze only factors which have an impact on trend in one direction.
2. When selecting a trending procedure, the actuary should first look to the Proceedings or the Syllabus of Examinations of the CAS before considering alternate procedures described in other publications.
3. Any trending procedure requires the actuary to exercise informed judgment.

1 | 1, 2 | 3 | 1, 3 | 1, 2, 3

Question 15

According to Werner and Modlin in "Basic Ratemaking", which of the following are true?

1. The description of the goal of the ratemaking process includes consideration of generating a reasonable-return on funds provided by investors.
2. Regulatory review generally requires that rates shall not be inadequate, excessive or unfairly discriminatory between risks of like kind and quality.
3. The two basic approaches used in manual ratemaking are the pure premium method and the loss ratio method.

A. 1. B. 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question 16

According to Werner and Modlin in "Basic Ratemaking", which of the following are true?

1. In-force exposures are the total exposures arising from policies issued during a specified time period.
2. Written exposures are the number of units exposed to loss at a given point in time.
3. Annual payroll in hundreds of dollars is the typical exposure unit for U.S. workers compensation insurance

A. 1. B. 3 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question 17

According to Werner and Modlin in "Basic Ratemaking", the uncollectability of deductible payments is not an additional risk associated with deductible policies.

True False

Question 18

According to Werner and Modlin in "Basic Ratemaking", which of the following statements are true?

1. The off-balance exists because the indicated classification relativities produce an average classification relativity different from the average classification relativity underlying the current rates.
2. If projected and indicated premiums are not in balance, balance may be achieved through expense reductions.
3. If projected and indicated premiums are not in balance, a company can also achieve balance by reducing the average expected loss.

1 only | 2 only | 1 and 3 | 1, 2, 3 | None of the given answer choices

Question 19

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. Regulators may prohibit the use of a characteristic for rating even if it can be demonstrated to be statistically strong predictors of risk.
2. Regulators may limit the amount of an insurer’s rate change to either the overall average rate change for the jurisdiction or to the change in premium for any individual or group of customers, or both, even if the actuary can justify all methods used in his or her ratemaking procedures.
3. In the case of banned or restricted usage of a variable (e.g. insurance credit scores), an insurer can use a different allowable rating variable (e.g. payment history with the company) it believes can explain some or all of the effect associated with the restricted variable.

1 only		2 only		3 only		2, 3 only		1, 2, 3

Question 20

According to Werner and Modlin in “Basic Ratemaking”, which of the following statements are true of the characteristics of the different methods for determining the complement of credibility?

1. Because Harwayne's method uses data from the same class in other states and attempts to adjust for state-to-state differences, the complement is unbiased.
2. In the Rate Change From the Larger Group Applied to Present Rates method, although the complement is a significant improvement over the Bayesian complement, the complement remains largely biased.
3. In the Trended Present Rates method, the complement is more accurate for loss costs with high process variance because the process variance is reflected in last year's rates.

1		2		3		1,3		1,2

Exam 5A – Solutions to Modified Past CAS Questions - Test 1

Question 1 discussion:

Answer: 1, 2, 3

See section 3.2

The actuary should consider the effect of known biases or distortions on the data relied upon (e.g. the impact of catastrophic influences, seasonality, coverage changes, nonrecurring events, claim practices, and distributional changes in deductibles, types of risks, and policy limits).

Question 2 discussion:

1. True. See chapter 8
2. False. The loss ratio method requires the calculation of on-level factors. See chapter 8
3. False. The loss ratio method produces indicated rate changes. See chapter 8

Answer: 1

Question 3 discussion: 1. True. See chapter 9

2. True. See chapter 9

3. False. See chapter 1

Answer: 3

Question 4 discussion: Blooms:

1. False. This is one of the social criteria. See chapter 9
2. True. See chapter 9
3. False. This is one of the social criteria. See chapter 9

Answer: 2

Question 5 discussion: Blooms:

1. True. See chapter 4.
2. False. Gross Sales. See chapter 4.
3. False. Payroll. See chapter 4.

Answer: 1 only

Question 6 discussion: Blooms: 1. False. The actuary should consider historical preference before implementing it. See chapter 4.

2. False. Earned House Years

3. True.

Answer: 3

Question 7 discussion: Blooms: 1. True. See chapter 4.

2. True. See chapter 4.

3. True. See chapter 4.

Answer: None of the given answer choices

Question 8 discussion: Blooms:

1. False.
2. True.
3. False. A rate is an estimate of the expected value of future costs.

Answer: 2

Question 9 discussion: Blooms:

1. True. This is a stated principle.
2. True. This is a stated principle.
3. True. This is a stated principle.

Answer: None of the given answer choices

Question 10 discussion:

1. True. See reinsurance as a consideration.
2. True. See operation changes as a consideration.
3. False.

Answer: 1, 2 only

Question 11 discussion:

1. False. Credibility is increased either by making groups more homogeneous or by increasing the size of the group analyzed.
2. False. When considering trends, consideration should be given to past and prospective changes in claims costs, claim frequencies, exposures expenses and premiums.
3. True.

Answer: 1, 2

Question 12 discussion:

"The rate should also include a charge for any systematic variation of the estimated costs from the expected costs. This charge should be reflected in the determination of the contingency provision."

Answer: 3 only

Note: With respect to the (i) charge for the risk of random variation from the expected costs, this risk charge should be reflected in the determination of the appropriate total return consistent with the cost of capital and, therefore, influences the underwriting profit provision.

Question 13 discussion:

1. True. See chapter 5.
2. True. See chapter 5.
3. True. See chapter 5.

Answer: 1, 2, 3

Question 14 discussion:

1. True. See section 5.6
2. False. There is no requirement to look to the Proceedings or to the Syllabus of Examinations of the CAS first. See page 2
3. True. See section 5.8

Answer: 1, 3

Question 15 discussion:

Answer: 1, 2, 3. Statement 3 = See chapter 8.

Question 16 discussion:

1. F. Written exposures are the total exposures arising from policies issued during a specified time period.
2. F. In-force exposures are the number of units exposed to loss at a given point in time.
3. T. Annual payroll in hundreds of dollars is the typical exposure unit for U.S. workers compensation insurance

Answer: 3 See Chapter 4.

Question 17 discussion:

False. See chapter 15

Deductible processing:

i. When the insurer is responsible for paying the entire claim and seeks reimbursement for amounts below the deductible from the insured, the premium should reflect the cost of invoicing and monitoring deductible activity as well as a provision for the risk that the insured may become bankrupt and be unable to pay for any future deductible invoices (i.e. credit risk).

ii. Even if collateral is received to cover potentially uncollectible deductible amounts, it is rare that this credit risk is fully collateralized.

Question 18 discussion:

1. True. See chapter 14
2. True. See chapter 14
3. True. See chapter 14

Answer: 1, 2, 3 only

Question 19 discussion:

1. True. See chapter 13.
2. True. See chapter 13.
3. True. See chapter 13.

Answer: 1, 2, 3

Question 20 discussion:

1. True. See chapter 12
2. False. ...the complement is largely unbiased.
3. False. The complement is less accurate for loss costs with high process variance.

Answer: 1

Exam 5 – Modified Past CAS Questions – T/F and Multiple Choice
Preparatory Test 2

General information about this exam

- This practice test contains 21 questions consisting of true/false and multiple choice questions.
- This practice test contains past CAS questions that have been modified (or completely re-written), because the content of past CAS questions asked are no longer applicable to the content covered by the Werner/Modlin text.
- This practice test should be taken after working all past CAS questions associated with the articles shown below, to demonstrate your understanding of the content covered in the chapters/articles listed below.
- After answering the multiple choice questions in this test, candidates should consider how such questions can be re-written in essay based format, since essay based questions will constitute approximately 25-30% of all questions appearing on the exam.

Articles covered on this exam:

Article	Author	Syllabus Section
A. Chapter 15: Commercial Lines Rating Mech	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 16: Claims Made Ratemaking	Modlin, Werner	A. Basic Techniques for Ratemaking
Personal Auto Premiums: Asset Share Pricing	Feldblum	A. Basic Techniques for Ratemaking

Exam 5A– Modified Past CAS Questions - Test 2

Question 1:

(1 point) According to Feldblum, "Personal Automobile Premium: An Asset Share Pricing Approach For Property-Casualty Insurance," which of the following are evidence that property-casualty insurance is taking on attributes that motivate asset share pricing?

1. Insurers rarely cancel or non-renew policies.
2. Expected loss costs are greater for renewal business than for new business.
3. A greater emphasis is being placed on the investment income component of rates.

1 2 1, 3 2, 3 1, 2, 3

Question 2

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," which of the following are true?

1. It is preferable to review persistency rates by original driver classification rather than by the current driver classification.
2. Analysis of persistency rates is important, but not a key part of asset share pricing models.
3. Agency ownership of policy renewals affects persistency rates.

1 2 1, 2 1, 3 1, 2, 3

Question 3

According to Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," the fundamental issue in asset share pricing methods is the predictability of long term profitability.

True False

Question 4

According to Werner and Modlin in “Basic Ratemaking”, which of the following is not one of the principles of claims-made (C-M) ratemaking?

A. C-M policies have less risk of case reserve inadequacies than do occurrence policies.
B. Substantially less investment income is earned on C-M policies than under occurrence policies.
C. Sudden unexpected shifts in the reporting pattern will have less of an impact on the cost of mature C-M coverage than on the cost of occurrence coverage.
D. A C-M policy should always cost less than an occurrence policy as long as pure premiums are increasing.
E. Whenever there is a sudden, unpredictable increase or decrease in the underlying trend, C-M policies priced on the basis of the prior trend will be closer to the correct price than occurrence policies priced the same way.

Question 5

According to Werner and Modlin in “Basic Ratemaking”, which of the following statements are true about claims-made coverage

1. The long period between the occurrence of a claim and the settlement of a claim can be driven by a reporting lag, a settlement lag, or both.
2. From a loss development perspective, reporting lag relates to IBNER (claims that are incurred but not enough reported), and settlement lag relates to pure IBNR (claims that are incurred but not reported).
3. The major difference between claims-made and occurrence coverage is that the coverage trigger is the date the claim is reported rather than the date the event occurs.

1 3 1, 2 1, 3 1, 2, 3

Question 6

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true of experience rating plans?

1. The experience rating adjustment for the future policy period manual premium is equal to a credibility weighting of the adjusted past experience and some expected results.
2. The experience period usually ranges from two to five policy years, ending with the last complete year.
3. Many experience rating plans apply per occurrence caps on the losses in order to exclude unusual or catastrophic losses.

1 3 1, 2 1, 3 1, 2, 3

Question 7

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. In the NCCI ER plan, primary losses are capped at $10,000 and the excess losses are calculated as the portion of each individual loss above $10,000.
2. The D-ratio is the loss elimination ratio at the primary loss limit
3. In the general liability experience rating plan, the maximum single loss (MSL) is applied to loss and allocated loss adjustment expense combined.

2 3 1, 3 2, 3 1, 2, 3

Question 8

According to Werner and Modlin in “Basic Ratemaking”, the basic premium in the NCCI retrospective rating plan provides for which of the following costs?

1. An allowance for profit and contingencies
2. Premium taxes
3. The cost of limiting the retrospective premium to be between the minimum and maximum premium negotiated under the policy.

1 2 1, 2 1, 3 1, 2, 3

Question 9

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. A retrospective rating plan uses the insured’s actual experience during the policy period as the basis for determining the premium for that same period.
2. Conceptually, retrospectively rated insurance is similar to self-insurance with the exception that retrospectively rated insurance policies contain provisions that cause the insurer to retain some risk and that affect the timing of payments for costs incurred under the policy.
3. The total premium charged may be subject to a minimum and maximum amount to help stabilize the year-to-year cost

2	3	1, 3	2, 3	1, 2, 3

Question 10

According to Werner and Modlin in “Basic Ratemaking”, which of the following statements are true regarding claims-made ratemaking?

1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies.
2. An occurrence policy will generally cost less than a claims-made policy.
3. Claims-made policies incur some liability for IBNR claims.

1	2	3	1, 2	1, 3

Question 11

A claim occurred in May 2001 and was reported in September 2003. Which of the following would cover this claim?

1. A one-year occurrence policy effective January 1, 2003
2. A second-year claims-made policy effective January 1, 2002
3. Tail coverage effective January 1, 2003 for a physician retiring after 10 years of practice covered by claims-made coverage

2	3	1	2, 3	1, 2

Question 12

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property Casualty Insurance,' which of the following are true?

1. The principal benefit to asset share pricing is the determination of profitability over the entire time a policyholder stays with the company.
2. The asset share pricing model is inappropriate to use for high risk drivers, such as young males, because they do not tend to remain with one company long enough to permit completion of a long term analysis.
3. Level premiums and losses in property and casualty insurance is a reason why property and casualty actuaries have relied on asset share pricing.

1	3	1, 3	2, 3	1, 2, 3

Question 13

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," which of the following is false?

A. Life insurance policy claim rates are more certain than property-casualty policy claim rates.

B. It is inappropriate to assume the same pattern of persistency ratios for both direct writers and independent agency companies.

C. A level commission structure is inappropriate for the persisting and profitable risks.

D. The dominant market share of the direct writers makes asset share pricing a more appropriate model for Personal auto insurance.

E. Asset share pricing determines rate revisions, not rates.

Question 14

According to Werner and Modlin in "Basic Ratemaking", which of the following are true?

1. The longer the settlement lag, the greater will be the difference in investment income between claims-made and occurrence policies.
2. A claims-made policy should always cost less than or equal to an occurrence policy.
3. The confidence interval about the projected losses for an occurrence policy is generally wider than for a claims-made policy priced at the same time.

1   2   3   1, 2   2, 3

Question 15

According to Werner and Modlin in "Basic Ratemaking", which of the following are true regarding how primary and excess credibility factors are expressed in NCCI's formula?

1. The primary credibility factor is a function of the ballast value (B).
2. The excess credibility factor is a function of both (B) and (w).
3. The ballast value and weighting value are obtained from a table based upon the policy's expected losses and both increase as expected losses increase.

1   2   3   1, 2   2, 3

Question 16:

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance, " which of the following are true?

1. In practice, persistency rates depend upon the premium discount that is offered.
2. The exposure to road hazards is higher for older drivers than it is for younger drivers.
3. Older drivers, and in particular retired drivers, have more time on their hands to compare prices and thus, have more of an impetus to price shop at renewal time.

1 only   1 and 2 only   2 and 3 only   1, 2, and 3   None of the given answer choices

Question 17

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance, " which of the following are true?

1. Although there is an intuitive relationship between duration and persistency for life insurance, this is not the case for casualty insurance.
2. If persistency differences are ignored in traditional ratemaking methods, then rate relativities are too high for the poorly persisting classes and too low for the long-persisting classes.
3. Asset share pricing helps the actuary determine the true profitability of the insurance writings.

1 only   3 only   1 and 3 only   1, 2, and 3   None of the given answer choices

Question 18

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. A tail policy covers all losses with accident dates and report dates occurring after the insured's last claims-made policy expired.
2. The term "lag", as used by the authors, is the difference between the date the accident occurred and the date the accident was reported.
3. The coverage trigger for a CM policy is the accident date.

1 2 3 1, 2 None of the given answer choices

Question 19

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. Claims-made rates are both more accurate and more responsive to changing conditions.
2. The major difference between the claims-made and the occurrence policy lies not in the coverage provided, but in the timing of pricing decisions affecting that coverage.
3. A mature claims made policy written at the beginning of a year contributes one exposure to all matrix elements within a report year column of a report year by lag matrix.

1, 2 2, 3 1, 2, 3 1, 3 None of the given answer choices

Question 20

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. Rating techniques for large commercial risks: large deductible plans, loss-rated composite rating, and retrospective rating plans
2. If the premium collected under experience rating plans does not equal the expected premium in total, then the plan has an "off-balance."
3. Experience rating is used when an individual insured’s past experience, with adjustments, can be predictive of the future experience.

1 only 2 only 1, 3 1, 2 1, 2, and 3

Question 21

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. In ISO's CGL Experience and Schedule Rating Plan, the maximum single limit per occurrence applies to total limits losses and unlimited ALAE.
2. Schedule rating is the only individual risk rating system that does not directly reflect an entity’s claim experience.
3. A unique characteristic of the NCCI experience rating plan is that it divides losses for each claim into a primary portion and an excess portion.

1 only 3 only 1, 3 1, 2 2 and 3

Exam 5A– Solutions to Modified Past CAS Questions - Test 2

Question 1 discussion:

Answers to this question are found on page 195, Proceedings, November 1996.

1. True. Cancellations. Insurers rarely cancel or non-renew policies, since profitability depends on the stability of the book of business.
2. False. Expected loss costs are greater for new business than for renewal business. See page 195.
3. False. This is not mentioned.

Answer: 1

Feldblum lists 3 attributes about P&C insurance that motivate the use of asset share pricing:

1. Commissions. Commission rates tend to be higher in the 1st year than in renewal years.
2. Cancellations. Insurers rarely cancel or non-renew policies, since profitability depends on the stability of the book of business.
3. Loss costs. Feldblum states that this phenomenon is valid for personal auto insurance as well as for other lines of business.

Question 2 discussion

1. True. See page 239. Although persistency rates by duration are easily determined for current classifications (the % of young male drivers in their 5th policy year who persist into their 6th year), it is persistency rates by original classification, not current classification, that it is needed.

   Notice the difference: the persistency of young male drivers in their 5th policy year does not tell us the expected 5th year persistency of young male drivers.
2. False. Feldblum states "Persistency rates (retention rates) are the crux of asset share pricing models. They are most important when the net insurance income varies by duration since policy inception." See page 207.
3. True. On page 208, Feldblum compares persistency rates among direct writers and independent agency companies:

Answer: 1, 3

Question 3 discussion

False Persistency rates (the term "retention rates" are used interchangeably in this paper) are the crux (and hence the fundamental issue) of asset share pricing models. See page 207.

Question 4 discussion

Answer: A. See chapter 6.

Question 5 discussion

1. True. See chapter 16

2. False. From a loss development perspective, reporting lag relates to pure IBNR (claims that are incurred but not reported), and settlement lag relates to IBNER (claims that are incurred but not enough reported).

2. True. See chapter 16

Question 6 discussion

1. True. See chapter 16
2. True. See chapter 16
3. True. See chapter 16

Answer: 1, 2, 3

Question 7discussion

1. False. In the NCCI ER plan, primary losses are capped at $5,000 and the excess losses are calculated as the portion of each individual loss above $5,000.
2. True.
3. True. See chapter 15.

Answer: 2, 3

Question 8 discussion

According to Modlin, the following elements are included in the basic premium.

1. Profit and contingency allowance.
2. Expenses, excluding expenses provided for by the LCF.
3. Net charge for limiting the retro premium between the minimum and the maximum.

Thus, 1 is True, 2 is False, and 3 is True

Answer: 1, 3

Question 9 discussion

1. True. See chapter 15.
2. True. See chapter 15.
3. True. See chapter 15.

Answer: 1, 2, 3

Question 10 discussion

1. The investment income earned under claims-made policies is substantially less than the investment income earned under occurrence policies. True. This is principle number 5.
2. An occurrence policy will generally cost less than a claims-made policy. False. This is a misstatement of principle number 1. A claims-made policy should always cost less than an occurrence policy, as lone as claim costs are increasing.
3. False. Claims-made policies incur NO liability for IBNR claims. This is principle number 4. Claims-made policies incur no liability for IBNR claims so the risk of reserve inadequacy is greatly reduced.

Question 11 discussion

1. A one-year occurrence policy effective January 1, 2003. False. Occurrence policies cover claims occurring during the policy period. An accident occurring on 5/1/2001 would not be covered by a policy covering the period 1/1/2003 – 12/31/2003
2. A second-year claims-made policy effective January 1, 2002. False. Since the claim was reported in 2003, it would not be covered by a claims-made policy effective in 2002.
3. Tail coverage effective January 1, 2003 for a physician retiring after 10 years of practice covered by claims-made coverage. True. A claims made policy covers claims reported (made) (in this example, 9/1/2003) during the policy period (i.e. 1/1/2003 – 12/31/2003), regardless of when the accident date occurred. See chapter 16.

Answer: 3 only

Question 12 discussion

1. T. It examines the profitability from inception to termination (including renewals) of the policy. See page 192
2. F. Feldblum demonstrates how asset share pricing is used to determine class relativities for young drivers. See page 217.
3. F. P&C premiums are variable. Level premiums associated with whole life policies have lead life actuaries to place greater reliance on asset-share pricing models than P&C actuaries (which work with premiums that fluctuate widely). See page 197.

Question 13 discussion

A. Life insurance policy claim rates are more certain than property-casualty policy claim rates. True. Claim rates in casualty insurance are more variable and less well understood. See page198.

B. It is inappropriate to assume the same pattern of persistency ratios for both direct writers and independent agency companies. True. Direct writers, like Sate Farm, have high retention rates because they offer low premium rates and provide renewal discounts. Many independent agency companies have low retention rates because they can move the insured to whichever company offers the lowest rate. See page 208.

C. A level commission structure is inappropriate for the persisting and profitable risks. True. A level commission structure works wells for risks that terminate quickly. It works poorly for risks that endure with the carrier. See page 206.

D. The dominant market share of the direct writers makes asset share pricing a more appropriate model for personal automobile insurance. True. In the personal lines of business, direct writers are steadily gaining market share, See page 206.

E. False. Asset share pricing determines rates, not rate revisions. See page 215.

Question 14 discussion

The answer to each of these questions can be found by reviewing the 5 principles of claims made ratemaking.

1. F. The longer the reporting lag or the shorter the settlement lag, the greater the difference will be. See chapter 16.
2. F. A CM policy should always cost less than an occurrence policy, as long as claim costs are rising. See chapter 16.
3. T. See chapter 16.

Question 15 discussion

1. True. See chapter 15.
2. True. See chapter 15.
3. True. See chapter 15.

Answer: 1, 2, 3

Question 16 discussion:

1. True. See pages 250 -- 251.
2. False. The exposure to road hazard declines as drivers age. See page 243.
3. False. Older drivers, with lower premiums and often with less information about competing carriers, have less incentive and less opportunity to price shop. See page 244.

Answer: 1 only

Question 17 discussion:

1. False. There is an intuitive relationship between duration and persistency for both life and casualty insurance. See page 209.
2. False. If persistency differences are ignored in traditional ratemaking methods, then rate relativities are too low for the poorly persisting classes and too high for the long-persisting classes. See page 217.
3. True. See page 217.

Answer: 3 only

Question 18 discussion

1. False. A tail policy covers all losses whose accident date lies in the period during which the claims-made coverage was in force, and whose reported date is after the insured's last claims-made policy expired. See chapter 16.
2. False. The term "lag", as used by the authors, is the difference between the year accident occurred and the year the accident was reported. See chapter 16
3. False. The coverage trigger for a CM policy is the report date.

Answer: None of the given answer choices

Question 19 discussion

1 True. See chapter 16.
2. True. See chapter 16.
3. True. See chapter 16.

Answer: 1, 2, 3

Question 20 discussion

1. True. See chapter 15.
2. True. See chapter 15.
3. True. See chapter 15.

Answer: 1, 2, 3

Question 21 discussion

1. False. The maximum single limit per occurrence applies to basic limits losses and unlimited ALAE. See chapter 15.
2. True. See chapter 15.
3. True. See chapter 15.

Answer: 2 and 3 only

Exam 5 – Modified Past CAS Questions – T/F and Multiple Choice
Preparatory Test 3

General information about this exam

- This practice test contains 21 questions consisting of true/false and multiple choice questions.
- This practice test contains past CAS questions that have been modified (or completely re-written), because the content of past CAS questions asked are no longer applicable to the content covered by the Werner/Modlin text.
- This practice test should be taken after working all past CAS questions associated with the articles shown below, to demonstrate your understanding of the content covered in the chapters/articles listed below.
- After answering the multiple choice questions in this test, candidates should consider how such questions can be re-written in essay based format, since essay based questions will constitute approximately 25-30% of all questions appearing on the exam.

Articles covered on this exam:

Article	Author	Syllabus Section
A. Chapter 5: Premium	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 6: Losses and LAE	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 8: Overall Indication	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Statement of Principles Re PC Ins Ratemaking	CAS	A. Basic Techniques for Ratemaking
A. Actuarial Standard No. 13 – Trending Proc.	CAS	A. Basic Techniques for Ratemaking
A. Chapter 11: Special Classification	Modlin, Werner	A. Basic Techniques for Ratemaking
A. Chapter 15: Commercial Lines Rating Mech	Modlin, Werner	A. Basic Techniques for Ratemaking
Personal Auto Premiums: Asset Share Pricing	Feldblum	A. Basic Techniques for Ratemaking
ISO Personal Auto Manual	ISO	A. Basic Techniques for Ratemaking

Exam 5A – Modified Past CAS Questions - Test 3

Question 1:

According to "Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking," in the absence of strong contrary indications, the actuary should rely on extrapolations of the historical insurance data from mathematical models.

True False

Question 2

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. The loss ratio method produces indicated rate changes whereas the pure premium method produces indicated rates.
2. The pure premium method and the loss ratio method will produce identical results when consistently applied to the same data.
3. The extension of exposures technique is a part of the pure premium method.

1 2 1, 2 2, 3 1, 2, 3

Question 3

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. The goal of the ratemaking process includes consideration of generating a reasonable-return on funds provided by investors.
2. Rate regulation generally requires that rates shall not be inadequate, excessive or unfairly discriminatory between risks of like kind and quality.
3. The two basic approaches used in manual ratemaking are experience rating and schedule rating.

A. 1. B. 2 C. 1, 2 D. 2, 3 E. 1, 2, 3

Question 4

1. An insurer writes the following policies during 1992:

Effective Date	Policy Term	Premium
May 1	6 months	\$6,000
August 1	12 months	\$12,000
November 1	6 months	\$2,400

What is the insurer's unearned premium reserve on December 31, 1992?

A. <\$6,000 B. $\geq$\$6,000 but <\$7,000 C. $\geq$\$7,000 but <\$8,000 D. $\geq$ \$8,000, but < \$9,000 E. $\geq$ \$9,000.

Question 5

According to the "Statement of Principles Regarding Property and Casualty Insurance Ratemaking," which of the following are true?

1. Historical premium, exposure, loss and expense experience is usually the starting point of ratemaking.
2. Policy year is the best acceptable method of organizing data to be used in ratemaking.
3. Marketing, underwriting, legal and other business considerations should NOT be a factor when applying the principles set forth in the above statement.

1 2 3 1, 2 None of the given answer choices

Question 6. You are given:

Effective Date	Rate Change
4/1/94	+5.0%
7/1/95	+13.0%
4/1/96	-3.0%

- All policies are 12 month policies.
- Policies are written uniformly throughout the year.

Using the parallelogram method described Werner and Modlin in “Basic Ratemaking”, in what range does the on-level premium factor fall, to bring calendar year 1995 earned premium to current rate level?

A. < 1.07 B. $\geq$ 1.07 but < 1.09 C. $\geq$ 1.09 but < 1.11 D. $\geq$ 1.11 but < 1.13 E. $\geq$ 1.13

Question 7

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property Casualty Insurance,' which of the following are true?

1. The principal benefit to asset share pricing is the determination of profitability over the entire time a policyholder stays with the company.
2. The asset share pricing model is appropriate to use for high risk drivers, such as young males, because they do not tend to remain with one company long enough to permit completion of a long term analysis.
3. Level premiums and losses in property and casualty insurance is a reason why property and casualty actuaries are now relying on asset share pricing.

3 1, 2 1, 3 2, 3 1, 2, 3

Question 8

According to Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," asset share modeling is considered particularly valuable when differences in termination rates influence expected profits.

True False

Question 9

According to Werner and Modlin in “Basic Ratemaking”, which of the following are true?

1. The D-ratio adjusts for the impact of the MSL by reducing the expected basic limits losses and ALAE for expected losses and ALAE higher than the MSL.
2. In the NCCI retrospective rating plan, the basic premium provides for a net charge for limiting the retrospective premium between the minimum and the maximum retrospective premiums.
3. In the ISO experience rating plan, both the maximum single loss (MSL) and basic limits are applied to losses and allocated loss adjustment expenses (ALAE).

3 1, 2 1, 3 2, 3 1, 2, 3

Question 10

According to Werner and Modlin in "Basic Ratemaking", which of the following are reasons why deductibles are popular among both insureds and insurers?

1. Premium reduction
2. Provides incentive for loss control
3. Controls catastrophic exposure, for insurers writing a large number of policies in cat prone areas.

3   1, 2   1, 3   2, 3   1, 2, 3

Question 11

10. A 12-month policy is written on March 1, 2002 for a premium of $900. As of December 31, 2002, which of the following is true?

	Calendar Year 2002 Written Premium	Calendar Year 2002 Earned Premium	Inforce Premium
A.	$900	$900	$900
B.	$750	$750	$900
C.	$900	$750	$750
D.	$750	$750	$750
E.	$900	$750	$900

Question 12. You are given:

- Full estimated policy premium is booked at inception.
- Premium develops upward by 7% at final audit, six months after the policy expires.
- All policies are written for an annual period.
- Premium is written uniformly throughout the year.

Based on Werner and Modlin in "Basic Ratemaking", in what range does the policy year premium development factor fall for 24 to 36 months?

A. < 1.01   B. $\geq$ 1.01 but < 1.02   C. $\geq$ 1.02 but < 1.03   D. $\geq$ 1.03 but < 1.04   E. $\geq$ 1.04

Question 13. Given the information below, determine the written premium trend period.

- Experience period is April 1, 2001 to March 31, 2002
- Planned effective date is April 1, 2003
- Policies have a 6-month term
- Rates are reviewed every 18 months
- Historical premium is earned premium

A. < 1.8 years   B. $\geq$ 1.8 years, but < 2.1 years   C. $\geq$ 2.1 years, but < 2.4 years

D. $\geq$ 2.4 years, but < 2.7 years   E. $\geq$ 2.7 years

Question 14. Given the following data and using the loss development method as described by Werner and Modlin in "Basic Ratemaking", calculate the projected ultimate accident year 2001 losses.

	As of December 31, 2002	
Accident Year	Paid Losses	Case Reserves
1999	\$11,000	\$1,000
2000	\$6,000	\$2,000
2001	\$3,500	\$4,000
2002	\$1,000	\$4,000

- Projected ultimate accident year 2000 losses = \$9,240
- 12-24 case-incurred link ratio = 1.71
- 24-36 case-incurred link ratio = 1.20

A. < \$8,700 B. ≥ \$8,700, but < \$9,200 C. ≥ \$9,200, but < \$9,700
D. ≥ \$9,700, but < \$10,200 E. ≥ \$10,200

Question 15

According to Werner and Modlin in "Basic Ratemaking", which of the following are true regarding coinsurance?

1. A coinsurance penalty corrects for inequity caused by similar homes insured to different insurance to value levels by adjusting the indemnity payment in the event of a loss.
2. Another way to achieve equity is to calculate and use rates based on the level of insurance to value.
3. A rate can be calculated given the expected frequency, the size of loss distribution, and the full value of the property.

1 3 2, 3 1, 3 1, 2, 3

Question 16

According to Werner and Modlin in "Basic Ratemaking",which of the following statements regarding insurance to value is false?

A. Coinsurance can adjust the premium rate to the amount of insurance.
B. The pure premium rate, which equates pure premiums and expected indemnity, falls as the policy faces increases, regardless of whether small or large losses predominate.
C. The possibility of losses less than the co-insurance requirement creates the pricing problem known as "insurance to value."
D. If large losses outnumber small ones, pure premium rates should decrease at an increasing rate.
E. If losses less than the policy face are possible, the pure premium rate decreases as the policy face increases.

Question 17

According to Werner and Modlin in "Basic Ratemaking", which of the following statements are true?

1. A coinsurance penalty is the amount by which a coinsurance requirement exceeds the amount of the carried insurance.
2. A coinsurance deficiency is the amount by which the indemnity payment resulting from a loss is reduced due to the coinsurance clause.
3. Given an insured with a coinsurance deficiency, a loss need not occur to be a coinsurer.

1 and 2 3 2 1 and 3 1, 2, and 3

Question 18. Given the following data, calculate the trended loss ratio.

Number of Insureds	Earned Premium	Developed Incurred Losses
20	$50,000	$35,000

- Years of Trend = 2.5
- Annual Exposure Trend = 2.0%
- Annual Premium Trend = 2.9%
- Annual Frequency Trend = -1 .0%
- Annual Severity Trend = 6.0%

A. < 68% B. $\geq$ 68% but < 71% C. $\geq$ 71 % but < 74% D. $\geq$ 74%, but < 77% E. $\geq$ 77%

Question 19. Based on Insurance Services Office, Inc., Personal Automobile Manual (Effective 6-98), which of the following is false?

A. The Manual describes the types of vehicles eligible for coverage.
B. The Manual specifies which drivers must be categorized as "Youthful Operators".
C. The Manual sets forth rating factor adjustments for companies electing not to use the Safe Driver Insurance Plan.
D. The Manual describes the primary and secondary classifications applicable.
E. The Manual specifies that all Liability and Physical Damage policies must have a policy period of no longer than 12 months.

Question 20. According to Insurance Services Office, Inc., Personal Vehicle Manual (Edition 6-98), which of the following are true?

1. Expense Fees are added separately to the premium for the Single Limit Liability or BI and PD Liability, Comprehensive, Collision and No-Fault Coverages applying to each auto.
2. Expense Fees are not subject to modification by the provisions of any rating plans or other rating rules (e.g. Classifications, Safe Driver Insurance Plan).
3. Expense Fees are subject to the Cancellation and Suspension provisions of this manual.

1 2 1, 2 1, 3 1, 2, 3

Question 21. According to Insurance Services Office, Inc., Personal Vehicle Manual (Edition 6-98), which of the following are true with respect to classification changes?

1. A policy may not be changed mid-term because of the attained age of an operator of the auto.
2. A policy may not be changed mid-term to effect a change in the Driving Record Sub Classification.
3. A policy may not be changed mid-term due to a change in symbol assignment based on a review of loss experience.

1	2	1, 2	1, 3	1, 2, 3

Question 1 discussion:

True. See page 2, section 4.2 (Models)

Question 2 discussion:

1. True. See chapter 8
2. True. See chapter 8
3. False. See chapter 8.

Answer: 1, 2

Question 3 discussion:

1. True. See chapter 1.
2. True. See chapter 9.
3. False. The two basic approaches used in manual ratemaking are the pure premium method and the loss ratio method. See chapter 8

Answer: 1, 2

Question 4 discussion:

The premium for the policy effective 5/1 is fully earned by 11/1/92. There is no unearned premium at 12/31/92.

5/12 ths of the premium for the policy effective 8/1 is earned by 12/31/92.

The unearned premium is = (7/12) * $12,000 = $7,000.

2/6 ths of the premium for the policy effective 11/1 is earned by 12/31/92.

The unearned premium is = (4/6) * $2,400 = $1,600.

Thus, the total unearned premium = $7,000 + 1,600 = 8,600. Answer D. See Chapter 5

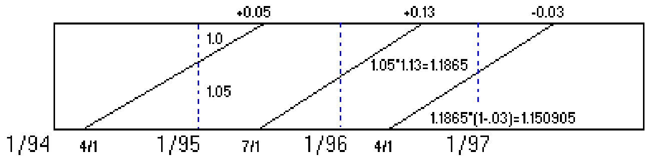
Question 5 discussion:

1. True.
2. False. There are several acceptable methods of organizing data including calendar year, accident year, report year and policy year. Each presents certain advantages and disadvantages; but, if handled properly, each may be used to produce rates.
3. False.

Answer: 1

Question 6 discussion:

To facilitate the calculation of CY on-level factors, setup a diagram similar to the one below:



Calculate the numerator of the on-level factor. This is equal to (1.05)*(1.13)*(1-.03) = 1.150905.

Calculate the average rate level factor for the **calendar year**. This is a weighted average of the rate level factors in the **calendar year**. The weights will be relative proportions of the **square**.

First calculate the area of all triangles (area = .50 * base * height) within a unit square and then determine the remaining proportion of the square by subtracting the sum of the areas of the triangles from 1.0.

For CY 1995, the average rate level factor = (1/2)(3/12)(3/12)*1.0 + (1/2)(1/2)(1/2)*1.1865+ (1.0 - .15625)*1.05
= .03125 + .1483125 + .8859375 = 1.0655

The on-level factor = 1.150905 / 1.0655 = 1.0801549. **Answer B. See Chapter 5**

Question 7 discussion:

1. True. It examines the profitability from inception to termination (including renewals) of the policy. See page 192
2. True. Feldblum demonstrates how asset share pricing is used to determine class relativities for young drivers. See page 217.
3. False. Level premiums associated with whole life policies have lead life actuaries to place greater reliance on asset-share pricing models than P&C actuaries (which work with premiums that fluctuate widely). See page 197.

Answer: 1, 2

Question 8 discussion:

True. Termination rates more clearly distinguish persistency patterns by classification. Probabilities of termination, in certain analyses, provide a better portrayal of the insurer's profitability. See pages 210 - 211.

Question 9 discussion:

1. True. See page 1.
2. True.
3. False. Limit paid losses to basic per occurrence limits (25,000) and then limit the latter, including unlimited ALAE, by the MSL

Answer: 1, 2 See chapter 15

Question 10 discussion:

1. True. See Chapter 11
2. False. See Chapter 11
3. True. See Chapter 11

Answer: 1, 3

Question 11 discussion:

A 12-month policy is written on March 1, 2002 for a premium of $900. As of December 31, 2002, which of the following is true?

Step 1: Answering this question is best understood in terms of exposures

Written exposures are those units of exposures on policies written during the period in question,

Earned exposures are the exposure units actually exposed to loss during the period, and

Inforce exposures are those exposure units exposed to loss at a given point in time.….

Step 2: Based on the definitions in Step 1, only earned premium differs from written premium and inforce premium and therefore needs to be computed.

Thus, earned premium at 12/31/02 equals $900 * 10/12 = $750. **Answer E. See Chapter 5**

Question 12 discussion:

Question 12. Assume that policy year 199X premium is being booked at $P per month.

Developed premium, due to final audits, is not known until 6 months after the policy expires.

At 12/31/9X+1, developed premium for only those policies issued during the 1st 6 months of PY 199X is known.

At 12/31/9X+2, developed premium for all policies issued during PY 199X is known.

	Reported Premium for polices issued during the		
<u>Evaluation Date</u>	1st 6 months of PY 199X	Last 6 months of PY 199X	<u>Total PY 199X</u>
12/31/9X	6 months * ($P/month)	6 months * ($P/month)	12P
12/31/9X+1	6 * P * 1.07	6 * P	12.42P
12/31/9X+2	6 * P * 1.07	6 * P * 1.07	12.84P

Therefore, the PY premium development factor for 24 to 36 months is 12.84P/12.42P = 1.034 **Answer D.** See Chapter 5

Question 13 discussion:

Step 1: Determine the average written date during the experience period. For the experience period 4/1/01 – 3/31/02, and given that 6 month policies are being written, the average earned date is 10/1/01 and the average written date is **7/1/01**, or ½ the policy term earlier from the average earned date.

Step 2: Determine the average written date during the exposure period. The average written date during the future policy period is a function of the length of time that the rates are expected to remain in effect. In this example, since rates are reviewed every 18 months, this would make the average written date 9 months after the proposed effective date of 4/1/03, which is **1/1/04.** Thus, the written premium trend period is 2.50 years.
Answer: D. ≥ 2.4 years, but < 2.7 years See Chapter 6

Question 14 discussion:

Step 1: Determine AY 2001 case incurred losses at 12/31/2002 projected to 36 months.

Case incurred losses at 12/31/2002 = $3500 + $4,000 = $7,500. Note that at 12/31/02, AY 2001 case incurred losses are at 24 months of development. The loss development factor from 24-36 months is given as 1.20. Thus, AY 2001 case incurred losses projected to 36 months equals $9,000.

Step 2: Determine AY 2001 case incurred losses at 12/31/2002 projected to ultimate.

AY 2000 36-48 months case incurred loss development factor is $9,240/$8,000 = 1.155. Thus, at 12/31/02, AY 2001 cased incurred losses are at ultimate equals $9,000 * 1.155 = $10,395.

Answer E. ≥ $10,200 See Chapter 6

Question 15 discussion:

1. True. See chapter 11.
2. True. See chapter 11.
3. True. See chapter 11.

Answer: 1, 2, 3

Question 16 discussion:

A. True. See chapter 11.

B. True. See chapter 11.

C. False. The possibility of losses less than the policy face creates the pricing problem known as "insurance to value". See chapter 11.

D. True. See chapter 11.

E. True. See chapter 11.

Question 17 discussion:

1. False. A coinsurance deficiency is the amount by which a coinsurance requirement exceeds the amount of the carried insurance. See chapter 11.
2. False. A coinsurance penalty is the amount by which the indemnity payment resulting from a loss is reduced due to the coinsurance clause. See chapter 11.
3. True. See chapter 11.

Answer: 3

Question 18 discussion:

When working with inflation-sensitive exposure bases, incorporate the exposure trend into the estimate of the expected future loss ratio. To maintain a valid loss ratio projection, the adjustments made to the numerator of the loss ratio should be on a consistent basis with those made to the denominator. …The numerator of the loss ratio is adjusted for frequency trend and severity trend, while the denominator is adjusted for average premium trend."

Step 1: Based on the givens of the problem, write an equation to determine the trended loss ratio.

$$\text{Trended Loss Ratio} = \left(\frac{\text{Developed Incurred Losses}}{\text{Earned Premium}}\right) * \left(\frac{\text{Freq Trend*Sev Trend}}{\text{Premium Trend}}\right)^{\text{Years of Trend}}$$

Step 2: Using the equation in Step 1, and the data in the problem, solve for the trended loss ratio.

$$\text{Trended Loss Ratio} = \left(\frac{\$35{,}000}{\$50{,}000}\right) * \left(\frac{.99 * 1.06}{1.029}\right)^{2.5} = .7352$$ **Answer C: $\geq$ 71 % but < 74%**

Question 19 discussion

A. The Manual describes the types of vehicles eligible for coverage. True. See page G-1.

B. The Manual specifies which drivers must be categorized as "Youthful Operators". True. See section 4: Classifications, page G-5.

C. The Manual sets forth rating factor adjustments for companies electing not to use the Safe Driver Insurance Plan. True. See section 5: Safe Driver Insurance Plan, section 2 page G-8.

D. The Manual describes the primary and secondary classifications applicable. True. See section 4: Classifications, page G-2.

E. The Manual specifies that all Liability and Physical Damage policies must have a policy period of no longer than 12 months. False. "No policy may be written for a period longer than 12 mos. for Liab. Coverage or 36 mos. for Physical Damage."

Question 20 discussion

1. True. See page G-2.
2. True. See page G-2.
3. True. See page G-2.

Answer: 1, 2, 3

Question 21 discussion

1. True. See page G-3.
2. True. See page G-3.
3. True. See page G-3.

Answer: 1, 2, 3

Exam 5A – Independently Authored Questions - Preparatory Test 1

General information about this exam

This practice test contains 30 questions consisting of computational and essay based questions.

	Essay Questions	Computational Questions	Total
Total Number of Qs:	18	12	30
Total Number of Points:	24.5	35.5	60

1. The recommend time for this exam is 3:30:00. Make sure you have sufficient time to take this practice test.

2. Consider taking this exam after working all past CAS questions first.

3. Make sure you have a sufficient number of blank sheets of paper to record your answers for computational questions.

Articles covered on this exam:

Article .... Author ....

Chapter 1: Introduction...Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 2: Rating Manuals..Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 3: Ratemaking Data..Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 4: Exposures ....Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 5: Premium...Modlin, Werner .... A. Basic Techniques for Ratemaking

Statement of Principles Re PC Ins Ratemaking..........CAS .... A. Basic Techniques for Ratemaking

Exam 5A – Independently Authored Questions - Test 1

Question 1 (1.25 points)

According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (.25 points). State the basic economic relationship for the price of any product.

b. (1.0 point). Transform the equation in part a. into the fundamental insurance equation, and briefly describe each component of the fundamental insurance equation using basic insurance terminology.

Question 2 (1.25 points)

a. (.25 points). Define the term ‘exposure’.

b. (1.0 point). Briefly describe four ways insurers measure exposures.

Question 3 (1.50 points)

a. (1.0 point). Briefly describe two reasons why reported losses may differ from ultimate losses.

b. (.50 points). Based on your response in part a, write an equation that relates reported losses to ultimate losses.

Question 4 (1.50 points)

a. (.50 points). Briefly describe the goal of ratemaking as it relates to the fundamental insurance equation.

b. (1.0 point). List and briefly describe two key points to consider in achieving balance in the fundamental insurance equation.

Question 5 (5.25 points)

You are given the following information about the ABC insurance company

Number of Reported Claims	2,000
Number of Earned Exposures	40,000
Total Reported Losses	6,000,000
Total Reported LAE	1,200,000
Total Earned Premium	8,000,000
Total Written Premium	8,400,000
Commissions and brokerage	840,000
Other acquisition costs	420,000
General expenses	640,000
Taxes, licenses, and fees	336,000
Number of Potential Renewal Policies	2,000
Number of Policies Renewed	1,700
Number of Quotes	6,000
Number of Accepted Quotes	1,200

a. (0.75 points). Compute ABC’s frequency, severity and pure premium

b. (1.0 point). Briefly describe what can be identified when analyzing changes in claim frequencies and claim severities.

c. (1.0 point). Compute ABC’s average premium, loss ratio, LAE ratio and underwriting expense ratio.

d. (1.0 point). Compute ABC’s operating ratio and combined ratio

e. (1.5 points). Compute ABC’s Retention ratio and Close ratio and briefly describe why computing such ratios are important.

Question 6 (1.0 point)

According to Werner and Modlin in “Basic Ratemaking”, list four elements that are necessary to calculate the premium for a given risk: for most lines of business.

Question 7 (1.0 point)

According to Werner and Modlin in “Basic Ratemaking”, Rating algorithms describes how to combine the components in the rules and rate pages to calculate the premium charged for any risk not pre-printed in a rate table. List four possible types of instructions included within a rating algorithm

Question 8 (1.0 point)

According to Werner and Modlin in “Basic Ratemaking”, while underwriting criteria has been historically subjective in nature, there has been a trend over time (especially for personal lines products) to designate new explanatory variables as underwriting criteria, which can then be used for placement into rating tiers or separate companies.

Briefly describe three underwriting characteristics that are currently used for three different types of insurance.

Question 9 (5.25 points)

You are given the following information from ABC insurance company' rating manual:

Protection Class and Construction Type

Protection	Construction Type	
Class	Frame	Masonry
1-4	1.00	0.90
5	1.05	1.00
6	1.10	1.05
7	1.15	1.10
8	1.25	1.15
9	2.10	1.75
10	2.30	1.90

Territory

Territory	Rate Relativity
1	0.80
2	0.90
3	1.00
4	1.10
5	1.15

Deductible

Deductible	Rate Relativity
$250	1.00
$500	0.95
$1,000	0.85
$5,000	0.70

Underwriting Tier

Tier	Rate Relativity
A	0.80
B	0.95
C	1.00
D	1.45

Amount of Ins (AOI) Rating Table

AOI (in 000s)	Rate Relativity
$80	0.56
$95	0.63
:::	:::
$170	0.91
$185	0.96
$200	1.00
$215	1.04

Miscellaneous Credits

Miscellaneous Credit	Credit Amount
New Home Discount	20%
5-Year Claims-Free Discount	10%
Multi-Policy Discount	7%

Add'l Optional Coverages

Jewelry Coverage Rate	
Limit	Additive
$2,500	Included
$5,000	$35
$10,000	$60

Expense Fee
Policy Fee
$50

Liability/Medical	
Limit	Additive
$100,000/$500	**Included**
$300,000/$1,000	$25
$500,000/$2,500	$45

ABC is preparing a renewal quote for a homeowner with the following risk characteristics:

- Amount of insurance = $185,000. Base rate = $750.
- The insured lives in Territory 2.
- The home is frame construction located in Fire Protection Class 7.
- Based on the insured's credit score, tenure with the company, and loss history, the policy is in UW Tier C.
- The insured opts for a $1,000 deductible.
- The home falls under the definition of a new home as defined in ABC's rating rules.
- The insured is eligible for the five-year claims-free discount.
- There is no corresponding auto or excess liability policy written with ABC.
- The policyholder opts to increase coverage for jewelry to $5,000 and to increase liability/medical coverage limits to $300,000/$1,000.

The rating algorithm calls for rating variables to be applied in a multiplicative manner, except for the following which are to be applied in an additive manner: Increased Jewelry Coverage; Increased Liability/Medical Coverage; Policy Fee

Calculate the final premium for the policy.

Question 10 (3.0 points) You are given the following information from a retirement center and ABC insurance company' rating manual. A retirement living center with the following employee classes groups has requested a quote.

Class	Payroll (from insured)	Rate per $100 of Payroll (from rating manual)
8810 – Clerical	$40,000	0.59
8825 - Food Service Employees	$85,000	2.88
8824 - Health Care Employees	$100,000	4.00
8826 - All Other Employees & Salespersons, Drivers	$30,000	3.75

The following underwriter determined schedule credits apply:

- The center has trained its entire staff in first aid and first aid equipment is available in the building: -2.5%
- The center has been inspected by ABC and the premises are clean and well-maintained: -10%
- The center follows careful procedures in selecting, training, and supervising its workers: - 5%

Other factors that apply to the policy from ABC's Rating Manual are as follows:

Entries from Rating Manual	
Pre-Employment drug screening test	5%
Expense Constant	$250

The minimum premium for the policy of $1,500.

The rating algorithm calls for rating variables to be applied in a multiplicative manner, except for the following expense constant.

Compute total premium for the policy.

Question 11 (1.0 point) According to Werner and Modlin in "Basic Ratemaking", list and provide examples of two types of internal data involved in a ratemaking analysis

Question 12 (3.0 points)

You are given the following information about three homeowner's policies written by the ABC insurance

- Policy A is written on 1/1/2012 with an annual premium of $1,300. The home is located in Territory 1 and the insured has a $250 deductible. The policy remains unchanged for the full term of the policy.
- Policy B is written on 4/1/2012 with an annual premium of $800. The home is located in Territory 2 and the insured has a deductible of $250. The policy is canceled on 12/31/2012.
- Policy C is written on 7/1/2012 with an annual premium of $1,500. The home is located in Territory 3 and has a deductible of $500. On 1/1/2013, the insured decreases the deductible to $250. The full annual term premium after the deductible change is $1,800.

Using the policy data above, complete ABC's policy database entries. Determine whether one or multiple records for each policy are needed when constructing the database.

Policy	Original Effective Date	Original Termination Date	Transaction Effective Date	Ded	Terr	Written Exposure	Written Premium

Question 13 (2.0 points)

According to Werner and Modlin in “Basic Ratemaking”, list the four type of data aggregation methods and briefly describe the advantages and disadvantages of their use.

Question 14 (1.5 points)

According to Werner and Modlin in “Basic Ratemaking”, list three types of third party data, not specific to insurance, and briefly describe how they are used for insurance/ratemaking purposes.

Question 15 (3.0 points)

According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (.75 points) Define the term exposure. List three criteria that a good exposure base should meet.

b. (2.25 points) With respect to homeowners insurance, should number of house years or amount of insurance be the exposure base. Briefly explain the rationale behind your choice for exposure base.

Question 16 (1.5 points) According to Werner and Modlin in “Basic Ratemaking” a well-defined and objective exposure should not be able to be manipulated by policyholders and producers/underwriters.

While the use of estimated annual miles driven as an exposure base for auto insurance has been cited as an opportunity for insureds to be dishonest, presenting an a moral hazard for insurers , briefly explain why it may not and given an example supporting your position.

Question 17 (1.5 points) Based on Werner and Modlin in “Basic Ratemaking”, use the homeowners policy data below to answer the following questions

Policy	Effective Date	Expiration Date	Exposure
A	10/1/2012	9/30/2013	10.00
B	1/1/2013	12/31/2013	10.00
C	4/1/2013	3/31/2014	10.00
D	7/1/2013	6/30/2014	10.00
E	10/1/2013	9/30/2014	10.00
F	1/1/2014	12/31/2014	10.00

a. (.75 points). Compute the number of CY 2012, CY 2013 and CY 2014 written exposures.

b. (.75 points). Compute the number of written exposures policy D will contribute to CY 2013 and CY 2014 if policy D is cancelled 3/31/2014.

c. (.75 points). Compute the number of written exposures policy D will contribute to PY 2013 and PY 2014 if policy D is cancelled 3/31/2014.

d. (.75 points). Compute the number of CY 2012, CY 2013 and CY 2014 earned exposures.

e. (.75 points). Assuming the above policies were written for 6 month terms (as opposed to annual terms), compute the number of CY 2012, CY 2013 and CY 2014 earned exposures.

Question 18 (1.5 points) Based on Werner and Modlin in "Basic Ratemaking", use the information below to answer the following questions.

An insurer begins writing annual policies in 2012 and writes 480 exposures each month during 2012 only.

The insurer is using the "15th of the month" rule to compute In-force exposures

a. (.75 points). Compute the aggregate In-force exposures as of 7/01/2012, 1/01/2013 and 7/01/2013

b. (.75 points). Compute the aggregate earned exposures for CY 2012 and CY 2013

Question 19 (1.5 points) According to Werner and Modlin in "Basic Ratemaking" list and briefly describe three adjustments to historical premium to produce projected future premium.

Question 20 (4.0 points) According to Werner and Modlin in "Basic Ratemaking" answer the following question based on the information given below. Assume ABC issues annual policies and premium is calculated according to the rating algorithm: **Premium = Exposure x Rate per Exposure x Class Factor + Policy Fee.**

Rate Change History

Rate Level Group	Effective Date	Overall Average Rate change	Rate Per Exposure	Class Factor X	Class Factor Y	Class Factor Z	Policy Fee
1	Initial	--	$1,800	1.00	0.75	1.15	$1,000
2	07/01/12	5.0%	$1,900	1.00	0.75	1.15	$1,000
3	01/01/13	10.0%	$2,090	1.00	0.75	1.15	$1,100
4	04/01/14	-1.0%	$2,090	1.00	0.80	1.15	$1,090

Assume ABC issued one policy effective on 3/1/2013 that had 10 class Y exposures.

Compute the actual premium that was charged using the extension of exposures method and the PY 2014 premium at current rate level using the extension of exposures method.

Question 21 (3.0 points) According to Werner and Modlin in "Basic Ratemaking" answer the following questions based on the given data below.

Annual policies have been issued and rate changes apply to policies effective on or after the date

Rate Level Group	Effective Date	Overall Average Rate
1	Initial	
2	07/01/10	5.0%
3	01/01/11	10.0%
4	04/01/12	-1.0%

a. (1.0 point). Compute the on-level factor applied to the CY 2011 EP to bring it to current rate level.

b. (1.0 point). Compute the on-level factor applied to the PY 2012 EP to bring it to current rate level.

c. (1.0 point). Assuming six month policies were issued, compute the on-level factor applied to the CY 2011 EP to bring it to current rate level.

d. (1.0 point). Assume a law change mandates a rate decrease of 5% on 7/1/2011 applicable to all policies, compute the on-level factor applied to the CY 2011 EP to bring it to current rate level.

Question 22 (1.0 point) According to Werner and Modlin in "Basic Ratemaking", list and briefly describe two problems with the parallelogram method.

Question 23 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following question.

- A WC carrier writes one policy per month in 2013.
- Estimated premium for each policy is booked at policy inception for $750,000.
- Premium develops upward by 8% at the first audit (6 months after the policy expires).

Compute the premium development factor from 12/31/2014 (24 months after the start of the PY) to 12/31/2015 (36 months after the start of the PY)

Question 24 (1.0 point) According to Werner and Modlin in “Basic Ratemaking”, list and briefly describe three examples that can cause changes in an insurer’s average premium level.

Question 25 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following question.
Assume the following:

- CY 2011 EP is being used to estimate the rate need for annual policies that are to be in effect from 1/1/2013 – 12/31/2013.
- WP is used as the basis of the trend selection and EP for the overall rate level indications
- The actuary selects a trend factor of 2%, the amount average premium is expected to change annually.

Compute the one step trend factor.

Question 26 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, list and briefly describe three examples that can affect the length of the trend period. Provide graphical representations of the adjustments if needed.

Question 27 (1.0 point) According to Werner and Modlin in “Basic Ratemaking”, list and briefly describe two examples when a one-step trending process is not appropriate to use.

Question 28 (3.0 points) According to Werner and Modlin in “Basic Ratemaking”, and given the information below, determine the written premium trend period using the one-step trending procedure.

- Experience period is April 1, 2001 to March 31, 2002
- Planned effective date is April 1, 2003
- Policies have a 6-month term
- Rates are reviewed every 18 months
- Historical premium is earned premium

Question 29 (3.0 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the information below, determine the projected premium at current rate level using the two-step trending procedure.

Use the latest average written premium at current rate level, the historical average EP at current rate level, and average written date during the period the proposed rates are to be in effect.

- Experience period is 1/1/2013 to 12/31/2013
- Planned effective date is 1/1/2015
- Policies have a 12-month term
- Rates are reviewed every 12 months
- Latest average written premium at current rate level for the 4th quarter 2013 is 953.00
- Average earned premium for CY 2013 is 940.00
- CY 2013 Earned Premium at Current Rate Level is $1,880,788
- CY 2013 Earned Exposures is 2,150
- Selected Projected Premium Trend is 2.0%

Question 30 (1.0 point) The CAS Statement of Principles on ratemaking describes a number of considerations that commonly apply to any ratemaking methodology. Under the heading of Other Influences, the Statement lists five external influences which might have an impact on future experience.

List four of these five external influences.

Exam 5A – Solutions to Independently Authored Questions - Test 1

Question 1 discussion: Blooms: Knowledge; Difficulty 1, LOKS: Describe the information requirements for ratemaking related to premiums and demonstrate the use of premiums in ratemaking

a. The basic economic relationship for the price of any product is Price = Cost + Profit.

b. Premium is the "price" of the insurance product.

"Cost" is the sum of the losses, LAE, and UW expenses.

UW profit is income minus the outgo from issuing policies (and Profit is also derived from II)

The fundamental insurance equation is Premium = Losses + LAE + UW Expenses + UW Profit. See chapter 1

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LOKS: Describe the information requirements for ratemaking related to exposures and demonstrate the use of exposures in ratemaking.

a. An exposure is a unit of risk that underlies the premium.

b. Four ways insurers measure exposures are as follows:

1. **Written exposures** are the total exposures arising from policies issued during a specified time period (e.g. a calendar year or quarter).
2. **Earned exposures** are the portion of written exposures for which coverage has already been provided (as of a certain point in time).
3. **Unearned exposures** are the portion of written exposures for which coverage has not yet been provided (as of that point in time).
4. **In-force exposures** are the number of units exposed to loss at a given point in time.

See chapter 1

Question 3 discussion: Blooms: Comprehension; Difficulty 1, LOKS: Describe the information requirements for ratemaking related to loss and loss adjustment expenses and demonstrate the use of loss and loss adjustment expenses in ratemaking.

a1. When there are unreported claims, the estimated amount to settle these claims is known as incurred but not reported (IBNR) reserve.

a2. The incurred but not enough reported (IBNER) reserve (a.k.a. development on known claims) is the difference between the aggregate reported losses at the time the losses are evaluated and the aggregate amount estimated to ultimately settle these reported claims.

b. Ultimate Losses = Reported Losses + IBNR Reserve + IBNER Reserve.

See chapter 1

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LOKS Describe the information requirements for ratemaking related to premiums and demonstrate the use of premiums in ratemaking

a. The goal of ratemaking is to assure that the fundamental insurance equation is balanced (e.g. rates should be set so premium is expected to cover all costs and achieve the target UW profit).

Two key points in achieving balance in the fundamental equation are:

b1. Ratemaking is prospective, and this involves estimating the components of the fundamental insurance equation to determine whether or not the estimated premium is likely to achieve the target profit during the period the rates will be in effect.

b2. Balance should be attained at the aggregate level (otherwise rates will either be redundant or inadequate and individual levels) and at the individual level (otherwise failure to recognize differences in risk will lead to rates that are not equitable, which violates principle 3 of the CAS Statement of Ratemaking Principles).

See chapter 1

Question 5 discussion: Blooms: Application. Difficulty 3. LO: Calculate the underwriting expense provisions underlying the overall rate level indication.

a1. $Frequency = \frac{Number\ of\ Claims}{Number\ of\ Exposures}$ is 5% (= 2,000 / 40,000).

a2. $Severity\ = \frac{Total\ Losses}{Number\ of\ Claims}$ is $3,000 (= $6,000,000 / 2,000).

a3. $Pure\ Premium = \frac{Total\ Losses}{No.of\ Exposures} = Freq\ x\ Sev$ is $150 (= $6,000,000 / 40,0000) = 5.0% x $3,000.

b. Analyzing changes in claims frequency can help identify, industry trends associated with the incidence of claims, utilization of insurance coverage, and the effectiveness of specific underwriting actions.

Analyzing changes in severity:

- provides information about loss trends and
- highlights the impact of any changes in claims handling procedures.

c $Average\ Premium = \frac{Total\ Premium}{No.of\ Exposures}$ is $200 (=$8,000,000 / 40,000).

$Loss\ Ratio = \frac{Total\ Losses}{Total\ Premium} = \frac{Pure\ Premium}{Average\ Premium}$ is 75% (= $6,000,000 / $8,000,000).

$LAE\ Ratio\ = \frac{Total\ Loss\ Adjustment\ Expenses}{Total\ Losses}$ is 20% (= $1,200,000 / $8,000,000).

$UW\ Expense\ Ratio = \frac{Total\,UW\ Expenses}{Total\ Premium}$ is 27%

Underwriting Expense Ratio = Total Underwriting Expense / Total Premium

	(1)		(2)	U/W Exp Ratio (3)=(1)/(2)
Commissions and brokerage	840,000	Total Written Premium	$8,400,000	10.0%
Other acquisition costs	420,000	Total Written Premium	$8,400,000	5.0%
General expenses	640,000	**Total Earned Premium**	$8,000,000	8.0%
Taxes, licenses, and fees	336,000	Total Written Premium	$8,400,000	4.0%
TOTAL				**27.0%**

d. $OER = UW\ Expense\ Ratio + \frac{LAE}{Total\ Earned\ Premium}$ is 27% + ($1,200,000 / $8,000,000) = 42%

$Combined\ Ratio = Loss\ Ratio + \frac{LAE}{Earned\ Premium} + \frac{Underwriting\ Expenses}{Written\ Premium}$ = 75%+15%+27% = 117%

e. $Retention\ Ratio = \frac{Number\ of\ Policies\ Renewed}{Number\ of\ Potential\ Renewal\ Policies}$ 85% (= 1,700 / 2,000).

$Close\ Ratio = \frac{Number\ of\ Accepted\ \ Quotes}{Number\ of\ Quotes}$ is 20% (= 1,200 /6,000).

Retention ratios are used to gauge the competitiveness of rates and are closely examined following rate changes or major changes in service, and as a key parameter in projecting future premium volume.

Closed ratios are used to determine the competitiveness of rates for new business.

See chapter 1

Question 6 discussion: Blooms: Knowledge; Difficulty 1, LOKS: Calculate a policy premium for a specified risk using the rate pages provided.

Rules	Found in the insurer's rating manual
Rate pages (i.e. base rates, rating tables, and fees)	Found in the insurer's rating manual
Rating algorithm	Found in the insurer's rating manual
Underwriting guidelines	Found in the insurer's UW manual

See chapter 2

Question 7 discussion: Blooms: Knowledge; Difficulty 1, LOKS: Calculate a policy premium for a specified risk using the rate pages provided

The algorithm includes instructions such as:

- the order in which rating variables should be applied
- how rating variables are applied in calculating premium (e.g. multiplicative, additive, or some unique mathematical expression)
- maximum and minimum premiums (or in some cases the maximum discount or surcharge to be applied)
- specifics with how rounding takes place.

See chapter 2

Question 8 discussion: Blooms: Comprehension; Difficulty 1, LOKS: Calculate a policy premium for a specified risk using the rate pages provided

Personal Automobile	Insurance Credit Score, Homeownership, Prior Bodily Injury Limits
Homeowners	Insurance Credit Score, Prior Loss Information, Age of Home
Workers Compensation	Safety Programs, Number of Employees, Prior Loss Information
Commercial General Liability	Insurance Credit Score, Years in Business, Number of Employees
Medical Malpractice	Patient Complaint History, Years Since Residency,
Commercial Automobile	Driver Tenure, Average Driver Age, Earnings Stability

See chapter 2

Question 9 discussion: Blooms: Application; Difficulty 3, LOKS: Calculate a policy premium for a specified risk using the rate pages provided

Total Premium = All-Peril Base Rate x AOI Relativity * Territory Relativity * Protection Class / Construction Type Relativity

* Underwriting Tier Relativity * Deductible Credit

* [1.0 - New Home Discount – Claims-Free Discount] * [1.0 - Multi-Policy Discount]

+ Increased Jewelry Coverage Rate + Increased Liability/Medical Coverage Rate + Policy Fee.

Entries from Rating Manual		
Base Rate		$750
AOI Relativity		0.96
Territory Relativity		0.90
Protection Class / Construction Type Relativity		1.15
Underwriting Tier Relativity		1.00
Deductible Credit		0.85
New Home Discount		20%
Claims-Free Discount		10%
Multi-Policy Discount		0%
Increased Jewelry Coverage Rate		$35
Increased Liability/Medical Coverage Rate		$25
Expense Fee		$50

The rating algorithm from the rating manual can be applied to calculate the final premium for the policy:

$$\$522.36 = \$750 * .96 * .90 * 1.15 * 1.00 * 0.85 * [1.0 - 0.20 - 0.10] * [1.0 - .07] + \$35 + \$25 + \$50.$$

Question 10 discussion: Blooms: Application; Difficulty 2, LOKS: Calculate a policy premium for a specified risk using the rate pages provided

The rating algorithm to calculate the final premium for a given policy using the aforementioned rating manual variables is as follows:

Total Premium = Higher of

$$[\sum_{i=1}^{N}(Class_i rate\ x\ \$Payroll\ for\ class_i / 100) \quad where\ N = number\ of\ classes$$

x (1.0+ Schedule Rating Factor)
x (1.0- Pre-Employment Drug Screening Credit)
x (1.0- Employee Assistance Program Credit)
x (1.0- Return-to-Work Program Credit)
+ Expense Constant]

and, the Minimum Premium specified in the rating manual ($1,500 in WGs case).

Step 1: Compute aggregate manual premium.

Class	Payroll	Payroll/$100	Rate per $100 of Payroll	Class Manual Premium
	(1)	(2)=(1)/100	(3)	(4)=(2)*(3)
8810 Clerical	$40,000	$400	0.59	$236.00
8825 - Food Service Employees	$85,000	$850	2.88	$2,448.00
8824 - Health Care Employees	$100,000	$1,000	4.00	$4,000.00
8826 - All Other Employees	$30,000	$300	3.75	$1,125.00
Total	$255,000			$7,809

Step 2: Determine the total reduction to manual premium based on the given schedule credits

Schedule Rating Modification					
Premises	Classification Peculiarities	Medical Facilities	Safety Devices	Employees — Selection, Training, Supervision	Management —Safety Organization
-10%	0%	0%	-2.5%	-5%	0%

The total credit (reduction to manual premium) for SR is 10% + 2.5% + 5% = 17.5%.

Step 3: Using the formula in Step 1, the results from Step 2 and the data given in the problem, compute the total premium for the policy.

Thus, the total premium for the policy is $6,370.30 = $7,809.00 x 0.825 x (1.0 - 0.05) + $250.
Since $6,370.30 is greater than the min premium per policy of $1,500, the total premium for the policy is $6,370.30.

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LOKS: Calculate the underwriting expense provisions underlying the overall rate level indication.

Two types of internal data involved in a ratemaking analysis are:

1. **risk information** (e.g. exposures, premium, claim counts, losses, and claim or policy characteristics).
2. **accounting information** (e.g. UW expenses and ULAE, which is often available only at an aggregate level).

See chapter 3

Question 12 discussion: Blooms: Application; Difficulty 2, LOKS: Calculate the underwriting expense provisions underlying the overall rate level indication.

Policy A can be represented with 1 record since expired at its original expiration date and had no changes.

Policy B is represented by two records because it was canceled before the policy expired.

The first record for contains information known at policy inception (e.g. 1 exposure and $800 in WP).

The second record represents an adjustment for the cancellation such that when aggregated, the two records show a result net of cancellation. As the policy was canceled 75% of the way through the policy period, the second record should show -0.25 exposure and -$200 (=25% x -$600) of written premium.

Policy C is represented by three records since it has a mid-term adjustment

Policy	Original Effective Date	Original Termination Date	Transaction Effective Date	Ded	Terr	Other	Written Exposure	Written Premium
A	1/1/2012	12/31/2012	1/1/2012	$250	1	…	1	$1,300
B	4/1/2012	3/31/2013	4/1/2012	$250	2	…	1	$800
B	4/1/2012	3/31/2013	12/31/2012	$250	2	…	-0.25	($200)
C	7/1/2012	6/30/2013	7/1/2012	$500	3	…	1	$1,500
C	7/1/2012	6/30/2013	1/1/2013	$500	3	…	-0.5	($750)
C	7/1/2012	6/30/2013	1/1/2013	$250	3	…	0.5	$900

See chapter 3

Question 13 discussion: Blooms: Comprehension Difficulty 2, LOKS: Organization of data: calendar year, policy year, accident year

Four types of data aggregation methods are calendar year (CY), AY (AY), policy year (PY), and report year (RY).

CY aggregation captures premium and loss transactions during a 12-month CY (without regard to policy effective date, accident date, or report date of the claim).

Advantage of CY aggregation: data is quickly available at CY end. CY data is used for financial reporting so there is no additional expense to aggregate the data this way for ratemaking purposes.

Disadvantage of CY aggregation: the mismatch in timing between premium and losses.

CY EP comes from policies in force during the year (written either in the previous or the current CY).

Losses, however, may include payments and reserve changes on claims from policies issued years ago.

CY year aggregation for ratemaking analysis may be most appropriate for lines of business or individual coverages in which losses are reported and settled relatively quickly (e.g. homeowners).

AY aggregation of premium and exposures follows the same precept as CY premium and exposures, and thus the method is often referred to as CY-AY or FY-AY.

Advantage: AY aggregation provides a better match of premium and losses than CY aggregation.

Losses on accidents occurring during the year are compared to EP on policies during the same year.

Since the AY is not closed (fixed) at year end, future development on known losses needs to be estimated.

PY aggregation (a.k.a. UW year) considers all premium and loss transactions on policies that were written during a 12-month period, regardless of when the claim occurred or was reported, reserved, or paid.

Advantage: PY aggregation represents the best match between losses and premium (since losses on policies written during the year are compared with premium earned on those same policies).

Disadvantage: Data takes longer to develop than both CY and AY, since PY exposures for a product with an annual policy term are not fully earned until 24 months after the start of the PY.

RY aggregation is similar to CY-AY except losses are aggregated according to when the claim was reported (as opposed to when the claim occurred).

RY data is used for commercial lines products using claims-made policies (e.g. medical malpractice).

See chapter 3

Question 14 discussion: Blooms: Comprehension; Difficulty 1, LO5, KS: Sources of data and selection criteria

The most commonly used types are:

1. Economic data (e.g. Consumer Price Index (CPI))

Insurers may examine the CPI at the component level (e.g. medical cost and construction cost indices) to find trends relevant to the insurance product being priced.

2. Geo-demographic data (i.e. average characteristics of a particular area).

i. Population density can be a predictor of accident frequency.

ii. Weather indices, theft indices, and average annual miles driven.

3. Credit data is used by insurers to evaluate the insurance loss experience of risks with different credit scores.

Insurers feel credit is an important predictor of risk and began to vary rates accordingly.

See chapter 3

Question 15 discussion: Blooms: Knowledge & Comprehension; Difficulty 2, LO2, KS: Definition of exposure base and b. Characteristics of exposure bases

a. An exposure is the basic unit that measures a policy's exposure to loss.

a1. be directly proportional to expected loss

a2. be practical

a3. consider preexisting exposure bases used within the industry.

b. It should be clear that the expected loss for one home insured for 2 years is two times the expected loss of the same home insured for 1 year.

Also, the expected loss for homes also varies by amount of insurance purchased.

However, while the expected loss for a $200,000 home is higher than that for a $100,000 home, it may not necessarily be two times higher.

Since the EB should be the factor most directly proportional to the expected loss, number of house years is the preferred EB, and amount of insurance should be used as a rating variable.

See chapter 4

Question 16 discussion Blooms: Comprehension; Difficulty 1, LO2, KS: b. Characteristics of exposure bases

Asking a personal auto policyholder to state their estimated annual miles driven provides opportunity for dishonesty more so than the use of car-years as the exposure base.

However, advances in technology may change the choice of EB for personal auto insurance.

Example: Onboard diagnostic devices can accurately track driving patterns and transmit this data to insurers.

Thus, some commercial long haul trucking carriers have implemented miles driven as an EB.

See chapter 4

Question 17 discussion: Blooms: Application; Difficulty 1, LO2, KS: Written exposure versus earned exposure versus

a.

Calendar Year Written Exposures a/o 12/31/14

	Effective	Expiration		Written Exposures		
Policy	Date	Date	Exposure	CY 2012	CY 2013	CY 2014
A	10/1/2012	9/30/2013	10.00	10.00	0.00	0.00
B	1/1/2013	12/31/2013	10.00	0.00	10.00	0.00
C	4/1/2013	3/31/2014	10.00	0.00	10.00	0.00
D	7/1/2013	6/30/2014	10.00	0.00	10.00	0.00
E	10/1/2013	9/30/2014	10.00	0.00	10.00	0.00
F	1/1/2014	12/31/2014	10.00	0.00	0.00	10.00
Total			60.00	10.00	40.00	10.00

b. If Policy D is cancelled on 3/31/2014 (i.e. after 75% of the policy has expired), then Policy D will contribute 10 written exposures to CY 2013 and -2.5 written exposures to CY 2014.

c. If Policy D is cancelled on 3/31/2014 (i.e. after 75% of the policy has expired), then Policy D will contribute 10 written exposures to PY 2013 and -2.5 written exposures to PY 2013. In case of cancellation, the original written exposure and the written exposure due to the cancellation are all booked in the same PY (since PY written exposures are aggregated by policy effective dates).

d.

Calendar Year Earned Exposures a/o 12/31/14

	Effective	Expiration		Earned Exposures		
Policy	Date	Date	Exposure	CY 2010	CY 2011	CY 2012
A	10/1/2012	9/30/2013	10.00	2.50	7.50	0.00
B	1/1/2013	12/31/2013	10.00	0.00	10.00	0.00
C	4/1/2013	3/31/2014	10.00	0.00	7.50	2.50
D	7/1/2013	6/30/2014	10.00	0.00	5.00	5.00
E	10/1/2013	9/30/2014	10.00	0.00	2.50	7.50
F	1/1/2014	12/31/2014	10.00	0.00	0.00	10.00
Total			60.00	2.50	32.50	25.00

e.

Calendar Year Earned Exposures a/o 12/31/14

	Effective	Expiration		Earned Exposures		
Policy	Date	Date	Exposure	CY 2012	CY 2013	CY 2014
A	10/1/2012	3/31/2013	10.00	5.00	5.00	0.00
B	1/1/2013	6/30/2013	10.00	0.00	10.00	0.00
C	4/1/2013	9/30/2013	10.00	0.00	10.00	0.00
D	7/1/2013	12/31/2013	10.00	0.00	10.00	0.00
E	10/1/2013	3/31/2014	10.00	0.00	5.00	5.00
F	1/1/2014	6/30/2014	10.00	0.00	0.00	10.00
Total			60.00	5.00	40.00	15.00

Question 18 discussion: Blooms: Application; Difficulty 1, LO 2KS: Written exposure versus earned exposure versus in-force exposure

a. (.75 points). Compute the aggregate In-force exposures as of 7/01/2012, 1/01/2013 and 7/01/2013

Aggregate In-force Calculation

Written Month	Exposure	Assumed Effective Date	In-Force Exposures a/o 07/01/12	01/01/13	07/01/13
Jan-12	480	01/15/12	480	480	0
Feb-12	480	02/15/12	480	480	0
Mar-12	480	03/15/12	480	480	0
Apr-12	480	04/15/12	480	480	0
May-12	480	05/15/12	480	480	0
Jun-12	480	06/15/12	480	480	0
Jul-12	480	07/15/12	0	480	480
Aug-12	480	08/15/12	0	480	480
Sep-12	480	09/15/12	0	480	480
Oct-12	480	10/15/12	0	480	480
Nov-12	480	11/15/12	0	480	480
Dec-12	480	12/15/12	0	480	480
Total	5,760		2,880	5,760	2,880

b. (.75 points). Compute the aggregate earned exposures for CY 2012 and CY 2013

Aggregate Earned Exposure Calculation

(1) Written Month	(2) Exposures Written	(3) Assumed Effective date	(4) Earning Percentage 2012	(5) Earning Percentage 2013	(6)=(2)*(4) Earned Exposure 2012	(7)=(2)*(5) Earned Exposure 2013
Jan-10	480	01/15/10	23/24	1/24	460	20
Feb-10	480	02/15/10	7/8	1/8	420	60
Mar-10	480	03/15/10	19/24	5/24	380	100
Apr-10	480	04/15/10	17/24	7/24	340	140
May-10	480	05/15/10	5/8	3/8	300	180
Jun-10	480	06/15/10	13/24	11/24	260	220
Jul-10	480	07/15/10	11/24	13/24	220	260
Aug-10	480	08/15/10	3/8	5/8	180	300
Sep-10	480	09/15/10	7/24	17/24	140	340
Oct-10	480	10/15/10	5/24	19/24	100	380
Nov-10	480	11/15/10	1/8	7/8	60	420
Dec-10	480	12/15/10	1/24	23/24	20	460
Total	5760				2,880	2,880

Question 19 discussion: Blooms: Comprehension; Difficulty 1, LO 3 KS: Written premium versus earned premium versus in-force premium

Historical premium must be:

1. Brought to current rate level. This involves adjusting premium for rate increases (decreases) that occurred during or after the historical experience period. This is known as adjusting the premium “to current rate level” or putting the premium “on-level”. Two current rate level methods are extension of exposures and the parallelogram method.
2. Developed to ultimate. This is relevant when an analyzing incomplete policy years or premium that has yet to undergo audit.
3. Adjusted for actual or expected distributional changes. This is done through premium trending, and both the one-step and two-step trending are discussed in this section.

See chapter 5

Question 20 discussion: Blooms: Application; Difficulty 3, LO 3, KS: Determinations of and application of premium trend

The actual premium charged for the policy was based on the rates effective on 1/1/2013, and was $16,775 (= 10 x $2,090 x 0.75 + $1,100).

To put the premium on-level, substitute the current base rate, class factor, and policy fee in the calculations; this results in an on-level premium of $17,810 (= 10 x $2,090 x 0.80 + $1,090).

Note: Perform the same calculation for every policy written in 2011 and then aggregate across all policies.

See chapter 5

Question 21 discussion: Blooms: Application; Difficulty 2, LO 3, KS: Determinations of and application of premium trend

a Step 1: Obtain the effective date and overall rate changes for the policies under consideration.

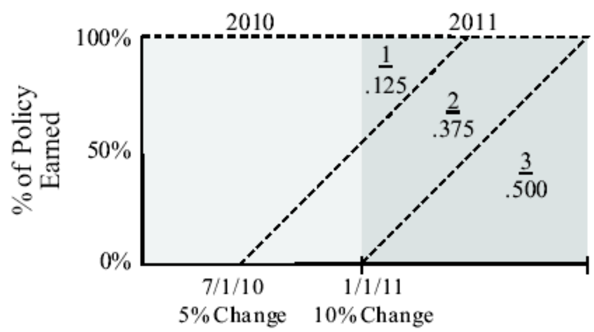
a Step 2: View these rate changes in graphical format.

CY 2011 rate levels area are shown below:

Area 1 in CY 2011: 0.125 =0.50 x 0.50 x 0.50

Area 2 in CY 2011: 0.375 =1.00 - (0.125 + 0.500)

Area 3 in CY 2011: 0.500 =0.50 x 1.00 x 1.0



a Step 3: Calculate the cumulative rate level index for each rate level group.

- The first rate level group is assigned a rate level of 1.00.
- The cumulative rate level index of each subsequent group is the prior group's cumulative rate level index multiplied by the rate level for that group.
  - i. the cumulative rate level index for the second rate level group is 1.05 (= 1.00 x 1.05).
  - ii. the cumulative rate level index for the third rate level group is 1.155 (= 1.05 x 1.10).

	1	2	3	4
Rate Level Group	Effective Date	Overall Average Rate Change	Rate Level Index	Cumulative Rate Level Index
1	Initial	--	1.00	1.0000
2	7/1/10	5.0%	1.05	1.0500
3	1/1/11	10.0%	1.10	1.1550
4	4/1/12	-1.0%	0.99	1.1435

(4)= (Previous Row 4) x (3)

a Step 4: Calculate the average rate level index for each year (i.e. the weighted average of the cumulative rate level indices in Step 3, using the areas calculated in Step 2 as weights).

The average rate level index for CY 2011 is 1.0963 =1.000 x 0.125 + 1.0500 x 0.375 + 1.1550 x 0.500.

a Step 5: Calculate the on-level factor as follows:

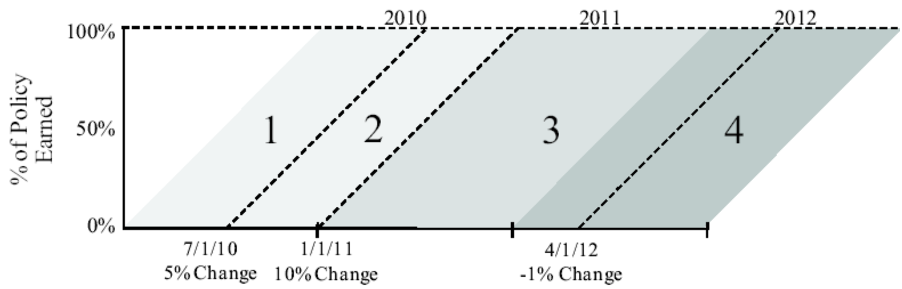
$$On\text{-}Level\ Factor\ for\ Historical\ Period = \frac{Current\ Cumulative\ Rate\ Level\ Index}{Average\ Rate\ Level\ Index\ for\ Historical\ Period}$$

- The numerator is the most recent cumulative rate level index
- The denominator is the result of Step 4.

The on-level factor for CY 2011 EP (assuming annual policies) is $1.0431 = \frac{1.1435}{1.0963}$

a Step 6: The on-level factor is applied to the CY 2011 EP to bring it to current rate level.
CY 2011 EP at current rate level= CY 2011 EP x 1.0431.

b. Standard PY Calculations for Annual Policies



Since PY 2011 only had one rate level applied to the whole year, PY 2012 will be reviewed.
The area of each parallelogram is base x height.
Area 3 in Policy Year 2012 has a base of 3 months (or 0.25 of a year) and the height is 12 months (or 1.00 year).

b Step 2: The relevant areas for PY 2012 are as follows:

- Area 3 in PY 2012: 0.25 = 0.25 x 1.00
- Area 4 in PY 2012: 0.75 = 0.75 x 1.00

b Step 3: The cumulative rate level indices are the same as those used in the CY example.

b Step 4: The average rate level index for PY 2012 is: 1.1464 = 1.1550 x 0.25 + 1.1435 x 0.75.

b Step 5: The on-level factor to adjust PY 2012 EP to current rate level is $0.9975 = \frac{1.1435}{1.1464}$

c. CY Calculations for Semi-Annual Policies

c Step 2: The areas for CY 2011 are:

Area 1 in CY 2011: N/A
Area 2 in CY 2011: 0.250 = 0.50 x 0.50 x 1.00
Area 3 in CY 2011: 0.750 = 1.00 - 0.250

c Step 3: The cumulative rate level indices are the same as those used for the annual policies.

c Step 4: The average rate level index for CY 2001 assuming semi-annual policies:
1.1288 = 1.0500 x 0.250 + 1.1550 x 0.750

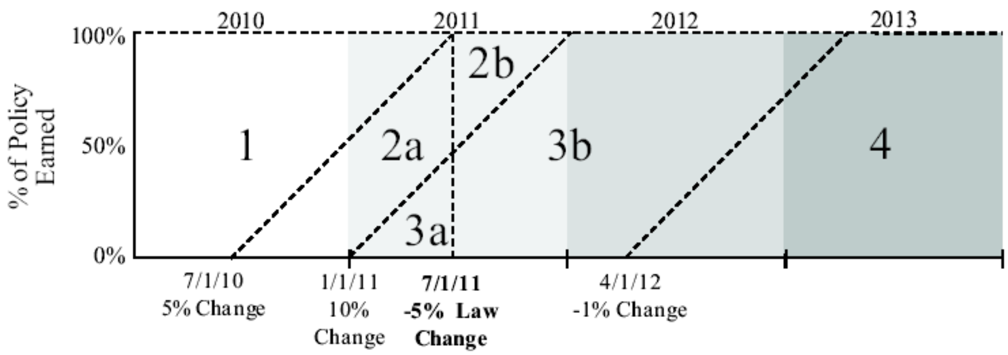
c Step 5: The on-level factor to adjust CY 2011 EP to current rate level is: $1.0130 = \frac{1.1435}{1.1288}$ (and is smaller than for annual policies because the semi-annual rate changes earn more quickly).

See chapter 5

Question 21 discussion (continued)

d. The rate level change is represented as a vertical line.

Assume a law change mandates a rate decrease of 5% on 7/1/2011 applicable to all policies.



The vertical line splits rate level groups 2 and 3 into two pieces each.

The -5% law change impacts rate level indices associated with the portion of areas 2b, 3b, and 4.

The areas for CY 2011 are as follows:

- Area 1 in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 2a in CY 2011: 0.250 = 0.50 - 0.125 - 0.125
- Area 2b in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3a in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3b in CY 2011: 0.375 = 0.50 - 0.125

The cumulative rate level indices associated with each group are as follows:

Step 3 (with Benefit Change)

Rate Level Group	Cumulative Rate Level Index
1	1.0000
2a	1.0500
2b	0.9975
3a	1.1550
3b	1.0973
4	1.0863

CY 2011 on-level factor:

$$1.0171 = \frac{1.0863}{1.0000 * 0.125 + 1.0500 * 0.250 + 0.9975 * 0.125 + 1.1550 * 0.125 + 1.0973 * 0.375}$$

See chapter 5

Question 22 discussion: Blooms: Comprehension; Difficulty 1, LO 3 KS: Determinations of and application of premium trend

1. The method is not useful if the assumption that policies are evenly written throughout the year is not true.

   Example: Boat owners policies are usually purchased prior to the start of boat season and thus are not uniformly written throughout the year.

   Ways to partially circumvent the need for uniform writings:

   a. Use a more refined period of time than a year (e.g. quarters or months).
   b. Calculate the actual distribution of writings and use these to determine more accurate weightings to compute the historical average rate level.

      Aggregate policies based on which rate level was applicable rather than based on a time period, and the premium for each rate level group is adjusted together based on subsequent rate changes.

2. Premium for certain classes will not be on-level if the implemented rate changes vary by class.

   Even if the overall premium may be adjusted to a current rate level, adjusted premium will not be appropriate for class ratemaking.

   This major shortcoming has caused insurers to favor of the extension of exposures approach.

See chapter 5

Question 23 discussion: Blooms: Application; Difficulty 1, LO 3, KS: Determinations of and application of premium trend

At 12/31/2014, the six policies written in the first half of 2013 have completed their audits, but the six policies written in the second half of the year have not.

PY 2013 premium as of 12/31/2014 is: $9,360,000 = 6 x $750,000 x 1.08 + (6 x $750,000)

At 12/31/2015, all twelve policies have completed their final audits and premium is final.

PY 2013 premium as of 12/31/2015 is: $9,720,000 = 12 x $750,000 x 1.08

From 12/31/2014 (24 months after the start of the PY) to 12/31/2015 (36 months after the start of the PY), the premium development factor is 1.0385 (= $9.72 million / $9.36 million).

See chapter 5

Question 24 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Determinations of and application of premium trend

Examples that can cause changes in the average premium level:

- **A rating characteristic can cause average premium to change** (e.g. HO premium varies based on the amount of insurance purchased, which is indexed and increases automatically with inflation; therefore, average premium increases as well).
- **Moving all existing insureds to a higher deductible** (e.g. if an insurer moves each insured to a higher deductible upon renewal, and renewals are spread throughout the year, there will be a decrease in average premium over the entire transition period).

  Trend is not necessary once the transition is complete.
- **Acquiring the entire portfolio of another insurer writing higher policy limits** (e.g. a HO insurer acquires a book of business that includes predominantly high-valued homes, the acquisition will cause a very abrupt increase in the average premium due to the increase in average home values).

  After the books are consolidated, no additional shifts in the business are expected.

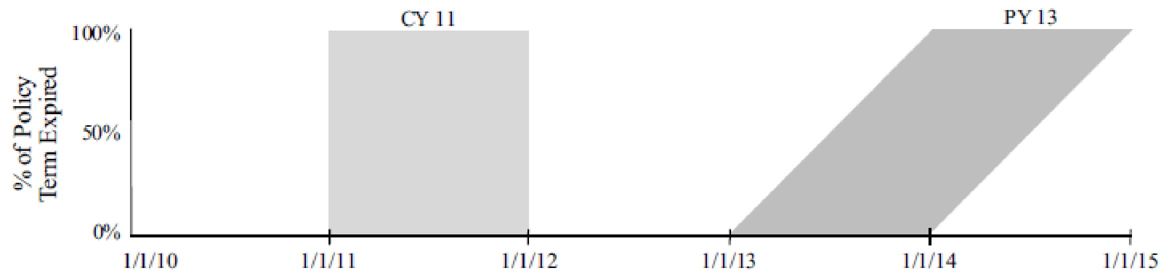
See chapter 5

Question 25 discussion: Blooms: Application; Difficulty 1, LO 3 KS: Determinations of and application of premium trend

The trend period as the length of time from the average written date of policies with premium earned during the historical period to the average written date for policies that will be in effect during the time the rates will be in effect. *

* Some insurers determine the trend period as the average date of premium earned in the experience period to the average date of premium earned in the projected period. This simply shifts both dates by the same amount, so the trend period is the same length.

The historical and projected periods can be represented as follows:



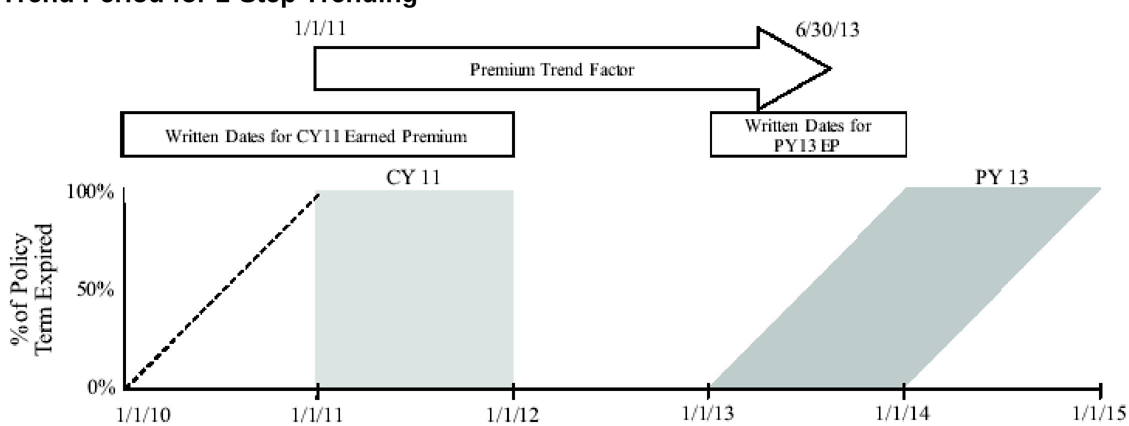
Historical period: CY 2011 EP contains premium from policies written 1/1/2010 to 12/31/2011.
Thus, the average written date for premium earned is **1/1/2011**.

Projected period: Policies will be written from 1/1/2013 – 12/31/2013.
Thus, the average written date during the projected period is **6/30/2013**.

Therefore, the trend period is 2.5 years (i.e. 1/1/2011 - 6/30/2013).

The adjustment to account for premium trend is: 1.0508 (= $(1.0 + 0.02)^{2.5}$).

Trend Period for 1-Step Trending



See chapter 5

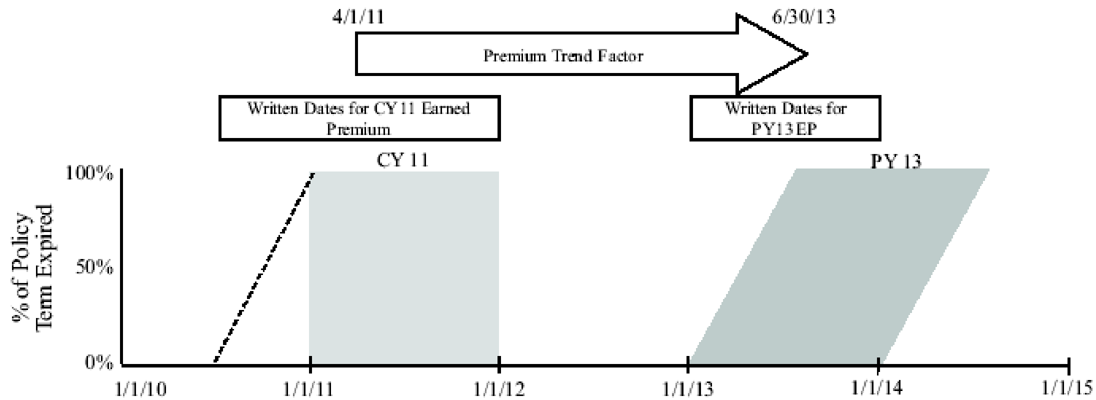
Question 26 discussion: Blooms: Comprehension; Difficulty 2, LOKS: Determinations of and application of premium trend

Items affecting the length of the trend period:

1. If the historical period consists of policies with terms other than 12 months, the "trend from" date will be different than discussed above.

   Example: If the policies in the prior example were six-month policies, then the "trend from" date is 4/1/2011. The "trend to" date is unchanged.

   Trend Period for 1-Step Trending with 6-Month Policies



2. If the historical premium is PY 2011 (rather than CY 2011) then the "trend from" date is later and corresponds to the average written date for PY 2011 (i.e. 7/1/2011).
3. If the proposed rates are expected to be in effect for more or less than one year, then the "trend to" date will be different (e.g. if the proposed rates are expected to be in effect for two years, then the "trend to" date will be 12/31/2013).

See chapter 5

Question 27 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Determinations of and application of premium trend

One-step trending process is not appropriate to use when:

1. Changes in average premium vary significantly year-by-year and/or
2. Historical changes in average premium are very different than the changes expected in the future.

   Example: If the insurer forced all insureds to a higher deductible at their first renewal on or after 1/1/11, the shift would have been completed by 12/31/11, and the observed trend would not continue into the future.

   When situations like this occur, companies may use a two-step trending approach.

See chapter 5

Question 28 discussion: Blooms: Application; Difficulty 2, LO 3, KS: Determinations of and application of premium trend

Step 1: Determine the **average written date** during the experience period. For the experience period 4/1/01 – 3/31/02, and given that 6 month policies are being written, the average earned date is 10/1/01 and the average written date is **7/1/01**, or ½ the policy term earlier from the average earned date.

Step 2: Determine the **average written date** during the exposure period. The average written date during the future policy period is a function of the length of time that the rates are expected to remain in effect. In this example, since rates are reviewed every 18 months, this would make the average written date 9 months after the proposed effective date of 4/1/03, which is **1/1/04.**

Thus, the written premium trend period is 2.50 years.

See chapter 5

Question 29 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Determinations of and application of premium trend

Step 1: Adjust the historical premium to the current trend level using the following adjustment factor:

$$Current\ Premium\ Trend\ Factor = \frac{Latest\ Average\ WP\ at\ Current\ Rate\ Level}{Historical\ Average\ EP\ at\ Current\ Rate\ Level}$$

If average EP for CY 2013 is $940.00 and the average WP for the latest available quarter (Calendar Quarter 4Q 2013) is $953.00, then the current premium trend factor is **1.0138** (= 953.00/940.00).

The latest average WP is for the fourth quarter of 2013; thus, the average written date is 11/15/2013 (this will be "trend from" date for the second step in the process).

If the average been based on the average WP for CY 2013 (as opposed to the fourth quarter), then the average written date would have been 6/30/2013.

When average premium is volatile, select a current trend versus using the actual change in average premium.

The current trend factor is calculated by trending (1.0 + selected current trend) from the average written date of premium earned in the experience period (i.e. 1/1/2013) to the average written date of the latest period in the trend data (i.e. 11/15/2003).

Step 2: Compute the projected premium trend factor.

Select the amount the average premium is expected to change annually from the "trend from" date to the projected period.

The "trend from" date is 11/15/2013.

The "trend to" date is the average written date during the period the proposed rates are to be in effect, which is still 6/30/2015.

Thus, the projected trend period is 1.625 years long (11/15/2013 to 6/30/2015).

Given a projected annual premium trend of 2%, the projected trend factor is **1.0327** (= $(1.0 + 0.02)^{1.625}$).

Trend Period for 2-Step Trending

The total premium trend factor for two-step trending is the product of the current trend factor and the projected trend factor (i.e. 1.0467 (= 1.0138 x 1.0327)).

That number is applied to the average historical EP at current rate level to adjust it to the projected level:

CY13 EP at projected rate level = CY13 EP at current rate level x Current Trend Factor x Projected Trend Factor.

Two-Step Trending

(1) Calendar Year 2013 Earned Premium at Current Rate Level	$1,880,788
(2) Calendar Year 2013 Earned Exposures	2,150
(3) Calendar Year 2013 Average Earned Premium at Current Rate Level	$940.00
(4) 4th Quarter of 2013 Average Written Premium at Current Rate Level	$953.00
(5) Step 1 Factor	1.01383
(6) Selected Projected Premium Trend	2.0%
(7) Projected Trend Period	1.6250
(8) Step 2 Factor	1.0327
(9) Total Premium Trend Factor	1.0470
(10) Projected Premium at Current Rate Level	$1,969,156

The latest average WP is for the fourth quarter of 2013; thus, the average written date is 11/15/2013 (this will be "trend from" date for the second step in the process).

The "trend to" date is the average written date during the period the proposed rates are to be in effect, which is still 6/30/2015.

Thus, the projected trend period is 1.625 years long (11/15/2013 to 6/30/2015).

(5) = (4) / (3)

(8) = $(1.0 + (6))^{(7)}$

(9) = (5) x (8)

(10)= (1) x (9)

See chapter 5

Question 30 discussion: Blooms: Knowledge; Difficulty 1, LO 6, KS: Mechanics associated with each method (including organization of the data)

1. Judicial environment
2. Regulatory and legislative changes
3. Guaranty funds
4. Economic variables
5. Residual market mechanisms

Exam 5A – Independently Authored Questions - Preparatory Test 2

General information about this exam

This practice test contains 29 questions consisting of computational and essay based questions.

	Essay Questions	Computational Questions	Total
Total Number of Qs:	13	16	29
Total Number of Points:	20.25	40.5	60.75

1. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.

2. Consider taking this exam after working all past CAS questions first.

3. Make sure you have a sufficient number of blank sheets of paper to record your answers for computational questions.

Articles covered on this exam:

Article .... Author ....

Chapter 6: Losses and LAE..Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 7: Other Expenses and Profit...........................Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 8: Overall Indication...Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 9: Traditional Risk Classification....................Modlin, Werner .... A. Basic Techniques for Ratemaking

Actuarial Standard No. 13 – Trending Proc. ....CAS.................................. A. Basic Techniques for Ratemaking

Exam 5A – Independently Authored Questions - Test 2

Question 1 (2.0 points)

You are given the following payment and reserve information about two different claims on two different policies:

Policy Effective Date	Date of Loss	Report Date	Transaction Date	Incremental Payment	Case Reserve
07/01/11	11/01/11	11/19/11	11/19/11	$0	$20,000
			02/01/12	$2,000	$18,000
			09/01/12	$14,000	$5,000
			01/15/13	$6,000	$0
09/10/11	02/14/12	02/14/12	02/14/12	$10,000	$20,000
			11/01/12	$16,000	$8,000
			03/01/13	$2,000	$0

a. (0.5 point) Calculate the calendar-year reported losses for 2012 and 2013.

b. (0.5 point) Calculate the accident-year reported for 2011 and 2012 evaluated as of 12/31/2013.

c. (0.5 point) Calculate the policy-year reported losses for 2011 and 2012 evaluated as of 21/31/2013.

d. (0.5 point) Briefly describe how losses are aggregated under a report year basis, what types of reserves can be analyzed, and for what type of business is this method of loss aggregation used.

Question 2 (0.75 points)

According to Werner and Modlin in "Basic Ratemaking", briefly describe three types preliminary adjustments to losses prior to projecting losses to the cost level expected when the rates will be in effect.

Question 3 (2.0 points)

You are given the following reported losses, number of claims with reported losses excess of $1,000,000, and ground-up excess losses:

Accident Year	(1) Reported Losses	(2) Number of Excess Claims	(3) Ground –Up Excess Losses
1996	$86,369,707	5	$6,212,939
1997	$85,938,146	1	$1,280,000
1998	$87,887,865	3	$3,903,023
1999	$86,488,983	0	$0
2000	$90,329,298	7	$12,918,382
Total	$437,013,999	16	$24,314,344

Using the procedure described by Werner and Modlin in "Basic Ratemaking", compute the excess loss factor.

Question 4 (3.0 points)

Ratio to Average Weekly Wage	# Workers	Total Weekly Wage
<50%	7	$3,000
50-75%	24	$16,252
75-100%	27	$23,950
100-125%	19	$23,048
125-150%	12	$16,500
>150%	11	$17,250
Total	100	$100,000

The state average weekly wage (SAWW) is $1,000

Current Workers' Compensation Law

- Compensation rate is 66.7% of worker's pre-injury wage.
- Maximum benefit limit = 100% of state average weekly wage.
- Minimum benefit limit = 50% of state average weekly wage.

Revised Workers' Compensation Law

- Compensation rate is 66.7% of worker's pre-injury wage.
- Maximum benefit limit = 83.3% of state average weekly wage.
- Minimum benefit limit = 50% of state average weekly wage.

Using the procedure described Werner and Modlin in “Basic Ratemaking”, calculate the direct effect of the benefit level change.

Question 5 (2.0 points)

Assume a law change implemented on August 15, 2010 only affects losses on policies written on or after August 15, 2010. The direct effect of the change for annual policies on an accident year basis is estimated at +5%.

a. (0.50 points) Calculate the law change adjustment factor to be applied to 3rd quarter 2010 calendar accident quarter reported losses.
b. (0.50 points) Calculate the law change adjustment factor to be applied to 3rd quarter 2010 policy quarter reported losses.

Now assume a benefit change affects losses on claims that occur on or after August 15, 2010, regardless of the effective date of the policy. The direct effect of the change for annual policies on an accident year basis is estimated at +5%.

c. (0.50 points) Calculate the benefit change adjustment factor to be applied to 3rd quarter 2010 calendar accident quarter reported losses.
d. (0.50 points) Calculate the benefit change adjustment factor to be applied to 3rd quarter 2010 policy quarter reported losses.

Question 6 (2.0 points) You are given the following:

Claim Number	(1) Total Limits Loss
1	$9,000
2	$13,000
3	$24,000
4	$29,000
5	$48,000
Total	$123,000

Assume

- basic limits losses are capped at 25,000.
- total limits losses are subject to a 10% severity trend.

Compute:

a. (1.0 point). Basic limits loss trend.

b. (1.0 point). Excess limits loss trend.

Question 7 (2.0 points) According to Werner and Modlin in "Basic Ratemaking", when loss experience being analyzed is subject to the application of limits, it is important that the leveraged effect of those limits on the severity trend be considered.

For each category of initial loss size shown below, complete the table below by stating or demonstrating algebraically the magnitude that 'Trend' has on Basic Limits Losses, Total Limits Losses and Excess Losses.

Initial Loss Size	Basic Limits	Total Losses	Excess Losses
Loss< [Limit/ (1+Trend)]			
[Limit/(1+Trend)] $\leq$ Loss < Limit			
Limit $\leq$ Loss			

Question 8 (2.0 points) According to Werner and Modlin in "Basic Ratemaking", while it is true that loss development incorporates inflationary pressures that cause payments for reported claims to increase in the time after reporting, this does not prove an overlap either.

Given the following:

- The historical experience period is CAY 2010.
- Assume it is typical for claims to settle within 18 months.
- The projection period is policy year beginning 1/1/ 2012
- Rates are expected to be in effect for annual policies written from 1/1/2012 – 12/31/2012.

Using the above information, create a graphical timeline illustration of how losses are trended and developed which demonstrates there is no overlap between loss development and loss trend.

Question 9 (1.0 point) According to Werner and Modlin in "Basic Ratemaking", and assuming that ULAE expenditures track with loss dollars consistently over time, both in terms of rate of payment and in proportion to the amount of losses paid, calculate the ratio of CY paid ULAE to CY paid loss plus ALAE.

Calendar Year	Paid Loss And ALAE	Paid ULAE
2010	\$963,467	\$149,026
2011	\$1,118,918	\$159,170
2012	\$1,284,240	\$190,968

Question 10 (1.5 points) ABC writes HO insurance and determines the following on a per policy basis:

- The average expected loss and LAE for each policy is \$360.
- ABC incurs \$40 in fixed expenses each time it writes a policy.
- 15% of each dollar of premium covers expenses that vary with the amount of premium
- Company management has determined that the target profit provision should be 5% of premium.

a. (1 point). Re-write the equation Premium = Losses + LAE + UW Expenses + UW Profit, using the notation in "Basic Ratemaking", to determine the average premium per policy.

b. (0.50 points). Using the values given in the problem, and the equation in part a., compute the premium ABC should charge.

Question 11 (1.5 points) According to Werner and Modlin in "Basic Ratemaking", answer the following questions.

a. (1 point). List and briefly describe four categories of underwriting expenses.

b. (0.50 points). List and briefly describe two groups the underwriting expense provision is divided into.

Question 12 (1.5 points) According to Werner and Modlin in "Basic Ratemaking", the data used in the all variable expense method can be either countrywide or state based and premiums used can be either earned or written premiums.

For each of the four expense categories below, fill in the table below and briefly describe the type of data that is used and why it is used.

Expense	Data Used	Divided By
General Expense		
Other Acquisition		
Commissions and Brokerage		
Taxes, Licenses, and Fees		

Question 13 (3.0 points). According to Werner and Modlin in "Basic Ratemaking", answer the following questions about the all variable expense method.

a. (0.50 points). List two possible distortions in computing the correct premium when the all variable expense method is used.

b. (1.5 points). Assume ABC insurer determines the following on a per policy basis:

- The average expected loss and LAE for each policy is $360.
- ABC incurs $40 in fixed expenses each time it writes a policy.
- 15% of each dollar of premium covers expenses that vary with the amount of premium
- Company management has determined that the target profit provision should be 5% of premium.

Using your response in part a., show mathematically the difference in premiums computed assuming that the correct premium always results from using a fixed expense of $40 and a variable expense and profit provision of 20% compared to assuming that all expenses are variable.

c. (1.0 points). Briefly describe two approaches used by insurers that use the all variable expense method to circumvent the incorrect premiums produced when using this method.

Question 14 (3.0 points). According to Werner and Modlin in "Basic Ratemaking", answer the following questions.

a. (1 point). Briefly describe the shortcoming when using the all variable expense method and the advantage to using the premium-based projection method.

b. (1 point). Assuming that the selected ratio of fixed vs. variable expenses are 75% to 25% respectively, and using the data below and the procedure described in the text, compute the fixed and variable expense percentage provisions.

	2013	2014	2015
a Countrywide Expenses	$24,331,974	$26,502,771	$30,975,169
b1 Countrywide Earned Premium	$445,000,000	$485,950,000	$525,000,000
b2 Countrywide Written Premium	$455,000,000	$490,000,000	$545,000,000

c. (1 point). Briefly describe the shortcoming of using this approach and list three situations that can cause such a shortcoming to exist.

Question 15 (3.0 points). According to Werner and Modlin in "Basic Ratemaking", answer the following questions.

a. (1 point). Briefly describe the difference in how the exposure/policy-based projection method is performed compared to the premium-based projection method.

b. (1 point). Assuming that the selected ratio of fixed vs. variable expenses are 75% to 25% respectively, and using the data below and the procedure described in the text, compute the fixed and variable expense percentage provisions using the exposure/policy-based projection method.

	2013	2014	2015	Selected
Countrywide Expenses	$24,331,974	$26,502,771	$30,975,169	
% Assumed Fixed				75.0%
Countrywide Earned Exposures	4,323,500	4,610,500	4,817,000	
Countrywide Earned Premium	$445,000,000	$485,950,000	$525,000,000	

c. (1 point). List three shortcomings when using the exposure/policy-based projection method.

Exam 5A – Independently Authored Questions - Test 2

Question 16 (2.0 points). According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (1 point) Using the fundamental insurance equation, Premium = Losses + LAE + UW Expenses + UW Profit, and the notation used in the text, derive the pure premium indicated rate formula.

b. (1 point) Given the following data, and using the pure premium indicated rate formula from part a., compute the indicated average rate per exposure.

- Projected pure premium including LAE = \$400
- Projected fixed UW expense per exposure = \$35
- Variable expense ratio = 25%
- Target profit percentage = 10%

Question 17 (3.0 points). According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (2 points) Using the fundamental insurance equation, Premium = Losses + LAE + UW Expenses + UW Profit, and the notation used in the text, derive the loss ratio indicated rate change formula.

b. (1 point) Given the following data, and using the pure premium indicated rate formula from part a., compute the loss ratio indicated rate change

- Projected ultimate loss and LAE ratio = 70%
- Projected fixed expense ratio = 5.5%
- Variable expense ratio = 20%
- Target profit percentage = =10%

Question 18 (3.0 points). According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (2 points) List and briefly describe two major differences between the loss ratio and pure premium approaches.

b. (1 point) List and briefly describe when it is preferable to use the loss ratio and pure premium approaches respectively.

Question 19 (2.0 points). Using the procedure shown by Werner and Modlin in “Basic Ratemaking”, demonstrate the equivalency of the loss ratio and pure premium methods.

Both formulae can be derived from the fundamental insurance equation (thus two approaches are mathematically equivalent).

Question 20 (1.0 point). According to According to “Actuarial Standard of Practice No. 13: Trending Procedures in Property/Casualty Insurance Ratemaking,” list four ways in which an actuary may present the trend estimate resulting from the trending procedure

Question 21 (1.0 point). According to According to “Actuarial Standard of Practice No. 13: Trending Procedures in Property/Casualty Insurance Ratemaking,” the actuary should select data appropriate for the trends being analyzed.

List four factors the actuary should consider when selecting historical insurance and non-insurance data.

Question 22 (1.0 point). According to According to “Actuarial Standard of Practice No. 13: Trending in Property/Casualty Insurance Ratemaking,” list two criteria that an actuary should consider when determining the trending period.

Question 23 (1.0 point). According to According to “Actuarial Standard of Practice No. 13: Trending in Property/Casualty Insurance Ratemaking,” list two disclosures an actuary should make in an actuarial communication.

Question 24 (2.0 points). According to Werner and Modlin in “Basic Ratemaking”, one criterion to evaluate the appropriateness of a rating variable is statistical.

a. (1 point) List three statistical criterion to help ensure the accuracy and reliability of a potential rating variable.

b. (1 point) Briefly describe what it means for a rating variable should be a statistically significant risk differentiator:

Question 25 (2.0 points). According to Werner and Modlin in “Basic Ratemaking”, one criterion to evaluate the appropriateness of a rating variable is operational.

a. (1 point) List three operational criterion for a rating variable to be considered practical.

b. (1 point) Briefly explain whether the skill level of a surgeon for medical malpractice insurance is an objective rating variable and if not, list two other objective rating variables for a surgeon.

Question 26 (1.5 points). According to Werner and Modlin in “Basic Ratemaking”, it is desirable for insurance to be affordable for all risks. List three situations which help to ensure that insurance will be affordable.

Question 27 (8.0 points). You are given the following data from ABC insurer's homeowners book of business:

- All UW expenses are variable. The variable expense provision is 30% of premium, the target profit percentage is 5% of premium
- There are only 2 rating variables: amount of insurance (AOI) and territory.

Exposure Distribution

	Territory			
AOI	1	2	3	Total
Low	8	125	139	272
Medium	106	129	130	365
High	180	131	40	351
Total	294	385	309	988

	Territory			
AOI	1	2	3	Total
Low	1%	13%	14%	28%
Medium	11%	13%	13%	37%
High	18%	13%	4%	35%
Total	30%	39%	31%	100%

- The "true" underlying loss cost relativities (which the actuary is attempting to estimate) as well as the relativities currently used in the insurer's rating structure are as follows:

True and Charged Relativities for AOI and for Territory

AOI	True Relativity	Charged Relativity
Low	0.7300	0.8000
Medium	1.0000	1.0000
High	1.4300	1.3500

Terr	True Relativity	Charged Relativity
1	0.6312	0.6000
2	1.0000	1.0000
3	1.2365	1.3000

The base levels are Medium AOI and Territory 2:

- The exposure, premium, and loss information needed for the analysis is summarized as follows:

Simple Example Data

AOI	Terr	Exposure	Loss & LAE	Premium @ Current Rate Level
Low	1	8	$220.93	$335.99
Medium	1	106	$4,448.05	$6,479.87
High	1	180	$10,565.98	$14,498.71
Low	2	125	$6,156.12	$10,399.79
Medium	2	129	$8,289.95	$12,599.75
High	2	131	$12,063.68	$17,414.65
Low	3	139	$8,391.25	$14,871.70
Medium	3	130	$10,238.70	$16,379.68
High	3	40	$4,625.34	$7,019.86
TOTAL		988	$65,000.00	$100,000.00

a. (2.0 points). Using the pure premium method, compute the indicated territory pure premium relativities to the base level.

b. (1.0 point). Briefly describe why the indicated relativities in part a. do not match the true relativities.

c. (2.0 points). Using the loss ratio method, compute the indicated territory pure premium relativities to the base level.

d. (1.0 point). Briefly describe why the indicated relativities using the loss ratio method are closer to the true relativities.

e. (2.0 points). Using the adjusted pure premium method, compute the indicated territory pure premium relativities to the base level.

Question 28 (2 points).

Using the one-step trending procedure described Werner and Modlin in “Basic Ratemaking”, and the data below, compute the indicated rate change for rates with an effective date of 1/1/2005.

Assumptions:

- All policies issued throughout the experience period were 12-month policies.
- The premium figures shown below are based on a book of business that has remained constant.
- The only rate increase implemented during the experience period was for 10% and occurred on 1/1/2002.
- The annual loss trend is 5%.
- The expense and profit ratio, including an allowance for investment income, is 0.254.

Year	Earned Premium	Developed Incurred Losses
(1)	(2)	(3)
1	100,000	71,200
2	105,000	79,800
3	110,000	83,930
Total	315,000	234,930

Question 29 (1 Point) According to "Actuarial Standard of Practice No. 13 - Trending Procedures in Property/Casualty Insurance," list the three criteria that should be considered when determining the trending period.

Question 1 discussion: Blooms: Application; Difficulty 1, LO 4, KS: Organization of data: CY, PY, AY

Calendar Year 2012 reported losses: $35,000 =2,000+14,000+10,000+16,000+5,000+8,000-20,000

Calendar Year 2013 reported losses: -$5,000 = 6,000+2,000-5,000-8,000

AY 2011 reported losses as of December 31, 2013: $22,000 =2,000+14,000+6,000+0

AY 2012 reported losses as of December 31, 2013: $28,000 =10,000+16,000+2,000+0

PY 2011 reported losses as of December 31, 2013: $50,000 =2,000+14,000+6,000+10,000+16,000+2,000+0

PY 2012 reported losses as of December 31, 2013: $0 Neither of the two policies is issued was 2012

RY Loss aggregation method:

Losses are aggregated according to when the claim is reported (as opposed to when the claim occurs for AY).

Accident dates are maintained so the lag in reporting can be determined, since report year losses can be subdivided based on the report lag.

This type of aggregation results in no IBNR claims, but a shortfall in case reserves (i.e. IBNER) can exist.

RY aggregation is limited to the pricing of claims-made (CM) policies. See chapter 6

Question 2 discussion: Blooms: Knowledge; Difficulty 1, LO 4, KS: Organization of data: calendar year, policy year, accident year

1. Removing individual shock losses and catastrophe losses from historical losses and replacing them with a long-term expectations provision.
2. Developing immature losses to ultimate.
3. Restating losses to the benefit and cost levels expected during the future policy period. See chapter 6

Question 3 discussion: Blooms: Application; Difficulty 1, LO 4, KS: Loss Development

Accident Year	(1) Reported Losses	(2) Number of Excess Claims	(3) Ground –Up Excess Losses	(4) Losses Excess of $1,000,000	(5)=(1) - (4) Non-Excess Losses	(6)=(4) / (5) Excess Ratio
1996	$86,369,707	5	$6,212,939	$1,212,939	$85,156,768	1.42%
1997	$85,938,146	1	$1,280,000	$280,000	$85,658,146	0.33%
1998	$87,887,865	3	$3,903,023	$903,023	$86,984,842	1.04%
1999	$86,488,983	0	$0	$0	$86,488,983	0.00%
2000	$90,329,298	7	$12,918,382	$5,918,382	$84,410,916	7.01%
Total	$437,013,999	16	$24,314,344	$8,314,344	$428,699,655	1.94%
				(7) Excess Loss Factor		1.0194

(4)= (3) - [$1,000,000 x (2)]

(7)= 1.0 + (Tot6)

Question 4 discussion: Blooms: Application; Difficulty 2, LO 4 KS: Adjustment for coverage and benefit level changes

The key is to calculate the benefits provided before and after the change.

The minimum benefit is 50% of the SAWW ($1,000) which equals $500 (= $1,000 x 50%).

The minimum benefit of $500 applies to workers who earn less than 75% of the SAWW (i.e. $500 = *66.7%* x **75%** x $1,000), given the current compensation rate of 66.7%.

The aggregate benefits for 31 (= 7 + 24) employees in this category are $15,500 (= 31 x $500).

The maximum benefit is 100% of the SAWW ($1,000) and thus equals $1,000 (= $1,000 x 100%).

The maximum benefit of $1,000 applies to workers who earn more than 150% of the SAWW (i.e. $1,000 = *66.7%* x **150%** x $1,000), given the current compensation rate of 66.7%.

The aggregate benefits for the 11 employees in this category are $11,000 (= 11 x $1,000).

The remaining 58 (= 27 + 19 + 12) employees fall between the minimum and maximum benefits.

This means their total benefits are 66.7% of their actual wages or $42,354 (= (66.7% x 23,950) + (66.7% x 23,048) + (66.7% x 16,500)).

The sum total of benefits is ***$68,854*** (= $15,500 + $11,000 + $42,354) under the current benefit structure.

Question 4 discussion (continued):

Once the maximum benefit is reduced from 100% to 83.3% of the SAWW, more workers will be subjected to the new maximum benefit.

Workers earning approximately $\geq$125% of the SAWW are subject to the maximum (i.e. $833.75 = (66.7% x 125% x $1,000) > $833). These 23 (= 11 + 12) workers will receive $19,159 (= 23 x $833) in benefits.

Workers subject to the min benefit, 31, are not impacted by the change, and their benefits remain $15,500.

There are now only 46 (= 27 + 19) employees that receive a benefit equal to 66.7% of their pre-injury wages or:

$31,348 (= (66.7% x 23,950) + (66.7% x 23,048)) because more workers are now impacted by the maximum.

The new sum total of benefits is $66,007 (= 19,159 + 15,500 + 31,348).

The **direct effect** from revising the maximum benefit is -4.1% (= 66,007 / 68,854 – 1.0).

See chapter 6

Question 5 discussion: Blooms: Application; Difficulty 1, LO 4 KS: Effect of law changes

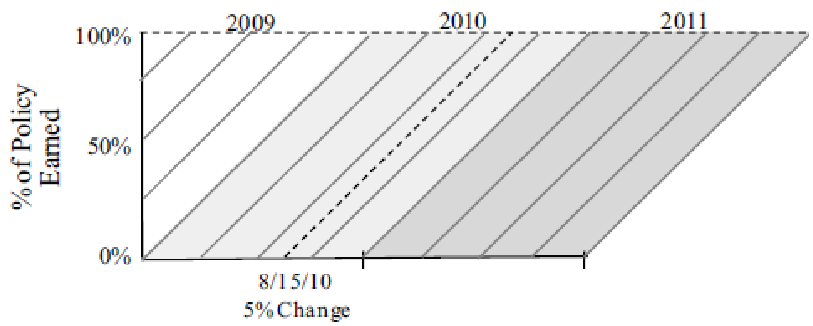
a. Focusing on the third quarter of 2010, the portion of losses assumed to be pre- and post-change are as follows:

- 3Q 2010 Post-change: 0.0078 = 0.50 x 0.125 x 0.125
- 3Q 2010 Pre-change: 0.2422 = 0.25 - 0.0078

The adjustment factor for 3rd quarter 2010 reported losses is $Adjustment = \dfrac{1.05}{1.00 * \left(\dfrac{0.2422}{0.2500}\right) + 1.05 * \left(\dfrac{0.0078}{0.2500}\right)} = 1.0484$

The adjustment factors for the reported losses from all other quarters are calculated similarly.

b. Affect on Losses on New Annual Policies (PY Basis)



The adjustment factor applicable to the third quarter 2010 policy quarter reported losses is:

$$Adjustment = \frac{1.05}{1.00 * \left(\dfrac{0.50 * 0.25}{0.25}\right) + 1.05 * \left(\dfrac{0.50 * 0.25}{0.25}\right)} = 1.0244$$

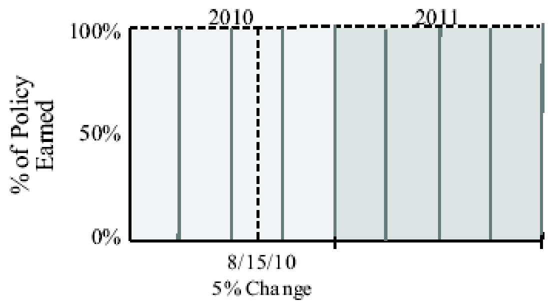
- Reported losses from quarters prior to the third quarter need to be adjusted by a factor of 1.05.
- Reported losses from quarters after the third quarter are already being settled in accordance with the new law, and need no adjustment.

See chapter 6

Question 5 discussion (continued)

c. Example: A benefit change affecting all losses occurring on or after 8/15/2010 (regardless of the policy effective date).

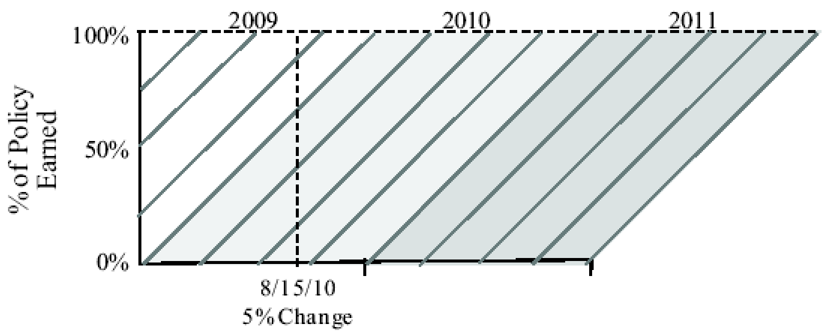
Affects all New Losses (AY Basis)



The adjustment factor applicable to the third accident quarter 2010 losses is as follows:

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.50*0.25}{0.25}\right)+1.05*\left(\frac{0.50*0.25}{0.25}\right)} = 1.0244$$

d. Affects all New Losses (PY Basis)



ii. The adjustment factor applied to third policy quarter 2010 losses is

$$Adjustment = \frac{1.05}{1.00*\left(\frac{0.0078}{0.2500}\right)+1.05*\left(\frac{0.2422}{0.2500}\right)} = 1.0015$$

See chapter 6

Question 6 discussion: Blooms: Application; Difficulty 1, LO 4 KS: Relationship between trend and loss development

Effect of Limits on Severity Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	Losses		Total Limits		Trended Losses		Excess Losses	
Claim	Limits	Capped @	Excess			Capped @ $25,000			
Number	Loss	$25,000	Losses	Loss	Trend	Loss	Trend	Loss	Trend
1	$9,000	$9,000	$0	$9,900	10.0%	$9,900	10.0%	$0	N/A
2	$13,000	$13,000	$0	$14,300	10.0%	$14,300	10.0%	$0	N/A
3	$24,000	$24,000	$0	$26,400	10.0%	$25,000	4.2%	$1,400	N/A
4	$29,000	$25,000	$4,000	$31,900	10.0%	$25,000	0.0%	$6,900	72.5%
5	$48,000	$25,000	$23,000	$52,800	10.0%	$25,000	0.0%	$27,800	20.9%
Total	$123,000	$96,000	$27,000	$135,300	10.0%	$99,200	3.3%	$36,100	33.7%

(2)=min [(1), $25,000] (3)= (1) - (2) (4)= (1) x 1.10 (5)=(4)/(1)-1.0 (6)=min [(4) , $25,000] (7)= (6)/(2)-1.0 (8)= (4) - (6) (9)=(8)/(3)-1.0

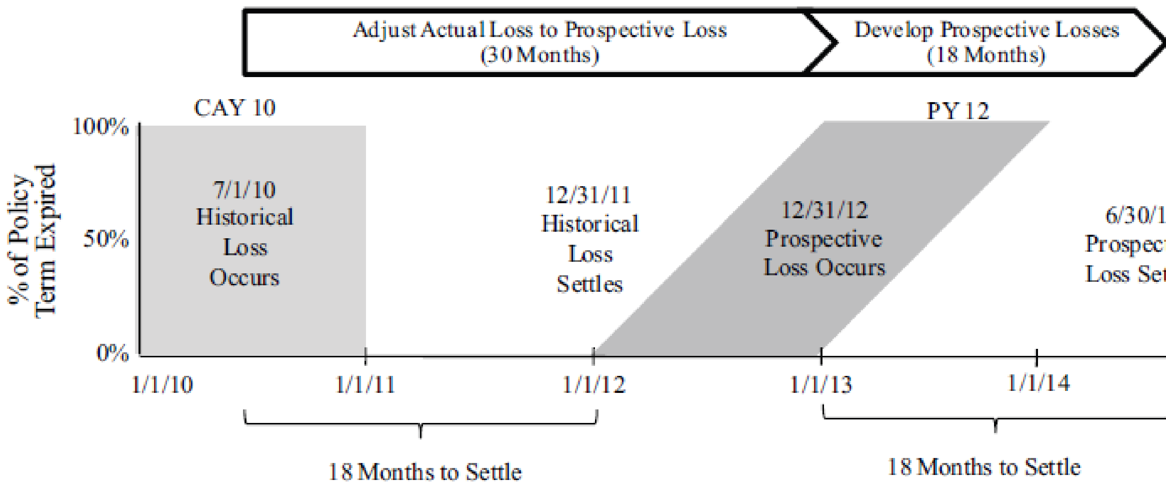
See chapter 6

Question 7 discussion: Blooms: Application; Difficulty 1, LO 4 KS: Relationship between trend and loss development

Initial Loss Size	Basic Limits	Total Losses	Excess Losses
Loss< Limit/ (1+Trend)	Trend	Trend	Undefined
Limit/ (1+Trend) < Loss < Limit	Limit/Loss-1.0	Trend	Undefined
Limit < Loss	0%	Trend	{ [Loss*(1.0+Trend)]-Limit} / (Loss-Limit)

See chapter 6

Question 8 discussion: Blooms: Synthesis Difficulty 1, LO 4 KS: Relationship between trend and loss development



Based on the given information, we know that:

- The average date of claim occurrence is 7/1/2010.
- Since it is typical for claims to settle within 18 months, the "average claim" will settle on 12/31/2011.
- Since rates are expected to be in effect for annual policies written from 1/1/2012 – 12/31/2012, the average hypothetical claim in the projected period will occur on 1/1/2013, and will settle 18 months later on 6/30/2014 (i.e. consistent with the settlement lag of 18 months).

Therefore:

- **Trend** adjusts the average historical claim from the loss cost level that exists on 7/1/2010 to the average loss cost level expected on 1/1/2013 (30 months)
- **Development** adjusts the trended, undeveloped claim on 1/1/2013 (at 30 months from 7/1/2010) to the ultimate level, expected to occur by 6/30/2014 (which constitutes an additional 18 months of development).

This 48 month period represents ***30 months of trend*** to adjust the cost level to that anticipated during the forecast period and the ***18 months of development*** to project this trended value to its ultimate settlement value.

Thus, there is no overlap between the use of loss trend and loss development.

See chapter 6

Question 9 discussion: Blooms: Application; Difficulty 1, LO 4 KS: Organization of data: calendar year, policy year, accident year

Note: Calculate the ratio of CY paid ULAE to CY paid loss plus ALAE over several years (e.g. three years or longer, depending on the line of business).

- This ratio is applied to each year's reported loss plus ALAE to incorporate ULAE.
- The ratio is calculated on losses that have not been adjusted for trend or development as this data is readily available for other financial reporting.
- The resulting ratio of ULAE to loss plus ALAE is then applied to loss plus ALAE that has been adjusted for extraordinary events, development, and trend.

ULAE Ratio

	(1)	(2)	(3)
Calendar	Paid Loss		ULAE
Year	And ALAE	Paid ULAE	Ratio
2010	$963,467	$149,026	15.5%
2011	$1,118,918	$159,170	14.2%
2012	$1,284,240	$190,968	14.9%
Total	$3,366,625	$499,164	14.8%
		(4) ULAE Factor	1.148

(3) = (2) / (1)
(4) = 1.0 + (Tot3)

See chapter 6

Question 10 discussion: Blooms: Application; Difficulty 1, LO 5 KS: Differences in procedures for loss adjustment expenses versus underwriting expenses

a. Premium = Losses + LAE + UW Expenses + UW Profit

$$P = L + E_L + (E_F + V * P) + Q_T * P$$

$$P - (V + Q_T) * P = L + E_L + E_F$$

$$P = \frac{[L + E_L + E_F]}{[1.0 - V - Q_T]}$$

$$\bar{P} = \frac{[L + E_L + E_F]/X}{[1.0 - V - Q_T]} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]}$$

b. $$\bar{P} = \frac{\bar{L} + \bar{E}_L + \bar{E}_F}{[1.0 - V - Q_T]} = \frac{[\$360 + \$40]}{[1.0 - 0.15 - 0.05]} = \$500$$

The company should charge $500, composed of $360 of expected losses and LAE, $40 of fixed expenses, $75.00 (= 15% x $500) of variable expenses, and $25.00 (= 5% x $500) for the target UW profit.

See chapter 7

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LO 5 KS: Expenses categories (e.g., commission, general, other acquisition, taxes, licenses and fees

a1. Commissions and brokerage:

- are paid as a percentage of premium written.
- may vary between new and renewal business.

a2. Other acquisition costs (e.g. media advertisements, mailings to prospective insureds, and salaries of sales employees who do not work on a commission) are other expenses to acquire business.

a3. Taxes, licenses, and fees (e.g. premium taxes and licensing fees) include all taxes and miscellaneous fees due from the insurer excluding federal income taxes.

a4. General expenses (e.g. overhead associated with the insurer's home office and salaries of certain employees (e.g. actuaries)) include the expenses associated with insurance operations.

The u/w expense provision is further divided into two groups: fixed and variable.

Fixed expenses (e.g. overhead costs associated with the home office) are assumed to be the same for each risk, regardless of premium size (i.e. the expense is a constant dollar amount for each risk or policy).

Variable expenses (e.g. premium taxes and commissions) vary directly with premium and thus are constant percentage of the premium.

See chapter 7

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 5 KS: Expenses categories (e.g., commission, general, other acquisition, taxes, licenses and fees

Expense	Data Used	Divided By
General Expense	Countrywide	Earned Premium
Other Acquisition	Countrywide	Written Premium
Commissions and Brokerage	Countrywide/State	Written Premium
Taxes, Licenses, and Fees	State	Written Premium

WP is used when expenses are incurred at policy inception (it reflects the premium at the onset of the policy).

EP is used when expenses are assumed to be incurred throughout the policy (it reflects the gradual payment of expenses that can be proportional to the earning of premium over the policy term).

Other acquisition costs and general expenses are assumed to be uniform across all locations, so C/W data from the IEE are used to calculate these ratios.

The data used to derive commissions and brokerage expense ratios varies from carrier to carrier (e.g. some insurers use state-specific data and some use C/W data, depending on whether the insurer's commission plans vary by location).

TL&F vary by state and the expense ratios are based on state data from the Annual Statement.

See chapter 7

Question 13 discussion: Blooms: Application Difficulty 2, LO 5 KS: Fixed expenses and variable expenses

a. By treating all expenses as variable, this understates the premium need for risks with a relatively small policy premium and overstates the premium need for risks with relatively large policy premium.

b. Results of All Variable Expense Method

	Correct Premium			All Variable Expense Method			
	Fixed	Variable Expense		Fixed	Var Expense		
Loss Cost	Expense	And Profit	Premium	Expense	And Profit	Premium	%Diff
$270	$40	20%	$387.50	$0	28%	$375.00	-3.2%
$360	$40	20%	$500.00	$0	28%	$500.00	0.0%
$450	$40	20%	$612.50	$0	28%	$625.00	2.0%

Note: The $40 as a ratio to premium is 8% (= $40 / $500). The variable expense method produces the correct premium only when variable expenses are 28% and when loss costs are $270.00

The All Variable Expense Method *undercharges* risks with premium less than the average and *overcharges* the risks with premium more than the average.

c1. WC insurers that use this approach may implement a premium discount structure that reduces the expense loadings based on the amount of policy premium charged.

c2. Some insurers using the All Variable Expense Method may also implement expense constants to cover policy issuance, auditing, and handling expenses that apply uniformly to all policies.

See chapter 7

Question 14 discussion: Blooms: Comprehension & Application; Difficulty 2, LO 5 KS: Fixed expenses and variable expenses

a. For insurers with a significant amount of both fixed and variable u/w expenses, the premium based projection method is used since it recognizes the two types of expenses separately.

The enhancement is that this approach calculates fixed and variable expense ratios separately (as opposed to a single variable expense ratio) so that each can be handled more appropriately within the indication formulae.

b. Step 1: Determine the % of premium attributable to each expense type by dividing historical underwriting expenses by EP or WP for each year during the historical experience period. Here, general expenses are assumed to be incurred throughout the policy period, and thus are divided by EP.

b. Step 2: Choose a selected ratio (e.g. if the ratios are stable over time, a 3-year average may be chosen; if the ratios demonstrated a trend over time, the most recent year's ratio or some other value may be selected). In this problem, the fixed % is given as 75%.

b. Step 3: Divide the selected expense ratio into fixed and variable ratios (using detailed expense data so that this division can be made directly, or using activity-based cost studies that help split each expense category appropriately). Since the problem states that 75% of the general expenses are fixed, that percentage is used to split the selected general expense ratio of 5.9% into a fixed expense provision of 4.4% and a variable expense provision of 1.5%.

General Expense Provisions Premium-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$24,331,974	$26,502,771	$30,975,169		
b1 Countrywide Earned Premium	$445,000,000	$485,950,000	$525,000,000		
b2 Countrywide Written Premium	$455,000,000	$490,000,000	$545,000,000		
c Ratio % [(a)/(b1)]	5.5%	5.5%	5.9%	5.6%	5.6%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c) x (d)]					4.2%
f Variable Expense % [(c) x (1.0-(d))]					1.4%

b. Step 4 (not needed to solve the problem, but is useful additional information): Sum the fixed and variable expense ratios across the different expense categories to determine total fixed and variable expense provisions.

If the average fixed expense per exposure (required for the pure premium approach discussed in Chapter 8) is needed, the fixed expense provision can be multiplied by the projected average premium.

Fixed Expense Per Exposure = Fixed Expense Ratio x Projected Average Premium

c. The fixed expense ratio will be distorted if the historical and projected premium levels are different.

Situations that can cause such a difference to exist:

c1. Recent rate increases (or decreases) implemented during or after the historical period will tend to overstate (or understate) the expected fixed expenses.

c2. Distributional shifts that have increased the average premium (e.g. shifts to higher amounts of insurance) or decreased the average premium (e.g. shifts to higher deductibles) will tend to overstate or understate the estimated fixed expense ratios, respectively.

c3. Countrywide expense ratios that applied to state projected premium to determine the expected fixed expenses can create inequitable rates for regional or nationwide carriers.

See chapter 7

Question 15 discussion: Blooms: Comprehension & Application; Difficulty 2, LO 5 KS: Fixed expenses and variable expenses

a. Variable expenses are treated the same way as the Premium-based Projection Method, but historical fixed expenses are divided by historical exposures or policy count rather than premium.

b. General Expense Provisions Using Exposure-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$24,331,974	$26,502,771	$30,975,169		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a) x (b)]	$18,248,981	$19,877,078	$23,231,377		
d Countrywide Earned Exposures	4,323,500	4,610,500	4,817,000		
e Fixed Expense Per Exposure [(c) / (d)]	$4.22	$4.31	$4.82	$4.45	$4.45
f Variable Expense $ [(a) x (1.0-(b))]	$6,082,994	$6,625,693	$7,743,792		
g Countrywide Earned Premium	$445,000,000	$485,950,000	$525,000,000		
h Variable Expense % [(f) / (g)]	1.4%	1.4%	1.5%	1.4%	1.4%

- Expenses are split into variable and fixed components (the assumption that 75% of GE are fixed is used).
- Fixed expenses are then divided by the exposures for that same time period.
- GEs are assumed to be incurred throughout the policy and thus are divided by earned exposures to determine an average expense per exposure for the indicated historical period.
- Selected expense ratios are based on either the latest year or a multi-year average.

c1. First, the method requires the actuary to judgmentally split the expenses into fixed and variable portions

c2. The method allocates countrywide fixed expenses to each state based on the exposure or policy distribution by state (as it assumes fixed expenses do not vary by exposure or policy).

However, average fixed expense levels may vary by location (e.g. advertising costs may be higher in some locations than others).

c3. Some expenses considered fixed actually vary by certain characteristics (e.g. fixed expenses may vary between new and renewal business).

See chapter 7

Question 16 discussion: Blooms: Application; Difficulty 1, LO 6 KS: Mechanics associated with each method (including organization of the data)

a. Derivation of Pure Premium Indicated Rate Formula

Premium = Losses + LAE + UW Expenses + UW Profit.

$$P_I = L + E_L + (E_F + V * P_I) + (Q_T * P_I).$$

$$P_I - V * P_I - Q_T * P_I = (L + E_L) + E_F.$$

$$P_I \times [1.0 - V - Q_T] = (L + E_L) + E_F; \quad P_I = \frac{(L + E_L + E_F)}{[1.0 - V - Q_T]}$$

Dividing by the number of exposures converts each of the component terms into averages per exposure, and the formula becomes the pure premium indication formula:

$$P_I/X = \frac{\left[(L + E_L)/X + E_F/X\right]}{\left[1.0 - V - Q_T\right]} = \frac{\left[\overline{L + E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]} = \overline{P_I}$$

b. Given the following information:

- Projected pure premium including LAE = \$400
- Projected fixed UW expense per exposure = \$35
- Variable expense ratio = 25%
- Target profit percentage = 10%

The indicated average rate per exposure equals $\frac{\left[\overline{L + E_L} + \overline{E_F}\right]}{\left[1.0 - V - Q_T\right]} = \frac{[\$400 + \$35]}{[1.0 - 0.25 - 0.10]} = \$669.23$

See chapter 8

Question 17 discussion: Blooms: Application; Difficulty 2, LO 6 KS: Mechanics associated with each method (including organization of the data)

a. Start with the fundamental insurance equation: Premium = Losses + LAE + UW Expenses + UW Profit.

$P_C = \text{Premium at current rates; } Q_C = \text{Profit percentage at current rates}$, the fundamental insurance equation can be rewritten as follows: $P_C = L + E_L + (E_F + V * P_C) + Q_C \ * P_C$

Rearranging the terms leads to $Q_C * P_C = P_C - (L + E_L) - (E_F + V * P_C)$

Dividing both sides by P_C yields $Q_C = 1.0 - \dfrac{(L + E_L) + (E_F + V * P_C)}{P_C} = 1.0 - \dfrac{L}{P_C} - \left(\dfrac{E_L + E_F}{P_C} + V\right)$

Substitute (Q_T) for (Q_C) and the indicated premium (P_I) for the projected premium at current rates (P_C)

$$Q_T = 1.0 - \frac{(L + E_L) + E_F}{P_C * \text{Indicated Change Factor}} - V$$

Rearranging terms leads to: $1.0 - V - Q_T = \dfrac{(L + E_L) + E_F}{P_C * \text{Indicated Change Factor}}$

Dividing through by P_C yields $\text{Indicated Change Factor} = \dfrac{L + E_L + E_F}{P_C * (1.0 - V - Q_T)} = \dfrac{(L + E_L)/P_C + E_F/P_C}{(1.0 - V - Q_T)}$,

which is equivalent to the loss ratio indication formula: $\text{Indicated Change Factor} = \dfrac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]}$

b. $\text{Indicated Change} = \dfrac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0 = \dfrac{[70\% + 5.5\%]}{[1.00 - 0.20 - 0.10]} - 1.0 = 7.9\%$

Thus, the overall average rate level is inadequate and should be increased by 7.9%.

See chapter 8

Question 18 discussion: Blooms: Comprehension; Difficulty 2, LO 6 KS: Assumption of each method

a. Two major differences between the two approaches.

1. The loss measure used in each approach:
   - The loss ratio indication formula requires premium at current rate level and the pure premium indication formula does not.
   - The pure premium formula requires exposures whereas the loss ratio indication formula does not.
2. The output of the two formulae.
   - The loss ratio formula produces an ***indicated change to rates*** currently charged.
   - The pure premium formula produces an **indicated rate** (thus, the pure premium method must be used with a new line of business for which there are no current rates to adjust).

b. Preference:
   - The pure premium approach is preferable if premium is not available or if it is difficult to calculate premium at current rate level
   - The loss ratio method is preferable if exposure data is not available or if the product being priced does not have clearly defined exposures

See chapter 8

Question 19 discussion: Blooms: Application; Difficulty 1, LO 6 KS: Mechanics associated with each method (including organization of the data)

1. Start with the loss ratio indication formula: $Indicated\ Change\ Factor = \dfrac{\left[(L+E_L)/P_C + F \right]}{[1.0 - V - Q_T]}$

   Restate the formula as: $Indicated\ Change\ Factor = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

2. The indicated adjustment factor, the ratio of the indicated premium (P_I) to the projected premium at current rates (P_C), yields the following: $P_I/P_C = \dfrac{\left[(L+E_L)/P_C + E_F/P_C \right]}{[1.0 - V - Q_T]}$

3. Multiplying both sides by the projected average premium at current rates (P_C / X) results in the pure premium indication formula (proving the two methods are equivalent):

$$P_I/X = \frac{\left[(L+E_L)/X + E_F/X \right]}{[1.0 - V - Q_T]} = \frac{[\,\overline{L+E_L} + \overline{E_F}\,]}{[1.0 - V - Q_T]}$$

See chapter 8

Question 20 discussion: Blooms: Knowledge; Difficulty 1, LO 3 KS: Determinations of and application of premium trend

The actuary may present the trend estimate resulting from the trending procedure in a variety of ways (e.g. a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the trend estimate).

Question 21 discussion: Blooms: Knowledge; Difficulty 1, LO 3 KS: Organization of data: calendar year, policy year, accident year

When selecting data, the actuary should consider the following:

1. the credibility assigned to the data by the actuary;
2. the time period for which the data is available;
3. the relationship to the items being trended; and
4. the effect of known biases or distortions on the data relied upon (e.g. the impact of catastrophic influences, seasonality, coverage changes, nonrecurring events, claim practices, and distributional changes in deductibles, types of risks, and policy limits).

Question 22 discussion: Blooms: Knowledge; Difficulty 1, LO 4 KS: Organization Approaches to determining trend (e.g., exponential and linear analyses)

The actuary should consider the following when determining the trending period:

1. the lengths of the experience and forecast periods
2. changes in the mix of data between the experience and forecast periods

Question 23 discussion: Blooms: Knowledge; Difficulty 1, LO 3 KS: Organization of data: calendar year, policy year, accident year

In addition, the actuary should disclose the following, as applicable, in an actuarial communication:

1. the intended purpose(s) or use(s) of the trending procedure, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses
2. significant adjustments to the data or assumptions in the trend procedure, that may have a material impact on the result or conclusions of the actuary's overall analysis.

Question 24 discussion: Blooms: Comprehension; Difficulty 1, LO 8 KS: Risk Classification of Principles, AAA

a. The following statistical criterion helps to ensure the accuracy and reliability of a potential rating variable:

- Statistical significance
- Homogeneity
- Credibility

b. The rating variable should be a ***statistically significant*** risk differentiator:

- Expected cost estimates should vary for the different levels of the rating variable
- Estimated differences should be within an acceptable level of statistical confidence
- Estimated differences should be relatively stable from one year to the next.

See chapter 9

Question 25 discussion: Blooms: Comprehension; Difficulty 1, LO KS: Risk Classification of Principles, AAA

a. For a rating variable to be practical, it should be

* Objective
* Inexpensive to administer
* Verifiable

b. Estimated costs for medical malpractice insurance vary by the skill level of a surgeon. However, the skill level of a surgeon is difficult to determine and subjective (thus, it is not a practical choice for a rating variable). More objective rating variables like board certification, years of experience, and prior medical malpractice claims can serve as proxies for skill level.

See chapter 9

Question 26 discussion: Blooms: Knowledge; Difficulty 1, LO 8 KS: Risk Classification of Principles, AAA

Affordability: It is desirable for insurance to be affordable for all risks. This is true when:

* it is required by law (e.g. states require "proof of financial responsibility" from owners of vehicles)
* it is required by a third party (e.g. lenders require homeowners insurance)
* it facilitates ongoing operation (e.g. stores purchase commercial general liability insurance).

See chapter 9

Question 27 discussion: Blooms: Application; Difficulty 3, LO 9 KS: Formulae and process for each rating differential or relativity

a. Pure Premium Method:

Pure Premium Method

(1) Terr	(2) Exposure	(3) Loss & ALE	(4) Indicated Pure Premium	(5) Indicated Relativity	(6) Indicated Relativity to Base
1	294	$15,234.96	$51.82	0.7877	0.7526
2	385	$26,509.75	$68.86	1.0466	1.0000
3	309	$23,255.29	$75.26	1.1439	1.0930
Total	988	$65,000.00	$65.79	1.0000	0.9555

(4)= (3)/(2); (5)= (4)/(Tot4); (6)= (5)/(Base5)

b. *The pure premium for each level is based on the experience of each level and assumes a uniform distribution of exposures across all other rating variables.*

- *If one territory has a disproportionate number of exposures of high or low AOI homes, this assumption is invalid.*
- *By ignoring this exposure correlation between territory and AOI, the loss experience of high or low AOI homes can distort the indicated territorial relativities resulting in a "double counting" effect.*

  i. Territory 1 indicated PP relativity is higher than the true relativity due to a disproportionate share of high-value homes in Territory 1.

  ii. Territory 3 indicated PP relativity is lower than the true relativity due to a disproportionate share of low-value homes in Territory 3.

c. Loss Ratio Method:

(1) Terr	(2) Premium @ Current Rate Level	(3) Loss & LAE	(4) Loss & LAE Ratio	(5) Indicated Relativity Change Factor	(6) Current Relativity	(7) Indicated Relativity	(8) Indicated Relativity @Base
1	$21,314.57	$15,234.96	71.5%	1.0996	0.6000	0.6598	0.6538
2	$40,414.19	$26,509.75	65.6%	1.0092	1.0000	1.0092	1.0000
3	$38,271.24	$23,255.29	60.8%	0.9348	1.3000	1.2153	1.2043
Total	$100,000.00	$65,000.00	65.0%	1.0000			

(4)= (3)/(2); (5)= (4)/(Tot4) ; (7)= (5)x(6); (8)= (7)/(Base7)

d.

* Since the PP approach relies on exposures (i.e. one exposure for each house year), the risks in each territory are treated the same regardless of the AOI.

* In contrast, LR approach relies on premium (in the denominator of the loss ratio) which reflects the fact that the insurer collects more premium for homes with higher AOI.

Using the current premium helps adjust for the distributional bias.

* Regardless, the LR method did not produce the correct relativities (the distortion coming from the variation in AOI relativities being charged rather than the true variation).

If the current AOI relativities equaled the true AOI relativities, then the LR method will produce the true territorial relativities.

See chapter 9

Question 27 discussion (continued):

e. The calculation of the current exposure-weighted average AOI relativities by territory is shown below:

Weighted AOI Relativity

AOI	Charged AOI Factor	Exposures by Territory 1	2	3
Low	0.80	8	125	139
Medium	1.00	106	129	130
High	1.35	180	131	40
Total		294	385	309
Wtd Avg AOI Rel by Terr		***1.2088***	***1.0542***	***0.9553***

Adjusted Pure Premium Method

(1) Terr	(2) Earned Exposures	(3) Wtd Avg AOI Relativity	(4) Adjusted Exposures	(5) Loss & LAE	(6) Indicated Pure Premium	(7) Indicated Relativity	(8) Indicated Relativity @Base
1	294	***1.2088***	355.40	$15,234.96	$42.87	0.6950	0.6563
2	385	***1.0542***	405.85	$26,509.75	$65.32	1.0590	1.0000
3	309	***0.9553***	295.2	$23,255.29	$78.78	1.2772	1.2061
Total	988		1,053.79	$65,000.00	$61.68	1.0000	0.9443

(4)= (2)*(3) (6)= (5)/(4); (7)= (6)/(Tot6); (8)= (7)/(Base7)

See chapter 9

Question 28 discussion: Blooms: Application; Difficulty 1, LO 6 KS: Mechanics associated with each method (including organization of the data)

Solution

Step 1: Restate premiums at current level.

Step 2: Trend the developed incurred losses.

Step 3: Compute the indicated change: $I.C = \left(\frac{\text{Projected Loss Ratio}}{\text{Permissable Loss Ratio}}\right) - 1.0$

Given: Year (1)	Earned Premium (2)	Developed Incurred Losses (3)	Compute: Current Rate Level Earned Premium (5)	Annual Loss Trend (6)	Years of Trend (7)	Projected Loss Ratio (8)
2001	100,000	71,200	110,000	1.05	4.5	0.806
2002	105,000	79,800	110,000	1.05	3.5	0.861
2003	110,000	83,930	110,000	1.05	2.5	0.862
Total	315,000	234,930		**Average**		**0.843**

$(8) = (3)*(6)^{(7)}/(5)$

Permissible loss ratio = 1.0 - .254 = .746

$I.C = \left(\frac{.843}{.746}\right) - 1.0 = .1300$

See chapter 8

Question 29 discussion: Blooms: Knowledge; Difficulty 1, LO 3 KS: Organization of data: calendar year, policy year, accident year

1. The length of the experience period.
2. The expected length of the forecast period.
3. The changes in the mix of data between the experience and forecast periods.

(Section 3.5)

Exam 5A – Independently Authored Questions - Preparatory Test 3

General information about this exam

This practice test contains 30 questions consisting of computational and essay based questions.

	Essay Questions	Computational Questions	Total
Total Number of Qs:	13	17	30
Total Number of Points:	21.75	34.5	56.25

1. The recommend time for this exam is 3:30:00. Make sure you have sufficient time to take this practice test.

2. Consider taking this exam after working all past CAS questions first.

3. Make sure you have a sufficient number of blank sheets of paper to record your answers for computational questions.

Articles covered on this exam:

Article .... Author ....

Chapter 10: Multivariate Classification .... Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 11: Special Classification .... Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 12: Credibility .... Modlin, Werner .... A. Basic Techniques for Ratemaking

Exam 5A – Independently Authored Questions - Test 3

Question 1 (1.50 points)

According to Werner and Modlin in "Basic Ratemaking", briefly describe the major shortcomings of the following three univariate approaches to classification ratemaking: the pure premium method, the loss ratio method and the adjusted pure premium method.

Question 2 (4.0 points) An insurer is revising its current relativities for two rating variables used in pricing its auto coverage because there is an uneven distribution of business along other classification dimensions not being analyzed in the current review.

- There are only two rating variables: gender and territory.
- Gender has values male (with a rate relativity g_1) and female (g_2).
- Territory has values urban (t_1) and rural (t_2).
- The base levels relative to multiplicative indications are female and rural (hence g_2 = 1.00 and t_2 = 1.00).

The company actuary has determined that it is appropriate to use the balance principle applied to a multiplicative minimum bias model and has complied the following data:

The actual loss costs (pure premiums) are as follows:

	Urban	Rural	Total
Male	$650	$300	$528
Female	$250	$240	$244
Total	$497	$267	$400

The exposure distribution is as follows:

	Urban	Rural	Total
Male	170	90	260
Female	105	110	215
Total	275	200	475

Using initial territorial relativities, t_1= 1.86, and t_2 = 1.0, calculate the revised relativities for Territory and Gender after one full iteration.

Question 3 (2.25 points) According to Werner and Modlin in "Basic Ratemaking", answer the following questions:

a. (0.75 points) Briefly describe four benefits associated with the use of multivariate methods.

b. (0.75 points) Briefly describe how univariate methods stack up to the list of benefits in part a.

c. (0.75 points) Briefly describe how minimum bias methods stack up to the list of benefits in part a.

Question 4 (2.0 points) According to Werner and Modlin in "Basic Ratemaking", GLM analysis is typically performed on loss cost data, or preferably frequency and severity separately. This is unlike univariate analysis of claims experience that is typically performed on either loss ratios or loss costs.

Briefly describe four, either statistical or practical reasons, supporting this practice:

Question 5 (1.50 points) According to Werner and Modlin in “Basic Ratemaking”, list three elements a modeler must have access to solve a generalized linear model.

Question 6 (3.0 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (1.0 point) Briefly describe three ways in which statistical diagnostics generated from a generalized linear model assist a modeler in evaluating potential rating variables.

b. (1.0 point) What is common statistical diagnostic for deciding whether a variable has a systematic effect on losses and briefly describe how is it used?

c. (1.0 point) Briefly describe what deviance measures and how deviance measures are used?

Question 7 (1.0 point) According to Werner and Modlin in “Basic Ratemaking”, insurers using GLMs seek to augment data that has already been collected and analyzed about their own policies with external data.

List four types of external data that can augment a multivariate analysis.

Question 8 (2.75 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (0.50 points) List the two general phases of territorial ratemaking.

b. (0.75 points) List three types of geographic units and briefly describe the advantage of using each type

c. (0.50 points) Historically, actuaries use univariate techniques (e.g. pure premium approach) to develop an estimator for each geographic unit. Briefly describe two major issues with this approach.

d. (1.0 point) Briefly describe a better approach to using univariate techniques to develop an estimator for each geographic unit.

Question 9 (1.75 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (0.75 points) Insurance providing protection against third-party liability claims are offered at the lowest limit, i.e. basic limits (BL), and at higher limits, i.e. increased limits (IL). List three reasons to establish rate relativities (i.e. to use increased limits ratemaking) for various limits.

b. (1.0 points) Lines of business in which IL ratemaking is used include private passenger and commercial auto liability, umbrella, any commercial product offering liability coverage (e.g. contractor’s liability, professional liability, etc). List and describe two types of policy limits offered, and how the limits are applied.

Question 10 (2.50 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, answer the following questions:

You are given the following 5,000 reported uncensored claims categorized by the size of the loss

Size of Loss Distribution

Size of Loss	Reported Claims	Reported Losses
X <= \$ 100,000	2,299	\$107,629,223
\$ 100,000 < X <= \$ 250,000	1,948	\$317,599,929
\$ 250,000 < X <= \$ 500,000	680	\$222,743,514
\$ 500,000 < X <= \$ 1,000,000	73	\$43,097,470
Total	5,000	\$691,070,136

a. (1.0 point) Compute the limited average severity at 100,000, i.e. LAS (100K)

b. (1.0 point) Compute the limited average severity at 250,000, i.e. LAS (250K)

c. (0.50 points) Compute the indicated increased limits factor for a 250,000 limit, i.e. ILF (250K)

Question 11 (2.50 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions:

An insurer writes policies at three policy limits ($100,000, $250,000, and $500,000) and the historical database contains only censored losses. 5,000 claims censored at the 3 policy limits are shown below:

Censored Loss Distribution of Policies with Policy Limit

	$100,000 Limit		$250,000 Limit		$500,000 Limit	
Size of Loss	Claims	Losses	Claims	Losses	Claims	Losses
X <= $ 100,000	2019	$156,657,898	690	$34,903,214	712	$35,768,111
$ 100,000 < X <= $ 250,000			773	$142,767,479	574	$90,009,422
$ 250,000 < X <= $ 500,000					232	$81,092,725
$ 500,000 < X <= $ 1,000,000						
Total	2,019	$156,657,898	1,463	$177,670,693	1,518	$206,870,258

a. (1.0 point) Compute the limited average severity at 100,000, i.e. LAS (100K)

b. (1.0 point) Compute the limited average severity at 250,000, i.e. LAS (250K)

c. (0.50 points) Compute the limited average severity at 500,000, i.e. LAS (500K)

Question 12 (1.0 point) According to Werner and Modlin in "Basic Ratemaking", list four reasons why deductibles are popular among both insureds and insurers:

Question 13 (1.50 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, compute the LER at $250 for the size of loss distribution of ground-up homeowners losses.

Size of Loss Distribution

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses
X <= $ 100	3,200	$225,365
$ 100 < X <= $ 250	1,225	$199,588
$ 250< X <= $ 500	1,137	$453,954
$ 500 < X <= $ 1,000	1,895	$1,531,938
$ 1,000 < X	2,543	$10,640,545
Total	10,000	$13,051,390

Question 14 (1.50 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, compute the LER (i.e. the credit) to change from a $250 to a $500 deductible.

Deductible	Reported Claims	Net Reported Losses	Net Reported Losses Assuming $500 Ded	Net Reported Losses Assuming $250 Ded
Full Cov	525	$700,220	$547,924	$608,134
$100	655	$1,248,403	$1,029,848	$1,156,269
$250	1,344	$2,910,672	$2,594,621	$2,910,672
$500	2,244	$5,299,242	$5,299,242	Unknown
$1,000	254	$909,755	Unknown	Unknown
Total	5,022	$11,068,292		

Question 15 (1.50 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, calculate of the premium discount for a policy with standard premium of $425,000.

Premium Range		Prod	General	Taxes	Profit
$0	$5,000	16.0%	12.0%	3.0%	5.0%
$5,000	$100,000	11.0%	9.0%	3.0%	5.0%
$100,000	$500,000	8.0%	5.0%	3.0%	5.0%
$500,000	above	6.0%	4.0%	3.0%	5.0%

Question 16 (2.50 points)

a. (1.0 points). Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, compute the loss constant. Assume that loss constants are to be applied to risks with annual premium of $2,500 or less in order to achieve a 70% loss ratio for both small and large risks.

Premium Range		Policies	Premium	Reported Loss
$1	$2,500	2,000	$2,000,000	$1,500,000
$2,501	above	2,000	$10,000,000	$7,000,000

b. (0.50 points). Small WC risks tend to have less favorable loss experience, as a % of premium, than large risks. List three reasons why this is the case.

Question 17 (2.5 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, answer the following questions.

Assume a home valued at $500,000 is insured only for $300,000 despite a coinsurance requirement of 80%.

a. (0.50 points). The indemnity payments and coinsurance penalties for a $200,000 loss.

b. (0.50 points). The indemnity payments and coinsurance penalties for a $300,000 loss.

c. (0.50 points). The indemnity payments and coinsurance penalties for a $350,000 loss.

d. (0.50 points). The indemnity payments and coinsurance penalties for a $450,000 loss.

e. (0.50 points). Briefly describe the magnitude of the co-insurance penalty for losses in the following ranges:
$0 - $F, F - $cV, $cV

Question 18 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions.

a. (0.50 points). Define the term credibility.

b. (1 point). List the three criteria upon which credibility (Z) is given to observed experience, assuming homogenous risks.

Question 19 (1.50 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions:

An actuary is using the classical credibility approach to determine the expected number of claims for the observed experience to be fully credible. Assume the following about the observed experience:

- Full credibility is set so that the observed value is to be within +/-10% of the true value 90% of the time.
- Exposures are homogeneous, claim occurrence follows a Poisson distribution, and no variation in claim costs exists.
- The observed pure premium of $250 is based on 30 claims.
- The pure premium of the related experience is $350.

a. (0.50 points). Compute the expected number of claims needed for full credibility.

b. (0.50 points). Calculate the credibility associated with the observed pure premium

c. (0.50 points). Calculate the credibility-weighted pure premium estimate.

Question 20 (1.0 point) According to Werner and Modlin in “Basic Ratemaking”, list three advantages to using classical credibility approach to computing credibility and one disadvantage to using it.

Question 21 (2.0 points) Using the procedures describe by Werner and Modlin in “Basic Ratemaking”, and the data below, answer the following questions.

- The observed value is $250 based on 21 observations.
- EVPV = 3.00, VHM = 0.75 and the prior mean is $275.
- The observed pure premium of $250 is based on 100 claims.

a. (0.50 points). Briefly describe the goal of the Bühlmann credibility approach to estimating credibility.

b. (0.50 points). State the formula for how Z is calculated, and describe what each term represents.

c. (0.50 points). State four assumptions under which Bühlmann credibility applies

d. (0.50 points). Calculate the Bühlmann credibility-weighted estimate.

Question 22 (1.0 point) According to Werner and Modlin in “Basic Ratemaking”, Bühlmann Credibility and Bayesian Credibility are uniquely related. List two specific unique relationships between Bühlmann Credibility and Bayesian Credibility.

Question 23 (1.50 points) According to Werner and Modlin in “Basic Ratemaking”, list and briefly describe six desirable qualities for a complement of credibility to possess.

Question 24 (1.0 point) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, calculate the complement of credibility for class 1 based on the rate change-for the larger group applied to the present rate.

Class	Exposure	Losses	Indicated Pure Premium	Present Pure Premium	Underlying Losses
1	100	$ 70,000	$700	$720	$ 72,000
2	200	$180,000	$900	$920	$184,000
3	300	$200,000	$667	$700	$210,000
Total	600	$450,000	$750	$772	$463,200

Notes: Both indicated and present pure premiums are at current cost levels.
Underlying losses are extension of exposures by present premiums.
Total present premium is ratio of total underlying to total exposures.

Question 25 (3.0 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, calculate the complement of credibility for class 1 in state S using Harwayne's method.

DATA FOR HARWAYNE'S METHOD

State s	Class c	Exposure E	Losses L	Pure Premium P
S	1	100	200	2.00
	2	180	600	3.33
	Subtotal	280	800	2.86
T	1	150	550	3.67
	2	300	1,200	4.00
	Subtotal	450	1,750	3.89
U	1	90	200	2.22
	2	220	900	4.09
	Subtotal	310	1,100	3.55
All	1	340	950	2.79
	2	700	2,700	3.86
	Total	1,040	3,650	3.51

Question 26 (1.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, calculate the complement of credibility using the trended present rates method.

Consider the following data for 2006 policy rates:

Present pure premium rate	$120
Annual inflation (trend)	10%
Amount requested in last rate change	+20%
Effective date requested for last rate change	1/1/04
Amount approved by state regulators	+15%
Effective date actually implemented	3/1/04

Question 27 (1.0 point) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, calculate the complement of credibility using the competitor's rates method.

Consider a competitor's rate of $200.

- A Schedule P analysis suggests the competitor will run a 70% loss ratio.
- One's own company has less underwriting expertise.
- One's own company expects twelve percent more losses per exposure than the competitor.

Question 28 (2.0 points) Suppose one wishes to estimate the layer between $500,000 and $1,000,000 given losses of $1,750,000 capped at $500,000 each. Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, calculate the complement of credibility using the Increased Limits Factor Method.

Limit of Liability	Increased Limits Factor
$ 50,000	1.00
$ 100,000	1.10
$ 250,000	1.25
$ 500,000	1.40
$1,000,000	2.40

Question 29 (2.0 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, calculate the complement of credibility for the layer between $500,000 and $750,000 using a lower limit analysis.

Assume losses capped at $500 are too sparse and thus you have chosen to used losses capped at a limit lower than the attachment point (i.e. losses at $250,000 limit)

Assume losses capped at $250,000 are $1,750,000, and the ILFs below apply.

Limit of Liability	Increased Limits Factor
$100,000	1.00
$250,000	1.75
$500,000	2.75
$750,000	3.25
$ 1,000,000	3.40

Question 30 (2.0 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, calculate the expected loss for the layer between $500,000 and $750,000 assuming a total limits loss ratio of 60% and using a Limits Analysis.

Limit of Liability (d)	Premium	ILF @ d
$100,000	$1,000,000	1.00
$250,000	$500,000	1.75
$500,000	$200,000	2.50
$750,000	$200,000	3.00
$1,000,000	$75,000	3.40
Total	$1,975,000	

Exam 5A – Solutions to Independently Authored Questions - Test 3

Question 1 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Formulae and process for each rating differential or relativity

In general, the major shortcoming of univariate approaches is their failure to accurately account for the effect of other rating variables.

1. The PP approach does not consider exposure correlations with other rating variables.
2. The LR approach uses current premium to adjust for an uneven mix of business to the extent the premium varies with risk, but premium is only an approximation since it deviates from true loss cost differentials.
3. The adjusted pure premium approach multiples exposures by the exposure-weighted average of all other rating variables' relativities to standardize data for the uneven mix of business before calculating the one-way relativities. But, this is an approximation to reflect all exposure correlations. See chapter 10

Question 2 discussion: Blooms: Application; Difficulty 2, LO 9 KS: : Fundamentals of univariate and multivariate relativity analyses

Step 1: Write four equations with observed weighted loss costs on the left and indicated weighted loss costs (the base rate, the exposure, and the indicated relativities) on the right.

Males	170 x \$650 +90 x \$300 = (\$100 x 170 xg_1 x t_1) +(\$100 x 90 x g_1 x t_2)
Females	105 x \$250 + 110 x \$240 = \$100 x 105 x g_2 x t_1 + \$100 x 110 x g_2 x t_2
Urban	170 x \$650+ 105 x \$250 = \$100 x 170 x g_1 x t_1 + \$100 x 105 x g_2 x t_1
Rural	90 x \$300+ 110 x \$240 = \$100 x 90 x g_1 x xt_2 + \$100 x 110 x g_2 x t_2

Step 2: Choose initial (or seed) relativities for the levels of one of the rating variables.

A sensible seed is the univariate PP relativities.

The urban relativity is the total urban loss costs divided by the total rural loss costs:

t1 = 1.86 = (\$497.27/\$267.00)

t2 = 1.00.

Step 3: Substituting these seed values into the first two equations, solve for the first values of g_1 and g_2:

170 x \$650 + 90 x \$300 = (\$100 x 170 x g1 x 1.86) + (\$100 x 90 x g1 x 1.00)

\$137,500 = (\$31,620 x g1) + (\$9,000 x g1)

\$137,500 = \$40,620 x g_1

g_1 = 3.39.

105 x \$250 + 110 x \$240 = (\$100 x 105 x g_2 x 1.86) + (\$100 x 110 x g_2 x 1.00)

\$52,650 = (\$19,530 x g_2) + (\$11,000 x g_2)

\$52,650 = \$30,530 x g_2

g_2 = 1.72.

Step 4: Using these seed values for gender, g_1 and g_2, set up equations to solve for the new intermediate values of t_1 and t_2:

170 x \$650 + 105 x \$250 = (\$100 x 170 x 3.39 x t1) + (\$100 x 105 x 1.72 x t_1)

\$136,750 = (\$57,630 x t_1) + (18,060 x $_{t1}$)

\$136,750 = \$75,690 x t_1

t_1 = 1.81.

90 x \$300 + 110 x \$240 = (\$100 x 90 x 3.39 x t_2) + (\$100 x 110 x 1.72 x t_2)

\$53,400 = (\$30,510 x t_2) + (\$18,920 x t_2)

\$53,400 =\$49,430 x t_2

t_2 = 1.08. See chapter 10

Question 3 discussion: Blooms: Knowledge; Difficulty 2, LO 9 KS: Fundamentals of univariate and multivariate relativity analyses

a1. The main benefit is the consideration of all rating variables simultaneously and automatically adjust for exposure correlations between rating variables

a2. Allows for randomness in determining what is driving the cost of claims and to what degree. Raw data contains systematic effects (a.k.a. signal) and unsystematic effects (a.k.a. noise), and the multivariate method seeks to remove the noise and capture the signal. It allows assumptions to be modified depending on what is being modeled (e.g. claim frequency, loss severity, or the probability a policy will be renewed).

a3. The methods produce model diagnostics (i.e. additional information about the certainty of results and the appropriateness of the model fitted).

a4. They allow interaction between two or more rating variables.

b. Univariate methods:

- are distorted by distributional biases.
- require no assumptions about the nature of the underlying experience.
- produce a set of answers with no additional information about the certainty of the results.
- can incorporate interactions but only by expanding the analysis into two-way or three-way tables.
- scores high in terms of transparency (but is plagued by the inaccuracies of the method).

c. Minimum bias methods:

- account for an uneven mix of business but iterative calculations are computationally inefficient.
- require no assumptions about the structure of the model and the bias function.
- do not produce diagnostics
- scores high on transparency and outperforms univariate analysis in terms of accuracy (but does not provide all of the benefits of full multivariate methods).

See chapter 10

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LO 9 KS: Fundamentals of univariate and multivariate relativity analyses

1. Modeling loss ratios requires premiums to be adjusted to current rate level at the granular level and that can be practically difficult.
2. Experienced actuaries already have an a priori expectation of frequency and severity patterns (e.g., youthful drivers have higher frequencies). In contrast, the loss ratio patterns are dependent on the current rates. Thus, the actuary can better distinguish the signal from the noise when building models.
3. Loss ratio models become obsolete when rates and rating structures are changed.
4. There is no commonly accepted distribution for modeling loss ratios.

See chapter 10

Question 5 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Fundamentals of univariate and multivariate relativity analyses

1. A modeling dataset with a suitable number of observations of the response variable and associated predictor variables to be considered for modeling.
2. A link function must be chosen to define the relationship between the systematic and random components (i.e. to define the relationship between the expected response variable (e.g., claim severity) and the linear combination of the predictor variables (e.g., age of home, amount of insurance, etc.)).
3. A distribution of the underlying random process must be chosen, typically a member of the exponential family of distributions (e.g., normal, Poisson, gamma, binomial, inverse Gaussian)

See chapter 10

Exam 5A – Solutions to Independently Authored Questions - Test 3

Question 6 discussion: Blooms: Comprehension; Difficulty 2 LO 9 KS: Fundamentals of univariate and multivariate relativity analyses

a. Statistical significance is an important criterion for evaluating rating variables, and statistical diagnostics are a major byproduct of GLMs. Statistical diagnostics:

* aid the modeler in understanding the certainty of the results and the appropriateness of the model.
* can determine if a predictive variable has a systematic effect on losses (and be retained in the model).
* assess the modeler's assumptions around the link function and error term.

b. A common statistical diagnostic for deciding whether a variable has a systematic effect on losses is the standard errors calculation.

* "standard errors are an indicator of the speed with which the log-likelihood falls from the maximum given a change in parameter."
* 2 standard errors from the parameter estimates are akin to a 95% confidence interval.
  i. the GLM parameter estimate is a point estimate
  ii. standard errors show the range in which the modeler can be 95% confident the true answer lies within.

c. Deviance measures (an additional diagnostic) assess the statistical significance of a predictor variable.

* Deviance measures of how much fitted values differ from the observations.
* Deviance tests are used when comparing nested models (one is a subset of the other) to assess whether the additional variable(s) in the broader model are worth including.

See chapter 10

Question 7 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Fundamentals of univariate and multivariate relativity analyses

1. geo-demographics (e.g. population density of an area, average length of home ownership of an area);
2. weather (e.g. average rainfall or number of days below freezing of a given area);
3. property characteristics (e.g. square footage of a home or business, quality of the responding fire department);
4. information about insured individuals or business (e.g. credit information, occupation).

See chapter 10

Question 8 discussion: Blooms: Comprehension; Difficulty 2, LO 11 KS: Common policy provisions

a. Territorial ratemaking generally involves two phases:

I. Establishing territorial boundaries

II. Determining rate relativities for the territories

b. Three common types of geographical units are postal/zip codes, counties and census blocks.

i. zip codes have the advantage of being readily available but the disadvantage of changing over time.

ii. counties have the advantage of being static and readily available, but due to their large size, tend to contain very heterogeneous risks.

iii. census blocks are static over time, but require a process to map insurance policies to the census blocks.

c. Two major issues with using the a univariate technique to develop an estimator for each geographic unit are:

1. The geographic estimator reflects both the signal and the noise.
   Since geographic units tend to be small, the data is sparse and the resulting loss ratios or pure premiums or both will be too volatile to distinguish the noise from the signal.
2. Since location is highly correlated with other non-geographic factors, the resulting estimator is biased.

Question 8 discussion (continued):

d. A better approach involves using a multivariate model (e.g. a GLM) on loss cost data using a variety of non-geographic and geographic explanatory variables.

1. Non-geographic variables include rating variables (e.g. age of insured, claim history) as well as other explanatory variables not used in rating.
2. Geographic variables include geo-demographic variables (e.g. population density) and geo-physical variables (e.g. average rainfall).

See chapter 11

Question 9 discussion: Blooms: Knowledge; Difficulty 1, LO 11 KS: Common policy provisions

a. Reasons to establish rate relativities (i.e. to use increased limits ratemaking) for various limits:

1. As personal wealth grows, individuals have more assets to protect and need more insurance coverage.
2. Inflation drives up costs and trends in costs have a greater impact on IL losses than on BL losses.
3. The propensity for lawsuits and the amount of jury awards have increased significantly (i.e. social inflation) and this has a disproportionate impact on IL losses.

b. Two types of policy limits offered:

1. Single limits: Refers to the total amount the insurer will pay for a single claim (e.g. if an umbrella policy has a limit of $1,000,000, then the policy will only pay up to $1,000,000 for any one claim).
2. Compound limits: Applies two or more limits to the covered losses. Examples:

i. A split limit: includes a per claimant and a per occurrence limit (e.g. in personal auto insurance, a split limit for bodily injury liability of $15,000/$30,000 means that if the insured causes an accident, the policy will pay each injured party up to $15,000 with total payment to all injured parties not to exceed $30,000).

ii. An occurrence/aggregate limit: limits the amount payable for any one occurrence and for all occurrences incurred during the policy period (e.g. if an annual professional liability policy has a limit of $1,000,000/$3,000,000, the policy will not pay more than $1,000,000 for any single occurrence and will not pay more than $3,000,000 for all occurrences incurred during the policy period).

See chapter 11

Question 10 discussion: Blooms: Application; Difficulty 2, LO 11 KS: Formula

a. LAS ($100,000) is calculated by capping every claim at $100,000 and dividing by the total number of claims.

- All 2,299 claims in the first interval have individual sizes of loss less than $100,000, so they are uncapped.
- The other 2,701 claims in the other three intervals have individual sizes of loss that exceed $100,000 and are capped at $100,000 [$270,100,000 (= 2,701 x $100,000)].
- LAS ($100,000) = the Sum ($377,729,223 = $107,629,223 + $270,100,000)/ total claim count.

$$LAS(\$100K) = \frac{\$107,629,223 + (1,948 + 680 + 73)\ x\ \$100,000}{5,000} = \$75,546$$

b. Using this technique, the ILF for $250,000 is calculated as follows: $Indicated\ ILF(\$250K) = \frac{LAS(\$250K)}{LAS(\$100K)}$

$$LAS\ \ (\$250K) = \frac{\$107,629,223 + \$317,599,929 + (680 + 73)\ x\ \$250,000}{5,000} = \$122,696$$

c. $Indicated\ ILF(\$250K) = \frac{LAS(\$250K)}{LAS(\$100K)} = \frac{\$122,696}{\$75,546} = 1.62$

See chapter 11

Question 11 discussion: Blooms: Application; Difficulty 2, LO 11 KS: Formula

a. To calculate LAS by limit, calculate a LAS for each layer of loss and combine the estimates for each layer taking into consideration the probability of a claim occurring in the layer. The LAS of each layer is based solely on loss data from policies with limits as high as or higher than the upper limit of the layer.

When calculating the LAS ($100K), use the experience from all policies limits censored at $100,000:

$$LAS(\$100K) = \frac{\$156,657,898 + \$34,903,214 + \$35,768,111 + \$100,000 * (773 + 574 + 232)}{5,000}$$

$$= \frac{\$385,229,223}{5,000} = \$77,046$$

b. Calculating LAS ($250,000)

Step 1: Determine the losses in the $100K - $250 K layer.

i. Policies with a limit of $100,000 cannot contribute any losses to that layer and the data is not used.

ii. Of the 1,463 claims with policies having a $250K limit, 773 claims have losses in the $100K to $250K layer.

Total censored losses for those 773 claims are $142,767,479.

Eliminating the first $100K of each of those losses results in losses in the $100K to $250K layer.

$142,767,479 - 773 x $100,000 = $65,467,479

iii. Policies with a limit of $500K also contribute loss dollars to the $100K to $250K layer.

Of the 1,518 claims associated with a limit of $500K limit, 574 have losses in the $100K to $250K layer.

These claims contribute $32,609,422 (=$90,009,422 – 574 x $100,000) of losses to the layer.

Another 232 claims exceed $250,000, and each contributes $150,000 to the $100K to $250K layer.

$34,800,000 = 232x ($250,000- $100,000)

The sum of the above values are the losses in the $100K to $250K layer:

$65,467,479+ $32,609,422+ $34,800,000 = $132,876,901.

These losses were from 1,579 (=773+574+232) claims. Thus, LAS(100K-250K) = $\$84,153 = \dfrac{\$132,876,901}{1,579}$

Step 2: Before combining this with the LAS ($100K), adjust for the fact that these losses are based on a subset of the claims used to calculate the LAS ($100K).

The adjustment involves calculating the probability that the loss will exceed $100K, given that a claim occurs.

Since the actuary cannot know whether or not the claims from the policies with a $100K limit would have exceeded $100K, that data is not used for this calculation. To adjust this, the LAS for the $100K to $250K layer can be multiplied by the following probability:

$$Pr(\$100K \le X \le \$250K) = \frac{773 + 574 + 232}{1,463 + 1,518} = \frac{1,579}{2,981}.$$

The values above are the numbers of claims from the 250K policy limit and 500K policy limit for losses > 100K.

This is equivalent to dividing the losses in the layer by the total claim count for those policies:

$$\$44,575 = \$84,153 * \frac{1,579}{2,981} = \frac{\$132,876,901}{2,981}$$

Thus, $LAS(\$250K) = \$77,046 + \$44,575 = \$121,621$

c. Calculating LAS ($500,000) using the same techniques: For losses in the $250K to $500K layer, only policies with a $500K limit or greater can be used: $\$15,213 = \dfrac{\$81,092,725 - 232 * \$250,000}{1,518}$

Thus, $LAS(\$500K) = \$77,046 + \$44,575 + \$15,213 = \$136,834$ See chapter 11

Question 12 discussion: Blooms: Knowledge; Difficulty 1, LO 11 KS: Layers of loss

1. Premium reduction: A deductible reduces the rate as the insured pays a portion of the losses.
2. Eliminates small nuisance claims: Deductibles minimize the filing of small claims (and the expense associated with investigating and handling small claims, which is often greater than the claim amount).
3. Provides incentive for loss control: Since the insured is responsible for the first layer of loss, the insured has a financial incentive to avoid losses.
4. Controls catastrophic exposure: For insurers writing a large number of policies in cat prone areas, the use of large cat deductibles can reduce its exposure to loss.

See chapter 11

Question 13 discussion: Blooms: Application Difficulty 1, LO 11 KS: Layers of loss

To calculate LER ($250), compute the amount of losses in each layer that will be eliminated by the deductible.

- The first two rows contain losses less than $250 and are completely eliminated by the deductible.
- The remaining rows contain individual losses that are at least $250; thus $250 will be eliminated for each of the 5,575 claims (=1,137+1,895+2,543).

The LER = losses eliminated/ total losses:

$$LER(\$250) = \frac{(\$225,365 + \$199,588) + \$250 \times (1,137 + 1,895 + 2,543)}{\$13,051,390} = 0.139$$

See chapter 11

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses	(4) Losses Eliminated By $250 Deductible
X <= $ 100	3,200	*$225,365*	*$225,365*
$ 100 < X <= $ 250	1,225	*$199,588*	*$199,588*
$ 250< X <= $ 500	1,137	**$453,954**	**$284,250**
$ 500 < X <= $ 1,000	1,895	**$1,531,938**	**$473,750**
$ 1,000 < X	2,543	**$10,640,545**	**$635,750**
Total	10,000	$13,051,390	$1,818,703
		(5) LER =	0.139

(4)Losses<250=	(3)
(4)Losses>=250=	(2) x $250
(5)	(Tot4) / (Tot3)

Question 14 discussion: Blooms: Application; Difficulty 1, LO 11 KS: Layers of loss

Data from policies with deductibles greater than the deductible being priced cannot be used to calculate the LER. For example:

- data from policies with a $500 deductible cannot be used to determine LERs for a $250 or $100 deductible, *however*
- data from policies with deductibles *less than the deductible being priced* can be used to determine LERs (e.g. data from policies with a $500 deductible can be used to determine the LER associated with moving from a $750 deductible to a $1,000 deductible).

Calculating the credit to change from a $250 to a $500 deductible.

(1) Deductible	(2) Reported Claims	(3) Net Reported Losses	(4) Net Reported Losses Assuming $500 Ded	(5) Net Reported Losses Assuming $250 Ded	(6) Losses Eliminated Moving from $250 to $500
Full Cov	525	$700,220	$547,924	$608,134	$60,210
$100	655	$1,248,403	$1,029,848	$1,156,269	$126,421
$250	1,344	$2,910,672	$2,594,621	$2,910,672	$316,051
$500	2,244	$5,299,242	$5,299,242	Unknown	Unknown
$1,000	254	$909,755	Unknown	Unknown	Unknown
Total	5,022	$11,068,292			
		(7) Net Reported Losses for Ded <=$250			$4,675,075
		(8) Losses Eliminated <=$250 Ded			$502,682
		(9)LER			0.108

(3)= Net of the deductible (4) =(3) Adjusted to a $500 deductible (5)=(3) Adjusted to a $250 deductible

(6)= (5) - (4) (7)= Sum of (5) for $0, $100, $250 Deductibles (8)=Sum of (6) for $0, $100, $250 Deductibles

- Each row contains data for policies with different deductible amounts.
- The analysis can only use policies with deductibles of $250 or less (since the goal is to determine the losses eliminated when changing from a $250 to a $500 deductible)
- Columns 4 and 5 contain the net reported losses in Column 3 restated to $500 and $250 deductible levels, respectively.

  Columns 4 and 5 are not Column 3 minus the product of Column 2 and the assumed deductible.

  This is because not every reported loss exceeds the assumed deductible.

  The losses in Columns 4 and 5 are based on an assumed distribution of losses by deductible and size of loss, and cannot be recreated given the data shown.

See chapter 11

Question 15 discussion: Blooms: Application; Difficulty 1, LO 11 KS: :Formula

Workers Compensation Premium Discount Example

(1) Premium Range	(2)	(3) Premium in Range	(4) Prod	(5) General	(6) Taxes	(7) Profit	(8) Total	(9) Expense Reduction	(10) Discount %	(11) Premium Discount
$0	$5,000	$5,000	16.0%	12.0%	3.0%	5.0%	36.0%	0.0%	0.0%	$0
$5,000	$100,000	$95,000	11.0%	9.0%	3.0%	5.0%	28.0%	8.0%	8.7%	$8,261
$100,000	$500,000	$325,000	8.0%	5.0%	3.0%	5.0%	21.0%	15.0%	16.3%	$52,989
$500,000	above		6.0%	4.0%	3.0%	5.0%	18.0%	18.0%	19.6%	$0
Standard Premium		$425,000								**$61,250**

(3)= Min of [(2) - (1), Standard Premium - Sum Prior(3)]

(9)= $(8_{\text{Row 1}})$-(8) (10)= (9)/[1.0 -(6) - (7)] (11)= (3) x (10)

See chapter 11

Question 16 discussion: Blooms: Application; Difficulty 2, LO 11 KS: Formula

a.

Workers Compensation Loss Constant Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Premium Range		Policies	Premium	Reported Loss	Initial Loss Ratio	Target Loss Ratio	Premium Shortfall	Loss Constant
$1	$2,500	2,000	$2,000,000	$1,500,000	75.0%	70.0%	$142,857	$71.43
$2,501	above	2,000	$10,000,000	$7,000,000	70.0%	70.0%		$0.00

b. Small companies:

1. have less sophisticated safety programs because of the large amount of capital to implement and maintain.
2. may lack programs to help injured workers return to work.
3. premiums are unaffected or slightly impacted by experience rating; small insureds may not be eligible for ER and may have less incentive to prevent or control injuries than large insureds.

See chapter 11

Question 17 discussion: Blooms: Application Difficulty 2, LO 11 KS: Formula

a. The coinsurance requirement of 80% is $400,000. Since F is $300,000 a coinsurance deficiency exists and a (the apportionment ratio) = 0.75 (=$300,000 / $400,000).

The indemnity payments and coinsurance penalties for a $200,000 loss are:

$$I = L \times \frac{F}{cV} = \$200,000 \times \frac{\$300,000}{\$400,000} = \$150,000$$

$$e = L - I = \$200,000 - \$150,000 = \$50,000$$

b. The indemnity payments and coinsurance penalties for a $300,000 loss:

$$I = L \times \frac{F}{cV} = \$300,000 \times \frac{\$300,000}{\$400,000} = \$225,000$$

$$e = L - I = \$300,000 - \$225,000 = \$75,000$$

c. The following are the indemnity payments and coinsurance penalties for a $350,000 loss:

$$I = L \times \frac{F}{cV} = \$350,000 \times \frac{\$300,000}{\$400,000} = \$262,500$$

$$e = F - I = \$300,000 - \$262,500 = \$37,500$$

d. The following are the indemnity payments and coinsurance penalties for a $450,000 loss:

$$I = L \times \frac{F}{cV} = \$450,000 \times \frac{\$300,000}{\$400,000} = \$337,500, \textbf{ but } \$337,500 > F, \text{ so } I = F = \$300,000$$

$$e = F - I = \$300,000 - \$300,000 = \$0.$$

e. The magnitude of the co-insurance penalty:

- the dollar coinsurance penalty increases linearly between $0 and F (where the penalty is the largest).
- the penalty decreases for loss sizes between F and cV.
- there is no penalty for losses larger than the cV, but the insured suffers a penalty in that the payment does not cover the total loss.

See chapter 11

Question 18 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Credibility and complements of credibility

a. Credibility is "a measure of the predictive value in a given application that the actuary attaches to a particular body of data."

b. The credibility (Z) given to observed experience, assuming homogenous risks, is based on three criteria:

1. $0 \leq Z \leq 1$ (i.e. no negative credibility and capped at fully credible).
2. Z should increase as the number of risks increases (all else being equal).
3. Z should increase at a non-increasing rate.

See chapter 12

Question 19 discussion: Blooms: Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

a. Since the actuary regards the loss experience fully credible if there is a 90% probability that the observed experience is within 10% of its expected value.

- This is equivalent to a 95% probability that observed losses are no more than 10% above the mean. In the SN table, the 95th percentile is 1.645 standard deviations above the mean; therefore, the expected number of claims needed for full credibility is: $E(Y) = \left(\frac{1.645}{0.10}\right)^2 = 270$
- If the number of observed claims $\geq$ the standard for full credibility (270 in the example), the measure of credibility (Z) is 1.00: $Z = 1.00 \text{ } where \text{ } Y \geq E(Y)$

b. If the number of observed claims is < the standard for full credibility, the square root rule is applied to calculate Z: $Z = \sqrt{\frac{Y}{E(Y)}}, \text{ } where \text{ } Y < E(Y).$

In the example, if the observed number of claims is 30, $Z = \sqrt{\frac{30}{270}} = 0.334.$

c. The credibility-weighted estimate is \$316.6 (=0.334 x \$250 + (1-0.334) x \$350). See chapter 12

Question 20 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Credibility and complements of credibility

3 Advantages:

1. It is the most commonly used and thus generally accepted.
2. The data required is readily available.
3. The computations are straightforward.

Disadvantage: Simplifying assumptions may not be true in practice (e.g. no variation in the size of losses).
See chapter 12

Question 21 discussion: Blooms: Knowledge & Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

a. The goal of Bühlmann credibility (a.k.a. least squares credibility): minimize the square of the error between the estimate and the true expected value of the quantity being estimated.

b. Z is defined as follows: $Z = \frac{N}{N+K}$, where N represents the number of observations and K is the ratio of the expected value of the process variance (EVPV) to the variance of the hypothetical means (VHM) (i.e. the ratio of the average risk variance to the variance between risks).

Question 21 discussion (continued):

c. The assumptions under the Bühlmann credibility formula are as follows:

* (1.0 - Z) is applied to the prior mean.
* Risk parameters and risk process do not shift over time.
* The EVPV of the sum of N observations increases with N.
* The VHM of the sum of N observations increases with N.

d. $K = \frac{EVPV}{VHM} = \frac{3.00}{.75} = 4.00,\ \ Z = \frac{21}{21+4.00} = 0.84;$ and

Bühlmann Credibility-weighted Estimate = Estimate = Z x Observed Experience + (1.0 - Z) x Prior Mean.

Bühlmann Credibility-weighted Estimate = 0.84 x $250 + (1- 0.84) x $275 = $254.

See chapter 12

Question 22 discussion: Blooms: Knowledge; Difficulty 1, LO 9 KS: Credibility and complements of credibility

1. Bühlmann credibility is the weighted least squares line associated with the Bayesian estimate.
2. The Bayesian estimate is equivalent to the LSC estimate in certain mathematical situations.

See chapter 12

Question 23 discussion: Blooms: Comprehension Difficulty 1, LO 9 KS: Credibility and complements of credibility

1. Accurate: A COC that causes rates to have a low error variance around the future expected losses being estimated is considered accurate.
2. Unbiased: Differences between the complement and the observed experience should average to 0 over time.

Accurate vs. Unbiased:

- An accurate statistic may be consistently higher or lower than the following year's losses, but it is <u>always close</u>.
- An unbiased statistic varies randomly around the following year's losses over many successive years, but it may <u>not be close</u>.

3. Independent: The complement should also be statistically independent from the base statistic (otherwise, any error in the base statistic can be compounded).

4 and 5. Available and Easy to Compute: If not, the COC is not practical and justification to a third party (e.g. regulator) for approval is needed.

6. Logical relationship (to the observed experience): is easier to support to any third party reviewing the actuarial justification.

Question 24 discussion: Blooms: Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

$$C = Current\ Loss\ Cost\ of\ Subject\ Experience \times \left(\frac{Larger\ Group\ Indicated\ Loss\ Cost}{Larger\ Group\ Current\ Average\ Loss\ Cost} \right)$$

Using this formula and the given data, the complement for Class 1 would be: $720 * ($750/$772] = $699.48

See chapter 12

Question 25 discussion: Blooms: Application; Difficulty 3, LO 9 KS: Credibility and complements of credibility

For Harwayne's full method, one first computes

P_T = [100 * 3.67 + 180 * 4.00]/[100 + 180] = 3.88

P_U = [100 * 2.22 + 180 * 4.09]/[100 + 180] = 3.42

Then, one computes the state adjustment factors:

F_T = 2.86/3.88 = .737 and F_U = 2.86*3.42 = .836.

The next step is to compute the other states' adjusted Class 1 rates:

$P'_{1,T}$ = .737 * 3.67 = 2.70 and $P'_{1,U}$ = .836/2.22 = 1.86.

The last step is to weight the two states' adjusted rates with their Class 1 exposures to produce

C= [2.70 * 150 + 1.86 * 90]/[150 + 90] =2.39. This is Harwayne's complement of the credibility.

See chapter 12

Question 26 discussion: Blooms: Application Difficulty 1, LO 9 KS: Credibility and complements of credibility

The complement of the credibility would be $C = \$120 * (1.1)^2 \left[\frac{1.20}{1.15}\right] = \$152$

See chapter 12

Question 27 discussion: Blooms: Application Difficulty 1, LO 9 KS: Credibility and complements of credibility

The complement would be $200 * .70 * 1.12 = $156.80 See chapter 12

Question 28 discussion: Blooms: Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

Suppose one wishes to estimate the layer between $500,000 and $1,000,000 given losses of $2,000,000 capped at $500,000 each. The complement using increased limits would be

$$C = P_A\left[\frac{ILF_{A+L}}{ILF_A} - 1\right] = \$1{,}750{,}000\left[\frac{2.4}{1.4} - 1\right] = \$1{,}250{,}000$$

See chapter 12

Question 29 discussion: Blooms: Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

$$C = \overline{L_d} \times \left(\frac{ILF_{\mathrm{A+L}} - ILF_A}{ILF_d}\right)$$,where

- L_d is the loss cost capped at the lower limit, d; • ILF_A is the ILF for the attachment point A;
- ILF_d is the ILF for the lower limit, d;
- $ILF_{\mathrm{A+L}}$ is the ILF for the sum of the attachment point A and the excess insurer's limit of liability L (i.e. this sum is the top of the excess layer being priced).

$$C = \$1{,}750{,}000 \times \left(\frac{3.25 - 2.75}{1.75}\right) = \$500{,}000$$

See chapter 12

Question 30 discussion: Blooms: Application; Difficulty 1, LO 9 KS: Credibility and complements of credibility

When insurers sell policies with a wide variety of policy limits.

- Some policy limits fall below the attachment point and some extend beyond the top of the excess layer.
- Thus, each policy's limit and ILF needs to be considered in the calculation of the complement.
  i. Policies at each limit of coverage are analyzed separately.
  ii. Estimated losses in a layer are computed using the premium and expected loss ratio in that layer.
  iii. An ILF analysis on each first dollar limit's loss costs is performed.

$$C = LR \times \sum_{d \le A} P_d \times \frac{(ILF_{\min(d,A+L)} - ILF_{A+L})}{ILF_d}$$, where

LR = Total loss ratio, and P_d= Total premium for policies with limit d.

Thus, expected loss for the layer $500,000 to $750,000 are computed as follows:

(1) Limit of Liability (*d*)	(2) Premium	(3) Expected Loss Ratio	(4) = (2)*(3) Expected Capped Losses	(5) ILF @ *d*	(6) ILF @ *A*	(7) ILF @ *A+L*	(8) % Loss In Layer	(9) = (4)*(8) Expected Loss in Layer
$ 100,000	$1,000,000	60.0%	$ 600,000	1.00	2.50	3.00	0.0%	
$ 250,000	$ 500,000	60.0%	$ 300,000	1.75	2.50	3.00	0.0%	
$ 500,000	$ 200,000	60.0%	$ 120,000	2.50	2.50	3.00	0.0%	
$ 750,000	$ 200,000	60.0%	$ 120,000	3.00	2.50	3.00	16.7%	$20,040
$ 1,000,000	$ 75,000	60.0%	$ 45,000	3.40	2.50	3.00	14.7%	$6,615
Total	$1,975,000							$26,655

(8): if d< =A then 0.0%; if A < d ≤ A +L then [(5)- (6)]/(5); if d >A+L then [(7)- (6)]/(5)

See chapter 12

Exam 5 – Independently Authored Questions - Preparatory Test 4

General information about this exam

This practice test contains 20 questions consisting of computational and essay based questions.

	Essay Questions	Computational Questions	Total
Total Number of Qs:	6	14	20
Total Number of Points:	9	40	49

1. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.

2. Consider taking this exam after working all past CAS questions first.

3. Make sure you have a sufficient number of blank sheets of paper to record your answers for computational questions.

Articles covered on this exam:

Article .... Author ....

Chapter 13: Other Considerations .... Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 14: Implementation .... Modlin, Werner .... A. Basic Techniques for Ratemaking

Personal Auto Premiums: Asset Share Pricing .... Feldblum .... A. Basic Techniques for Ratemaking

Appendix D: Workers Compensation Indication....... Modlin, Werner .... A. Basic Techniques for Ratemaking

Exam 5 – Independently Authored Questions - Test 4

Question 1 (2.0 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions:

a. (1.0 points). List four regulatory constraints that cause insurers to implement rates different from those indicated by their ratemaking analyses.

b. (1.0 points). List four insurer actions that can be taken with respect to regulatory restrictions.

Question 2 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, answer the following questions:

a. (1.0 points). Operational constraints can make it difficult for an insurer to implement the actuarially indicated rate change. List two types of operational constraints that insurers can face.

b. (.50 points). Briefly describe the best course of action an insurer can undertake when operational constraints arise.

Question 3 (1.25 points) According to Werner and Modlin in “Basic Ratemaking”, list five factors that affect an insured’s propensity to renew an existing policy or purchase a new policy.

Question 4 (4.0 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, answer the following questions:

- Assume an insurer issues 30,000 quotes in the month of April and generates 7,500 new policies.
- Assume 40,000 policies are up for renewal in the month of May and 35,000 renew
- Assume there were 240,000 policies at the beginning of the June, 7,600 new policies were added and 5,200 policies were lost during June.

a. (1.0 point). Compute the insurer’s close ratio, and briefly describe why it is important to understand the denominator of the ratio.

b. (1.0 point). Compute the insurer’s retention ratio, and briefly describe two desirable aspects of renewal policyholders vs. new policyholders from the insurer’s perspective.

c. (1.0 point). Briefly describe why insurers rely on closely monitoring close ratios and retention ratios and what impact rate changes can have upon close and retention ratios

d. (1.0 point). Compute the insurer’s growth ratio, and describe one way that growth can be impacted other than by price.

Question 5 (1.25 points) According to Werner and Modlin in “Basic Ratemaking”, briefly describe two types of non-pricing solutions an insurer can implement when the indicated average premium per exposure does not equal the projected average premium per exposure. For each type, list several ways in which balance can be achieved.

Question 6 (1.0 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, compute the proposed fixed expense fee.

Expense Type	Total Expense	% Fixed
Commission	0.19	0%
Other Acquisition	0.04	85%
General	0.03	95%
Taxes, Licenses and Fees	0.02	85%
Profit and Contingencies	0.08	0%

Projected Average Premium per Exposure = $250.00

Exam 5 – Independently Authored Questions - Test 4

Question 7 (4.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions.

Assume the insurer relies on the following data to select proposed rate differentials for each rating variable:

R1	Current Differential	Indicated Differentia	Competitor Differential	Proposed Differential
1	0.8000	0.9000	0.9200	0.9000
2	1.0000	1.0000	1.0000	1.0000
3	1.2000	1.2500	1.2500	1.2500

R2	Current Differential	Indicated Differential	Competitor Differential	Proposed Differential
A	1.0000	1.0000	1.0000	1.0000
B	1.0500	0.9000	0.9500	0.9500
C	1.2000	1.3000	1.6500	1.3000

D1	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	5.0%	4.0%	5.0%	5.0%
N	0.0%	0.0%	0.0%	0.0%

D2	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	10.0%	2.5%	7.5%	5.0%
N	0.0%	0.0%	0.0%	0.0%

Exposures and proposed rate differentials and discounts are given below

Exposures	R1	R2	D1	D2
10,000	1	A	Y	Y
7,500	2	A	Y	Y
3,000	3	A	Y	Y
9,000	1	B	Y	Y
20,000	2	B	Y	Y
5,000	3	B	Y	Y

Assume the following:

- The proposed rating algorithm for a given risk is defined as follows:
  $$P_{P,\,ijkm} = [B_P \times R1_{P,\,i} \times R2_{P,\,j} \times (1.0 - D1_{P,\,k} - D2_{P,m}) + A_P] \times X_{ijkm}$$
- The 'seed' base rate is \$215.00, $A_P = 25$, and the proposed average premium is \$250.
- The current average premium using extension of exposures on current rates is \$242.13.

a. (3 points). Compute the proposed base rate using the extension of exposure technique.

b. (1.5 points). Compute the proposed base rate using the loss ratio method, assuming the indicated % change in average premium is 3.25%.

Question 8 (2.0 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following question.

Assume an insurer relies on the following data to compute the average proposed rate differential across all rating variables:

Proposed Differentials Wtd by Exposures

(1) R1	(2) Exposures	(3) Proposed Differential
1	152,500	0.9000
2	570,000	1.0000
3	147,000	1.2500
Total	869,500	1.0247

(1) R2	(2) Exposures	(3) Proposed Differential
A	235,000	1.0000
B	480,000	0.9500
C	154,500	1.3000
Total	869,500	1.0257

(1) D1	(2) Exposures	(3) Proposed Discount
Y	156,625	0.0500
N	712,875	0.0000
Total	869,500	0.0090

(1) D2	(2) Exposures	(3) Proposed Discount
Y	153,625	0.0500
N	715,875	0.0000
Total	869,500	0.0088

- Let $\overline{S_P}$ can be approximated as the product of the average differential of each of the rating variables:

$$\overline{S_P} \approx \frac{\sum_i X_i \times R1_{P,i}}{X} \times \frac{\sum_j X_j \times R2_{Pj}}{X} \times \left[1.0 - \left[\frac{\sum_k X_k \times D1_{P,k}}{X} + \frac{\sum_m X_m \times D2_{P,m}}{X}\right]\right]$$

- $A_P = 25$ and the proposed average premium is \$250.

Compute the proposed base rate using the Approximated Average Rate Differential Method.

Question 9 (2.0 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following question.

- The Current Base Rate = $210.00
- The Current Average Premium = $242.13
- The Target Change in Average Premium = 3.25%
- The Proposed Additive Premium per Policy = $25.00

Proposed Average Change in Differentials (Using Exposures)

(1) D1	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	156,625	0.0500	0.0500
N	712,875	0.0000	0.0000
Total	869,500	0.0090	0.0090

(1) D2	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	153,625	0.1000	0.0500
N	715,875	0.0000	0.0000
Total	869,500	0.0177	0.0088

(Tot3) = (3) Weighted by (2) (Tot4) = (4) Weighted by (2)

(5) R1	(6) Exposures	(7) Current Differential	(8) Proposed Differential
1	152,500	0.8000	0.9000
2	570,000	1.0000	1.0000
3	147,000	1.2000	1.2500
Total	869,500	0.9987	1.0247

(5) R2	(6) Exposures	(7) Current Differential	(8) Proposed Differential
A	235,000	1.0000	1.0000
B	480,000	1.0500	0.9500
C	154,500	1.2000	1.3000
Total	869,500	1.0631	1.0257

(10) 1-D1-D2	(11) Exposures	(12) Current Differential	(13) Proposed Differential
Total	235,000	0.9733	0.9822

Compute the proposed base rate using the Approximated Change in Average Rate Differential Method.

Question 10 (4.5 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data below, answer the following question.

An actuary has decided to limit the premium impact caused by the change in rate differentials for a rating variable. In particular, the proposed rate relativity for any level that produces a premium impact that exceeds the desired maximum premium increase of 20% must be adjusted.

- Assume there is no additive premium.
- You are given the following information:

Level	Premium	Current	Selected
1	$158,000	0.8200	0.9300
2	$644,000	1.0000	1.0000
3	$198,000	1.1500	1.2000
Total	$1,000,000		

- The actuary selects an overall change for all levels of 15%.

a. (3 points). Compute the base rate adjustment.

b. (1.5 points). Compute the proposed Level 1 relativity adjusted for base rate offset

Question 11 (1.5 points) According to Werner and Modlin in “Basic Ratemaking”, when writing a new insurance product, insurers often do not have the data to generate rates, and often rely on similar products sold by competitors. List and briefly describe four types of adjustments an insurer may make if it uses a competitor’s manual as a starting point.

Question 12 (1.50 points).

According to Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," asset share pricing is not yet common in property/casualty insurance for several reasons.

List three reasons cited by the author.

Question 13 (5.50 points)

The Non-Standard Auto Insurance Company is trying to compute the proper premium rate relativity for its young male driver class using an asset share pricing approach with a 3-year time horizon. The following information is known for their two classes of drivers:

Adult Drivers

First year average premium 1,000

First year average Loss & LAE 500

Adult Drivers

	New	Renewal
Variable expense ratio	10%	5%
Fixed expense ratio	15%	5%

Persistency Rates

Year	Adult Drivers	Young Male Drivers
1	100%	100%
2	90%	80%
3	92%	82%

- Cost of capital: 10%
- Loss and LAE trend: 5%
- Fixed expense trend: 3%
- Expected rate increases: 6%

Using the method described in Feldblum "Personal Automobile Premium: An Asset Share Pricing Approach For Property-Casualty Insurance," Answer the following questions.

a. (3.0 points). Compute the present value of premium for adult drivers.

b. (.50 points). Compute the rate of return on premium.

c. (2 points). Given a present value of profit of $1500 on young male drivers, compute the premium rate relativity for young male drivers, such that the Non-Standard Auto Company will earn the same return on premium for both classes.

Question 14 (3 points)

You are given the following for an average policy:

Policy			Variable Expense		Fixed Expense	
Year	Premium	PV Loss	Year 1	Renewal	Year 1	Renewal
1	1,000	800.00	250	0	150	0
2	1,000	776.00	0	50	0	40
3	1,000	752.72	0	50	0	40
4	1,000	730.14	0	50	0	40
5	1,000	708.23	0	50	0	40

Policy	Persistency			Discount	Present Value	
Year	Rate	Cumulative	Profit	Factor	Profit	Premium
1	1.000	1.000	(200.00)	1.000	(200.00)	1,000.00
2	0.850	0.850	113.90	1.100	103.55	772.73
3	0.850	0.723	113.63	1.210	93.91	597.11
4	0.850	0.614	110.46	1.331	82.99	461.40
5	0.850	0.522	105.33	1.464	71.94	356.56
Total					152.39	3,187.80

- PV Loss is the present value at the beginning of each policy year.
- Assume all policies are annual and have January 1 effective dates.
- The policy count at year 0 is 1,000.

Using the asset share pricing model described by Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance:"

a. (2 points) If you increase rates 5% on January 1 of year 1 and then keep rates constant throughout the five-year period, you project a 25% policy count decrease in year 1 and all other patterns will remain the same.

Calculate the revised present value 5-year aggregate profit.

b. (1 point) If you increase rates 5% on January 1 of year 1 and then keep rates constant throughout the five-year period, what decrease (in decimals) in year 1 policy counts would result in the original estimated present value 5-year aggregate profit of $152,390, assuming all other patterns will remain the same?

Question 15 (1 point)

Based on Feldblum, "Personal Automobile Premiums: An Asset Share Pricing Approach for Property-Casualty Insurance," and the following information, calculate the termination rate for the third year.

- Number of policies originally issued = 1,000
- Number of first-year lapses = 300
- Number of second-year lapses = 150
- Number of third-year lapses = 100

Question 16 (2.5 points) You have been asked to compute the indicated rate change for a workers' compensation book of business. Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and the data given below, answer the following question.

Accident Year	Expected Indemnity Loss Ratio	Expected Medical Loss Ratio	Expected ALAE Ratio	Expected ULAE Ratio
2012	27.9%	59.1%	10.2%	7.7%
2013	33.2%	52.0%	10.2%	7.7%
2014	34.4%	53.4%	10.2%	7.7%
2015	28.0%	55.6%	10.2%	7.7%
2016	35.6%	49.8%	10.2%	7.7%
Total	31.9%	53.9%	10.2%	7.7%

Compute the indicated overall rate change.

Question 17 (2.5 points) You have been asked to calculate the adjustment an individual company should make to the advisory loss costs to account for underwriting expenses, profit targets, and operational differences that would affect loss cost levels for a workers' compensation book of business.

Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following question.

- General Expenses 9.3%
- Other Acquisition Costs 6.8%
- Taxes, License and Fees 2.7%
- Commissions and Brokerage Fees 8.8%
- Target Profit Provision 1.7%
- Expected Loss Cost Difference -6.0%
- Operational Adjustment 0.940
- Current Deviation 1.350
- Industry Deviation 8.2%

Compute the company change to industry advisory loss costs.

Question 18 (2.5 points) You have been asked to calculate the medical benefit cost level factors for a workers' compensation book of business. Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following question.

Accident Year	Medical Fee Schedule Change	Annual "Other Medical" Level Change	Protion of Medical Losses Subject to Fee Schedules
2012	0.0%	2.2%	70.0%
2013	0.0%	1.7%	70.0%
2014	-15.0%	3.7%	65.0%
2015	0.0%	3.8%	65.0%
2016	5.0%	3.6%	65.0%
Projected	0.0%	6.1%	65.0%

Compute the factors needed to adjust historical accident year reported medical losses to the projected loss cost levels.

Question 19 (2.5 points) You have been asked to calculate the expected medical loss ratios for each accident year in the experience period for a workers' compensation book of business. Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following question.

Year	Projected Loss Cost Premium	Reported Medical Losses	Medical Loss Development Factor	Factor to Adjust Medical Benefits to Projected Cost
2012	$3,888,921,656	$1,862,884,241	1.343	0.995
2013	$4,039,795,024	$1,624,586,453	1.426	0.990
2014	$4,086,617,127	$1,341,387,071	1.564	1.082
2015	$4,212,122,582	$1,233,856,180	1.843	1.067
2016	$4,297,583,764	$812,155,751	2.795	1.021
Total	$20,525,040,153	$6,874,869,695		

Compute the expected medical loss ratios for each accident year in the experience period.

Question 20 (2.5 points) You have been asked to calculate the projected loss cost premium for each accident year in the experience period for a workers' compensation book of business. Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the data below, answer the following question.

Accident Year	Industry Loss Cost Premium	Annual Payroll Level Change	Exposure Trend Expected Future Wage Level Change	Historical Average Experience Modification	Expected Average Experience Modification
2012	$3,250,810,701	2.2%	6.1%	0.987	0.950
2013	$3,457,177,017	2.7%	6.1%	0.981	0.950
2014	$3,611,917,078	3.4%	6.1%	0.977	0.950
2015	$3,883,157,640	3.9%	6.1%	0.978	0.950
2016	$3,996,217,983	3.2%	6.1%	0.953	0.950

Compute the projected loss cost premium for each accident year in the experience period.

Exam 5 – Solutions to Independently Authored Questions - Test 4

Question 1 discussion: Blooms: Knowledge; Difficulty 1, LO 7 KS: Regulatory constraints

a1. Regulations may limit the amount of an insurer's rate change (to either the overall average rate change for the jurisdiction or to the change in premium for any individual or group of customers, or both)

a2. Regulation requiring insurers to provide written notice to its insureds regarding the magnitude of the requested change.

a3. Regulations prohibiting the use of a characteristic for rating (even if it can be demonstrated to be statistically strong predictors of risk).

a4. Regulations prescribing the use of certain ratemaking techniques (e.g. the use of multivariate classification analysis).

a5. Regulators disagreeing with the insurer's actuarial ratemaking assumptions (e.g. a regulator may disagree with the method the actuary used to calculate loss trend, or may disagree with the trend selected).

Insurer actions that can be taken with respect to regulatory restrictions:

b1. An insurer can take legal action to challenge the regulation.

b2. An insurer may revise its U/W guidelines to limit business written at what it considers to be inadequate rate levels (although some locations require insurers to "take all comers" for personal lines).

b3. An insurer may change marketing directives to minimize new applicants whose rates are thought to be inadequate (e.g. concentrate its advertising on areas in which it believes the rate levels to be adequate).

b4. In the case of banned or restricted usage of a variable (e.g. insurance credit scores), an insurer can use a different allowable rating variable (e.g. payment history with the company) it believes can explain some or all of the effect associated with the restricted variable.

See chapter 13

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LO 7 KS: Operational constraints

a1. Modifying rating algorithms can require significant systems changes, and the complexity of the change depends on the extent of the changes and the number of systems.

a2. Implementing a new rating variable may require data that has not been previously captured, and may require getting the data directly, either through a questionnaire sent to insureds or by visually inspecting the insured item. These approaches can call for additional staff with unique skills.

b. When an operational constraint arises, a cost-benefit analysis can determine the appropriate course of action. The cost of implementing the change is the cost associated with modifying the system. The benefit is the incremental profit that can be generated by charging more accurate rates, and attracting more appropriately priced customers.

See chapter 13

Question 3 discussion: Blooms: Knowledge; Difficulty 1, LO 7 KS: Marketing constraints: competitive comparisons, close ratios, retention ratios, growth, distributional analysis, policyholder dislocation analysis

1. Price of competing products: If the same product is offered at a lower price, they are likely to purchase the competing product.
2. Overall cost of the product: If the product is costly, insureds are likely to compare prices to determine any potential savings (and vice versa).
3. Rate changes: Significant increases (or decreases) in premium for an existing policy can cause existing insureds to look for better options.
4. Characteristics of the insured (e.g. a young policyholder may shop (and change insurers) more frequently than an older policyholder).
5. Customer satisfaction and brand loyalty: Poor claims handling or a bad customer service experience may cause existing insureds to explore other options.

See chapter 13

Question 4 discussion: Blooms: Application; Difficulty 3, LO 7 KS: Marketing constraints: competitive comparisons, close ratios, retention ratios, growth, distributional analysis, policyholder dislocation analysis

a. $$Close\ Ratio\ =\ \frac{Number\ of\ Accepted\ Quotes}{Total\ Number\ of\ Quotes}=\frac{7,500}{30,000}=25\%$$

Assume Insurer A includes all quotes issued, while insurer B may only include one quote per applicant. Insurer A will have a lower close ratio if applicants request more than one quote before making a decision (e.g. if an applicant gets several quotes with different limits).

b. $$Retention\ Ratio=\frac{Number\ of\ Policies\ Renewed}{Total\ Number\ of\ Potential\ Renewal\ Policies}=\frac{35,000}{40,000}=875\%$$

Renewal customers are less expensive to service and generate fewer losses than new customers.

c. Insurers rely on close ratios and retention ratios as primary signals of the competitiveness of rates for new business and renewal customers, respectively. Rate changes affect renewal business directly (since any change can motivate existing customers to shop elsewhere) and influence the insurer's competitive position (e.g. If an insurer takes a rate decrease, the expectation is that the close and retention ratios will improve, and vice versa)

d. $$\%PolicyGrowth=\frac{(New\ Policies\ Written\ -\ Lost\ Policies)}{Policies\ at\ Onset\ of\ Period}=\frac{Policies\ at\ End\ of\ Period}{Policies\ at\ Onset\ of\ Period}-1.0\ ,$$

Monthly policy growth is 1.0% (= [7,600 - 5,200] / 240,000).

If an insurer tightens or loosens the underwriting standards, growth can be affected. See chapter 13

Question 5 discussion: Blooms: Comprehension; Difficulty 1, LO 10 KS: Non-pricing solutions

1. Balance can be achieved through expense reductions (i.e. reduction in UW or LAE expenses, by reducing the marketing budget or staffing levels).
2. Balance can be achieved by reducing the average expected loss by changing the make-up of the portfolio of insureds, by reducing the coverage provided by the policy (a.k.a. a coverage level change) or by instituting better loss control procedures. See chapter 14

Question 6 discussion: Blooms: Application; Difficulty 1, LO 10 KS: Fixed expenses

Using the given information (cols (1) and (2)) below, compute cols (3) and (4).

Expense Type	Total Expense (1)	% Fixed (2)	H Fixed (3)=(1)*(2)	V+Q Variable (4)=(1)*(1.0 - (2))
Commission	0.19	0.00%	0.000	0.190
Other Acquisition	0.04	85.00%	0.034	0.006
General	0.03	95.00%	0.029	0.002
Licenses and Fees	0.02	85.00%	0.017	0.003
Profit and Contingencies	0.08	0.00%	0.000	0.080
		H=Fixed Expense Fee Ratio =	0.0795	0.2805

$$Expense\ Fee=\frac{F}{1-V-Q}=\frac{H*R}{1-V-Q}$$ *, where F = fixed expense per exposure, H = fixed expense ratio (fixed expenses as a % of the rate).* Calculation of $Fee (Using the Fixed Expense Ratio)

Calculation of $Fee (Using the Fixed Expense Ratio)

	(1) Fixed Expense Ratio	7.950%
	(2) Projected Average Premium per Exposure	$250.00
(3)=(1)*(2)	(3) Average Fixed Expense	$19.88
From col (4)	(4) Variable Expense %	20.05%
From col (4)	(5) Target Profit %	8.0%
(6)=1.0-(4)-(5)	(6) Variable Permissible Loss Ratio	71.95%
(7)=(3)/(6)	(7) Proposed Fee	$27.62

See chapter 14

Exam 5 – Solutions to Independently Authored Questions - Test 4

Question 7 discussion: Blooms: Application; Difficulty 3, LO 10 KS: Calculation of final base rate

a. The proposed base rate is given by the following: $B_p = B_S \times \frac{(\overline{P_P} - A_P)}{(\overline{P_S} - A_P)}$

Extension of Exposures (Assuming Seed Base Rate = $215)

(1) Exposures	(2) R1	(3) R2	(4) D1	(5) D2	(6) Proposed Premium (assuming Seed Base Rate = $215)
10,000	1	A	Y	Y	1,991,500.00
7,500	2	A	Y	Y	1,638,750.00
3,000	3	A	Y	Y	800,625.00
9,000	1	B	Y	Y	1,713,982.50
20,000	2	B	Y	Y	4,176,500.00
5,000	3	B	Y	Y	1,273,906.25
54,500					11,595,264
(7) Avg Prop Prem (Base Seed = $215)					212.76

Proposed Base Rate (Extension of Exposures)

(1) Seed Base Rate	$215.00
(2) Average Premium assuming Seed Base Rate	$212.76
(3) Proposed Fixed Fee per Policy	$25.00
(4) Proposed Average Premium	$250.00
(5)Proposed Base Rate	$257.65

(2)= from Row (7)
(5)= (1) x [(4) - (3)] /[(2) - (3)]

b. The proposed base rate is given by the following: $B_P = B_S \times \frac{\overline{P_P} - A_P}{\overline{P_S} - A_P} = B_S \times \frac{(1+\Delta\%) \times \overline{P_C} - A_P}{\overline{P_S} - A_P}$

Proposed Base Rate (Extension of Exposures, Loss Ratio Method)

(1) Target % Change in Average Premium	3.25%
(2) Current Average Premium	$242.13
(3) Proposed Average Premium	$250.00
(4) Seed Base Rate	$215.00
(5) Average Premium assuming Seed Base Rate	$212.76
(6) Proposed Fixed Fee per Policy	$25.00
(7) Proposed Base Rate	$257.65

(3)= (1.0 + (1)) x (2)
(7)= (4) x [(3) - (6)] /[(5) - (6)]

See chapter 14

Question 8 discussion: Blooms: Application; Difficulty 1, LO 10 KS: Calculation of final base rates

Step 1: Compute the proposed differentials weighted by exposures.

Proposed Differentials Wtd by Exposures

(1) R1	(2) Exposures	(3) Proposed Differential
1	152,500	0.9000
2	570,000	1.0000
3	147,000	1.2500
Total	869,500	1.0247

(1) R2	(2) Exposures	(3) Proposed Differential
A	235,000	1.0000
B	480,000	0.9500
C	154,500	1.3000
Total	869,500	1.0257

(1) D1	(2) Exposures	(3) Proposed Discount
Y	156,625	0.0500
N	712,875	0.0000
Total	869,500	0.0090

(1) D2	(2) Exposures	(3) Proposed Discount
Y	153,625	0.0500
N	715,875	0.0000
Total	869,500	0.0088

(Tot3) = (3) weighted by (2). (4) $\overline{S}_p$ = 1.0323 (4) = ($Tot3_{R1}$) x ($Tot3_{R2}$) x (1.0 - $Tot3_{D1}$ - $Tot3_{D2}$)

Step 2: Solve for the proposed base rate: $B_P = \dfrac{\overline{P}_P - A_P}{\overline{S}_P}$

The proposed base rate, assuming the exposure-weighted average proposed rate differential across all rating variables from the table above, is: $B_P = \dfrac{\overline{P}_P - A_P}{\overline{S}_P} = \dfrac{\$250 - \$25}{1.0323} = \$217.96$

See chapter 14

Question 9 discussion: Blooms: Application; Difficulty 1, LO10 KS: Calculation of final base rates

Step 1: Compute the proposed average change in differentials using exposures

Proposed Average Change in Differentials (Using Exposures)

(1) D1	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	156,625	0.0500	0.0500
N	712,875	0.0000	0.0000
Total	869,500	0.0090	0.0090

(1) D2	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	153,625	0.1000	0.0500
N	715,875	0.0000	0.0000
Total	869,500	0.0177	0.0088

(Tot3) = (3) Weighted by (2) (Tot4) = (4) Weighted by (2)

(5) R1	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
1	152,500	0.8000	0.9000	1.1250
2	570,000	1.0000	1.0000	1.0000
3	147,000	1.2000	1.2500	1.0417
Total	869,500	0.9987	1.0247	1.0260

(5) R2	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
A	235,000	1.0000	1.0000	1.0000
B	480,000	1.0500	0.9500	0.9048
C	154,500	1.2000	1.3000	1.0833
Total	869,500	1.0631	1.0257	0.9648

(10) 1-D1-D2	(11) Exposures	(12) Current Differential	(13) Proposed Differential	(14) Proposed / Current
Total	235,000	0.9733	0.9822	1.0091

(15) Average Change in Differential	0.9989

(9)= (8) / (7)
(Tot9)= (9) Weighted by (6)
(12)= 1 - (Tot3D1) - (Tot3D2)
(13)= 1 - (Tot4D1) - (Tot4D2)
(14)= (13) / (12)
(15) = (Tot9R1) x (Tot9R2) x (Tot14)

Step 2: Using the results from the prior table and $(1.0+\Delta_B\%)=\dfrac{(1.0+\Delta\%)\times\overline{P_C}-A_P}{\overline{P_C}-A_C}\times\dfrac{1.0}{(1.0+\Delta_S\%)}$, the proposed base rate can be calculated as shown in the following table.

Proposed Base Rate (Approximated Method)

(1) Current Base Rate (given)	$210.00
(2) Current Average Premium (given)	$242.13
(3) Target Change in Average Premium (given)	3.25%
(4) Proposed Average Premium	$250.00
(5) Proposed Additive Premium per Policy (given)	$ 25.00
(6) Average Rating Differential Adjustment	0.9989
(7) Proposed Base Rate Adjustment	1.0374
(8) Proposed Base Rate	$217.85

(4)= (1.0 + (3)) x (2) (7)= [(4) - (5)] / [(2) - (5)] x [1.0 /(6)] (8)=(1) x (7)

See chapter 14

Question 10 discussion: Blooms: Application; Difficulty 3, LO 10 KS: Calculation of final base rates

a. Step 1: Compute whether the proposed rate relativity for any level produces a premium impact that exceeds the desired maximum premium increase of 20%.

Rate Change after Capping Non-Base Level at 20%

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Level	Premium	Current	Selected	Differential Change	Off-Balance Factor	Selected Overall Change	Total Change	Premium Above 20% Cap
1	$158,000	0.8200	0.9300	13.41%	0.9711	15.0%	26.65%	10,510
2	$644,000	1.0000	1.0000	0.00%	0.9711	15.0%	11.67%	0
3	$198,000	1.1500	1.2000	4.35%	0.9711	15.0%	16.53%	0
Total	$1,000,000			2.98%	0.9711	15.0%	15.00%	10,510

(10)	Proposed Premium from Non-capped Levels (2, 3)	$949,890
(11)	Proposed Level 1 Relativity to Comply with Cap	0.8812
(12)	Base Rate Adjustment to cover Shortfall	1.0111
(13)	Proposed Lev 1 relativity adjusted for base rate offset	0.8715

(5)= (4) / (3) - 1.0
(Tot5)= (5) weighted by (2)
(6)= [1.0] / [1.0 + (Tot5)]
(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0
(9)= max of [(2) x ((1.0 + (8))] - [(2) x (1.0 + 20%)] and 0
(10)= (2) x (1+(8)) summed over Levels 2 and 3
(11)= [(1.0 + 20%) / ((6Row 1) x (1.0 + (7Row 1))] x (3Row 1)
(12)= 1.0 + (Tot9) / (10)
(13)= (11) / (12)

a Step 2: Compute the base rate adjustment.

The base rate needs to be adjusted upward to cover the premium shortfall caused by the cap:

$$Base\ Rate\ Adj = 1.0 + \frac{Premium\ Above\ Cap}{Proposed\ \ Premium\ \ from\ all\ \ Non\text{-}Capped\ Levels} = 1 + \frac{10{,}510}{949{,}890} = 1.011$$

b. The relativity for the capped level (Level 1) needs to be reduced to account for:

i. the amount the change exceeds the cap and for

ii. the amount the base rate will be increased by the base rate adjustment:

$$Differential\ \ Adjustment = [\frac{1.0 + \%Cap}{1.0 + Overall\ \ Rate\ Change \times OBF}] \times Curr\ \ Rel \times \frac{1.0}{Base\ Rate\ Adj}$$

Adjustment to Level 1 Differential due to Capping [1.0 + 20%]/[1.15 * .9711] *.82 = .8812

Thus, the Proposed Level 1 relativity adjusted for base rate offset = .8812/1.0111 = .8715

See chapter 14

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LO 10 KS: Rating variables and differentials

1. Estimate whether its fixed expenses will be higher or lower than those of the target competitor and increase or decrease the competitor's expense fee by the appropriate percentage.

2. Estimate whether its variable expenses will be higher or lower than those of the target competitor, and adjust the base rate and the expense fee by the ratio of [the target competitor's variable permissible loss ratio/ the expected variable permissible loss ratio].

3. Estimate whether its expected loss costs will be different than the target competitor's due to operational differences or a lack of experience with the product, and change the base rate.

4. Target a certain segment of the market that the competitor does not seem to be targeting.

If the insurer chooses to reduce the rate differential in that territory, it can adjust the base rate to offset the change in the average territorial differential.

See chapter 14

Question 12 discussion: Blooms: Knowledge; Difficulty 1, LO 13 KS: Model characteristics and formulae

1. The data needed are not always available.
2. Casualty pricing techniques are still somewhat undeveloped.
3. The casualty insurance policy allows great flexibility in premiums and benefit levels.
4. Liability claim costs are uncertain, both in magnitude and in timing.

See page 196.

Question 13 discussion Blooms: Application; Difficulty 3, LO 13 KS: Premium

Step 1. Compute the PV of Premium for adult male drivers:

Policy Year	Premium	Annual Losses Year 1	Annual Losses subsequent	Fixed Expense New	Fixed Expense Renewal	Variable Expense Year 1	Variable Expense Renewal	Persistency Rate	Cumulative Persistency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	**1,000.00**	500.00	0.00	150	0	100	0	1.00	1.00
2	1,060.00		525.00		**51.50**		53.00	0.90	0.90
3	1,123.60		551.25		53.05		56.18	0.92	0.83
Total	3,183.60								

Policy Year	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(11)	(12)	(13)	(14)
1	250.00	1.000	250.00	1,000.00
2	387.45	1.100	352.23	867.27
3	383.47	1.210	316.92	768.88
Total			919.14	2,636.15

Column 2 is an average premium per car of 1000 with a 6% annual growth due to annual rate increases
Column (3) is column (2) * 0.5 new business loss ratio. Column (4) is column (3) * 1.05 net trend.
Column (5). First year fixed expenses are .15*1,000. Fixed renewal expenses in renewal year 1.
equal fixed renewal expenses in policy year 1 times fixed expense trend: 52 = 1,000*.05*1.03
Variable expenses are 10% of 'premium' in the 1st 'year', and 5% in the following years
Column (9) is 1.0 - termination rates
Column (10) = the downward product of column (9).
Column (11) = Column (10) *{Column (2) - Sum of Columns (3, 4, 5, 6, 7 and 8)}.
Column (12) uses a rate of 10% per year compounded annually.
Column (13) = column (11) / column (12).
Column (14) = column (2) * column (10) / column (12) .

Step 2. Compute the PV of Premium for Young Male Drivers

The return on premium is 919.14/2,636.15 = 34.87%

The PV of Profit for young male drivers is $1,500, therefore to earn a 34.87% return, the PV of premium must be equal to 1,500/.3487 = 4,302.08

Step 3. Compute the premium rate relativity.

First, we need the initial premium for young male drivers. Let Initial premium for Young Male drivers = P

Set up an equation for the present value of premium for young male drivers by multiplying initial premium by annual increases and cumulative persistency and dividing by discount factors.

P + P*1.06*.8/1.1 + P*(1.062)*.656/1.21 = 4,302.08

P + .77P + .609P = 4302.08

P = 1808.36

Premium relativity for young male drivers = 1,816.78/1,000 = 1.817

Question 14 discussion: Blooms: Application; Difficulty 2 LO 13 KS: Model characteristics and formulae

The following is given:

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	Present Value of Profit	Present Value of Premium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	**1,000**	800.00	**250**	0	150	0	1.000	1.000	-200.00	1.000	-200.00	1,000.00
2	1,000	776.00		**50**		40	0.850	0.850	113.90	1.100	103.55	772.73
3	1,000	752.72		50		40	0.850	0.723	113.63	1.210	93.91	597.11
4	1,000	730.14		50		40	0.850	0.614	110.46	1.331	82.99	461.40
5	1,000	708.23		50		40	0.850	0.522	105.33	1.464	71.94	356.54
Total											152.38	3,187.77

Only the values in bold need to be adjusted in accordance with the 5% rate increase. This produces the following impact:

Policy Year	Premium	PV of Loss	Variable Expense Year 1	Variable Expense Renewal	Fixed Expense Year 1	Fixed Expense Renewal	Persistency Rate	Cumulative Persistency	Profit	Discount Factor	PV of Profit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	**1,050**	800.00	**263**	0	150	0	1.000	1.000	-162.50	1.000	-162.50
2	**1,050**	776.00		**53**		40	0.850	0.850	154.28	1.100	140.25
3	**1,050**	752.72		**53**		40	0.850	0.723	147.95	1.210	122.28
4	**1,050**	730.14		**53**		40	0.850	0.614	139.63	1.331	104.90
5	**1,050**	708.23		**53**		40	0.850	0.522	130.12	1.464	88.87
Total											293.80

Therefore, the revised present value 5-year aggregate profit = 1,000 * .75 * $293.80 = $220,350

b. 5-year aggregate profit = (Policy count at time 0)*(policy count impact)*(aggregate present value profit).
$152,390 = 1,000 * (1 - x) * $293.8. x = .48.

Question 15 discussion Blooms: Application; Difficulty 1, LO 13 KS: Termination rates

General information:

"Persistency may be analyzed either by termination rates or by probabilities of termination.

The termination rate is the number of terminations during a given renewal period divided by the sum of terminations during that period plus policies persisting through that period.

Termination rates more clearly distinguish persistency patterns by classification."

Solution:

The termination rates by year are:

30.00% [= 300 / 1000] the 1st year

21.43% [=150 / (1,000 -- 300) = 700] the 2nd year, and

18.18% [=100 / (1,000 -- 300 -- 150) = 550] the 3rd year.

See page 210.

Question 16 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Effect of rate changes

Accident Year	(1) Expected Indemnity Loss Ratio	(2) Expected Medical Loss Ratio	(3) Expected ALAE Ratio	(4) Expected ULAE Ratio	(5) Expected Loss & LAE Ratio
2012	27.9%	59.1%	10.2%	7.7%	102.6%
2013	33.2%	52.0%	10.2%	7.7%	100.5%
2014	34.4%	53.4%	10.2%	7.7%	103.6%
2015	28.0%	55.6%	10.2%	7.7%	98.5%
2016	35.6%	49.8%	10.2%	7.7%	100.7%
Total	31.9%	53.9%	10.2%	7.7%	101.2%

(5) = [(1) + (2)] * [1.0 + (3) + (4)]
(6) Selected
(7) = (6) - 1.0

(6) Selected	101.2%
(7) Indication	1.2%

Interpreting the results. The objective of the overall analysis is to determine advisory loss costs, the premium (derived in another exhibit) does not include any underwriting expenses or profit; therefore, the target loss ratio is 100%. Subtracting one from the selected loss ratio produces the overall indicated change to the current advisory loss cost premium.

See Appendix D.

Question 17 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

(1) General Expenses	9.3%
(2) Other Acquisition Costs	6.8%
(3) Taxes, License and Fees	2.7%
(4) Commissions and Brokerage Fees	8.8%
(5) Target Profit Provision	1.7%
(6) Total Expense and Profit	29.3%
(7) Expense and Profit Adjustment	1.413
(8) Expected Loss Cost Difference	-6.0%
(9) Operational Adjustment	0.940
(10) Proposed Deviation	1.329
(11) Current Deviation	1.350
(12) Industry Deviation	8.2%
(13) Company Change	6.5%

(6) = (1) + (2) + (3) + (4) + (5)   (10) = (7) * (9)
(7) = 1.0 / [1.0 - (6)]
(9) = 1.0 + (8)
(13) = (10) / (11) * [1.0 + (12)] - 1.0

Interpreting the results. Row 8 is the expected difference in loss costs due to any known operational differences between the individual company and the industry. An overall average adjustment of -6% was selected to reflect an expectation of lower losses attributable to the company's more stringent underwriting and claims handling practices.

Row 10: Combines the adjustment for expenses and profit with the adjustment for operational differences, and represents the deviation factor that the company should apply to the industry advisory loss costs.

Row 11 (the current company deviation factor); Row 12 (the industry loss cost change).

See Appendix D.

Question 18 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

Accident Year	(1) Medical Fee Schedule Change	(2) Annual "Other Medical" Level Change	(3) Protion of Medical Losses Subject to Fee Schedules	(4) Combined Effect	(5) Factor to Adjust Medical Benefits to Projected Cost Level
2012	0.0%	2.2%	70.0%	0.7%	0.995
2013	0.0%	1.7%	70.0%	0.5%	0.990
2014	-15.0%	3.7%	65.0%	-8.5%	1.082
2015	0.0%	3.8%	65.0%	1.3%	1.067
2016	5.0%	3.6%	65.0%	4.5%	1.021
Projected	0.0%	6.1%	65.0%	2.1%	1.000

(1) Based on evaluations of the cost impact of changes to the Fee Schedule
(1 Proj) Selected
(2) Based on medical component of the Consumer Price Index
(2 Proj) Selected (3% annual trend)
(3) Selected Based on separate study
(4) = (1) * (3) + [(2) * (1 - (3)]
(5) = [1.0 + (4NextRow)] * (5NextRow)

Note: These factors are used in computing projected ultimate medical losses. See Appendix D.

Question 19 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

Year	(1) Projected Loss Cost Premium	(2) Reported Medical Losses	(3) Medical Loss Development Factor	(4) Factor to Adjust Medical Benefits to Projected Cost	(5) Projected Ultimate Medical Losses	(6) Expected Medical Loss Ratio
2012	$3,888,921,656	$1,862,884,241	1.343	0.995	$2,489,604,052	64.0%
2013	$4,039,795,024	$1,624,586,453	1.426	0.990	$2,294,295,718	56.8%
2014	$4,086,617,127	$1,341,387,071	1.564	1.082	$2,268,860,623	55.5%
2015	$4,212,122,582	$1,233,856,180	1.843	1.067	$2,427,333,777	57.6%
2016	$4,297,583,764	$812,155,751	2.795	1.021	$2,318,553,868	54.0%
Total	$20,525,040,153	$6,874,869,695			$11,798,648,038	57.5%

(1) From Premium Exhibit
(2) Input
(3) From Medical Sheet 1 (Development)
(4) From Medical Sheet 2 (Cost Change)
(5) = (2) * (3) * (4)
(6) = (5) / (1)

See Appendix D.

Question 20 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

Accident Year	(1) Industry Loss Cost Premium	(2) Annual Payroll Level Change	(3) Exposure Trend Factor to Current Wage Level	(4) Exposure Trend Expected Future Wage Level Change	(5) Factor to Adjust to Future Wage Level	(6) Historical Average Experience Modification	(7) Expected Average Experience Modification	(8) Projected Loss Cost Premium
2012	$3,250,810,701	2.2%	1.139	6.1%	1.208	0.987	0.950	$3,779,712,874
2013	$3,457,177,017	2.7%	1.109	6.1%	1.176	0.981	0.950	$3,937,916,001
2014	$3,611,917,078	3.4%	1.072	6.1%	1.138	0.977	0.950	$3,995,181,436
2015	$3,883,157,640	3.9%	1.032	6.1%	1.095	0.978	0.950	$4,129,751,491
2016	$3,996,217,983	3.2%	1.000	6.1%	1.061	0.953	0.950	$4,226,241,632
Total	$18,199,280,418							$20,068,803,435

(1) Industry loss costs at current rate level (assuming no company derivations and no provision for expense and profit)
(2) Determined in separate study
(3) = [1.0 + (2NextRow)] * (3NextRow)
(4) Based on 3% trend projected for 2 years
(5) = (3) * [1.0 + (4)]
(6) Determined in a separate analysis
(7) Selected
(8) = (1) * (5) * (7) / (6)

See Appendix D.

Exam 5 – Independently Authored Questions - Preparatory Test 5

General information about this exam

This practice test contains 20 questions consisting of computational and essay based questions.

	Essay Questions	Computational Questions	Total
Total Number of Qs:	3	17	20
Total Number of Points:	5	47.5	52.5

1. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.

2. Consider taking this exam after working all past CAS questions first.

3. Make sure you have a sufficient number of blank sheets of paper to record your answers for computational questions.

Articles covered on this exam:

Article .... Author ....

Chapter 15: Commercial Lines Rating Mech ....Modlin, Werner .... A. Basic Techniques for Ratemaking

Chapter 16: Claims Made Ratemaking ....Modlin, Werner .... A. Basic Techniques for Ratemaking

Appendix B: Homeowners indication ....Modlin, Werner .... A. Basic Techniques for Ratemaking

Appendix C: Medical Malpractice Indication..............Modlin, Werner .... A. Basic Techniques for Ratemaking

Exam 5 – Independently Authored Questions - Test 5

Question 1 (4.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions. Assume the following:

- The policy being experience rated is an occurrence policy with an annual term, and the effective date is 7/1/2010.
- The experience period consists of the last three completed policies effective 7/1 to 6/30 (i.e. annual policies originating in July 2006, 2007, and 2008), evaluated at 3/31/2010.
- Expected percentage of unreported losses at 3/31/2010 for the three years are 42.0%, 32% and 21.2%
- Losses are capped at basic limits, and ALAE are unlimited.
- A MSL is applied to the basic limits losses and unlimited ALAE combined.
- The Z of the company is 0.44.
- The expected experience ratio (EER) is 0.85
- Reported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL = $130,000
- Current company B/L Losses and ALAE = $74,000
- Loss trend equals 4.3%

a. (3 points). Compute the Expected Unreported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL

b. (1.5 points). Compute the experience modification.

Question 2 (4.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions regarding a WC experience rating plan..

- The effective date of the policy being rated is 9/1/2010
- The policy is comprised of only one class code.
- The 1st table below lists the actual losses from the last three complete policy years.
- The 2nd table shows payroll and expected loss costs rates for the prospective period.

Policy Year	Claim #	Reported Losses
9/1/06-07	1	$20,000
	2	$105,000
	3	$30,000
9/1/07-08	1	$45,000
	2	$50,000
	3	$7,500
9/1/08-09	1	$12,000
	2	$55,000
Total		$324,500

Policy Year	Payroll	Expected Loss Cost
9/1/06-07	$1,778,182	4.35
9/1/07-08	$1,934,545	3.48
9/1/08-09	$2,106,364	2.67
Total	$5,819,091	

- The D-ratio is 0.26
- B = $35,000 and w = 0.30

a. (3 points). Compute actual and expected primary losses, and actual and expected excess losses.

b. (1.5 points). Compute the experience modification.

Question 3 (1.5 points) According to Werner and Modlin in "Basic Ratemaking", briefly describe two purposes why schedule rating is used and provide an example which demonstrates these two purposes.

Question 4 (3.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions regarding composite rating.

- Bob's Rentals sells new and used equipment, operates a repair and service shop, and offers leases and rentals on equipment it owns.
- Bob's Rentals is large enough to meet ISO's Composite Rating Plan eligibility requirements for loss rating and desires coverage up to $1,000,000 per occurrence with $2,000,000 general aggregate.
- The last three years of reported losses and ALAE over all 3operations, separated into BI and PD is shown below. Amounts are capped at $250,000 per occurrence.
- The selected composite exposure base is total receipts.
- * Loss and ALAE annual trend (for bodily injury and property damage) is 5%.
  * Exposure annual trend rate is 3%.
  * Expected loss & ALAE ratio is 68%.
- Total receipts for the proposed policy period are estimated to be $152,000

Reported Loss and ALAE as of 12/31/2008

Policy Year	Incurred Loss and ALAE BI	PD
7/1/05-06	1,356,511	517,616
7/1/06-07	1,355,545	623,184
7/1/07-08	1,193,012	568,669
Total	3,905,068	1,709,469

Total Receipts
$122,387,756
$126,490,456
$131,443,738
$380,321,950

Development Factors

Age to Ultimate	Bodily Injury	Property Damage
42-Ult	1.50	1.23
30-Ult	1.75	1.38
18-Ult	1.95	1.53

a. (3.0 points). Compute the loss-rated composite rate for Bob's Rentals for its upcoming annual policy effective 7/1/2009.

b. (0.50 points). Compute the Deposit Premium for the proposed policy

Question 5 (3.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, compute the large deductible CGL policy premium.

Assume the following

* The deductible is $500,000 per occurrence.
* The insurer will handle all claims (including those that fall below the deductible)
* The deductible is not expected to reduce ALAE costs, which are estimated to be 12% of total losses.
* The deductible applies to losses only.
* Total ground-up losses without recognition of a deductible are estimated to be $1,000,000.
* Fixed expenses are assumed to be $50,000.
* Variable expenses are assumed to be 13% of premium.
* The insurer makes payments on all claims and seeks reimbursement for amounts below the deductible from the insured. The cost to process deductibles is 4% of the losses below the deductible.
* Deductible recoveries are not fully collateralized, and the credit risk is estimated to be 1% of the expected deductible payments.
* The desired UW profit for full-coverage (i.e. no deductible) premium is 2%.
* An additional risk margin of 10% of excess losses for policies with a deductible of $500,000 is charged.
* The % of total losses below the deductible (i.e. the LER) are summarized below.

Loss Elimination Ratios

Loss Limit	LER
$100,000	60%
$250,000	75%
$500,000	90%

Question 6 (3.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, compute the retrospective premium at first adjustment.

The 1st computation of the retrospective premium occurs 6 months after the end of the policy period

The policy is an annual policy and limited reported losses valued as of 18 months are $162,000.

(1) Minimum retrospective premium ratio (negotiated)	62.0%
(2) Maximum retrospective premium ratio (negotiated)	135.0%
(3) Loss Conversion Factor (negotiated)	1.10
(4) Per Accident Loss Limitation (negotiated)	$100,000
(5) Expense Allowance (excludes tax multiplier)	20%
(6) Expected Loss Ratio	65%
(7) Tax Multiplier	1.03
(8) Standard Premium	$769,231
(9) Insurance Charge for Maximum Premium	0.42
(10) Insurance Savings for Minimum Premium	0.03

Question 7 (1.5 points) According to Werner and Modlin in "Basic Ratemaking", briefly describe three elements provided by the basic premium in retrospective rating

Exam 5 – Independently Authored Questions - Test 5

Question 8 (2.0 points) According to Werner and Modlin in "Basic Ratemaking", briefly describe the five principles of claims-made ratemaking.

Question 9 (1.0 point) According to Werner and Modlin in "Basic Ratemaking", answer the following questions:

a. (.50 points). Using report year by lag notation, write an equation representing an annual occurrence policy written on January 1, 2012. Assume all claims are reported within 5 years of occurrence.

b. (.50 points). Using report year by lag notation, write an equation representing a mature claims made policy written on January 1, 2012. Assume all claims are reported within 5 years of occurrence.

Question 10 (3.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and the data below, answer the following questions:

Assume the following:

- Exposure levels are constant.
- The average loss cost for RY 2015 is $2,000.
- Loss costs increase by 6% each report year.
- Loss costs do not vary by report year lag. Any trends affecting settlement lag have been ignored.

a. (1.50 points). If an equal number of incurred claims are reported each year and all claims are reported within 5 years of occurrence, compute the cost of an annual occurrence policy written on January 1, 2016.

b. (1.50 points). If an equal number of incurred claims are reported each year and all claims are reported within 5 years of occurrence, compute the cost of a mature claims made policy written on January 1, 2016.

c. (1.50 points). If 5% of the claims are reported one year later than expected, but all claims are reported within five years, compute the cost of an annual occurrence policy written on January 1, 2016

Question 11 (2.5 points) According to Werner and Modlin in "Basic Ratemaking",

a. (0.50 points). Define the term retroactive date.

b. (2.0 points). Draw a report year by report year lag matrix for an insured switching from a mature CM policy to an occurrence policy in 2011. Assume all claims are reported within 5 years of occurrence. Use report year by report year lag notation to indicate what portion of the matrix:

   i. would be covered by the 2010 claims made policy,

   ii. would be covered by the continued purchase of occurrence policies beginning in 2011,

   iii. represents coverage for an extending reporting endorsement purchased by the insured after switching from a mature CM policy to an occurrence policy in 2011.

Question 12 (1.0 points) You have been asked to compute the annual fixed expense trend for a homeowners book of business.

Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the following data, compute the average annual fixed expense trend percentage for CY 2015.

(1) Employment Cost Index - Finance, Insurance & Real Estate, excluding Sales Opportunity - (annual change over latest 2 years) U.S. Department of Labor	3.8%
(2) % of Other Acquisition and General Expense used for Salaries and Employee Relations & Welfare - Insurance Expense Exhibit, 2015	50.0%
(3) Consumer Price Index, All Items - (annual change over latest 2 years)	2.2%

Question 13 (2.5 points) You have been asked to compute the projected fixed expense provision and the variable expense provision for a homeowners book of business, to be used directly in the pure premium indication formula for new rates in State XX effective 1/1/2017.

Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following questions:

	2015	Selected
(1) General		
Countrywide Expenses	$2,211,221	
% Assumed Fixed		75.0%
Countrywide Earned Exposures	52,752	
Countrywide Earned Premium	$49,059,360	
(2) Other Acquisition		
Countrywide Expenses	$2,647,322	
% Assumed Fixed		75.0%
Countrywide Written Exposures	53,015	
Countrywide Written Premium	$50,213,747	
(3) Taxes, Licenses and Fees		
Fixed Expense Per Exposure		$3.00
Variable Expense % [(f)/(g)]		1.40%
(4) Commission and Brokerage		
Fixed Expense Per Exposure		$0.00
Variable Expense %		10.20%

Compute:

a. The dollar amount of projected fixed expenses.

b. The variable expense provision %.

Question 14 (2.5 points) Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following question.

A reinsurance contract was purchased with an effective date of January 1, 2017 and a twelve-month term covering a Homeowners book of business.

- Expected Reinsurance Recoveries under the contract = $408,672
- Cost of Reinsurance (Expected Ceded Premium) = $613,248
- AY 2015 Earned Exposures = 12,911
- Expected Increase in Annual Exposures = 1.5%

Compute the Projected Net Reinsurance Cost Per Exposures

Question 15 (2.5 points) Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the data below, answer the following question:

You are an in-house actuary and are charged with computing the non-modeled catastrophe pure premium for your company's Homeowners book of business using the data below.

Calendar Year	Amount of Insurance Years ($000s)	Reported Cat Losses and Paid ALAE	Cat-to-AIY Ratio
1996	$1,592,745	$4,011	0.003
1997	$1,737,727	$23,851	0.014
1998	$1,918,827	$141,702	0.074
1999	$2,121,436	$35,172	0.017
2000	$2,267,800	$132,264	0.058
2001	$2,314,018	$206,471	0.089
2002	$2,392,245	$202,240	0.085
2003	$2,489,736	$757,560	0.304
2004	$2,598,391	$157,863	0.061
2005	$2,661,682	$2,426,190	0.912
2006	$2,669,491	$88,165	0.033
2007	$2,657,573	$233,412	0.088
2008	$2,645,909	$49,394	0.019
2009	$2,676,445	$432,295	0.162
2010	$2,651,309	$1,118	0.000
2011	$2,423,000	$63,908	0.026
2012	$2,519,920	$440,935	0.175
2013	$2,620,716	$26,386	0.010
2014	$2,725,545	$63,516	0.023
2015	$2,916,501	$162,000	0.056
(4) All-Year Arithmetic Average			0.110

- ULAE Factor 1.023
- Non-Modeled Cat Provision Per AIY 0.113
- Selected Average AIY Per Exposure $247.20

Compute the Non-Modeled Cat Pure Premium

Question 16 (2.5 points) You have been asked to compute the underwriting expense and ULAE ratio for a medical malpractice book of business, to be used directly in the pure premium indication formula for new rates, with a proposed effective date in State XX of 5/1/2016

Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following question.

	2013	2014	2015
(1) General Expenses			
a Countrywide Expenses			$32,039
b Countrywide Earned Premium			$498,269
(2) Other Acquisition			
a Countrywide Expenses			$13,730
b Countrywide Written Premium			$523,866
(3) Taxes, Licenses, and Fees			
a Countrywide Expenses			$11,114
b Countrywide Written Premium			$523,866
(4) Commission and Brokerage			
a Countrywide Expenses			$111,101
b Countrywide Written Premium			$523,866

The company has derived a ULAE ratio of 2.8%

Compute the Underwriting Expense and ULAE ratio

Question 17 (2.5 points) You have been asked to compute the severities and adjusted frequencies for a medical malpractice book of business, so that exponential trends can be fit to the severity and adjustment frequency data. Using the procedure described by Werner and Modlin in “Basic Ratemaking”, and given the data below, answer the following questions.

Accident Year	Selected Ultimate Loss & ALAE	Reported Claim Count	Reported Age-to-Ultimate Factor	Earned Premium	Current Rate Level Factor
2011	$10,181,756	59	1.0488	$13,176,857	1.2058
2012	$5,716,706	63	1.1953	$13,129,499	1.2724
2013	$16,597,848	52	1.4992	$13,486,005	1.3018
2014	$21,238,428	26	2.6041	$16,604,630	1.2390

a. Compute the ultimate severities for accident years 2011 – 2014

b. Compute the adjusted frequencies for accident years 2011 – 2014

Exam 5 – Independently Authored Questions - Test 5

Question 18 (2.5 points) You have been asked to compute the two year average ultimate Loss and ALAE ratio for a medical malpractice book of business, so that reported Bornhuetter-Ferguson method can be used to develop losses and ALAE to ultimate for the three most recent accident years (2012 – 2014)

Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the data below, answer the following question.

Accident Year	Earned Premium	Ultimate Loss and ALAE	Adjustment to Avg Rate Level in 2011	Selected BF Net Trend
2010	11,923,731	$9,727,917	0.9876	11.3%
2011	11,595,634	$9,333,276	1.0000	11.3%

Compute: The two year average ultimate Loss and ALAE ratio.

Question 19 (2.5 points) You have been asked to compute the B-F ultimate Loss and ALAE ratio for a medical malpractice book of business, for the three most recent accident years (2012 – 2014). Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the data below, answer the following question.

Accident Year	2- Year Avg Ultimate Loss and ALAE Ratio (2010-2011)	Earned Premium	Average Rate Level	Rate Level 2011	Selected BF Net Trend	Reported Age-to-Ult Factor	Reported Losses and ALAE a/o 9/30/15
2012	86.2%	11,553,959	0.9329	0.9876	11.3%	1.8690	$1,628,500
2013	86.2%	11,867,684	0.9115	0.9876	11.3%	3.9128	$3,228,250
2014	86.2%	14,612,074	0.9583	0.9876	11.3%	21.3756	$1,082,250

Compute: the B-F ultimate Loss and ALAE ratio for accident years 2012 - 2014

Question 20 (2.5 points) You have been asked to compute the indicated rate change for a medical malpractice book of business. Using the procedure described by Werner and Modlin in "Basic Ratemaking", and given the data below, answer the following questions:

Calendar Accident Year	Earned Premium	Current Rate Level Factor	Ultimate Loss and ALAE	Net Trend Factor
2010	$12,420,553	1.1969	$9,338,800	1.7842
2011	$12,078,786	1.1998	$8,959,945	1.6379
2012	$12,035,374	1.2664	$5,030,701	1.5035
2013	$12,362,171	1.2958	$14,606,107	1.3802
2014	$15,220,911	1.2330	$18,689,817	1.2669

- Expense and ULAE Ratio = 35.1%
- Profit and Contingency Provision = -5%
- Number of Reported Claims = 313
- Claims Required for Full Credibility Standard = 683
- Countrywide Indicated Rate Change = 20.3%

Compute the Credibility - Weighted Indicated Rate Change

Exam 5 – Solutions to Independently Authored Questions - Test 5

Question 1 discussion: Blooms: Application; Difficulty 3 LO 12 KS: Experience modification

a.

Calculation of Expected Unreported Losses and ALAE and Company Subject Loss Costs

(1) Policy Period	(2) Coverage	(3) Current Company B/L Loss & ALAE Costs	(4) Detrend Factors	(5) Company Subject B/L Loss & ALAE Costs	(6) Expected Experience Ratio	(7) Expected Percentage B/L Losses & ALAE Unreported at 3/31/2010	(8) Expected B/L Losses & ALAE Unreported at 3/31/2010
7/1/06-07	Prem/Ops+Prod	74,000.00	0.845	62,530.87	0.850	0.212	11,268.06
7/1/07-08	Prem/Ops+Prod	74,000.00	0.881	65,219.70	0.850	0.320	17,739.76
7/1/08-09	Prem/Ops+Prod	74,000.00	0.919	68,024.15	0.850	0.420	24,284.62
Total		222,000.00		195,774.72			53,292.44

(4)= 1.0/ [1.043]^No of years of trend; (5)= (3) x (4) (6),(7) = given (8)= (5) x (6) x (7)

b.

Experience Credit/Debit Calculation

(1)	Experience Components		
	(a)	Reported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL	130,000.00
	(b)	Expected Unreported Losses+ ALAE at 3/31/10 Limited by BL and MSL	53,292.44
	(c)	Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL	183,292.44
	(d)	Company Subject Basic Limit Loss and ALAE Costs	195,774.72
	(e)	Actual Experience Ratio	0.936
(2)		Expected Experience Ratio	0.850
(3)		Credibility	0.440
(4)		Experience (Credit)/Debit	4.5%

(1a)= Given (1b)=Table 2 (1c)=(1a) + (1b) (1d)=Table 2 (1e)= (1c)/(1d)
(2),(3)= Given (4)=[((1e) - (2)) / (2)] x (3)

See chapter 15

Question 2 discussion: Blooms: Application; Difficulty 3, LO 12 KS Layers of loss

a.

Policy Year	Claim #	(1) Reported Losses	(2) Primary Losses	(3) Excess Losses
9/1/06-07	1	$20,000	$5,000	$15,000
	2	$105,000	$5,000	$100,000
	3	$30,000	$5,000	$25,000
9/1/07-08	1	$45,000	$5,000	$40,000
	2	$50,000	$5,000	$45,000
	3	$7,500	$5,000	$2,500
9/1/08-09	1	$12,000	$5,000	$7,000
	2	$55,000	$5,000	$50,000
Total		$324,500	$40,000	$284,500

(2) = Minimum [(1), $5,000] (3) = (1) - (2)

See chapter 15

Question 2 discussion (continued):

	(1)	(2)	(3)	(4)	(5)	(6)
Policy Year	Payroll	Expected Loss Cost	Expected Losses	D-Ratio	Expected Primary Losses	Expected Excess Losses
9/1/06-07	$1,778,182	4.35	$77,350.91	0.26	$20,111.24	$57,239.67
9/1/07-08	$1,934,545	3.48	$67,322.18	0.26	$17,503.77	$49,818.41
9/1/08-09	$2,106,364	2.67	$56,239.91	0.26	$14,622.38	$41,617.53
Total	$5,819,091		$200,913.00		$52,237.38	$148,675.62

(3) = [(1) / $100] x (2)   (5) = (3) x (4)   (6) = (3) - (5)

$$M = \frac{A_P + w \times A_e + (1.0 - w) \times E_e + B}{E + B},$$

$$M = \frac{40,000 + [0.30 \times \$284,500] + [(1.0 - 0.30) \times \$148,675.62] + \$35,000}{\$52,237.38 + \$148,675.62 + \$35,000} = 1.121$$

The e-mod factor of 1.121 is applied multiplicatively to policy standard premium.

See chapter 15

Question 3 discussion: Blooms: Knowledge; Difficulty 1, LO 12 KS: Purpose of individual risk rating

Schedule Rating is used to modify the manual rate, in commercial lines pricing, to reflect characteristics that are:

1. expected to have a material effect on the insured's future loss experience but that are not actually reflected in the manual rate, or
2. not adequately reflected in the prior experience (if ER applies).

Example: If an insured implements a new loss control program, it is expected that losses will be lower than that indicated by the actual historical experience (hence an underwriter can use SR to reflect this).

See chapter 15

Question 4 discussion: Blooms: Application Difficulty 3, LO 12 KS: Composite loss-rated risks

a. Step 1: Develop trend factors to be applied to the loss and ALAE and the exposure base.

- The AAD of the proposed policy period is 12/31/2009, and the AAD of each policy year from the experience period is 12/31.
- Based on the assumed trend rates, the trend factors are calculated as follows:

Trend Factors

Policy Year	(1) Trend Period	(2) Annual Loss & ALAE Trend	(3) Loss & ALAE Trend Factor	(4) Annual Exposure Trend	(5) Exposure Trend Factor
7/1/05-06	4	5.00%	1.2155	3.00%	1.1255
7/1/06-07	3	5.00%	1.1576	3.00%	1.0927
7/1/07-08	2	5.00%	1.1025	3.00%	1.0609

(3) =[1.0 + (2)]^(1) (5) =[1.0+ (4)]^(1)

a. Step 2: Estimate the trended ultimate loss and ALAE.

Trended Ultimate Loss & ALAE

Policy Year	(1) Incurred Loss and ALAE BI	(2) Incurred Loss and ALAE PD	(3) Development Factors BI	(4) Development Factors PD	(5) Loss & ALAE Trend Factor	(6) Trended Ultimate Loss & ALAE
7/1/05-06	1,356,511	517,616	1.50	1.23	1.2155	3,247,145
7/1/06-07	1,355,545	623,184	1.75	1.38	1.1576	3,741,673
7/1/07-08	1,193,012	568,669	1.95	1.53	1.1025	3,524,072
Total	3,905,068	1,709,469				10,512,890

(6) = [(1) x (3) + (2) x (4)] x (5)

a. Step 3: Compute trended composite exposures.

Policy Year	(1) Total Receipts ($000's)	(2) Exposure Trend Factor	(3) = (1) x (2) Trended Exposure
7/1/05-06	122,388	1.1255	137,748
7/1/06-07	126,490	1.0927	138,220
7/1/07-08	131,444	1.0609	139,449
Total	380,322		415,417

a. Step 4: Compute the composite rate:

(1) Trended Ultimate Loss & ALAE	$10,512,890
(2) Expected Loss & ALAE Ratio	68.0%
(3) Adjusted Premium	$15,460,132
(4) Trended Composite Exposure	$415,417
(5) Composite Rate	$37.22

(3) = (1) / (2) (5) = (3) / (4)

b. Compute the Deposit premium:

Assuming total receipts for the proposed policy period are estimated to be $152,000, then the deposit premium is $$5,656,826.11 (= $152,000 x 37.22).

See chapter 15

Question 5 discussion: Blooms: Application Difficulty 2, LO 12 KS: Formulae

The formula for the large deductible policy premium is

$$Premium = \frac{Losses\ above\ Deductible + ALAE + Fixed\ Expense + Credit\ Risk + Risk\ Margin}{(1.0 - Variable\ Expense\ Provision - Profit\ Provision)}$$

Step 1: Estimate losses above the $500,000 deductible.

(1) Expected total ground-up losses	$1,000,000
(2) Excess ratio = [1.0 - .90 (500K LER)]	10%
(3) Estimated losses above deductible (1) x (2)	$ 100,000

Step 2: Compute the premium as follows:

(1) Estimated Losses Above the Deductible	$100,000
(2) ALAE	$120,000
(3) Fixed Expenses	
(a) Standard	$50,000
(b) Deductible Processing	$36,000
(4) Credit Risk	$9,000
(5) Risk Margin	$10,000
(6) Variable Expenses and Profit (.13+.02)	15%
(7) Premium	$382,353

(1) = prior table; (2) = 12% x $1,000,000 (3a) = Provided (3b) = 4% x $1,000,000 x .90 (LER at 500K)
(4) = 1% x $1,000,000 x .90 (LER at 500K) (5) = 10% x (1)
(7) = [(1) + (2) + (3a) + (3b) + (4) + (5)] / [1.0 - (6)]
See chapter 15

Question 6 discussion: Blooms: Application; Difficulty 3, LO 12 KS: Retrospective rating

The basic formula for retrospective premium is as follows:

Retro Premium = [Basic Premium + Converted Losses] x Tax Multiplier, where the retro premium is subject to a maximum and minimum.

Basic Premium = [Expense Allowance - Expense Provided Through LCF + Net Ins Charge] x Standard Premium

LCF = Loss Conversion Factor

Expense Provided Through LCF = Expected Loss Ratio x (LCF -1.0)

Net Insurance Charge = [Insurance Charge - Insurance Savings] x Expected Loss Ratio x LCF.

Converted Losses: Converted Losses = Reported Losses x LCF.

Minimum/Maximum Retrospective Premium

Minimum Retro Premium = Standard Premium x Minimum Retro Premium Ratio.

Maximum Retro Premium= Standard Premium x Maximum Retro Premium Ratio.

(11) Basic Premium	$318,346
(12) Converted Losses	$178,200
(13) Preliminary Retrospective Premium	$511,443
(14) Minimum Retrospective Premium	$476,923
(15) Maximum Retrospective Premium	$1,038,462
(16) Retrospective Premium	**$511,443**

(11) = [(5)-(6) x [(3)-1.0]+[(9)-(10)] x (6) x (3)] x (8)

(12) = $162,000 x (3)

(13) = [(11)+(12)] x (7)

(14) = (1) x (8)

(15) = (2) x (8)

(16) = Min [Max[(13),(14)] , (15)]

See chapter 15

Question 7 discussion: Blooms: Knowledge; Difficulty 1, LO 4 KS: Organization of data: calendar year, policy year, accident year

The Basic Premium provides for:

1. The insurer's target UW profit and expenses (excluding expenses provided for by the LCF and the tax multiplier), and
2. The cost of limiting the retrospective premium (to be between the minimum and maximum premium negotiated under the policy), and
3. The cost of limiting each occurrence to a negotiated loss limitation (if applicable). See chapter 15

Question 8 discussion: Blooms: Knowledge; Difficulty 1, LO 4 KS: Claims made coverage: report lag, coverage triggers, principles of claims-made policies, retroactive date, tail coverage

1. A claims-made policy should always cost less than an occurrence policy as long as claim costs are increasing.
2. If there is a sudden, unexpected change in the underlying trends, a claims-made policy priced based on the prior trend will be closer to the correct price than an occurrence policy based on the prior trend.
3. If there is a sudden, unexpected shift in the reporting pattern, the cost of a mature claims-made policy (i.e. a policy that covers claims reported during the policy period regardless of accident date) will be affected relatively little, if at all, relative to the occurrence policy.
4. Claims-made policies incur no liability for IBNR, so the risk of reserve inadequacy is greatly reduced.
5. Investment income earned from claims-made policies is substantially less than under occurrence policies.

See chapter 16

Question 9 discussion: Blooms: Comprehension; Difficulty 1, LO 4 KS: Claims made coverage: report lag, coverage triggers, principles of claims-made policies, retroactive date, tail coverage

a. Occurrence policies cover claims that occur during the policy period regardless of when the claim is reported, and are aggregated by accident year (i.e. ***each diagonal*** in the table). Example:

- An annual occurrence policy written on 1/1/2012 covers claims incurred during the policy period and reported either during or after the policy period.
- This policy covers claims reported in 2012 with no report lag, claims reported in 2013 with a one-year report lag, claims reported in 2014 with a two-year report lag, etc.

Thus, Occurrence Policy (2012) = L(2012,0)+ L(2013,1)+ L(2014,2)+ L(2015,3)+ L(2016,4).

b. The coverage trigger for a CM policy is the report date. A CM policy is represented by the entries in a ***row***.

A CM policy written on 1/1/2012 covers all claims reported in 2012 (regardless of the report lag):

CM Policy (2012) = L(2012,0)+ L(2012,1)+ L(2012,2)+ L(2010,3)+ L(2012,4).

See chapter 16

Question 10 discussion: Blooms: Application; Difficulty 3, LO 4 KS: Claims made coverage: report lag, coverage triggers, principles of claims-made policies, retroactive date, tail coverage

a. and b.

Report Year	Loss Costs by Report Year Lag 0	1	2	3	4	**Claims Made Loss Costs**
2015	$400.00	$400.00	$400.00	$400.00	$400.00	$2,000.00
2016	$420.00	$420.00	$420.00	$420.00	$420.00	**$2,100.00**
2017	$441.00	$441.00	$441.00	$441.00	$441.00	$2,205.00
2018	$463.05	$463.05	$463.05	$463.05	$463.05	$2,315.25
2019	$486.20	$486.20	$486.20	$486.20	$486.20	$2,431.01
2020	$510.51	$510.51	$510.51	$510.51	$510.51	$2,552.56
2021	$536.04	$536.04	$536.04	$536.04	$536.04	$2,680.19
2022	$562.84	$562.84	$562.84	$562.84	$562.84	$2,814.20
2023	$590.98	$590.98	$590.98	$590.98	$590.98	$2,954.91

Accident Year	**Occurrence Loss Costs**	Using Loss Costs by Report Year Lag from above
2015	$2,210.25	=400 + 420 + 441 + 463.05 + 486.20
2016	**$2,320.77**	=420 + 441 + 463.05 + 486.20 + 510.51
2017	$2,436.80	
2018	$2,558.64	
2019	$2,686.58	

Question 10 discussion (continued):

c.

Report Year	Loss Costs by Report Year Lag 0	1	2	3	4	Claims Made Loss Costs
2015	**$300.00**	$400.00	$400.00	$400.00	**$500.00**	$2,000.00
2016	**$315.00**	$420.00	$420.00	$420.00	**$525.00**	**$2,100.00**
2017	$330.75	$441.00	$441.00	$441.00	$551.25	$2,205.00
2018	$347.29	$463.05	$463.05	$463.05	$578.81	$2,315.25
2019	$364.65	$486.20	$486.20	$486.20	$607.75	$2,431.01
2020	$382.88	$510.51	$510.51	$510.51	$638.14	$2,552.56
2021	$402.03	$536.04	$536.04	$536.04	$670.05	$2,680.19
2022	$422.13	$562.84	$562.84	$562.84	$703.55	$2,814.20
2023	$443.24	$590.98	$590.98	$590.98	$738.73	$2,954.91

Accident Year	Occurrence Loss Costs	Using Loss Costs by Report Year Lag from above
2015	$2,231.80	=300 + 420 + 441 + 463.05 + 607.75
2016	**$2,343.39**	=315.00 + 441 + 463.05 + 486.20 + 638.14
2017	$2,460.56	
2018	$2,583.59	
2019	$2,712.77	

"If there is a sudden, unexpected shift in the reporting pattern, the cost of a **mature** CM policy will be affected relatively little, if at all, relative to the occurrence policy."

Example: Assume that 5% of the claims are reported one year later than expected, but all claims are reported within five years (e.g. in 2010, $100 of the loss cost shifts from lag 0 to lag 1, $100 of the loss costs from lag 1 shift to lag 2, and so on).

Since an equal amount of loss costs are shifting in and out of lag periods 1, 2, and 3, the only impact is on the **first** and **last** lag periods.

Conclusions:

- There is no impact on the loss cost estimates for the CM policies
- Estimates for the occurrence policies have changed (e.g. for AY 2016 loss cost estimate for the occurrence policies has changed by .0097 (= ($2,343.39 / $2,320.67) – 1.0).

See chapter 16

Question 11 discussion: Blooms: Application; Difficulty 2, LO 4 KS: Claims made coverage: report lag, coverage triggers, principles of claims-made policies, retroactive date, tail coverage

a. A retroactive date is the date associated with a claims-made policy for which coverage is provided for claims occurring on or after the retroactive date.

To obtain complete coverage without overlap, the retroactive date should coordinate with the expiration of the last occurrence policy.

b. Insurers offer an extended reporting endorsement (or tail coverage) that covers claims that occurred but were not reported before the expiration of the last CM policy.

Switching from Claims-Made to Occurrence Policy with Tail Coverage

		Report Year Lag				
		0	1	2	3	4
Report Year	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,3)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

CM = within dotted rectangle ***Tail Coverage = within the dotted triangle***

Occurrence Policy Coverage = shaded

See chapter 16

Question 12 discussion: Blooms: Application; Difficulty 3, LO 3 KS: Organization of data: calendar year, policy year, accident year

(4) Annual Expense Trend = [(1) * (2)] + [(3) * { 100% - (2) }]= [.038 * .50] + [.022 * { 100% - .50 } = 3.0%

See Appendix B:

Question 13 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

		2015		Selected
(1) General				
a Countrywide Expenses		$2,211,221		
b % Assumed Fixed				75.0%
c Fixed Expense $ [(a)*(b)]		$1,658,416		
d Countrywide Earned Exposures		$52,752		
e Fixed Expense Per Exposure [(c)/(d)]		$31.44	$31.44	$31.44
f Variable Expense % [(a)*(1.0-(b))]		$552,805		
g Countrywide Earned Premium		$49,059,360		
h Variable Expense % [(f)/(g)]		1.1%	1.1%	1.1%
(2) Other Acquisition				
a Countrywide Expenses		$2,647,322		
b % Assumed Fixed				75.0%
c Fixed Expense $ [(a)*(b)]		$1,985,491		
d Countrywide Written Exposures		$53,015		
e Fixed Expense Per Exposure [(c)/(d)]		$37.45	$37.45	$37.45
f Variable Expense % [(a)*(1.0-(b))]		$661,830		
g Countrywide Written Premium		$50,213,747		
h Variable Expense % [(f)/(g)]		1.3%	1.3%	1.3%
(3) Taxes, Licenses and Fees				
a. Fixed Expense Per Exposure				$3.00
b.Variable Expense % [(f)/(g)]				1.40%
(4) Commission and Brokerage				
a. Fixed Expense Per Exposure				$0
b. Variable Expense %				10.20%
(5) Total Fixed Expenses	(1e) + (2e) + (3a) + (4a)			$71.89
(6) Fixed Expense Trend				3.75%
(7) Trend Period	From 07/01/2015 to 07/01/2017			2
(8) Fixed Expense Trend Factor	[1.0 + (6)]^ (7)			1.076
(9) Projected Fixed Expense	(5) * (8)			77.38
(10) Variable Expense Provision	(1h) + (2h) + (3h) + (4h)			14.0%

See Appendix B:

Question 14 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Extension of exposures

(1) Expected Reinsurance Recoveries	$408,672
(2) Cost of Reinsurance (Expected Ceded Premium)	$613,248
(3) Net Cost of Reinsurance	$204,576
(4) Latest Year Exposures	12,911
(5) Expected Annual Exposure Increase	1.5%
(6) Projection Period	2.0
(7) Projected Exposures	13,301
(8) Projected Net Reinsurance Cost Per Exposure	$15.38

(3) = (2) - (1)
(6) From Midpoint of Latest Year to Midpoint of Reinsurance
Contract [(07/01/2015) to (07/01/2017)]
(7) = (4) * [1.00 + (5)] ^ (6)
(8) = (3) / (7)

See Appendix B:

Question 15 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

	(4) All-Year Arithmetic Average	0.110
(5) From ULAE Ratio Exhibit	(5) ULAE Factor	1.023
(6) = (4) * (5)	(6) Non-Modeled Cat Provision Per AIY	0.113
(7) From AIY Projection Exhibit	(7) Selected Average AIY Per Exposure	$247.20
(8) = (6) * (7)	(8) Non-Modeled Cat Pure Premium	$27.91

See Appendix B:

Question 16 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Organization of data: calendar year, policy year, accident year

	2013	2014	2015	Selected
(1) General Expenses				
a Countrywide Expenses			$32,039	
b Countrywide Earned Premium			$498,269	
c Ratio [(a)/(b)]			6.4%	6.4%
(2) Other Acquisition				
a Countrywide Expenses			$13,730	
b Countrywide Written Premium			$523,866	
c Ratio [(a)/(b)]			2.6%	2.6%
(3) Taxes, Licenses, and Fees				
a Countrywide Expenses			$11,114	
b Countrywide Written Premium			$523,866	
c Ratio [(a)/(b)]			2.1%	2.1%
(4) Commission and Brokerage				
a Countrywide Expenses			$111,101	
b Countrywide Written Premium			$523,866	
c Ratio [(a)/(b)]			21.2%	21.2%
(5) UW Expense Ratio	(1c) + (2c) + (3c) + (4c)			32.4%
(6) ULAE Ratio				2.8%
(7) UW Expense and ULAE Ratio	(5) + (6)			35.1%

See Appendix C.

Question 17 discussion: Blooms: Application; Difficulty 2, LO 10 KS: Rating algorithms

Accident Year	(1) Selected Ultimate Loss & ALAE	(2) Reported Claim Count	(3) Reported Age-to-Ultimate Factor	(4) Developed Claim Count	(5) Severity	(6) Earned Premium	(7) Current Rate Level Factor	(8) Earned Premium at Current Rate Level	(9) Adjusted Frequency
2011	$10,181,756	59	1.0488	62	$164,546	$13,176,857	1.2058	$15,888,176	3.89
2012	$5,716,706	63	1.1953	75	$75,917	$13,129,499	1.2724	$16,706,042	4.51
2013	$16,597,848	52	1.4992	78	$212,912	$13,486,005	1.3018	$17,556,618	4.44
2014	$21,238,428	26	2.6041	68	$313,683	$16,604,630	1.2390	$20,573,637	3.29

(4) = (2) * (3)
(5) = (1) / (4)
(8) = (6) * (7)
(9) = [(4) / (8)] * 1,000,000

See Appendix C.

Question 18 discussion: Blooms: Application; Difficulty 3, LO 10 KS: Rating algorithms

Accident Year	(1) Earned Premium	(2) Ultimate Loss and ALAE	(3) Ultimate Loss and ALAE Ratio	(4) Adjustment to Avg Rate Level in 2011	(5) Selected BF Net Trend	(6) Trend Length	(7) Net Trend Adjustment to 2011	(8) Ultimate Loss and ALAE Ratio as of 2011
2010	11,923,731	9,727,917	81.6%	0.9876	11.3%	1.00	1.1130	91.9%
2011	11,595,634	9,333,276	80.5%	1.0000	11.3%	0.00	1.0000	80.5%

(3) = (2) / (1)
(6) From 07/01/20XX to 07/01/2011
(7) = [1 + (5)] ^ (6)
(8) = (3) / (4) * (7)
(9) Straight Average of (8)

(9) 2- Year Avg Ultimate Loss and ALAE Ratio (2010-2011) **86.2%**

See Appendix C.

Question 19 discussion: Blooms: Application; Difficulty 2, LO 10 KS: Rating algorithms

Accident Year	(1) 2- Year Avg Ultimate Loss and ALAE Ratio (2010-2011)	(2) Earned Premium	(3) Average Rate Level	(4) Rate Level 2011	(5) Average Rate Level Adjustment	(6) Selected BF Net Trend	(7) Trend Length from 2011	(8) Net Trend Adjustment
2012	86.2%	11,553,959	0.9329	0.9876	0.9446	11.3%	1.00	1.1130
2013	86.2%	11,867,684	0.9115	0.9876	0.9229	11.3%	2.00	1.2388
2014	86.2%	14,612,074	0.9583	0.9876	0.9703	11.3%	3.00	1.3787

(5) = (3) / (4)
(8) = [1.0 + (6)] ^ (7)

(9) Expected Losses and ALAE Ratio	(10) Expected Losses and ALAE	(11) Reported Age-to-Ult Factor	(12) Percent Unreported	(13) Reported Losses and ALAE a/o 9/30/15	(14) Expected Losses and ALAE Not Yet Reported a/o 9/30/15	(15) B-F Ultimate Losses and ALAE
101.6%	11,735,508	1.8690	46.5%	$1,628,500	$5,456,348	$7,084,848
115.7%	13,730,899	3.9128	74.4%	$3,228,250	$10,221,716	$13,449,966
122.5%	17,896,871	21.3756	95.3%	$1,082,250	$17,059,615	$18,141,865

(9) = (1) / (5) * (8)
(10) = (2) * (9)
(12) = 1 - 1 / (11)
(14) = (10) * (12)
(15) = (13) + (14)

See Appendix C.

Question 20 discussion: Blooms: Application; Difficulty 2, LO 3 KS: Effect of rate changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Calendar Accident Year	Earned Premium	Current Rate Level Factor	Earned Premium @ CRL	Ultimate Loss and ALAE	Net Trend Factor	Projected Ultimate Loss and ALAE	Projected Ultimate Loss and ALAE Ratio
2010	$12,420,553	1.1969	$14,866,160	$9,338,800	1.7842	$16,662,243	112.1%
2011	$12,078,786	1.1998	$14,491,689	$8,959,945	1.6379	$14,675,397	101.3%
2012	$12,035,374	1.2664	$15,241,660	$5,030,701	1.5035	$7,563,861	49.6%
2013	$12,362,171	1.2958	$16,019,393	$14,606,107	1.3802	$20,158,923	125.8%
2014	$15,220,911	1.2330	$18,767,842	$18,689,817	1.2669	$23,677,834	126.2%
Total	$64,117,795		$79,386,744	$56,625,370		$82,738,259	104.2%

(3) = (1)*(2)	(8) Selected Loss and ALAE Ratio	104.2%
(6) = (4)*(5)	(9) Expense and ULAE Ratio	35.1%
(7) = (6)/(3)	(10) Profit and Contingency Provision	-5.0%
(11) = 100% - (9) - (10)	(11) Permissible Loss Ratio	69.9%
(12)= [(8)/ (11)] - 1.0	(12) Statewide Indicated Rate Change	49.1%
	(13) Number of Reported Claims	313
	(14) Claims Required for Full Credibility Standard	683
(15) = Min { [(13) / (14)] ^ 0.5, 1.0 }	(15) Credibility	67.7%
	(16) Countrywide Indicated Rate Change	20.3%
(17) = (12) * (15) + (16) * [1.0 - (15)]	(17) Credibility - Weighted Indicated Rate Change	39.8%
	(18) Selected Rate Change	39.8%

See Appendix C.

ALL 10, Inc.

Comprehensive Study Materials and Internet-Based Training

Actuarial Notes for the Spring 2014 CAS Exam 5B

Estimating Claim Liabilities

Volume 3

Independently Authored and Modified Past CAS Multiple Choice Questions Tests

and

Independently Authored Preparatory Tests Computational and Essay Based Questions

Exam 5B – Independently Authored and Modified Past CAS MC Questions
Preparatory Test 1

General information about this exam

1. This test contains 21 multiple choice questions.

2. The recommend time for this exam is 40 min.

3. Consider taking this exam after working all past CAS questions first.

Articles covered on exam:

Article .... Author ....Syllabus Section

Chapter 1 – Overview .... Friedland ....B: Estimating Claim Liabilities
Chapter 2 – The Claims Process .... Friedland ....B: Estimating Claim Liabilities
Chapter 3 – Understanding the Types of Data Used .... Friedland ....B: Estimating Claim Liabilities
Chapter 7 – Development Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 8 – Expected Claims Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 9 – Bornhuetter-Ferguson Technique .... Friedland ....B: Estimating Claim Liabilities

Statement of Principles: Loss and LAE Reserves .... CAS ....B: Estimating Claim Liabilities
ASOP No. 9 – Documentation and Disclosure .... AAA ....B: Estimating Claim Liabilities

Exam 5B – Independently Authored and Modified
Past CAS MC Questions - Test 1

Question 1

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. A loss liability's valuation date can be before, after or the same as its accounting date.
2. The accounting date is the date that defines the group of claims for which liability may exist
3. For claims-made policies, the accident date may not be defined as the date the claim was reported.

A. 1 B. 1, 2 C. 1, 2, 3 D. 2, 3 E. None of the given answer choices

Question 2

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. An insured loss that occurred on 1/5/2009, for a policy written on 12/31/2008, would be included in the unpaid claim estimate for the accounting date 12/31/2008.
2. The valuation date is used to define the group of claims to be included in the liability estimate.
3. The valuation date does not depend on when the actuary does his/her analysis.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 3

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. The carried reserve is the result of the application of a particular estimation technique.
2. The unpaid claim for unpaid claims is the amount reported in a published statement or in an internal statement of financial condition.
3. The unpaid claims estimate includes four components: case outstanding on known claims, provision for future development on known claims, estimate for reopened claims, and provision for claims incurred but not reported.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. None of the given answer choices

Question 4

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the types of work an independent adjuster (IA) is hired to handle?

1. To handle an individual claim or a group of claims.
2. The book of claims from small to mid-sized commercial insurers and self-insurers.
3. A specific type of claim or a claim in a particular region where the insurer does not have the necessary expertise.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. 1, 2, 3

Question 5

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following is/are NOT approaches used by insurers to set case outstanding?

1. Establish case outstanding for ALAE (or DCC) only and other insurers for ULAE (or A&O) only.
2. Set the case outstanding using the advice of legal counsel.
3. Set the case outstanding based on the maximum value, which would be the policy limit.
4. Establish the case outstanding based on the best estimate of the ultimate settlement value of the claim including consideration of future inflationary forces.

A. 1 B. 2 C. 3 D. 4 E. All are approaches used by insurers.

Question 6

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. Some of the key assumptions of the expected claims method include consistent claim processing and a stable mix of types of claims.
2. Using the development technique, unpaid claim estimate equal the difference between projected ultimate claims and actual reported claims.
3. Reporting patterns are derived from the cumulative paid claim development factors.

A. 2 B. 2, 3 C. 1, 2, 3` D. 1, 3 E. None of the given answer choices

Question 7

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. Reporting patterns can be used in monitoring the development of claims during the year as well as for present value (i.e., discounting) calculations.
2. The development technique is used for high-frequency, low-severity lines with stable and timely reporting of claims throughout the accident year.
3. When using reported claims and the loss development technique, it is assumed that there have been no significant changes during the experience period in the speed of claims closure and payment.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 8

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to impact of changing conditions on the U.S. PP Auto Insurance example (steady state)?

1. In the case of increasing claim ratios (and no case reserve strengthening), the paid development method produces an IBNR estimate greater than the IBNR estimate produced under the reported development method.
2. In the case of increasing case outstanding (and stable claim ratios), the paid development method produces an IBNR estimate smaller that the IBNR estimate produced under the reported development method, but greater than the actual IBNR estimate.
3. Without adjustment, the reported claim development method understates the projected ultimate claims and thus the IBNR in times of increasing case outstanding strength.

A. 1 B. 1, 2 C. 2 D. 2, 3 E. None of the given answer choices

Question 9

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to impact of changing conditions on the U.S. PP Auto Insurance example (steady state)?

1. In the case of increasing claim ratios and case reserve strengthening, the paid development method produces an IBNR estimate greater than the IBNR estimate produced under the reported development method.
2. In the case of increasing claim ratios and case reserve strengthening, the reported development method produces an IBNR estimate greater than the actual IBNR estimate.
3. In the case of increasing claim ratios and case reserve strengthening, the reported development method produces an IBNR estimate greater than the IBNR estimate produced under the increasing case outstanding (and stable claim ratios) scenario

A. 2　B. 2, 3　C. 1, 2, 3　D. 1, 3　E. None of the given answer choices

Question 10

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true regarding the use of the expected claims method?

1. It is often used when there is stable reinsurance retention limits throughout the experience period.
2. It is often used when there is a stable mix of types of claims and policy limits.
3. It is often used when an insurer enters a new line of business or a new territory.

A. 3　B. 2, 3　C. 1, 2, 3　D. 1, 3　E. None of the given answer choices

Question 11

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true under the Bornhuetter-Ferguson technique?

1. Ultimate Claims = Actual Reported Claims + (Expected Claims) x (% Unreported)
2. Ultimate Claims = Actual Paid Claims + (Expected Claims) x (% Unpaid)
3. Ultimate Claims = Actual Paid Claims + Expected Unreported Claims

A. 2　B. 1, 2　C. 3　D. 1, 3　E. None of the given answer choices

Question 12

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. The expected loss method ignores actual results.
2. For the reported BF technique, the estimated IBNR is identical under both the steady state situation and in the increasing claim ratios scenario.
3. The loss development method yields the correct answer in an increasing claim ratio situation but is vulnerable to distortion from case outstanding strengthening.

A. 2　B. 1, 2　C. 3　D. 1, 3　E. None of the given answer choices

Question 13

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. When claim ratios are increasing and there is no reserve strengthening, the expected loss method produces a lower IBNR estimate than that produced in the steady-state situation.
2. When claim ratios are stable, but there is increasing case outstanding strengthening, the expected loss method produces the same IBNR estimate than that produced in the steady-state situation.
3. When claim ratios are increasing and there is reserve strengthening, the loss development method produces an IBNR estimate which is overstated.

A. 3　B. 3　C. 1, 2, 3　D. 1, 3　E. None of the given answer choices

Question 14

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true when analyzing traditional loss development triangles?

1. The volume (or scale) of the accident year cohort changes horizontally from one accident year to the next.
2. The value of cumulative paid claims for an accident year changes vertically from age to age.
3. Loss development can be negative

A. 3　B. 3　C. 1, 2, 3　D. 1, 3　E. None of the given answer choices

Question 15

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. Actuaries often rely on report year development triangles for the analysis of claims-made coverages such as U.S. medical malpractice and errors and omissions liability.
2. Reinsurers often organize claims data by accident year.
3. For self-insurers, the policy year, fiscal year, and accident year are often the same.

A. 3　B. 3　C. 1, 2, 3　D. 1, 3　E. None of the given answer choices

Question 16

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. The Benktander technique is significantly more responsive to changes in the underlying claim ratio but is less responsive to changes in the case outstanding adequacy.
2. The Benktander technique is also less responsive to changes in the product mix than the Bornhuetter-Ferguson technique.
3. Thus, where there are no changes in the underlying claim development patterns, we expect the Benktander method to be more responsive than the Bornhuetter-Ferguson method.

A. 1　B. 2　C. 1, 2　D. 1, 2, 3　E. None of the given answer choices

Question 17

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. The Benktander method is a credibility mixture of Bornhuetter-Ferguson and Expected Claims techniques
2. The Benktander method is often considered an iterative Bornhuetter-Ferguson method.
3. In the Benktander technique, the expected claims are the projected ultimate claims from an initial Bornhuetter-Ferguson projection.

A. 1 B. 2 C. 1, 2 D. 1, 2, 3 E. None of the given answer choices

Question 18

According to "ASOP No. 9, Documentation and Disclosure", which of the following are true?

1. A required actuarial document is an actuarial communication which the formal content is prescribed by law or regulation.
2. The term "actuarial work product" applies only to written actuarial communications.
3. A Statement of Actuarial Opinion is a formal statement of the actuary's professional opinion on a defined subject. It outlines the scope of the work but normally does not include descriptive details.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. None of the given answer choices

Question 19

According to "ASOP No. 9, Documentation and Disclosure", which of the following are true?

1. If someone other than an actuary conveys information prepared by the actuary to indirect users of the work product, the actuary should take steps to rectify misquotation, misinterpretation, or other misuse of the work product by indirect users.
2. If aware of any significant conflict between the interests of indirect users and the interests of the client or employer, the actuary should advise the client or employer of the conflict and should include appropriate qualifications or disclosures in any related actuarial communication.
3. Ownership of documentation is normally established by client or employer.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. 1, 2, 3

Question 20

According to "Statement of Principles Regarding Property and Casualty Loss and LAE Reserves," which of the following are true?

1. Line and coverage definitions suitable for the establishment of reserves for large insurers can be in much finer detail than in the case of small insurers.
2. It may be necessary to augment claims-made statistics with appropriate report period statistics generated under occurrence programs.
3. If reserves are established in less detail than necessary for reporting requirements, procedures for properly assigning the reserves to required categories must be developed.

A. 1, 2 B. 2, 3 C. 1, 2, 3 D. 1, 3, E. None of the given answer choices

Question 21

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. An inadequate estimate of unpaid claims could drive an insurer to raise its rates unnecessarily, resulting in a loss of market share and a loss of premium revenue to the insurer.
2. Unpaid claims estimates impact financial decision-making such as capital management.
3. An inaccurate estimate can have a negative impact on the insurer's decisions regarding its reinsurance needs and claims management procedures and policies.

A. 1　　B. 1, 2　　C. 1, 2, 3　　D. 2, 3　　E. None of the given answer choices

Solutions to Exam 5B – Independently Authored and Modified Past CAS MC Questions - Test 1

Question 1 discussion:

1. True. See chapter 3
2. True. See chapter 3
3. False. See chapter 3

Answer B: 1, 2

Question 2 discussion:

1. False. See chapter 3
2. False. The accounting date is used to define the group of claims to be included in the liability estimate. See chapter 3
3. True. See Chapter 3

Answer E: None of the given answer choices.

Question 3 discussion:

1. False. The unpaid claim estimate is the result of the application of a particular estimation technique. See chapter 1
2. False. The carried reserve for unpaid claims is the amount reported in a published statement or in an internal statement of financial condition. See chapter 1
3. False. The unpaid claims estimate includes five components: case outstanding on known claims, provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and provision for claims in transit (i.e., claims reported but not recorded). See chapter 1

Answer E: None of the given answer choices

Question 4 discussion:

1. True. See chapter 2.
2. False. This is typically handled by a third party administrator. See chapter 2.
3. True. See chapter 2.

Answer: B

Question 5 discussion:

1. False. This is a common approach used by insurers. See chapter 2
2. False. This is a common approach used by insurers. See chapter 2
3. False. This is a common approach used by insurers. See chapter 2
4. False. This is a common approach used by insurers. See chapter 2

Answer: E

Question 6 discussion:

1. False. This statement is true of the development method. See chapter 7
2. False. Using the development technique, unpaid claim estimate equal the difference between projected ultimate claims and actual **paid** claims. See chapter 7
3. False. Reporting patterns are derived from the cumulative reported claim development factors. See chapter 7

Answer: None of the given answer choices

Question 7 discussion:

1. False. Payment patterns can be used in monitoring the development of claims during the year as well as for present value (i.e., discounting) calculations. See chapter 7

2. True. See chapter 7

3. False. When using **paid** claims and the loss development technique, it is assumed that there have been no significant changes during the experience period in the speed of claims closure and payment. See chapter 7

Answer: A

Question 8 discussion:

1. False. See chapter 7
2. False. See chapter 7.
3. False. See chapter 7.

Answer: None of the given answer choices

Question 9 discussion:

1. False. See chapter 7
2. True. See chapter 7.
3. True. See chapter 7.

Answer: B

Question 10 discussion:

1. False. See chapter 8.
2. False. See chapter 8
3. True. See chapter 8.

Answer: A

Question 11 discussion:

1. True. See chapter 9.
2. True. See chapter 9.
3. False. Ultimate Claims = Actual Paid Claims + Expected UnPaid Claims See chapter 9.

Answer: B

Question 12 discussion:

1. True. See chapter 9
2. True. See chapter 9
3. True. See chapter 7.

Answer: E

Question 13 discussion:

1. True. The estimated IBNR will be lower than actual IBNR as in the steady state situation. See chapter 8
2. True. It produces an IBNR estimate that is correct. See page 163. See chapter 8
3. True. See section 10, chapter 7.

Answer: C

Question 14 discussion:

1. False. The volume (or scale) of the accident year cohort changes vertically from one accident year to the next. See chapter 5.
2. False. The value of cumulative paid claims for an accident year changes horizontally from age to age. See chapter 5.
3. True. See chapter 5.

Answer: B

Question 15 discussion:

1. True. See chapter 5.
2. False. Reinsurers often use underwriting year data. See chapter 5.
3. True. See chapter 5.

Answer: D

Question 16 discussion:

1. True. See chapter 9.
2. True. See chapter 9.
3. True. See chapter 9.

Answer: D

Question 17 discussion:

1. False. The Benktander method is a credibility mixture of Bornhuetter-Ferguson and Development techniques See chapter 9
2. True. See page chapter 9.
3. True. See page chapter 9.

Answer E: None of the given answer choices

Question 18 discussion:

1. True. See page 1.
2. False. The term “actuarial work product” applies to written and oral actuarial communications. See page 1.
3. True. See page 2.

Answer: None of the given answer choices

Question 19 discussion:

1. False. The actuary should take reasonable steps to ensure that an actuarial work product is presented fairly, that the presentation as a whole is clear in its actuarial aspects, and that the actuary is identified as the source of the actuarial aspects and as the individual who is available to answer questions. See section 5.3
2. True. See section 5.6.
3. False. Ownership of documentation is normally established by the actuary and the client or employer, in accordance with law.

Answer: B

Question 20 discussion:

1. True. See commentary under the "Credibility" consideration.
2. True. See commentary under the "Claims Made" consideration.
3. True. See commentary under the "Data Availability" consideration.

Answer: C

Question 21 discussion:

1. False. An inadequate estimate of unpaid claims could drive an insurer to **reduce** its rates not realizing that the estimated unpaid claims were insufficient to cover historical claims. An excessive estimate of unpaid claims could cause the insurer to **increase** rates unnecessarily, resulting in a loss of market share and a loss of premium revenue to the insurer. See chapter 1
2. True. See chapter 1
3. True. See chapter 1

Answer D.

Exam 5B – Independently Authored and Modified Past CAS MC Questions
Preparatory Test 2

General information about this exam

1. This test contains 20 multiple choice questions.

2. The recommend time for this exam is 40 min.

3. Consider taking this exam after working all past CAS questions first.

Articles covered on exam:

Article	Author	Syllabus Section
Chapter 10 – Cape Cod Technique	Friedland	B: Estimating Claim Liabilities
Chapter 11 – Frequency-Severity Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 12 – Case Outstanding Development Technique	Friedland	B: Estimating Claim Liabilities
Chapter 13 – Berquist-Sherman Techniques	Friedland	B: Estimating Claim Liabilities

Exam 5B – Independently Authored and Modified Past CAS MC Questions - Test 2

Question 1

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true regarding the Cape Cod technique?

1. The Cape Cod method splits ultimate claims into two components: actual reported (or paid) and expected unreported (or unpaid).
2. In the Bornhuetter-Ferguson technique, the expected claim ratio is obtained from the reported claims experience instead of an independent and often judgmental selection as in the Cape Cod technique.
3. The key assumption of the Cape Cod method is that unreported claims will develop based on expected claims, which are derived using reported (or paid) claims and earned premium.

A. 1 B. 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question 2

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true regarding the Cape Cod technique?

1. Reinsurers are among the most frequent users of the Cape Cod technique.
2. Actuaries generally use the Cape Cod method in a reported claims application, but they can also use it with paid claims.
3. The technique is appropriate for mainly for short-tailed lines and not long-tail lines.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. 1, 3

Question 3

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true regarding the Bornhuetter-Ferguson technique and the Cape Cod technique?

1. The Cape Cod method is a blend of two other methods: the Bornhuetter-Ferguson method and the expected claims method.
2. Under the Cape Cod method: Ultimate Claims = Actual Reported Claims + Expected Unreported Claims
3. The major difference between the Cape Cod technique and the Bornhuetter-Ferguson technique is the source of the expected claims.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. 1, 3

Question 4

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true?

1. A problem with the SB (Stanard-Buhlmann) Method is that the IBNR by year is highly dependent upon the rate level adjusted premium by year.
2. The key innovation of the SB Method is that the ultimate expected loss ratio for all years combined is estimated from the overall reported claims experience, instead of being selected judgmentally, as in the BF Method.
3. A problem which affects the SB method, unlike the BF method, is that the user must adjust each year's premium to reflect the rate level cycle on a relative basis.

A. 2 B. 1, 2 C. 1, 2, 3 D. 3 E. None of the given answer choices

Exam 5B – Independently Authored and Modified Past CAS MC Questions - Test 2

Question 5

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the Cape Cod technique?

1. Used-up premium is equal to the earned premium multiplied by the percentage of claims unreported.
2. Instead of calculating used-up premium, the actuary could calculate used-up exposures and calculate estimated pure premiums instead of estimated claim ratios for each year in the experience period.
3. Reinsurers often use ultimate premiums in computing used up premium instead of earned premium.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 6

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding frequency and severity techniques?

1. Projections based on frequency-severity techniques can be extremely valuable, not only in providing additional estimates of unpaid claims, but also in understanding the drivers in claims activity.
2. When actuaries use frequency-severity techniques in their simplest form, they project ultimate claims by multiplying the estimated ultimate number of claims by the estimated ultimate average value divided by estimated ultimate exposures.
3. One of the problems with frequency-severity methods is that they cannot be used to validate or reject the findings from other actuarial projection techniques.

A. 3 B. 2, 3 C.1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 7

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding frequency and severity techniques?

1. Frequency-severity techniques can use accident year, policy year, report year, and calendar year data.
2. Reinsurers often use frequency-severity methods with underwriting year data.
3. Frequency-severity techniques are appropriate for all lines of insurance but are more often used for medium tail lines.

A. 1 B. 1, 2 C. 1, 3 D. 2, 3 E. None of the given answer choices

Question 8

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding frequency and severity techniques?

1. The simplest frequency-severity approach is based on a disposal rate analysis.
2. In the second frequency-severity approach discussed, the authors' focus on projecting ultimate claims for the most recent two accident years, since the development method can often result in substantial development factors to ultimate for the most recent accident years.
3. In the third frequency-severity approach discussed, the authors' examine the rate of claim count closure at each maturity age and the incremental paid severity by maturity age.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. None of the given answer choices

Question 9

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding frequency and severity techniques?

1. Two of the major requirements of frequency-severity techniques are that the individual claim counts being grouped are defined in a consistent manner over the experience period and that the claim counts are reasonably homogenous.
2. Since many frequency-severity methods rely on the development technique applied separately to claim counts and average values, a key assumption of the development technique is also applicable to this type of frequency-severity analysis.
3. The actuary using the development technique on severities assumes that the relative change in a given year's severities from one evaluation point to the next is similar to the relative change in prior years' severities at similar evaluation points.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 10

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to the disposal rate technique to estimating unpaid claims?

1. Similar to the previous two frequency-severity approaches, it is assumed that historical patterns of claims emergence and settlement are predictive of future patterns of reported and closed claim counts.
2. While there is an implicit assumption of this method is that there are no significant partial (i.e. interim) payments, the method ultimately adjusts itself for such payments.
3. The selected trend rate to account for inflation adjustment in severity is important, but a slight change in trend will not result in a material change in the estimated of unpaid claims.

A. 1 B. 1, 2 C. 1, 2, 3 ` D. 1, 3 E. None of the given answer choices.

Question 11

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are advantages to using a frequency-severity approach?

1. Changes in the definition of claim counts, claims processing, or both are offset by the relative impact it has upon paid and reported claims, resulting in relatively stable frequencies and severities.
2. The data to perform such analysis is often available.
3. The ability to explicitly reflect inflation in the projection methodology instead of assuming that past development patterns will properly account for inflationary forces.

A. 1 B. 3 C. 2, 3 D. 1, 2, 3 E. None of the given answer choices

Question 12

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to the case outstanding development technique?

1. The case reserve development method attempts to analyze the adequacy of both case and IBNR reserves based on the history of payments against those case reserves.
2. It is assumed that claims activity related to IBNR is related consistently to claims already reported.
3. Assumptions for the case outstanding development technique are similar to those for other loss development techniques.

A. 1 B. 2 C. 2, 3 D. 1, 2 E. None of the given answer choices

Question 13

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to the case outstanding development technique?

1. The case outstanding development technique is used extensively by actuaries.
2. The assumption that IBNR claim activity is related to development on known claims versus pure IBNR limits its use.
3. The case outstanding development method is appropriate for claims-made coverages and report year analysis because the claims for a given accident year are known at the end of the accident year.

A. 1 B. 2, 3 C 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 14

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to the case outstanding development technique?

1. Ratios of the incremental paid claims at age x to the case outstanding at age x+12 are computed.
2. Ratios of the case outstanding to the previous case outstanding are computed.
3. A challenge of this technique is the selection of the "to ultimate" ratios for both the ratio of incremental paid claims to subsequent case outstanding and the ratio of case outstanding to previous case outstanding.

A. 1 B. 2 C. 1, 2 D. 1, 3 E. 1, 2, 3

Question 15

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to limitations of the case outstanding development technique?

1. The assumption that future IBNR is related to claims already reported does not hold true for many P&C lines of insurance.
2. The infrequent use and the absence of benchmark data (for accident year applications of this method).
3. A lack of intuitive sense and experiential knowledge as to what ratios are appropriate at each maturity for both the incremental paid claims to case outstanding and the case outstanding to previous case outstanding across P&C lines of insurance.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 16

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, Berquist and Sherman cite which of the following examples for selecting alternative data to respond to potential problems related to a changing environment?

1. Using written exposures instead of the number of claims when claim count data is of questionable accuracy or if there has been a major change in the definition of a claim count.
2. Substituting policy year data for calendar year data when there has been a significant change in policy limits or deductibles between successive policy years.
3. Substituting policy year data for accident year data when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the policy year than with the accident date.

A. 1 B. 3 C. 1, 3 D. 2, 3 E. None of the given answer choices

Question 17

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true for selecting data to respond to potential problems related to a changing environment?

1. One way to adjust the data for changes in operations is to divide the data into less homogeneous groups, and is valuable when there have been changes in the composition of business by jurisdiction, coverage, class, territory, or size of risk.
2. While dividing the data into less homogeneous groups, the actuary must seek to retain sufficient volume of experience within each grouping to ensure the credibility of the data.
3. If greater attention is directed at the handling of large claims, there may be a speed-up in the settlement of these particular claims that could affect both the paid claims and case outstanding triangles; if the large claims are settled earlier then the case outstanding will no longer be present in the triangle at the later maturities and the payments will appear in the triangles at earlier maturities than in the past.

A. 1, 2 B. 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 18

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the approaches an actuary can use to determine if an insurer has sustained changes in case outstanding adequacy?

1. A meeting with claims department management to discuss the claims process should be a prerequisite to any analysis of unpaid claims.
2. The actuary can also calculate various claim development diagnostic tests, including: the ratio of paid-to-reported claims, average case outstanding, average reported claim, and average paid claims.
3. In their medical malpractice example, Berquist and Sherman compare the annual change in the average case outstanding to the annual change in the average reported claims to confirm a shift in case outstanding adequacy.

A. 2 B. 1, 2 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 19

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to the Mechanics of the Berquist-Sherman Paid Claim Development Adjustment?

1. The first step of the Berquist-Sherman paid claims adjustment is to determine the disposal rates by policy year and maturity.
2. To determine the disposal rates, we first project the number of ultimate claims based on reported claim counts.
3. The disposal rate is equal to the cumulative closed claim counts for each policy-maturity age cell divided by the ultimate claim counts for the particular policy year.

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 20

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the authors' last projection for XYZ Insurer, which adjusts the data for changes in both case outstanding adequacy and the rate of claims settlement?

1. The authors' use both an adjusted average paid claim triangle and the adjusted average case outstanding triangle.
2. There is one new adjusted triangle we need to create for this projection: the adjusted number of open claims.
3. The authors' derive the adjusted open claim count triangle by subtracting the adjusted closed claim count triangle from paid claim counts.

A. 1 B. 2 C. 1, 2 D. 2, 3 E. 1, 2, 3

Question 1 discussion:

1. True. See chapter 10
2. False. In the Cape Cod technique, the expected claim ratio is obtained from the reported claims experience instead of an independent and often judgmental selection as in the Bornhuetter-Ferguson technique. See chapter 10
3. True. See chapter 10

Answer: C

Question 2 discussion:

1. True. See chapter 10
2. True. See chapter 10
3. False. The technique is appropriate for all lines of insurance including short-tail lines and long-tail lines. See chapter 10

Answer: C

Question 3 discussion:

1. False. The Cape Cod method is a blend of two other methods: the claim development method and the expected claims method. See chapter 10
2. True. See chapter 10
3. True. See chapter 10

Answer: D

Question 4 discussion:

1. True. See chapter 10
2. True. See chapter 10
3. False. This is a problem for the BF method as well. See chapter 10

Answer: B

Question 5 discussion:

1. False. Used-up premium is equal to the earned premium multiplied by the percentage of claims unreported. See chapter 10
2. True. See chapter 10
3. True. See chapter 10

Answer: B

Question 6 discussion:

1. True. See chapter 11
2. False. When actuaries use frequency-severity techniques in their simplest form, they project ultimate claims by multiplying the estimated ultimate number of claims by the estimated ultimate average value.
3. False. Frequency-severity methods can also be important to validate or reject the findings from other actuarial projection techniques. See chapter 11

Answer: E. None of the given answer choices

Question 7 discussion:

1. True. See chapter 11
2. False. Generally reinsurers do not use frequency-severity methods with underwriting year data simply because they do not have access to detailed statistics regarding the number of claims. See chapter 11
3. False. Frequency-severity techniques are appropriate for all lines of insurance but are more often used for short tail lines. See chapter 11

Answer: A

Question 8 discussion:

1. False. The first and simplest frequency-severity approach is the development technique applied separately to claim counts and average values. See chapter 11
2. True. See chapter 11
3. True. See chapter 11

Answer: D

Question 9 discussion:

1. True. See chapter 11
2. True. See chapter 11
3. True. See chapter 11

Answer: C

Question 10 discussion:

1. True. See chapter 11
2. False. There is no mention of this. See chapter 11
3. False. "… a slight change in trend can result in a material change in the estimated of unpaid claims, and therefore the trend rate must be selected carefully. See chapter 11

Answer: A

Question 11 discussion:

1. False. This is not mentioned. See chapter 11
2. False. See chapter 11
3. True. See chapter 11

Answer: B

Question 12 discussion:

1. False. The case reserve development method attempts to analyze the adequacy of **case reserves** based on the history of payments against those case reserves. See chapter 12.
2. True. See chapter 12.
3. True. See chapter 12.

Answer: C

Question 13 discussion:

1. False. See chapter 12.
2. True. See chapter 12.
3. True. See chapter 12.

Answer: B

Question 14 discussion:

1. False. Ratios of the incremental paid claims at age x to the case outstanding at age x-12 are computed.
2. True. See chapter 12.
3. False. A challenge of this technique is the selection of the "to ultimate" ratios for both the ratio of incremental paid claims to **previous** case outstanding and the ratio of case outstanding to previous case outstanding. See chapter 12.

Answer: B

Question 15 discussion:

1. True. See chapter 12.
2. True. See chapter 12.
3. True. See chapter 12.

Answer: C

Question 16 discussion:

1. False. Using **earned** exposures… See chapter 13.
2. False. Substituting policy year data for **accident** year data. See chapter 13.
3. False. Substituting **report** year data for accident year data when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the **report** year than with the accident date. See chapter 13.

Answer: E. None of the given answer choices

Question 17 discussion:

1. False. "… the data into **more** homogeneous groups,…". See chapter 13.
2. False. "… the data into **more** homogeneous groups,…". See chapter 13.
3. True. See chapter 13.

Answer: B

Question 18 discussion:

1. True. See chapter 13.
2. True. See chapter 13.
3. False. In their medical malpractice example, Berquist and Sherman compare the annual change in the average case outstanding to the annual change in the average **paid** claims to confirm a shift in case outstanding adequacy. See chapter 13.

Answer: B

Question 19 discussion:

1. False. he first step of the Berquist-Sherman paid claims adjustment is to determine the disposal rates by **accident** year and maturity. See chapter 13.
2. True. See chapter 13.
3. False. The disposal rate is equal to the cumulative closed claim counts for each **accident**-maturity age cell divided by the ultimate claim counts for the particular **accident** year. See chapter 13.

Answer: A

Question 20 discussion:

1. True. See chapter 13.
2. True. See chapter 13.
3. False. We derive the adjusted open claim count triangle by subtracting the adjusted closed claim count triangle from reported claim counts. See chapter 13.

Answer: C

Question 21 discussion:

1. True. See chapter 13
2. True. See chapter 13
3. True. See chapter 13

Answer: 1, 2, and 3

Exam 5B – Independently Authored and Modified Past CAS MC Questions
Preparatory Test 3

General information about this exam

1. This test contains 20 multiple choice questions.

2. The recommend time for this exam is 40 min.

3. Consider taking this exam after working all past CAS questions first.

Articles covered on exam:

Article	Author	Syllabus Section
Chapter 14 – Recoveries: Salvage & Subro and Reins	Friedland	B: Estimating Claim Liabilities
Chapter 15 – Evaluation of Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 16 — Estimating Unpaid Claim Adj Expenses	Friedland	B: Estimating Claim Liabilities
Chapter 17 - Estimating Unpaid ULAE	Friedland	B: Estimating Claim Liabilities

Exam 5B – Independently Authored and Modified Past CAS MC Questions - Test 3

Question 1

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to salvage and subrogation?

1. Salvage refers to an insurer's right to recover the amount of claim payment to a covered insured from a third-party responsible for the injury or damage.
2. Subrogation represents any amount that the insurer is able to collect from the sale of such damaged property.
3. Recoveries due to salvage, can take years to realize, well after the underlying claims are paid, resulting in age-to-age factors less than one for older maturities for some lines of business.

A. 1 B. 2, 3 C 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 2

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to salvage and subrogation?

1. Actuaries frequently use the both the development technique and the Bornhuetter-Ferguson technique to quantify the affect of S&S recoveries on estimates of total unpaid claims.
2. Paid S&S represents a payment made by the insured to the insurer.
3. Many actuaries also use a ratio approach when analyzing S&S.

A. 1 B. 3 C 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 3

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to salvage and subrogation?

1. One advantage of the ratio approach is that the development factors tend not to be as highly leveraged as the development factors based on received S&S dollars.
2. One advantage or the ratio approach is related to the selection of the ultimate S&S ratio(s) for the most recent year(s) in the experience period, especially when the development approach produces an ultimate S&S ratio which is not consistent with the more recent reported ratios.
3. Ultimate S&S using the ratio approach is determined by multiplying selected ultimate claims and the selected ultimate S&S ratio.

A. 1 only B. 2 only C. 3 only D. 1, 2 only E. 1, 2, 3

Question 4

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to gross and net data?

1. If ceded claims are coded in the same database as gross data, net data is available. In this case, the actuary is more likely to conduct both gross and net analyses.
2. Some insurers code the ceded claims data to a different system; thus matching the gross and ceded data to derive net claim triangles may be more difficult. In this case, the actuary will likely prepare separate gross and ceded analyses.
3. The choice of gross versus net versus ceded analysis may be a function of data volume and quality.

A. 1 B. 2 C. 3 D. 1, 2 E. 1, 2, 3

Question 5

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to gross and net data?

1. If the reinsurance program consists of quota share arrangements, the actuary can create a development triangle with the ratio of net-to-gross claims and thus test the quota share percentage(s) by year.
2. If the reinsurance program consists of excess of loss arrangements, the actuary may want to examine large claims to confirm that retentions and limits for ceded claims by year are consistent with the corresponding excess of loss reinsurance contracts or with information provided.
3. Since net claims are often capped due to excess or aggregate coverage, we frequently observe net claim development patterns that are less than or equal to gross claim development patterns

A, 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 6

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true with respect to gross and net IBNR

1. Net IBNR in each AY is generally not greater than gross IBNR.
2. When an estimate of uncollectible reinsurance is included in the net IBNR but not in the gross IBNR and there are significant billed reinsurance amounts for which significant collectibility issues exist, net IBNR will be greater than the gross IBNR
3. For a runoff book with reinsurance disputes for items such as asbestos, net IBNR will be greater than the gross IBNR

A, 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 7

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, Berquist and Sherman recommend that where possible, the actuary conducting an analysis of unpaid claims should use methods that incorporate which the following?

1. Projections of reported claims
2. Projections of paid claims
3. Projections of ultimate reported claim counts and severities
4. Estimates of the number and average amount of outstanding claims
5. Claim ratio estimates

A. 1, 2 B. 1, 2, 3 C. 1, 2, 4 D. 1, 2, 3, 4 E. 1, 2, 3, 4, 5

Question 8

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. When selecting the most appropriate estimate of unpaid claims, actuaries may incorporate the concept of credibility into the selection process, while at other times actuarial judgment will prevail.
2. If there is sufficient claim history available, testing a reserving method retroactively can help the actuary to determine the historical accuracy of the method and whether or not the particular method is free from bias in projecting future results
3. An important final check of the selected ultimate claims, particularly for the oldest years, should include calculation of claim ratios, severities, pure premiums, and claim frequencies.

A. 1 B. 1, 2 C. 3 D. 2, 3 E. None of the given answers

Question 9

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true with respect to selecting ultimate claims when the results from a variety of reserving methods are fairly consistent for older accidents years, but are more variable for more recent accident years?

1. Some actuaries may select one method and use it for all years.
2. Some actuaries may select different methods for different accident years.
3. Some actuaries may use a weighted average of the results from various methods based on assigned weights to those methods; these weights may be consistent for all years or may vary by accident year.

A. 1 B. 1, 2 C. 3 D. 2, 3 E. 1, 2, 3

Question 10

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true when monitoring unpaid claim estimates.

1. It is typically a simple exercise to develop a model that allows comparisons of actual and expected claims by accident year between successive annual valuations.
2. Expected paid claims in the calendar year 2008 for AY 2007 are equal to [(ultimate claims selected at December 31, 2007 — actual reported claims at December 31, 2007) / (% unreported at December 31, 2007)] x (% reported at December 31, 2008 - % reported at December 31, 2007)
3. When actuaries rely on techniques other than the development technique to select ultimate claims, it is often valuable to look at an alternative method for deriving reporting and payment patterns (other than the inverse of the age to age development factor).

A. 2 B. 2, 3 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 11

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are true regarding an appropriate system for quarterly or monthly monitoring of loss development?

1. It is a relatively easy task to develop a system for quarterly or monthly monitoring given an estimation process that focuses only on annual claim development patterns.
2. Insurers that maintain claim development data on a quarterly basis have development factors that are readily available for quarterly analyses, and linear interpolation between quarters is likely sufficient for monthly monitoring purposes.
3. For insurers who only have annual claim development data, linear interpolation of annual development patterns is usually appropriate.

A. 1 B. 2 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question 12

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are common techniques to develop ALAE?

1. The development technique using paid ALAE.
2. The development technique using reported ALAE (when case O/S for ALAE exists)
3. The development of the ratio of reported ALAE-to-reported claims only.

A. 2 B. 1 C. 1, 2 D. 2, 3 E. None of the given answer choices

Question 13

According to Friedland et al. in "Estimating Unpaid Claims Using Basic Techniques", which of the following are advantages to using the ratio method to develop ALAE?

1. It recognizes the relationship between ALAE and claims only.
2. The ratio development factors are not as highly leveraged as those based on paid ALAE dollars.
3. The ability to interject actuarial judgment in the projection analysis, especially for the selection of the ultimate ALAE ratio for the most recent year(s) in the experience period.

A. 1 B. 1, 2 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 14

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true?

1. An important assumption underlying the ratio analysis is that the relationship between ALAE and claims only is relatively stable over the experience period.
2. A disadvantage of the ratio method is that any error in the estimate of ultimate claims only could affect the estimate of ultimate ALAE.
3. A potential challenge with a ratio method exists for some lines of business where large amounts of ALAE may be spent on claims that ultimately settle with no claim payment.

A. 1 B. 1, 2 C. 1, 2, 3 D. 1, 3 E. None of the given answer choices

Question 15

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding dollar-based and count based techniques for estimating unpaid ULAE?

1. These techniques may produce similar results.
2. Many self-insurers use market values, fees paid to third-party claims administrator to manage a book of claims, to determine the unpaid ULAE for financial reporting purposes.
3. These techniques, which rely on fundamentally different assumptions, vary significantly in the amount of data and calculations required.

A. 1 B. 3 C. 1, 3 D. 2, 3 E. 1, 2, 3

Question 16

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the key assumptions of the Classical (traditional) technique to computing unpaid ULAE?

1. ULAE is sustained as claims are reported even if no claim payments are made.
2. ULAE payments for a specific calendar year are related to both the reporting and payment of claims.
3. The volume and cost of future claims management on not-yet-reported claims and reported-but-not-yet-closed claims will be proportional to IBNR and case O/S, respectively.

A. 1 B. 1, 2 C. 3 D. 2, 3 E. None of the given answers

Question 17

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the Classical and Kittel refinement techniques to estimating unpaid claims?

1. One challenge with the Kittel refinement technique is that “closing” a claim and “paying” a claim do not necessarily mean the same thing.
2. The definition of IBNR poses a challenge for actuaries using the classical technique.
3. According to Johnson, the classical technique “will only give good results for very short-tailed, stable lines of business.”

A. 1 B. 1, 2 C. 3 D. 2, 3 E. None of the given answers

Question 18

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the Classical and Kittel refinement techniques to estimating unpaid claims?

1. The paid to paid methodology assumes that claims incur expenses only when initially opened and when closed, which is an unreasonable assumption for claims from short-tailed lines.
2. In the Kittel refinement, calendar year incurred claims are defined to be calendar year reported claims plus the change in total claim liabilities, including both case outstanding and IBNR.
3. The classical technique makes the implicit simplifying assumption that paid claims are approximately equal to reported claims, and thus the two quantities can be used interchangeably.

A. 1 B. 1, 2 C. 3 D. 2, 3 E. None of the given answers

Question 19

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the Kittel's refinement technique to estimating unpaid claims?

1. The relative volume and cost of future claims management activity on not-yet-reported claims and reported-but-not-yet-closed claims is expected to be proportional to the dollars of IBNR and case outstanding, respectively.
2. One-half of expenses are sustained when opening a claim and one-half of expenses when closing a claim.
3. The Kittel refinement fails to addresses the distortion created when using the classical technique for a growing insurer.

A. 1 B. 2 C. 3 D. 2, 3 E. 1, 2, 3

Question 20

According to Friedland et al. in “Estimating Unpaid Claims Using Basic Techniques”, which of the following are true regarding the Conger and Nolibos Method – Generalized Kittel Approach?

1. The claim basis for a particular time period is defined to be the weighted average of the ultimate cost of claims reported during the period, the ultimate cost of claims closed during the period, and the amount of claims outstanding at the end of the period.
2. Since Conger and Nolibos believe that handling costlier claims warrants and requires relatively more resources than handling smaller claims, they use claim counts instead of claim dollars in their generalized approach.
3. The values of U_1, U_2, and U_3 could vary significantly from insurer to insurer and between lines of business.

A. 1 B. 3 C. 1, 3 D. 1, 2 E. 1, 2, 3

Solutions to Exam 5B – Independently Authored and Modified Past CAS MC Questions - Test 3

Question 1 discussion:

1. False. Statement 1 refers to Salvage. See chapter 14
2. False. Statement 2 refers to Subrogation. See chapter 14
3. False. Statement 2 refers to Subrogation. See chapter 14

Answer: None of the given answer choices

Question 2 discussion:

1. False. The development technique… See chapter 14
2. False. Paid S&S represents a payment made by a third-party to the insurer. See chapter 14
3. True. See chapter 14

Answer: B

Question 3 discussion:

1. True. See chapter 14
2. True. See chapter 14
3. True. See chapter 14

Answer: E

Question 4 discussion:

1. True. See chapter 14
2. True. See chapter 14
3. True. See chapter 14

Answer: E

Question 5 discussion:

1. True. See chapter 14
2. True. See chapter 14
3. True. See chapter 14

Answer: C

Question 6 discussion:

1. True. See chapter 14
2. True. See chapter 14
3. True. See chapter 14

Answer: C

Question 7 discussion:

Answer: E – See chapter 15

Question 8 discussion:

1. True. See chapter 15
2. True. See chapter 15
3. False. An important final check of the selected ultimate claims, particularly for the **most recent years**, should include calculation of claim ratios, severities, pure premiums, and claim frequencies. See chapter 15

Answer: B

Question 9 discussion:

1. True. See chapter 15
2. True. See chapter 15
3. True. See chapter 15

Answer: E

Question 10 discussion:

1. True. See chapter 15
2. False. " Expected **reported** claims… See chapter 15
3. False. " the inverse of the **cumulative** development factor).See chapter 15

Answer: E

Question 11 discussion:

1. False. It can be a challenging task to develop a system for quarterly or monthly monitoring given an estimation process that focuses only on annual claim development patterns. See chapter 15
2. True. See chapter 15
3. False. For insurers who only have annual claim development data, linear interpolation of annual development patterns is usually not appropriate, particularly for the most immature accident years. See chapter 15

Answer: B

Question 12 discussion:

1. True. See chapter 16
2. True. See chapter 16
3. False. The development of the ratio of paid ALAE-to-paid claims only. See chapter 16

Answer: C

Question 13 discussion:

1. True. See chapter 16
2. True. See chapter 16
3. True. See chapter 16

Answer: C

Question 14 discussion:

1. True. See chapter 16
2. True. See chapter 16
3. True. See chapter 16

Answer: C

Question 15 discussion:

1. True. See chapter 17.
2. True. See chapter 17.
3. True. See chapter 17.

Answer: E

Question 16 discussion:

1. False. This is an assumption of the Kittel refinement technique. See chapter 17.
2. False. This is an assumption of the Kittel refinement technique. See chapter 17.
3. True. See chapter 17.

Answer: C

Question 17 discussion:

1. False. This is an assumption of the Classical refinement technique. See chapter 17.
2. True. See chapter 17.
3. True. See chapter 17.

Answer: D

Question 18 discussion:

1. False. See chapter 17.
2. False. In the Kittel refinement, calendar year incurred claims are defined to be calendar year **paid** claims plus the change in total claim liabilities, including both case outstanding and IBNR. See chapter 17.
3. True. See chapter 17.

Answer: C

Question 19 discussion:

1. True. See chapter 17.
2. True. See chapter 17.
3. False. See chapter 17.

Answer: C

Question 20 discussion:

1. False. "… and the claims paid during the period". See chapter 17.
2. False. Since Conger and Nolibos believe that handling costlier claims warrants and requires relatively more resources than handling smaller claims, they use claim dollars instead of claim counts in their generalized approach. See chapter 17.
3. True. See chapter 17.

Answer: B

Exam 5B – Independently Authored Preparatory Test 1

General information about this exam

1. This test contains 22 computational and essay questions.
2. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.
3. Consider taking this exam after working all past CAS questions, associated with the articles below, first.
4. Many of the essay questions may require lengthy responses.
5. Make sure you have a sufficient number of blank sheets of paper to record your answers.

Articles covered on exam:

Article	Author	Syllabus Section
Chapter 1 – Overview	Friedland	B: Estimating Claim Liabilities
Chapter 2 – The Claims Process	Friedland	B: Estimating Claim Liabilities
Chapter 3 – Understanding the Types of Data Used	Friedland	B: Estimating Claim Liabilities
Chapter 4 - Meeting with Management	Friedland	B: Estimating Claim Liabilities
Chapter 5 - The Development Triangle	Friedland	B: Estimating Claim Liabilities
Chapter 6 - Development Triangle as a Diagnostic Tool	Friedland	B: Estimating Claim Liabilities
Chapter 7 – Development Technique	Friedland	B: Estimating Claim Liabilities
Chapter 9 – Bornhuetter-Ferguson Technique	Friedland	B: Estimating Claim Liabilities
Statement of Principles: Loss and LAE Reserves	CAS	B: Estimating Claim Liabilities
ASOP No. 9 – Documentation and Disclosure	AAA	B: Estimating Claim Liabilities

Exam 5B - Independently Authored Preparatory Test 1

Question 1. (4 points) You are given the following information:

Accident Year	Earned Premium ($000)	Case Incurred Losses ($000), Valued as of 12/31/2005	Expected Loss Ratio
2002	400	200	80%
2003	2000	2000	80%
2004	3000	1800	80%
2005	3000	1200	80%

Selected age-to-age incurred loss development factors:

12 - 24 months	1.250
24 - 36 months	1.100
36 - 48 months	1.050
48 - 60 months	1.080

No further development after 60 months

a. (1 point) Calculate the IBNR reserve as of December 31, 2005 using case incurred loss development. Show all work.

b. (1 point) Calculate the IBNR reserve as of December 31, 2005 using the Bornhuetter-Ferguson method. Show all work.

c. (0.5 point) Identify one situation in which it would be preferable to use the case incurred method rather than the Bornhuetter-Ferguson method to develop the IBNR.

d. (0.5 point) Identify one situation in which it would be preferable to use the Bornhuetter-Ferguson method rather than the case incurred loss development method to estimate the IBNR.

e. (1 point) Using the Bornhuetter-Ferguson method, calculate the amount of loss development to be expected during calendar year 2006 on accident years 2002 through 2005. Show all work.

Question 2.

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", accurately estimating unpaid claims is essential for proper decision-making.

With respect to either rates, market share, or underwriting, strategic and financial decision making, briefly describe how improper estimates could ruin an insurer's financial condition in terms of an:

a. (.50 points) *inadequate* estimate of unpaid claims.

b. (.50 points) *excessive* estimate of unpaid claims.

c. (.50 points) *inaccurate* estimate of unpaid claims.

Question 3.

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", there are several approaches to establishing case outstanding reserves. List and briefly describe three approaches.

Question 4.

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe three approaches, for many insurers, determining the case outstanding for reinsurance recoveries is a fairly straightforward exercise. Briefly describe how ceded case outstanding is set for both proportional and non-proportional reinsurance.

Question 5.

(2.25 points) Friedland in ""Estimating Unpaid Claims Using Basic Techniques", describes the computation of cumulative reported claims, cumulative paid claims and case outstanding reserves. Assume the following:

* An automobile insurer issues a 1 year policy effective 1/1/2007 – 11/30/2008.
* An accident occurred on 11/15/2008, but the insurer does not receive notice of the claim until 2/20/2009.
* Over the life of the claims, a claims professional records a number of transactions which include:

Date	Transaction
February 20, 2009	Case 0/S of $15,000 established for claim only
April 1, 2009	Claim payment of $1,500 - case 0/S reduced to $13,500 (case 0/S change of -$1,500)
May 1, 2009	Expense payment to IA of $500; no change in case O/S
September 1, 2009	Case 0/S for claim increased to $30,000 (case 0/S change of +$16,500)
March 1, 2010	Claim thought to be settled with additional payment of $24,000 – case 0/S reduced to $0 and claim closed (case 0/S change of -$30,000)
January 25, 2011	Claim reopened with case 0/S of $10,000 for claim and $10,000 for defense costs
April 15, 2011	Partial payment of $5,000 for defense litigation and case 0/S for defense costs reduced to $5,000 – no change in case 0/S for claim
September 1, 2011	Final claim payment for an additional $12,000 case 0/S for claim reduced to $0 (case 0/S change of -$10,000)
March 1, 2012	Final defense cost payment for an additional $6,000 – case 0/S for defense costs reduced to $0 and claim closed (case 0/S change of -$5,000)

a. (.75 points) Compute cumulative reported claims as of 3/1/2010.

b. (.75 points) Compute cumulative paid claims as of 4/15/2011.

c. (.75 points) Compute Case outstanding as of 9/1/2011.

Question 6

(1 point). Based on the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," define what constitutes an actuarially sound loss reserve, for a defined group of claims as of a given valuation date.

Question 7

(1 point). Based on the CAS "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves," one of the considerations when establishing a loss reserve is to examine the impact of external influences. List 5 types of external influences.

Question 8

(2.25 points) Friedland in ""Estimating Unpaid Claims Using Basic Techniques", describes the computation of cumulative reported claims, cumulative paid claims and case outstanding reserves.

Assume the following:

	At December 31, 2007			Transactions During 2008			At December 31, 2008		
Claim Number	Cumulative Paid Claims	Case O/S	Reported Claims	Paid Claims	Change in Case O/S	Reported Claims	Cumulative Paid Claims	Case O/S	Reported Claims
'(1)	'(2)	'(3)	'(4)	'(5)	'(6)	'(7)	'(8)	'(9)	'(10)
1	500	5,000	5,500	200	(1,000)				
2	5,000	15,000	20,000	4,500					
3	2,000	10,000	12,000	1,000	5,000				

a. (.75 points) Compute cumulative reported claims as of 12/31/2008 for claim number 1.

b. (.75 points) Compute case outstanding as of 12/31/2008 for claim number 2.

c. (.75 points) Compute cumulative reported claims as of 12/31/2008 for claim number 3.

Question 9

(3 points). According to ASB "Actuarial Standard of Practice No. 9, Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations," documentation of an actuarial work product is required whether or not there is a legal or regulatory requirement for the documentation. In addition, appropriate records, worksheets, and other documentation of the actuary's work should be maintained by the actuary and retained for a reasonable period of time.

List and briefly describe three other requirements regarding the extent of documentation required in an actuarial work product.

Question 10

(1 point) A total loss reserve is composed of five elements, although the five elements may not necessarily be individually quantified. List the five elements.

Question 11

(1.5 points). According to ASB "Actuarial Standard of Practice No. 9, Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations," briefly discuss the extent of an actuary's responsibility when relying on another actuary's work product.

Question 12

(1 point). According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe one reason why a small insurer and a larger insurer would have a need for external data.

Question 13

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe three key claims characteristics that actuaries focus on when separating data into groups prior to the analysis of unpaid claims.

Question 14

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe three claims characteristics actuaries consider when establishing a large claim threshold.

Question 15

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", the presence of unusually large claims can distort some of the methods used for estimating unpaid claims.

Briefly describe three steps an actuary can perform to handle the projection of large claims.

The actuary may choose to exclude the large claims from the initial projection and then, at the end of the unpaid claims analysis, add a case specific projection for the reported portion of large claims and a smoothed provision for the IBNR portion of large claims.

Question 16

(3 points). Based on Frieldland in "Estimating Unpaid Claims Using Basic Techniques" and using the data below, answer the following questions:

You are given the following information:

		Incurred Loss and ALAE Age of Development in Months			
Earned Premiums	Accident Year	12	24	36	48
$2,000	2002	$500	$1,000	$1,500	$1,650
2,000	2003	400	700	980	
3,000	2004	600	900		
3,600	2005	800			

The expected loss and ALAE ratio is 70%.
Loss development factors should be calculated using a simple average.
The tail factor is 1.05 for development from 48 months to ultimate.

a. (1.5 point) Using the incurred age-to-age development factor method, calculate the total IBNR reserve. Show all work.

b. (1.5 point) Using the Bornhuetter-Ferguson method, calculate the total IBNR reserve. Show all work.

Question 17

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe two advantages and two disadvantages of using calendar year data.

Question 18

(1.5 points) You are the reserving actuary for the XYZ insurance company. You are about to conduct a year end review of unpaid claims.

According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, what types of questions would you ask actuaries in your ratemaking unit prior to conducting your reserve review?

Question 19. (3.5 points) Friedland in "“Estimating Unpaid Claims Using Basic Techniques” provide a detailed example of how to create paid claims and reported claims triangles using claims transaction data.

Using the following data:

a. (2 points) Create a cumulative paid claim triangle for accident years 2005 – 2008.

b. (1.5 points) Create a case outstanding claim triangle for accident years 2005 – 2008.

Claims Transaction Data

			2005 Transactions		2006 Transactions		2007 Transactions		2008 Transactions	
Claim ID	Accident Date	Report Date	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S
1	Jan-5-05	Feb-1-05	400	200	220	0	0	0	0	0
2	May-4-05	May-15-05	200	300	200	0	0	0	0	0
3	Aug-20-05	Dec-15-05	0	400	200	200	300	0	0	0
4	Oct-28-05	May-15-06			0	1,000	0	1,200	300	1,200
5	Mar-3-06	Jul-1-06			260	190	190	0	0	0
6	Sep-18-06	Oct-2-06			200	500	0	500	230	270
7	Dec-1-06	Feb-15-07					270	420	0	650
8	Mar-1-07	Apr-1-07					200	200	200	0
9	Jun-15-07	Sep-9-07					460	390	0	390
10	Sep-30-07	Oct-20-07					0	400	400	400
11	Dec-I2-07	Mar-10-08							60	530
12	Apr-12-08	Jun-18-08							400	200
13	May-28-08	Jul-23-08							300	300
14	Nov-12-08	Dec-5-08							0	540
15	Oct-15-08	Feb-2-09								

Question 20

(1.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, answer the following:

a. (.50 points) What does a review of the ratio of paid to reported claims help the actuary determine?

b. (.50 points) How can changes in the ratio of paid-to-reported claims be taking place, but such changes cannot be observed?

c. (.50 points) What does a review of the ratio of paid claims to on-level earned premiums help the actuary determine?

Question 21

(1.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, list and briefly describe factors affecting the reporting and closing of claims.

Question 22

(1.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, actuaries compute average reported claims, average paid claims, and average outstanding claims.

List and briefly describe two important issues related to computing average values.

Solutions to Exam 5B - Independently Authored Preparatory Test 1

Question 1 discussion:

a. (1 point) Calculate the IBNR reserve as of December 31, 2005 using case incurred loss development.

Accident Year	Case Incurred at 12/31/05	Age to Age LDFs	LDFs to Ultimate	IBNR Factor	IBNR at 12/31/2005
	(1)	(2)	(3)	(4)=(3)-1.0	(5) = (1)*(4)
2002	200	1.080	1.080	0.0800	16.00
2003	2,000	1.050	1.134	0.1340	268.00
2004	1,800	1.100	1.247	0.2474	445.32
2005	1,200	1.250	1.559	0.5593	671.10
					1400.42

Notes: (1) and (2) are given
(3) = downward multiplicative product of (2)

Thus, the IBNR reserve at 12/31/05 is 1,400,420.

b. (1 point) Calculate the IBNR reserve as of December 31, 2005 using the Bornhuetter-Ferguson method. Show all work.

Accident Year	Earned Premium	ELR	Age to Age LDFs	LDFs to Ultimate	% Unreported at 12/31/05	IBNR at 12/31/2005
	(1)	(2)	(3)	(4)	(5)=1.0 - 1.0/(4)	(6) = (1)*(2)*(5)
2002	400	0.80	1.080	1.080	0.0741	23.70
2003	2,000	0.80	1.050	1.134	0.1182	189.07
2004	3,000	0.80	1.100	1.247	0.1983	476.00
2005	3,000	0.80	1.250	1.559	0.3587	860.80
						1549.57

Notes: (1) and (2) and (3) are given
(4) = downward multiplicative product of (3)

Thus, the IBNR reserve using the BF method at 12/31/05 is 1,549,570.

c. (0.5 point) Identify one situation in which it would be preferable to use the case incurred method rather than the Bornhuetter-Ferguson method to develop the IBNR.

When there is a deteriorating loss ratio, but a consistent loss emergence pattern, the case incurred method is preferable to the BF method to develop IBNR. Key: Since we assume no change in the adequacy of case outstanding, there are no changes in the age-to-age factors, and thus no changes in the cumulative claim development factors between the increasing claim ratio scenario and the steady-state environment.

The higher value of projected ultimate claims is solely due to higher values of claims reported and paid

The estimated IBNR is the same for both the reported and paid claim development methods, and is equal to the actual IBNR.

Thus, conclude that the development technique is responsive to changes in the underlying claim ratios assuming no changes in the underlying claims reporting or payment pattern.

d. (0.5 point) Identify one situation in which it would be preferable to use the Bornhuetter-Ferguson method rather than the case incurred loss development method to estimate the IBNR.

The B-F method is preferable to use when historical data is extremely thin or volatile or both. Insurers face this when writing new lines of business.

Question 1 discussion (continued):

e. (1 point) Using the Bornhuetter-Ferguson method, calculate the amount of loss development to be expected during calendar year 2006 on accident years 2002 through 2005. Show all work.

Loss emergence during CY 2006 from AY's 2001 - 2005

Accident Year	Earned Premium	ELR	Expected Losses	Age to Age LDFs	LDFs to Ultimate	% Unreported at 12/31/05
	(1)	(2)	(3) = (1)*(2)	(4)	(5)	(6)=1.0 - 1.0/(5)
2002	400	0.80	320	1.080	1.080	0.0741
2003	2,000	0.80	1,600	1.050	1.134	0.1182
2004	3,000	0.80	2,400	1.100	1.247	0.1983
2005	3,000	0.80	2,400	1.250	1.559	0.3587

Accident Year	Estimated IBNR at 12/31/2005	% Reported at 12/31/05	% Reported at 12/31/06	% Reported during CY 2006	Expected IBNR emergence during CY 2006
	(7) = (3)*(6)	(8)=1.0/(5)	(9) using (8)	(10) = (9) - (8)	(11) = (3) * (10)
2002	23.70	92.59%	100.00%	7.41%	23.704
2003	189.07	88.18%	92.59%	4.41%	70.547
2004	476.00	80.17%	88.18%	8.02%	192.400
2005	860.80	64.13%	80.17%	16.03%	384.800
					671.451

Thus, the amount of loss emergence during CY 2006 on AYs 2002 – 2005 is 671,451.

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Importance of accurate estimates of unpaid claims

a. An inadequate estimate of unpaid claims could cause an insurer to reduce its rates not realizing that the estimated unpaid claims were insufficient to cover historical claims.

The new lower rates would be insufficient to pay the claims arising from the new policies. If the insurer gains market share as a result of the lower rates, the premiums collected would prove to be inadequate to cover future claims, and could lead to a situation where the future solvency of the insurer is at risk.

b. An excessive estimate of unpaid claims could cause the insurer to increase rates unnecessarily, resulting in a loss of market share and a loss of premium revenue to the insurer, negatively impacting the insurer's financial strength.

c. An inaccurate estimate of unpaid claims could lead to poor underwriting, strategic, and financial decisions, because financial results influence an insurer decisions (e.g. where to increase business and whether to exit an underperforming market).

An inaccurate estimate can have a negative impact on the insurer's decisions regarding its reinsurance needs and claims management procedures and policies.

See chapter 1

Question 3 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Key terms: case outstanding, paid claims, reported claims, incurred but not reported, ultimate claims, claims related expenses, reported and closed claim counts, claim counts closed with no payment, insurance recoverables, exposures, experience period, maturity or age, and components of unpaid claim estimates

Approach 1: Establish case O/S based on the best estimate of the ultimate settlement value of such a claim including inflation.

Approach 2: Set case O/S equal to the maximum value (i.e. the $1 million policy limit)

Approach 3: Seek the advice of legal counsel.

Assume that legal counsel estimates that there is an 80% chance that the claim will settle without payment and a 20% chance of a full policy limit claim.

1. Set the case O/S based on the mode ($0 in this case).
2. Set the case O/S based on the expected value calculation or $200,000 = [(80% x $0) + (20% x $1 million)].

Approach 4: Establish case O/S for the estimated claim amount only.

Approach 5: Establish case O/S for the estimated claim amount and all claim-related expenses.

Approach 6: Establish case O/S for ALAE (or DCC) only, Establish case O/S for ULAE (or A&O) only.

See chapter 2

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Key terms: case outstanding, paid claims, reported claims, incurred but not reported, ultimate claims, claims related expenses, reported and closed claim counts, claim counts closed with no payment, insurance recoverables, exposures, experience period, maturity or age, and components of unpaid claim estimates

When the reinsurance is proportional (i.e., quota share), insurers determine the ceded case outstanding based on the reinsurers share of the total case outstanding.

If the reinsurance is excess of loss, the reinsurance ceded case outstanding for a claim that exceeds the insurer's retention is simply the total case outstanding estimate (provided that the claims adjuster estimates the case outstanding on a total limits basis) less the insurer's retention.

See chapter 2

Question 5 discussion: Blooms: Comprehension; Difficulty 2, LO 3, KS: Mechanics associated with each technique (including organization of the data)

Date	Transaction	Reported Value of Claim to Date	Cumulative Paid to Date	Case O/S
February 20, 2009	Case 0/S of $15,000 established for claim only	$15,000	$0	$15,000
April 1, 2009	Claim payment of $1,500 - case 0/S reduced to $13,500 (case 0/S change of -$1,500)	$15,000	$1,500	$13,500
May 1, 2009	Expense payment to IA of $500; no change in case O/S	$15,500	$2,000	$13,500
September 1, 2009	Case 0/S for claim increased to $30,000 (case 0/S change of +$16,500)	$32,000	$2,000	$30,000
March 1, 2010	Claim thought to be settled with additional payment of $24,000 – case 0/S reduced to $0 and claim closed (case 0/S change of -$30,000)	**$26,000**	$26,000	0
January 25, 2011	Claim reopened with case 0/S of $10,000 for claim and $10,000 for defense costs	$46,000	$26,000	$20,000
April 15, 2011	Partial payment of $5,000 for defense litigation and case 0/S for defense costs reduced to $5,000 – no change in case 0/S for claim	$46,000	**$31,000**	$15,000
September 1, 2011	Final claim payment for an additional $12,000 case 0/S for claim reduced to $0 (case 0/S change of -$10,000)	$48,000	$43,000	**$5,000**
March 1, 2012	Final defense cost payment for an additional $6,000 – case 0/S for defense costs reduced to $0 and claim closed (case 0/S change of -$5,000)	$49,000	$49,000	$0

a. 26,000

b. 31,000

c. 5,000

See chapter 2

Question 6 discussion: Blooms: Comprehension; Difficulty 3, LO 1, KS: Statement of Principles, CAS

An actuarially sound loss reserve, for a defined group of claims as of a given valuation date, is a provision, based on estimates derived from reasonable assumptions and appropriate actuarial methods, for the unpaid amount required to settle all claims, reported or not, for which liability exists on a particular accounting date.

Question 7 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Statement of Principles

Examples include:

1. Judicial environment
2. Regulation
3. Legislative changes
4. Residual market
5. Economic variables

Question 8 discussion: Blooms: Comprehension; Difficulty 2, LO 3 KS: Mechanics associated with each technique (including organization of the data)

	At December 31, 2007			Transactions During 2008			At December 31, 2008		
Claim Number	Cumulative Paid Claims	Case O/S	Reported Claims	Paid Claims	Change in Case O/S	Reported Claims	Cumulative Paid Claims	Case O/S	Reported Claims
'(1)	'(2)	'(3)	'(4)	'(5)	'(6)	'(7)	'(8)	'(9)	'(10)
1	500	5,000	5,500	200	(1,000)	(800)	700	4,000	**4,700**
2	5,000	15,000	20,000	4,500		4,500	9,500	**15,000**	24,500
3	2,000	10,000	12,000	1,000	5,000	6,000	3,000	15,000	**18,000**

See chapter 2

Question 9 discussion:

1. Documentation should be sufficient for another actuary practicing in the same field to evaluate the work.
2. The documentation should describe clearly the sources of data, material assumptions, and methods.
3. Any material changes in sources of data, assumptions, or methods from the last analysis should be documented. The actuary should explain the reason(s) for and describe the impact of the changes.

See Section 5.2

Question 10 discussion:

1. case reserve
2. provision for future development on known claims
3. reopened claims reserve
4. provision for claims incurred but not reported
5. provision for claims in transit (incurred and reported but not recorded)

Question 11 discussion:

"Reliance on Another—An actuary who makes an actuarial communication assumes responsibility for it, except to the extent the actuary disclaims responsibility by stating reliance on another person. Reliance on another person means using that person's work without assuming responsibility therefore. A communication should define the extent of any such reliance." See section 5.8

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Types of data and their sources

* Smaller insurers may have less internal data because of a limited volume of business written or because the organizations' system does not provide such data. Thus, actuaries must turn to external sources of data.

* Large insurers who have entered a new line of insurance or have focused on a new geographical region may also need external sources of information when developing estimates of unpaid claims.

See chapter 3

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Types of data and their sources

* Volume of claim counts
* Length of time to report the claim once an insured event has occurred (i.e. reporting patterns)
* Ability to develop a case outstanding estimate from earliest report through the life of the claim
* Length of time to settle the claim (i.e. settlement, or payment, patterns)
* Likelihood of claim to reopen once it is settled
* Average settlement value (i.e. severity)
* Consistency of coverage triggered by the claims in the group (i.e. group claims subject to the same or similar laws, policy terms, claims handling, etc.)

See chapter 3

Question 14 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Types of data and their sources

* Size of claim relative to policy limits
* Size of claim relative to reinsurance limits
* Number of claims over the threshold each year
* Credibility of internal data regarding large claims
* Availability of relevant external data

See chapter 3

Question 15 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Importance of accurate estimates of unpaid claims

The actuary may choose to exclude the large claims from the initial projection and then, at the end of the unpaid claims analysis, add a case specific projection for the reported portion of large claims and a smoothed provision for the IBNR portion of large claims.

See chapter 3.

Question 16 discussion: Blooms: Comprehension; Difficulty 3

A. Step 1: Compute loss development factors (age to age and factors to ultimate):

AY	12-24	24-36	36-48	48-ULT
2002	2.0000	1.5000	1.1000	1.0500
2003	1.7500	1.4000		1.0500
2004	1.5000			1.0500
2005				1.0500
3 yr avg	1.7500	1.4500	1.1000	1.0500
Factor to Ult	**2.9309**	**1.6748**	**1.1550**	**1.0500**

Step 2: Isolate CY 2005 incurred losses from the given data

2005	2004	2003	2002
800	**900**	**980**	**$1,650**

Step 3: Compute ultimate losses and IBNR for AY's 1999 - 2002

AY	2005	2004	2003	2002
Ultimate losses	**2,345**	**1,507**	**1,132**	**1,733**
IBNR	1544.72	607.32	151.9	82.5
Total IBNR for AYs 1999 - 2002				**2386.44**

B. Step 1: Set up a table similar to the one below:

AY	EP	ELR	EL	Factor to Ult	IBNR
	(1)	(2)	(3)=(1)*(2)	(4)	**(5)=(3)*(1.0-1/(4))**
2002	$2,000	0.70	1,400	1.0500	66.67
2003	$2,000	0.70	1,400	1.1550	187.88
2004	$3,000	0.70	2,100	1.6748	846.12
2005	$3,600	0.70	2,520	2.9309	1,660.20
Total					2,760.86

(1) and (2) are given
(4) from Part A. Above

Question 17 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Organization of data: calendar year, accident year, policy year, underwriting year, report year

Advantages of CY data:

* no future development as the value remains fixed as time goes unlike claims and exposures aggregated based on accident year, policy year, and even report year bases.
* readily available because most insurers conduct financial reporting on a CY basis.

Disadvantage of calendar year data:

* cannot be used for loss development purposes.
* very few techniques for estimating unpaid claims are based on CY claims.

See chapter 3

Question 18 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Types of data and their sources

1. Have there been any changes in company operations or procedures which have caused you to depart from standard ratemaking procedures? If so, please describe those changes and how they were treated.
2. What data used for ratemaking purposes could also be used in testing unpaid claims?
3. Has there been any significant shifts in the business by type of risk or type of claim within the past several years?
4. Do you have any of the following sources of information which may be of value in reserve testing:

a. External economic indices,

b. Combined claims data for several companies (e.g., data obtainable from bureau rate filings),

c. Special rating bureau studies,

d. Changes in state laws or regulations, and

e. Size of loss or cause of loss studies?

5. Could we obtain copies of recent rate filings?
6. Were there any changes in statues, court decisions, extent of coverage that necessitated some reflection in the rate analysis?
7. How are new programs priced? If you are relying on another insurer's filing, how similar are the underlying books of business?

See chapter 4

Question 19 discussion: Blooms: Comprehension; Difficulty 3, LO 2 , KS: Development triangle as a diagnostic tool

a Step 1: Consolidate claims transaction data into incremental paid claims by CY

Claims Transaction Paid Claims Data

			Incremental Payments in Calendar Year			
Claim ID	**Accident Date**	**Report Date**	**2005**	**2006**	**2007**	**2008**
1	Jan-5-05	Feb-1-05	400	220	0	0
2	May-4-05	May-15-05	200	200	0	0
3	Aug-20-05	Dec-15-05	0	200	300	0
4	Oct-28-05	May-15-06		0	0	300
5	Mar-3-06	Jul-1-06		260	190	0
6	Sep-18-06	Oct-2-06		200	0	230
7	Dec-1-06	Feb-15-07			270	0
8	Mar-1-07	Apr-1-07			200	200
9	Jun-15-07	Sep-9-07			460	0
10	Sep-30-07	Oct-20-07			0	400
11	Dec-12-07	Mar-10-08				60
12	Apr-12-08	Jun-18-08				400
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				0
15	Oct-15-08	Feb-2-09				

a Step 2: Consolidate (sum down the column) the incremental paid claims in Step 1 into an AY incremental paid claim triangle

Incremental Paid Claim Triangle				
Accident	**Incremental Paid Claims as of (months)**			
Year	**12**	**24**	**36**	**48**
2005	600	620	300	300
2006	460	460	230	
2007	660	660		
2008	700			

a Step 3: Using the incremental paid claim triangle from Step 2, create the cumulative paid claim triangle below.

Cumulative Paid Claim Triangle				
Accident	**Cumulative Paid Claims as of (months)**			
Year	**12**	**24**	**36**	**48**
2005	600	1,220	1,520	1,820
2006	460	920	1,150	
2007	660	1,320		
2008	700			

b Step 1: Consolidate claims o/s transaction data into ending case o/s by CY

Claims Transaction Ending Case Outstanding Data						
				Ending Case Outstanding		
Claim ID	**Accident** Date	**Report** Date	2005	2006	2007	2008
1	Jan-5-05	Feb-1-05	200	0	0	0
2	May-4-05	May-15-05	300	0	0	0
3	Aug-20-05	Dec-15-05	400	200	0	0
4	Oct-28-05	May-15-06		1000	1200	1200
5	Mar-3-06	Jul-1-06		190	0	0
6	Sep-18-06	Oct-2-06		500	500	270
7	Dec-1-06	Feb-15-07		0	420	650
8	Mar-1-07	Apr-1-07			200	0
9	Jun-15-07	Sep-9-07			390	390
10	Sep-30-07	Oct-20-07			400	400
11	Dec-12-07	Mar-10-08			0	530
12	Apr-12-08	Jun-18-08				200
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				540
15	Oct-15-08	Feb-2-09				

b Step 2: Consolidate (sum down the column) the ending case o/s in Step 1 into an AY case o/s triangle

Case Outstanding Triangle				
Accident	**Case Outstanding as of (months)**			
Year	12	24	36	48
2005	900	1,200	1,200	1,200
2006	690	920	920	
2007	990	1,320		
2008	1,040			

See chapter 5

Question 20 discussion: Blooms: Comprehension; Difficulty 1, LO 2 KS: Purposes of the development triangle

a. The ratio of paid to reported helps determine whether there might have been changes in case outstanding adequacy or in settlement patterns. Determine whether there are changes in paid claims (i.e., the numerator) occurring or whether changes in case outstanding, which impact reported claims (i.e., the denominator), taking place

b. Changes in the ratio of paid-to-reported claims may be taking place, but cannot be observed, because offsetting changes in both claim settlement practices and the adequacy of case outstanding can result in no change to the ratio of paid-to-reported claims.

c. This diagnostic triangle can help to determine whether there was a speedup in claims payment or possibly deterioration in underwriting results.

See Chapter 6

Question 21 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

Factors affecting the reporting and closing of claims include:

* A change in guidelines on how claims are established
* A decrease in the statute of limitations duration (from a major tort reform action)
* Delegating higher claim settlement limits to a TPA
* Restructuring of the claim field offices (e.g. merging or adding of new offices).
* Introducing a new claim call center

A change resulting in a temporary increase in closing patterns occurs when a claim department makes an extra effort to get the backlog as low as possible before making a transition to a new system.

A speed-up due to faster processing occurs when the new system leads to a slowdown in closing, due to a learning curve necessary before the new system is fully operational.

See Chapter 6

Question 22 discussion: Blooms: Comprehension; Difficulty 1, LO , KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

Two important issues related to average values:

1. Have a clear understanding of the definition of closed and reported claim counts.

   Some insurers include claims with no payment (CNP) in the definition of closed claim counts and some include claims with no case outstanding and no payments in the definition of reported claim counts.

   Including CNPs in closed claim count statistics or claims with no case outstanding or payments in reported claim counts produces a much lower average value.

   A change in the definition of claim counts can impact the results of diagnostic analyses using claim counts and on estimation techniques that rely on the number of claims.

2. Large claims. Both the presence and absence of such claims can distort average claims. Methods to deal with large claims include:

a. Removing large claims from the database before conducting both ratio and average value calculations and handling the unpaid large claim estimate separately.

b. Use development triangles using limited claims (e.g. claims can be limited to $500,000 or $1 million per occurrence in the reported and paid claim development triangles).

See Chapter 6

Exam 5B – Independently Authored Preparatory Test 2

General information about this exam

1. This test contains 25 computational and essay questions.

2. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.

3. Consider taking this exam after working all past CAS questions, associated with the articles below, first.

4. Many of the essay questions may require lengthy responses.

5. Make sure you have a sufficient number of blank sheets of paper to record your answers.

Articles covered on exam:

Article .... Author ....Syllabus Section

Chapter 5 - The Development Triangle............................Friedland ....B: Estimating Claim Liabilities
Chapter 6 - Development Triangle as a Diagnostic Tool..Friedland ....B: Estimating Claim Liabilities

Chapter 7 – Development Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 8 – Expected Claims Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 9 – Bornhuetter-Ferguson Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 10 – Cape Cod Technique .... Friedland .... B: Estimating Claim Liabilities

Exam 5B - Independently Authored Preparatory Test 2

Question 1

(5.5 points) Based on Friedland in ""Estimating Unpaid Claims Using Basic Techniques", you are given the following data as of 12/31/08:

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**1st Report**	**2nd Report**	**3rd Report**	**4th Report**	**5th Report**	**6th Report**
4,000	2003	1,880	3,240	3,400	3,500	3,500	3,500
4,400	2004	2,400	3,380	3,420	3,600	3,600	
5,000	2005	2,500	3,450	3,600	3,900		
5,300	2006	2,800	3,100	3,800			
6,000	2007	3,000	3,800				
6,300	2008	4,500					

a. Estimate the IBNR as of 12/31/08 using the Development Technique
To select claim development factors, use the volume-weighted averages for the latest three years.

b. Using the data above and based on the discussion by Friedland, what is the 12-24 month age-to-age factor using:
(i) Simple (arithmetic) average of the last three years
(ii) Geometric average of the last four years
(iii) Medial average for the latest five years excluding one high and low value, "Medial latest 5x1"

c. Estimate the IBNR as of 12/31/08 using the Expected Claims Technique.
Use an Expected Claim Ratio = 80% for all years.
To select claim development factors, use the volume-weighted averages for the latest three years.

d. Estimate the IBNR as of 12/31/08 using the Bornhuetter-Ferguson Technique

Use Expected Claim Ratio = 80% for all years.
To select claim development factors, use the volume-weighted averages for the latest three years.

e. Show that the Bornhuetter-Ferguson method produces Ultimate Claims that are a credibility weighting between the Development method and the Expected Claims method.

f. Estimate the IBNR as of 12/31/08 using the Cape Cod Technique
To select claim development factors, use the volume-weighted averages for the latest three years.

Question 2

(1.25 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe the underlying assumption made when using the development technique and four other key assumptions associated with this technique.

Question 3

(2 points). Based on the following information:

Accident Year	Case Incurred Losses at 12/31/02	Calendar Year Earned Premium	Development Factor to Ultimate at 12/31/02
2002	30,000	150,000	4.00
Expected Loss Ratio =		0.75	

a. (.75 points). What is the Bornhuetter-Ferguson IBNR estimate at 12/02?

b. (.75 points). What is the Chain Ladder IBNR estimate at 12/02?

c. (.75 points). What is the Benktander IBNR estimate at 12/02?

Question 4

(1 point). Based on the following information for Accident Year 2003 at 12 months of development:

Method	Reserve Estimate
Chain Ladder	8.50
Bornhuetter Ferguson	10.72
Expected Loss Ratio	12.20

Estimated % of claims paid at 12 months .35%

Estimate the Benktander reserve $R_{GB.}$

Question 5

(2 points) Friedland in "Estimating Unpaid Claims Using Basic Techniques" describes two approaches to employing case outstanding development methods:

1. Accident year Case Outstanding Development Technique - Approach #1
2. Accident Year Case Outstanding Development Technique using Industry Benchmark Factors - Approach #2

a. (.50 point) What are the key assumptions under the Approach #1 technique?

b. (.50 points) Key limitation when using the case O/S development technique

c. (1 point) What are the key assumptions under the Approach #2 technique?

Question 6

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe two reasons why selection of a tail factor is of utmost importance.

Question 7

(1.50 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", answer the following questions:

a. (0.75 points) List and briefly describe the type of insurance environment and types of claims experience in which the development technique works well.

b. (0.75 points) Describe two examples when the development

Question 8

(1.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, list and briefly describe three situations in which the expected claims method is often used.

Question 9

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, list and briefly describe two methods for selecting expected claim ratios using the expected claims method.

Question 10

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, briefly describe one advantage and one disadvantage to using the expected claims method.

Question 11

(1.50 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, answer the following questions:

a. (0.50 points) What techniques are the Bornhuetter-Ferguson Technique a blend of?

b. (0.50 points) How are weights distributed to these two techniques?

c. (0.50 points) Why was the Bornhuetter-Ferguson Technique developed?

Question 12

(1.50 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, list three scenarios in which the BF technique is most often used.

Question 13

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, the Benktander method is an iterative BF method. The only difference in the two methods is the derivation of the expected claims. Describe the difference in how expected claims are derived in the BF and the Benktander methods.

Question 14

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, answer the following questions:

a. (.50 points) Briefly describe the key assumption underlying the Cape Cod Technique.

b. (.50 points) How does this assumption differ from the primary assumption underlying the development method?

Question 15

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, briefly describe one advantage over the development technique and one disadvantage relative to the BF technique to using the Cape Cod method

Question 16

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, briefly describe data adjustments that are recommended when using the Cape Cod technique.

Question 17

(1.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, there are three important dimensions in a development triangle: Row; Diagonals; and Columns

Briefly describe what each represents for a triangle comprised of four accident years beginning with AY 20XX

Question 18

(2.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, you are given the following information:

Table 5 – Detailed Example – Claims Transaction Data

			2005 Transactions		2006 Transactions		2007 Transactions		2008 Transactions	
Claim ID	Accident Date	Report Date	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S	Total Payments	Ending Case 0/S
1	Jan-5-05	Feb-1-05	400	200	220	0	0	0	0	0
2	May-4-05	May-15-05	200	300	200	0	0	0	0	0
3	Aug-20-05	Dec-15-05	0	400	200	200	300	0	0	0
4	Oct-28-05	May-15-06			0	1,000	0	1,200	300	1,200
5	Mar-3-06	Jul-1-06			260	190	190	0	0	0
6	Sep-18-06	Oct-2-06			200	500	0	500	230	270
7	Dec-1-06	Feb-15-07					270	420	0	650
8	Mar-1-07	Apr-1-07					200	200	200	0
9	Jun-15-07	Sep-9-07					460	390	0	390
10	Sep-30-07	Oct-20-07					0	400	400	400
11	Dec-I2-07	Mar-10-08							60	530
12	Apr-12-08	Jun-18-08							400	200
13	May-28-08	Jul-23-08							300	300
14	Nov-12-08	Dec-5-08							0	540
15	Oct-15-08	Feb-2-09								

Compute the following:

a. the amount the insurer paid during CY 2005 during the first 12 months for AY 2005

b. the amount the insurer paid during the second 12 months (CY 2006) for AY 2005

c. the amount the insurer paid during the 3rd and 4th 12 months periods (CY 2007 and CY 2008) for AY 2005

d. the amount the insurer paid during the CY 2006 for accidents occurring during 2006

e. the amount the insurer paid during the CY 2007 for accidents occurring during 2006

Question 19

(1.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, claim count and loss development can be positive or negative. Briefly describe how claims counts and loss development can develop in a negative manner.

Question 20

(3.0 points) Use the procedure described by Friedland in "Estimating Unpaid Claims Using Basic Techniques" to answer the following questions:

Table 9 – Detailed Example – Claims Transaction Ending Case Outstanding Data						
			Ending Case Outstanding			
Claim ID	**Accident** Date	**Report** Date	2005	2006	2007	2008
1	Jan-5-05	Feb-1-05	200	0	0	0
2	May-4-05	May-15-05	300	0	0	0
3	Aug-20-05	Dec-15-05	400	200	0	0
4	Oct-28-05	May-15-06		1,000	1,200	1,200
5	Mar-3-06	Jul-1-06		190	0	0
6	Sep-18-06	Oct-2-06		500	500	270
7	Dec-1-06	Feb-15-07			420	650
8	Mar-1-07	Apr-1-07			200	0
9	Jun-15-07	Sep-9-07			390	390
10	Sep-30-07	Oct-20-07			400	400
11	Dec-12-07	Mar-10-08				530
12	Apr-12-08	Jun-18-08				200
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				540
15	Oct-15-08	Feb-2-09				

a. Compute Case O/S for AY 2005 at 12 months

b. Compute Case O/S for AY 2005 at 24 months

c. Compute Case O/S for AY 2005 at 36 months

d. Compute Case O/S for AY 2006 at 12 months

e. Compute Case O/S for AY 2006 at 24 months

f. Compute Case O/S for AY 2006 at 36 months

Question 21

(2.5 points) Using the procedure described by Friedland in “Estimating Unpaid Claims Using Basic Techniques”, and the data below, create a reported claim count triangle for AYs 2005 - 2008

Table 5 – Detailed Example – Claims Transaction Data

			2005 Transactions		2006 Transactions		2007 Transactions		2008 Transactions	
Claim ID	Accident Date	Report Date	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S
1	Jan-5-05	Feb-1-05	400	200	220	0	0	0	0	0
2	May-4-05	May-15-05	200	300	200	0	0	0	0	0
3	Aug-20-05	Dec-15-05	0	400	200	200	300	0	0	0
4	Oct-28-05	May-15-06			0	1,000	0	1,200	300	1,200
5	Mar-3-06	Jul-1-06			260	190	190	0	0	0
6	Sep-18-06	Oct-2-06			200	500	0	500	230	270
7	Dec-1-06	Feb-15-07					270	420	0	650
8	Mar-1-07	Apr-1-07					200	200	200	0
9	Jun-15-07	Sep-9-07					460	390	0	390
10	Sep-30-07	Oct-20-07					0	400	400	400
11	Dec-I2-07	Mar-10-08							60	530
12	Apr-12-08	Jun-18-08							400	200
13	May-28-08	Jul-23-08							300	300
14	Nov-12-08	Dec-5-08							0	540
15	Oct-15-08	Feb-2-09								

Question 22

(2.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic, types of claims data commonly appearing in development triangles include:

* Reported claims
* Case O/S
* Cumulative total paid claims
* Cumulative paid claims on closed claim counts
* Incremental paid claims Reported claim counts
* Claim counts on closed with payment
* Claim counts on closed with no payment
* Total closed claim counts
* O/S claim counts

Using the data types above, describe 5 types of triangles of ratios and average claim values that actuaries often analyze.

Question 23

(2.0 points) According to Friedland in “Estimating Unpaid Claims Using Basic, actuaries often review the ratio of paid claims to on-level earned premiums. You are given the following triangle

Table 7 - Ratio of Cumulative Paid Claims to On-Level Earned Premium

Accident	Ratio of Cumulative Paid Claims to On-Level Earned Premium as of (months)						
Year	12	24	36	48	60	72	84
2002	0.041	0.142	0.247	0.395	0.571	0.727	0.795
2003	0.029	0.104	0.211	0.38	0.573	0.653	
2004	0.028	0.123	0.323	0.54	0.657		
2005	0.031	0.126	0.278	0.412			
2006	0.051	0.171	0.331				
2007	0.071	0.238					
2008	0.071						

a. What does this diagnostic triangle help the actuary determine?

b. Identify one notable observation occurring in the data.

c. State one question that an actuary may wish to explore based on your response to b.

d. What type of additional data may an actuary need to answer the question posed in c.?

Question 24

(1.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic, actuaries often review triangles of reported and closed claim counts.

However, before commencing the analysis of the claim count development triangles, it is important that the actuary understand the types of data contained within such triangles.

State three questions an actuary should ask before analyzing reported and closed claim counts.

Question 25

(1.0 point) According to Friedland in “Estimating Unpaid Claims Using Basic, actuaries often review triangles of average case outstanding.
State two questions an actuary should ask before analyzing case outstanding adequacy.

Solutions to Exam 5B - Independently Authored Preparatory Test 2

Question 1 discussion: Blooms: Comprehension; Difficulty 3 LO 5,

1a. Estimate the IBNR as of 12/31/08 using the Development Technique

To select claim development factors, use the volume-weighted averages for the latest three years.

		Reported Claims including ALAE ($000's omitted)					
Earned Premium	**Accident Year**	**1st Report**	**2nd Report**	**3rd Report**	**4th Report**	**5th Report**	**6th Report**
4,000	2003	1,880	3,240	3,400	3,500	3,500	3,500
4,400	2004	2,400	3,380	3,420	3,600	3,600	
5,000	2005	2,500	3,450	3,600	3,900		
5,300	2006	2,800	3,100	3,800			
6,000	2007	3,000	3,800				
6,300	2008	4,500					

Selected CDF calculations	***1st to 2nd Report***	***2nd to 3rd Report***	***3rd to 4th Report***	***4th to 5th Report***	***5th to 6th Report***
ATA: 3-yr Volume-weighted average	*1.25*	***1.09****	*1.06*	*1.00*	*1.00*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.43*	***1.15*****	*1.06*	*1.00*	*1.00*

** Example of Age-to-Age calculation for 2nd to 3rd report, using 3-year volume-weighted average:*
(3800+3600+3420)/(3100+3450+3380) = 1.0897 or 1.09 as shown

*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.090 for 2nd-to-3rd) * (1.056 for 3rd-to-4th) * (1.00 for 4th-to-5th) * (1.0 tail) = 1.15*

Accident Year	***Age of Data at 12/31/08***	***Reported Claims at 12/31/08***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
2003	*72 months*	*3,500*	*1.00*	*3,500*	*0*		*0*
2004	*60 months*	*3,600*	*1.00*	*3,600*	*0*		*0*
2005	*48 months*	*3,900*	*1.00*	*3,900*	*0*		*0*
2006	*36 months*	*3,800*	*1.06*	*4,012*	*212*		*212*
2007	*24 months*	*3,800*	*1.15*	*4,371*	*571*		*571*
2008	*12 months*	*4,500*	*1.43*	*6,455*	*1,955*		*1,955*
Total					***2,737***		***2,737***

1b. What is the 12-24 month age-to-age factor using:

(i) 12-24 month age-to-age factor using Simple (arithmetic) average of the last three years =1.25

(ii) 12-24 month age-to-age factor using Geometric average of the last four years =1.28

(iii) 12-24 month age-to-age factor using Medial latest 5x1 =1.35

Age-to-Age Development Factors by Accident Year

Note: Did not need these "Link Ratios" to calculate the volume-weighted ATA selections:

ATA factors by AY:

Example:
12:24 month ATA
for AY 2005 =
(3450)/(2500) = 1.38
between 1st and 2nd
annual valuation dates

Accident Year	1st to 2nd Report	2nd to 3rd Report	3rd to 4th Report	4th to 5th Report	5th to 6th Report
	12:24 mo	**24:36 mo**	**36:48 mo**	**48:60 mo**	**50:72 mo**
2003	1.723	1.049	1.029	1.000	1.000
2004	1.408	1.012	1.053	1.000	
2005	1.380	1.043	1.083		
2006	1.107	1.226			
2007	1.267				

Alternative ATA Selections	*12:24 mo*	*Calculation Details*
3-year Simple (Arithmetic) Average	*1.25*	*= (1.380+1.107+1.267)/3*
4-year Geometric Average	*1.28*	*= (1.408*1.38*1.107*1.267)^(1/4)*
"Medial latest 5x1"	*1.35*	*= (1.408+1.38+1.267)/3*

Note: "Medial latest 5x1" excludes the highest and lowest values (1.723 and 1.107) in 5-yr period

1c. Estimate the IBNR as of 12/31/08 using the following method: Expected Claims Technique.

Accident Year	*Earned Premium*	*Expected Claim Ratio*	*Expected Claims (Ultimate)*	*Reported Claims at 12/31/2008*	*IBNR (broadly defined)*
	(1)	*(2)*	*(3)=(1)*(2)*	*(4) given*	*(5)=(4)-(3)*
2003	*4,000*	*80.00%*	*3,200*	*3,500*	*-300*
2004	*4,400*	*80.00%*	*3,520*	*3,600*	*-80*
2005	*5,000*	*80.00%*	*4,000*	*3,900*	*100*
2006	*5,300*	*80.00%*	*4,240*	*3,800*	*440*
2007	*6,000*	*80.00%*	*4,800*	*3,800*	*1000*
2008	*6,300*	*80.00%*	*5,040*	*4,500*	*540*
Total					***1,700***

1d. Estimate the IBNR as of 12/31/08 using the following method: Bornhuetter-Ferguson

Selected CDF calculations	***1st to 2nd Report***	***2nd to 3rd Report***	***3rd to 4th Report***	***4th to 5th Report***	***5th to 6th Report***
ATA: 3-yr Volume-weighted average	*1.25*	***1.09****	*1.06*	*1.00*	*1.00*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.43*	***1.15*****	*1.06*	*1.00*	*1.00*

** Example of Age-to-Age calculation for 2nd to 3rd report, using 3-year volume-weighted average:*
(3800+3600+3420)/(3100+3450+3380) = 1.0897 or 1.09 as shown

*** Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.090 for 2nd-to-3rd) * (1.056 for 3rd-to-4th) * (1.00 for 4th-to-5th) * (1.0 tail) = 1.15*

Accident Year	***Age of Data at 12/31/08***	***Reported CDF to Ultimate***	***Percent Reported 12/31/08***	***Percent Unreport 12/31/08***
	(1)	*(2) above*	*(3)=1.0/(2)*	*(4)=1.-(3)*
2003	*72 months*	*1.00*	*100.0%*	*0.0%*
2004	*60 months*	*1.00*	*100.0%*	*0.0%*
2005	*48 months*	*1.00*	*100.0%*	*0.0%*
2006	*36 months*	*1.06*	*94.7%*	*5.3%*
2007	*24 months*	*1.15*	*86.9%*	*13.1%*
2008	*12 months*	*1.43*	*69.7%*	*30.3%*
Total				

Note: The Percent Unreported
= 1 minus inverse of Ult. CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or Shortcut using Expected Claims * Percent Unreported*	***IBNR (broadly defined)***
	(5) given	*(6) given*	*(7)=(5)*(6)*	*(8)=(7)*(4)*		*(8)=(5)*(6)*[1.0-1.0/CDF]*
2003	*4,000*	*80.0%*	*3,200*	*0*		*0*
2004	*4,400*	*80.0%*	*3,520*	*0*		*0*
2005	*5,000*	*80.0%*	*4,000*	*0*		*0*
2006	*5,300*	*80.0%*	*4,240*	*224*		*224*
2007	*6,000*	*80.0%*	*4,800*	*627*		*627*
2008	*6,300*	*80.0%*	*5,040*	*1,526*		*1,526*
Total				***2,377***		***2,377***

1e. Show that the Bornhuetter-Ferguson method produces Ultimate Claims that are a credibility weighting between the Development method and the Expected Claims method.

b. Since Expected Ultimate Claims = Actual Reported + Expected Unreported:

		Bornhuetter-Ferguson "B-F"			Development Method	Expected Claims	Credibility Weighted
Accident Year	*Reported Claims at 12/31/08*	*"IBNR" Expected Unreport*	*Expected Ultimate Claims*	*Credibility to "Actual" by B-F*	*Expected Ultimate Claims*	*Expected Ultimate Claims*	*Expected Ultimate Claims*
	(9)	*(10)=(8)*	(11)=(9)+(10)	*(12)=(3)*	*(13) Ch 7.*	*(14) Ch. 8*	*(15)*
2003	*3,500*	*0*	*3,500*	*100.0%*	*3,500*	*3,200*	*3,500*
2004	*3,600*	*0*	*3,600*	*100.0%*	*3,600*	*3,520*	*3,600*
2005	*3,900*	*0*	*3,900*	*100.0%*	*3,900*	*4,000*	*3,900*
2006	*3,800*	*224*	*4,024*	*94.7%*	*4,012*	*4,240*	*4,024*
2007	*3,800*	*627*	*4,427*	*86.9%*	*4,371*	*4,800*	*4,427*
2008	*4,500*	*1,526*	*6,026*	*69.7%*	*6,455*	*5,040*	*6,026*
Total			***25,477***	*(15) = (12)*(13) + [1.0-(12)]*(14)*			***25,477***
(13) & (14) See details in Ch. 7 & Ch. 8 Q & A.				*Matches B-F Expected Ultimate Claims in (11)*			

Note: Credibility assigned to Development Method (relies on "actual" reported losses) = % reported. Compliment of credibility assigned to Expected Claim technique.

1f. Estimate the IBNR as of 12/31/08 using the Cape Cod Technique

Selected CDF calculations	*1st to 2nd Report*	*2nd to 3rd Report*	*3rd to 4th Report*	*4th to 5th Report*	*5th to 6th Report*
ATA: 3-yr Volume-weighted average	*1.25*	***1.09****	*1.06*	*1.00*	*1.00*
Note: 1st report at 12 months	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***
Reported CDF to Ultimate	*1.43*	***1.15*****	*1.06*	*1.00*	*1.00*

Accident Year	***Adjusted Premium if avail.****	***Reported CDF to Ultimate***	***Percent Reported to date***	***Used-Up Premium to date***	***Reported Claims as avail.****	"CC" Estimated Claim Ratio
	(1) given	*(2) above*	*(3)=1.0/(2)*	*(4)=(1)*(3)*	*(5) given*	*(6)=(5)/(4)*
2003	*4,000*	*1.00*	*100.0%*	*4,000*	*3,500*	*see total*
2004	*4,400*	*1.00*	*100.0%*	*4,400*	*3,600*	*see total*
2005	*5,000*	*1.00*	*100.0%*	*5,000*	*3,900*	*see total*
2006	*5,300*	*1.06*	*94.7%*	*5,021*	*3,800*	*see total*
2007	*6,000*	*1.15*	*86.9%*	*5,216*	*3,800*	*see total*
2008	*6,300*	*1.43*	*69.7%*	*4,392*	*4,500*	*see total*
Total	*31,000*			*28,029*	*23,100*	**82.42%**

*** The Cape Cod technique allows/prefers use of "adjusted" data where available.*

(4) Used-Up premium also equals (1)/(2): Adjusted Premium divided by Ult. CDF

(6) " … method requires the use of the weighted average claim ratio from all years.'

Accident Year	***"CC" Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using C.C. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(6) total	*(7)=(1)*(6)*	*(8)=(7)*[1-(3)]*	*(8)=(Prem)*(CC %)*[1.0-1.0/CDF]*	
2003	*82.4%*	*3,297*	*0*		*0*
2004	*82.4%*	*3,626*	*0*		*0*
2005	*82.4%*	*4,121*	*0*		*0*
2006	*82.4%*	*4,368*	*230*		*230*
2007	*82.4%*	*4,945*	*646*		*646*
2008	*82.4%*	*5,192*	*1,572*		*1,572*
Total			*2,449*		*2,449*

Note: See Ch. 9 Q&A. If B-F claim ratio = "CC" claim ratio, results would be identical.

Question 2 discussion: Blooms: Comprehension; Difficulty 1 LO 3, KS: Assumptions of each estimation technique, KS:

The underlying assumption in the development technique is that claims recorded to date will continue to develop in a similar manner in the future (i.e. the past is indicative of the future).

Other key assumptions of the development method include:

* consistent claim processing,
* a stable mix of types of claims,
* stable policy limits, and
* stable reinsurance (or excess insurance) retention limits throughout the experience period.

Question 3 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Mechanics associated with each technique (including organization of the data)

Method	Estimated IBNR
1. Bornhuetter-Ferguson: EP*ELR*(1-1/LDF)	**84,375**
2. Chain Ladder: Losses * LDF	**90,000**
3. Pk (credibility to CL, % reported)	0.25
4. Pk (credibility to BF, % unreported)	0.75
5. Benktander Reserve (Hovinien calc): 2.*3. +1.*4.	**85,781**
Alternative calculation for Benktander # 1	
6. Bornhuetter-Ferguson ultimate: 1. + case incurred	114,375
7. Benktander Reserve: 6. * 4.	**85,781**
Alternative calculation for Benktander # 2	
8. A prior ultimate: EP * ELR	112,500
9. Chain Ladder ultimate	120,000
	0.25
	0.75
10. Credibility to CL: 1 - 4.^2	0.4375
11. Credibility to BF: 4.^2	0.5625
12. Benktander Ultimate	115,781
13. Benktander Reserve	**85,781**

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS:

Using the Hovinen method:

$q_k R_{BF} + (1 - q_k) R_{CL}$

(.35 x 8.5) + (.65 x 10.72) = 9.943

Question 5 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

a. Key assumptions

Claims activity related to IBNR is related in a consistent manner to claims already reported.

Assumptions similar to those for the development techniques also apply to the case outstanding (O/S) development technique.

b. Key limitation when using the case O/S development technique is the assumption that future IBNR is related to claims already reported does not hold true for many lines of insurance.

c1. The assumptions regarding the development technique are applicable in this example.

c2. Claims recorded to date will develop in a similar manner in the future as our industry benchmark (i.e., the historical industry experience is indicative of the future experience for the self-insurer). Thus, industry-based reporting and payment development patterns are used to derive case O/S development patterns.

Question 6 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: The claim process

1. It influences the unpaid claim estimate for all accident years (in the experience period).
2. It can have a disproportionate amount of leverage on the total estimated unpaid claims.

Question 7 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: When each techniques works and when it does not

a1. The development method is appropriate for insurers in a stable environment.

a2. The development technique requires a large volume of historical claims experience.

a3. It works best when the presence or absence of large claims does not greatly distort the data.

b. The development technique may not be suitable when there is not a sufficient volume of credible data, as in the following situations:

b1. When entering a new line of business or new territory

b2. For smaller insurers with limited portfolios.

Question 8 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: The claim process

1. when an insurer enters a new line of business or a new territory.
2. when operational or environmental changes make recent historical data irrelevant for projecting future claims activity for that cohort of claims.
3. for the most recent years in the experience period, since cumulative CDFs are highly leveraged.
4. when data is unavailable for other methods
5. for the latest year in the experience period after major changes in the legal environment take place.

Question 9 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: The claim process

1. Use insurance industry experience for benchmark claim ratios.
2. Use an average of the projected ultimate unadjusted reported and paid claims to earned premium ratios using the development method.

Question 10 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: The claim process

An advantage to using the expected claims technique is that the technique maintains stability over time since actual claims do not enter into the calculations. This is because the claim ratios can be judgmentally adjusted based on historical experience due to a belief that either the pricing or underwriting or both are changing.

A disadvantage is that it is not responsive when actual claims experience differs from the initial expectations.

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

a. It is a blend of the development and expected claims techniques, by splitting ultimate claims into two components: actual reported (or paid) claims and expected unreported (or unpaid) claims.

b. It gives more weight to actual claims as experience matures, and less weight to expected claims .

c. It was developed to overcome the problems with the development and expected claims technique.

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

1. For the most immature years associated with long-tail lines of insurance, due to the highly leveraged nature of claim development factors for such lines.
2. If the data is extremely thin or volatile or both. For example, when an insurer enters a new line of business or a new territory and there is not yet a credible volume of historical claim development experience. The actuary would likely need to rely on benchmarks, either from similar lines at the same insurer or insurance industry experience, for development patterns and expected claim ratios (or pure premiums).
3. For very short-tail lines, where the IBNR can be set equal to a multiple of the last few months EP.

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

For the BF method, expected claims equal an expected claim ratio time earned premium.

For the Benktander technique, expected claims are the projected ultimate claims from an initial BF projection (thus, the reference to the Benktander method as an iterative BF method). Also, the Benktander projection of ultimate claims will approach the projected ultimate claims produced by the development technique after sufficient iterations.

Question 14 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

a. The key assumption: Unreported claims will develop based on expected claims, which are computed using reported (or paid) claims and earned premium.

   This is also the same assumption underlying the BF method.

b. This assumption differs from the primary assumption under the development method, which is unreported claims will develop based on reported claims to date.

Question 15 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: When each techniques works and when it does not

An advantage of the Cape Cod method (over the development technique) is that it may not be distorted by random fluctuations early in the development of an AY.

A shortcoming of the Cape Cod method compared to the BF technique is that it is not necessarily as appropriate as the BF method if the data is extremely thin or volatile or both.

Since expected claims are based on reported claims to date, there must be a sufficient volume of credible reported claims to derive a reliable expected claims estimate.

Question 16 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

1. EP adjustments. Include using historical rate level changes to adjust historical premiums to an on-level basis.
2. Claims would also be adjusted for trend, benefit-level changes, and other similar factors.

Question 17 discussion: Blooms: Comprehension; Difficulty 1, LO 2, KS: Purposes of the development triangle

Each row in the triangle represents one AY. By grouping the data into AYs, each row consists of a fixed group of claims.

Each subsequent diagonal in the reported claim triangle represents a successive valuation date.

The first diagonal, which starts in the upper left corner of the triangle, is at a December 31, 20XX valuation date and represents accident year 20XX at 12 months of maturity.

The second diagonal in the triangle is at the December 31, 20XX+1.

The last diagonal of the triangle, at a valuation date of December 31, 20XX+3

Each column in the claim development triangle represents an age (or maturity) and is directly related to the combination of accident year (row) and valuation date (diagonal) used to create the triangle. In our example, we present accident year data using annual valuations, and thus the ages in the columns are 12 months, 24 months, 36 months, and 48 months. Different valuations can be used by the actuary (e.g., 6 months, 12 months, 18 months, etc.). See Chapter 5

Question 18 discussion: Blooms: Comprehension; Difficulty 2 LO 2, KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

Compute the following:

a. the amount the insurer paid during CY 2005 during the first 12 months for AY 2005
b. the amount the insurer paid during the second 12 months (CY 2006) for AY 2005
c. the amount the insurer paid during the 3rd and 4th 12 months periods (CY 2007 and CY 2008) for AY 2005
d. the amount the insurer paid during the CY 2006 for accidents occurring during 2006
e. the amount the insurer paid during the CY 2007 for accidents occurring during 2006

a, b, c. For claims that occurred during 2005, the insurer paid a total of:

- $600 (400 +200) during the first 12-month period (2005),
- $620 (220+200+200) during the second 12-month period (2006), and
- $300 in each of the following two 12-month periods (2007 and 2008).

d. and e, For claims that occurred during CY 2006, the insurer paid

- $460 (260+200) during CY 2006,
- $460 (190+270) during CY 2007 and

See Chapter 5

Question 19 discussion: Blooms: Comprehension; Difficulty 1, LO 2, KS: Development triangle as a diagnostic tool

(1.5 points) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, claim count and loss development can be positive or negative. Briefly describe how claims counts and loss development can develop in a negative manner.

- the number of claims can decrease from one valuation point to another (see chapter 11, private passenger auto collision coverage)
- reported claim development can show downward patterns if the insurer:
  i. settles claims for a lower value than the case O/S estimate or
  ii. includes recoveries with the claims data.

See Chapter 5

Question 20 discussion: Blooms: Comprehension; Difficulty 3, LO 2, KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

Table 10 – Case Outstanding Triangle

Accident	**Case Outstanding as of (months)**			
Year	12	24	36	48
2005	900	1,200	1,200	1,200
2006	690	920	920	
2007	990	1,320		
2008	1,040			

Case O/S for AY 2005 at 12 months is computed by adding the ending case O/S values for Claim IDs 1, 2, and 3 (200+300+400) to derive the case O/S value of $900.

Claim ID 4 case O/S is not included since it is not reported until 5/15/2006.

Case O/S for AY 2005 at 24 months equal case O/S values for Claim IDs 3 and 4 or $1,200 ($200 + $1,000).

Note that case O/S for Claim IDs 1 and 2 are both $0 at December 31, 2006.

Case O/S for AY 2005 at 36 months and 48 months equal the ending case O/S for Claim ID 4 of $1,200.

Case O/S for AY2006 at 12 months (i.e., valuation date December 31, 2006) equals $690 which is equal to the sum of the ending case O/S for Claim IDs 5 and 6 ($190 + $500).

Case O/S at 24 months equals the sum of case O/S on all three AY 2006 claims ($0 + $500 + 420).

Case O/S for AY 2006 at 36 months equals $920 which is equal to the case O/S for Claim IDs 6 and 7

See Chapter 5

Question 21 discussion: Blooms: Comprehension; Difficulty 2, LO 2, KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

The data in Table 5 can be used to build a reported claim count triangle. A description of how to build the claim count development triangle by using AYs 2005 and 2008 follows.

Table 12 — Reported Claim Count Development Triangle

Accident	Reported Claim Counts as of (months)			
Year	12	24	36	48
2005	3	4	4	4
2006	2	3	3	
2007	3	4		
2008	3			

There are 4 claims for 2005, but only 3 of them were reported as of 12/31/2005.

Thus, the first cell in the reported claim count triangle which represents AY2005 as of 12/31/2005 shows 3 claims reported.

By 12/31/2006, all 4 claims were reported.

No further claims were reported for AY 2005, and thus the number of reported claims remains unchanged at 4 for ages 36 months and 48 months.

There are 4 claims for AY 2008, but as of 12 months, only 3 claims were reported for AY 2008 (claim ID 15 was not reported until 2009 and thus is not included in the triangle).

See Chapter 5

Question 22 discussion: Blooms: Comprehension; Difficulty 1, LO 2 , KS: Purposes of the development triangle

Actuaries use the data types previously listed to create triangles of ratios and average claim values, which include:

* Ratio of paid-to-reported claims
* Ratio of total closed claim counts-to-reported claim counts
* Ratio of claim counts on closed with payment-to-total closed claim counts
* Ratio of claim counts on closed without payment-to-total closed claim counts
* Average case O/S (case O/S divided by O/S claim counts)
* Average paid on closed claims (cumulative paid claims on closed claims divided by claim counts closed with payment)

  Cumulative paid claims on closed claim counts may be difficult to obtain; Actuaries may determine that interim or pre-closing payments are immaterial enough to justify the inexact match from including all payments, even those from open claims/closed claim counts.
* Average paid (cumulative total paid claims divided by total closed claim counts)
* Average reported (reported claims divided by reported claim counts)

See Chapter 5

Question 23 discussion: Blooms: Comprehension; Difficulty 1, LO 2, KS: Examples and uses of diagnostic development triangles: * Claim and claim count * Ratio of premium to claims * Average values * Ratios of claims and counts

a. What does this diagnostic triangle help the actuary determine?

   This diagnostic triangle can help to determine whether there was a speedup in claims payment or possibly deterioration in underwriting results.

b. Identify one notable observation occurring in the data.

   There seems to be evidence of a possible speed-up in payments, particularly at 12 and 24 months.

c. State one question that an actuary may wish to explore based on your response to b.

   Has there been a shift in the type of claim settled at each age?

d. What type of additional data may an actuary need to answer the question posed in c.?

   Reported and closed claim counts development diagnostic triangles are needed for further review.

See Chapter 6

Question 24 discussion: Blooms: Comprehension; Difficulty 1, LO 2, KS: Purposes of the development triangle

1. How does the insurer treat reopened claims? Are they coded as a new claim or is a previously closed claim re-opened? If the insurer treats reopened claims in the latter, there could potentially be a decrease across a row in the closed claim count development triangle.
2. Does the insurer include claims closed with no payment (CNP) in the reported and closed claim count triangles?
3. How are claims classified that have only expense payments and no claim payment?

See Chapter 6

Question 25 discussion: Blooms: Comprehension; Difficulty 1, LO 2 KS: Purposes of the development triangle

1. Has there been a change in case outstanding practices, policies, philosophy, staff, or senior management of the claims department?
2. Has there been changes in the mix of business in the portfolio that have nothing to do with changes in case outstanding strength?

See Chapter 6

Exam 5B – Independently Authored Preparatory Test 3

General information about this exam

1. This test contains 23 computational and essay questions.
2. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.
3. Consider taking this exam after working all past CAS questions, associated with the articles below, first.
4. Many of the essay questions may require lengthy responses.
5. Make sure you have a sufficient number of blank sheets of paper to record your answers.

Articles covered on exam:

Article	Author	Syllabus Section
Chapter 1 – Overview	Friedland	B: Estimating Claim Liabilities
Chapter 2 – The Claims Process	Friedland	B: Estimating Claim Liabilities
Chapter 3 – Understanding the Types of Data Used	Friedland	B: Estimating Claim Liabilities
Chapter 4 - Meeting with Management	Friedland	B: Estimating Claim Liabilities
Chapter 11 – Frequency-Severity Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 12 – Case Outstanding Development Technique	Friedland	B: Estimating Claim Liabilities
Chapter 13 – Berquist-Sherman Techniques	Friedland	B: Estimating Claim Liabilities

Question 1

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe two key assumptions underlying the use of FS Approach #1 – Development Method with Claim Counts and Severities. Provide an example supporting each assumption.

Question 2

a. (1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe three advantages to using a Frequency-Severity Technique.

b. (1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list and briefly describe three disadvantages to using a Frequency-Severity Technique.

Question 3

(5.0 points) Use the Frequency-Severity Development technique, along with the data below, to answer the following questions.

Note: No adjustments for exposures or severity trend are needed to be made.

3a. Given the following data, project ultimate claim counts for accident years 2004 - 2008

Use a 3-period simple average to select age-to-age factors.

Assume a 1.002 tail factor after 60 months.

		Reported Claim Counts: Data Triangle				
Accident Year	**Period Ending**	**1st report 12 mo.**	**2nd report 24 mo.**	**3rd report 36 mo.**	**4th report 48 mo.**	**5th report 60 mo.**
2004	31-Dec	1,932	2,168	2,234	2,249	2,258
2005	31-Dec	2,067	2,293	2,367	2,390	
2006	31-Dec	1,473	1,645	1,657		
2007	31-Dec	1,192	1,264			
2008	31-Dec	1,036				

3b. Given this additional data, project ultimate claim severities for accident years 2004 - 2008

		Reported Claims ($000s): Data Triangle				
Accident Year	**Period Ending**	**1st report 12 mo.**	**2nd report 24 mo.**	**3rd report 36 mo.**	**4th report 48 mo.**	**5th report 60 mo.**
2004	31-Dec	16,995	40,180	58,866	71,707	74,002
2005	31-Dec	28,674	47,432	70,340	70,655	
2006	31-Dec	27,066	46,783	48,804		
2007	31-Dec	19,477	31,732			
2008	31-Dec	18,632				

Use a 2-period simple average to select age-to-age factors.

Assume a 10% tail factor after 60 months.

3c. Project ultimate claim severities for accident years 2004 – 2008.

3d. Calculate IBNR estimates for accident years 2004 – 2008.

Question 4

(4 points) You are given the following information:

- Annual Average Severity Trend: 5%
- Tort reform factors: AY 2005 = 0.67; AY 2006 = 0.75; AYs 2007-2008 = 1.00
- Reported claims through 12/31/2008 for AY 2008 = 6,669
- Annual Average Severity Trend: 5%

Accident Year	Incremental Closed Claim Counts (months of development)				Ultimate Claim Counts
	0 to 12	*12 to 24*	*24 to 36*	*36 to 48*	
2005	295	824	545	282	2,402
2006	307	599	295		1,680
2007	329	462			1,309
2008	276				1,172

Accident Year	Incremental Payments on Closed Claims (months of development)			
	0 to 12	*12 to 24*	*24 to 36*	*36 to 48*
2005	3,043	9,176	14,854	12,953
2006	3,531	8,247	11,041	
2007	3,529	8,336		
2008	3,409			

a. (3 points) Using a Frequency-Severity Disposal Rate method, determine the projected ultimate payments for accident year 2008.

b. (1.0 point) Compute the estimated IBNR for accident year 2008.

Show all work and state any additional assumptions.

Question 5

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", briefly describe when the Case Outstanding Development Technique is used, and what assumption it is based on that limits its use.

Question 6

(1.0 point) According to Friedland in "Estimating Unpaid Claims Using Basic Techniques", briefly describe three limitations in using Case O/S Development Technique – Approach #2, which assumes that the only available data is case outstanding.

Question 7

(4 points) You are given the following information:

Report Year	Reported Claims as of Months 12	24	36	48
2005	28,674	47,432	70,340	70,655
2006	27,066	46,783	48,804	
2007	19,477	31,732		
2008	18,632			

Report Year	Paid Claims (cumulative) 12	24	36	48
2005	3,043	12,219	27,073	40,026
2006	3,531	11,778	22,819	
2007	3,529	11,865		
2008	3,409			

Using the case outstanding development technique, compute the estimated reserves for unpaid losses as of 12/31/2008.

Question 8

(3.5 point) Based on Friedland in ""Estimating Unpaid Claims Using Basic Techniques", you are given the following information as of December 31, 2008:

Cumulative Reported Claims

Accident	(Age of Development in Months)		
Year	12	24	36
2006	$36,000	$81,600	$124,500
2007	46,410	84,840	
2008	47,522		

Open Claim Counts

Accident	(Age of Development in Months)		
Year	12	24	36
2006	20	16	4
2007	24	12	
2008	22		

Closed Claim Counts

Accident	(Age of Development in Months)		
Year	12	24	36
2006	40	82	114
2007	50	86	
2008	46		

Cumulative Paid Claims

Accident	(Age of Development in Months)		
Year	12	24	36
2006	$20,000	$65,600	$119,700
2007	26,250	72,240	
2008	25,346		

- Select ATA factors using all-years simple averages.
- The selected tail factor for incurred development after 36 months is 1.150.

a. (1.5 points) Based on Berquist and Sherman's method, demonstrate that the relative level of the Case Outstanding adequacy has changed for accident year 2008.

b. (2 points) Using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy, calculate the ultimate reported claims for accident year 2008.

Question 9

(3 points) You are given the following information for a company that has recently undergone changes affecting its claim settlement rates.

Cumulative Closed Claim Counts

Accident Year	Age (in Months) 12	24	36	48	Projected Ultimate
2005	32,500	70,000	100,000	100,000	100,000
2006	36,750	78,750	105,000		105,000
2007	41,250	88,000			110,000
2008	46,000				115,000

Cumulative Paid Claims ($000)

Accident Year	Age (in Months) 12	24	36	48
2005	243,750	525,000	750,000	750,000
2006	275,626	590,626	787,500	
2007	309,376	660,000		
2008	345,000			

- Assume that the relationship between the incremental number of closed claim counts (#) and the incremental paid claims ($) is linear.
- Use all-year simple averages to select ATA factors.

Using the Berquist and Sherman method described by Friedland, calculate an estimate of ultimate paid claims for accident year 2007. Show all work.

Question 10

(2 points) According to Friedland, Berquist and Sherman B/S suggest several ways for selecting alternative data to respond to potential problems related to a changing environment.

For each of the following data types, identify what alternative data type they suggest using and the situation that would give rise to using the alternative data type.

* Number of claims
* Accident year (describe three situations that could arise and what alternative data types could be used)

Question 11.

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", proper estimating of unpaid claims is more than just a necessity for managing, investing in, and regulating insurers.

For U.S. based insurers, list and briefly describe two further requirements for maintaining accurate reserves.

Question 12.

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", insurers used to categorize claim adjustment expenses as allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE). In 1998, the NAIC promulgated two new categorizations of adjustment expenses (effective January 1, 1998) for U.S. insurers reporting on Schedule P of the P&C statutory Annual Statement.

List and briefly describe these two new categories and examples of expense types included in these categories.

Question 13.

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", a range of estimates of the unpaid and a statement of confidence that the actual unpaid claims will be within the stated range are valuable to management, regulators, policyholders, investors, and even the general public.

As such, briefly explain why a point estimate of the unpaid claims is necessary, and what guidance is given to the actuary in developing such a point estimate.

Question 14.

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", briefly describe the difference between the terms 'unpaid claim estimate' and 'carried reserve'

Question 15.

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", actuaries refer to the sum of the following four components (i.e., provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and provision for claims in transit) as the broad definition of incurred but not reported (IBNR).

Briefly describe one of the most important reasons for separating IBNR into its components.

Question 16.

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", large commercial insurers generally maintain internal claims departments with many claims adjusters managing the claims. Small to mid-sized commercial insurers and self-insurers often hire third-party claims administrators (TPAs) or independent adjuster (IA) to manage claims.

Briefly describe/differentiate the types of work performed by TPAs and IAs and how compensation for their services is arrived at.

Question 17.

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", a single claim may extend over a period of several years. List four types of claims transactions that could occur over the life of the claim.

Question 18

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", one area that requires the actuary's close attention is the treatment of ALAE in excess of loss reinsurance contracts.

Briefly describe three possible treatments of ALAE in excess of loss reinsurance contracts.

Question 19

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list one advantage and one disadvantage to using report year aggregation.

Question 20

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list one advantage and one disadvantage to using policy year aggregation.

Question 21

(1.5 points) You are a consulting actuary for the XYZ insurance company. You are about to conduct a year end review of unpaid claims.

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", what are three questions would you ask the 'in-house' prior to conducting your reserve review?

Question 22

(1.5 points) You are a consulting actuary for the XYZ insurance company. You are about to conduct a year end review of unpaid claims.

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", what are three questions would you ask those managing the reinsurance for the company prior to conducting your reserve review?

Question 23

(1.5 points) You are a consulting actuary for the XYZ insurance company. You are about to conduct a year end review of unpaid claims.

According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", what are three questions would you ask an underwriting executive for the company prior to conducting your reserve review?

Solutions to Exam 5B - Independently Authored Preparatory Test 3

Question 1 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique

1. Individual claim counts are defined in a consistent manner over the experience period.

Example: Do not group claimant counts and occurrence counts together (i.e. recording all claimants under an occurrence as a single claim), unless the mix of the two ways of counting a claim is consistent.

2. Claim counts are reasonably homogenous.

Example: Do not analyze first-dollar, low-limit claims with high-layer, multi-million dollar, excess claims.

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: When each techniques works and when it does not

1. Its use in developing estimated unpaid claim estimates for the most recent AYs.
   a. Both paid and reported claim development methods can prove unstable and inaccurate for the more recent AYs.
   b. This weaknesses can be addressed by separating estimates of ultimate claims into frequency and severity.

   The number of reported claims reported is usually stable, and thus the projection of ultimate claim counts produces reliable estimates.

   Since severity estimates for the more mature AYs can be obtained with greater certainty, adjusting these severities using tend factors can help in developing estimates of severities for the most recent AYs.
2. Its used to gain greater insight into the claims process (e.g. the rate of claims reporting and settlement and the average dollar value of claims)
3. It can be used with paid claims data only. Thus, changes in case outstanding philosophy or procedures will not affect the results.
4. Its ability to explicitly reflect inflation in the projection methodology instead of assuming that past development patterns will properly account for inflationary forces.

A potential disadvantage in doing so is its highly sensitive to the inflation assumption.

1. The unavailability of data.
2. Changes in the definition of claim counts, claims processing, or both may invalidate the assumption that future claim count development will be similar to historical claim count development.
3. If the mix of claims is inconsistent, this will distort a FS analysis unless an adjustment is made for the change in the mix of claim types or claim causes.

Question 3 discussion: Blooms: Comprehension; Difficulty 3, LO 3, KS: Mechanics associated with each technique (including organization of the data)

Assume a 1.002 tail factor after 60 months.

(A) Given Frequency

		Reported Claim Counts: Data Triangle				
Accident Year	**Period Ending**	**1st report 12 mo.**	**2nd report 24 mo.**	**3rd report 36 mo.**	**4th report 48 mo.**	**5th report 60 mo.**
2004	31-Dec	1,932	2,168	2,234	2,249	2,258
2005	31-Dec	2,067	2,293	2,367	2,390	
2006	31-Dec	1,473	1,645	1,657		
2007	31-Dec	1,192	1,264			
2008	31-Dec	1,036				

(B) ATA and CDF Frequency

		Closed Claim Counts: Age-to-Age Factors				
Accident Year	***Period Ending***	***1st to 2nd 12:24 mo***	***2nd to 3rd 24:36 mo***	***3rd to 4th 36:48 mo***	***4th to 5th 48:60 mo***	***See Tail Below***
2004	31-Dec	*1.122*	*1.030*	*1.007*	*1.004*	
2005	31-Dec	*1.109*	*1.032*	*1.010*		
2006	31-Dec	*1.117*	*1.007*			
2007	31-Dec	*1.060*				*Given*
3-period simple avg ATA		*1.096*	*1.023*	*1.008*	*1.004*	*1.002*
Development Age		***12 mo.***	***24 mo.***	***36 mo.***	***48 mo.***	***60 mo.***
CDF to Ultimate		*1.137*	*1.038*	*1.014*	*1.006*	*1.002*

(C) Est. Ultimate Frequency

Accident Year	***Period Ending***	***Age of Data at 12/31/08***	***Reported Counts at 12/31/08***	***CDF to Ultimate***	***Estimated Ultimate Counts***
		(1)	*(2) from (A)*	*(3) from (B)*	*(4)=(2)*(3)*
2004	31-Dec	*60 months*	*2,258*	*1.002*	*2,263*
2005	31-Dec	*48 months*	*2,390*	*1.006*	*2,404*
2006	31-Dec	*36 months*	*1,657*	*1.014*	*1,681*
2007	31-Dec	*24 months*	*1,264*	*1.038*	*1,312*
2008	31-Dec	*12 months*	*1,036*	*1.137*	*1,178*

Note: Friedland performs this work twice: ***on closed claims and*** *on reported claims, and considers both in selecting the Ultimate Claim Counts in Exhibit II, Sheet 3.*

Question 3 discussion:

3b. Given this additional data, project ultimate claim severities for accident years 2004 – 2008
Use a 3-period simple average to select age-to-age factors.
Assume a 10% tail factor after 60 months.

(D) Given Claims

		Reported Claims ($000s): Data Triangle				
Accident Year	**Period Ending**	**1st report 12 mo.**	**2nd report 24 mo.**	**3rd report 36 mo.**	**4th report 48 mo.**	**5th report 60 mo.**
2004	31-Dec	16,995	40,180	58,866	71,707	74,002
2005	31-Dec	28,674	47,432	70,340	70,655	
2006	31-Dec	27,066	46,783	48,804		
2007	31-Dec	19,477	31,732			
2008	31-Dec	18,632				

*(E) =(D)/(A) * 1000 Severities*

MUST DIVIDE FOR …		***Reported Severity: Data Triangle (calculated)***				
Accident Year	**Period Ending**	**1st report 12 mo.**	**2nd report 24 mo.**	**3rd report 36 mo.**	**4th report 48 mo.**	**5th report 60 mo.**
2004	31-Dec	*8,797*	*18,533*	*26,350*	*31,884*	*32,773*
2005	31-Dec	*13,872*	*20,686*	*29,717*	*29,563*	
2006	31-Dec	*18,375*	*28,440*	*29,453*		
2007	31-Dec	*16,340*	*25,104*			
2008	31-Dec	*17,985*				

(F) ATA and CDF Severities

		Severities: Age-to-Age Factors				
Accident Year	***Period Ending***	***1st to 2nd 6:12 mo***	***2nd to 3rd 12:18 mo***	***3rd to 4th 18:24 mo***	***4th to 5th 24:30 mo***	***See Tail Below***
2004	31-Dec	*2.107*	*1.422*	*1.210*	*1.028*	
2005	31-Dec	*1.491*	*1.437*	*0.995*		
2006	31-Dec	*1.548*	*1.036*			
2007	31-Dec	*1.536*				*Given*
2-period simple avg ATA		*1.542*	*1.236*	*1.102*	*1.028*	*1.100*
Development Age		***12 mo.***	***24 mo.***	***36 mo.***	***48 mo.***	***60 mo.***
CDF to Ultimate		*2.376*	*1.541*	*1.246*	*1.131*	*1.100*

(G) Est. Ultimate Severities

Accident Year	***Period Ending***	***Age of Data at 12/31/08***	***Reported Severities at 12/31/08***	***CDF to Ultimate***	***Estimated Ultimate Severities***
		(1)	*(2) from (E)*	*(3) from (F)*	*(4)=(2)*(3)*
2004	31-Dec	*60 months*	*32,773*	*1.100*	*36,050*
2005	31-Dec	*48 months*	*29,563*	*1.131*	*33,426*
2006	31-Dec	*36 months*	*29,453*	*1.246*	*36,713*
2007	31-Dec	*24 months*	*25,104*	*1.541*	*38,681*
2008	31-Dec	*12 months*	*17,985*	*2.376*	*42,732*

3c. Project ultimate claim severities for accident years 2004 - 2008

(H)=(C)(G)*
Ultimate
Claims

Accident Year	**Period Ending**	**Estimated Ultimate Counts**	**Estimated Ultimate Severities**	**Product of Frequency and Severity (/1000) = Est. Ultimate Claims**
		(1) = (C4)	*(2) = (G4)*	*(3) = (1) * (2) / 1000*
2004	31-Dec	*2,263*	*36,050*	*81,565*
2005	31-Dec	*2,404*	*33,426*	*80,368*
2006	31-Dec	*1,681*	*36,713*	*61,701*
2007	31-Dec	*1,312*	*38,681*	*50,748*
2008	31-Dec	*1,178*	*42,732*	*50,338*
Estimated Ult. Claims for Accident Years 2004 - 2008				*324,720*

3d. Calculate the IBNR estimates for accident periods in accident years 2004 – 2008

(I)=(H)-(D)
IBNR

Accident Year	**Period Ending**	**Estimated Ultimate Claims**	**Reported Claims at 12/31/08**	**Estimated IBNR (broadly defined to include IBNER)**
		(1) = (H3)	*(2) from (D)*	*(3) = (1) - (2)*
2004	31-Dec	*81,565*	*74,002*	*7,563*
2005	31-Dec	*80,368*	*70,655*	*9,713*
2006	31-Dec	*61,701*	*48,804*	*12,897*
2007	31-Dec	*50,748*	*31,732*	*19,016*
2008	31-Dec	*50,338*	*18,632*	*31,706*
Estimated IBNR for Accident Years 2004 - 2008				*80,895*

Note: Compare to Exhibit II, Sheet 7 in Friedland's Chapter 11, which also includes a total Unpaid Claims estimate. Rounding differences exist.

Question 4 discussion: Blooms: Comprehension; Difficulty 3, LO 3

(4 points) You are given the following information:

a. (3 points) Using a Frequency-Severity Disposal Rate method, determine the projected ultimate payments for accident year 2008.

Disposal Rate Method STEP 1: Select Ultimate Claim Counts by year

(A) Almost given (but need to ***cumulate*** *the incremental counts for use later)*

Accident Year	Cumulative Claim Counts – Age of Development (Months) 12	24	36	48	Ultimate
2005	295	1119	1664	1946	2402
2006	307	906	1,201		1,680
2007	329	791			1,309
2008	276				1,172

Disposal Rate Method STEP 2A: Select Disposal Rates

(B) Calculate as Cumulative closed counts / Ultimate counts

Accident Year	Selected Disposal Rates – Age of Development (Months) 12	24	36	48	Ultimate
2005	12.3%	46.6%	69.3%	**81.0%**	100%
2006	18.3%	53.9%	**71.5%**		100%
2007	25.1%	**60.4%**			100%
2008	**23.5%**				100%
Selected*	**24.3%**	**57.2%**	**70.4%**	**81.0%**	

**Selected from avg latest two. Note: If not told how to select, state your assumption. Friedland shows 3-yr and 5-yr simple average, and medial 5x1.*

STEP 2B: Calculate CONDITIONAL factor from Disposal Rates (incremental)

DON'T FORGET THIS STEP.

(C) = [Difference in consecutive selections in (B)] / [1.0 minus earlier percent in (B)]

Accident Year	Conditional Factor from Disposal Rates (incremental) – Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2005	12.3%	39.1%	42.5%	38.2%	
2006	18.3%	43.6%	38.1%	use 35.9%	
2007	25.1%	47.1%	use 30.8%	use 35.9%	
2008	23.5%	use 43.4%	use 30.8%	use 35.9%	
Projection*	24.3%	43.4%	30.8%	35.9%	to use

** Note: These projections are based on the selected disposal rates above.*
Example: for 12 to 24 mo.: 43.4% = (57.2% - 24.3%) / (1 - 24.3%)

Disposal Rate Method STEP 3: Project Claim Counts (Incremental)

(D) = [Factor selected in (C)] [(A) ultimate - all prior entries for (D)]*

WARNING: This can be tricky to do in one step.

Accident Year	Incremental Claim Counts (incl projections) – Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2005	295	824	545	282	
2006	307	599	295	172.0	
2007	329	462	159.7	128.6	
2008	**276**	**388.9**	**156.4**	**125.9**	

Example for 2008: 276 = 24.3%[1,172 - 0] and 389 = 43.4%*[1,172 - 276] and . . . and 156.4 = 30.8%*[1,172-276-389] and 125.9 = 35.9%*[1,172-sum prev]*

Solutions to Exam 5B - Independently Authored Preparatory Test 3

4. (4 points) (continued):

*STEP 4A: To analyze severities, first need Incremental **Claims** to date*

(E) Given

Accident Year	Incremental Claims to date Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2005	3,043	9,176	14,854	12,953	
2006	3,531	8,247	11,041		
2007	3,529	8,336			
2008	3,409				

*STEP 4B: To analyze severities, next find Average **Severities** to date*

(F) = (E)/(D)

Accident Year	Actual Average Severities to date Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2005	10.315	11.136	27.255	45.933	
2006	11.502	13.768	37.427		
2007	10.726	18.043			
2008	12.351				

STEP 5: Project Severities, Incorporating trend

(G) Trend factors (given at 5% annually)

Accident Year	Trend Factors to 2008 (at given 5%) Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
2005	1.158	1.158	1.158	1.158	
2006	1.103	1.103	1.103		
2007	1.050	1.050			
2008	1.000				

(H)=(F)(G)*

TortFact	Accident Year	Trended and Tort Reform Average Severities to 2008 level Age of Development (Months) 0 to 12	12 to 24	24 to 36	36 to 48	
0.67	2005	8.001	8.637	21.139	**35.626**	
0.75	2006	9.510	11.384	**30.948**		
1.0	2007	11.263	**18.945**			
1.0	2008	**12.351**				
	Selected Severity *		**15.165**	**26.043**	**35.626**	2008 level

Tort reform factors: 2005=0.67; 2006=.75; 2007-2008=1.00

Trend* Tort reform factors * Severities

**Selected from latest two average. Note: If not told how to select, state your assumption. Friedland shows 3-yr and medial 5x1.*

4. (4 points) (continued):

(I) from (H)

for AY 2008 only including selected projections

Accident Year	Trended Average Severities to date				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2005					
2006					
2007					
2008	12.351	15.165	26.043	35.626	

STEP 6A: Multiply Severities by Counts for Incremental Paid Claims

*(J) = (I) * (D)*

Accident Year	Estimated Total $ Claims (Projected)				
	Age of Development (Months)				
	0 to 12	12 to 24	24 to 36	36 to 48	
2005					
2006					
2007					
2008	$3,409	$5,897	$4,072	$4,487	

*24-36: $4,072 = (Count of 156 closing) * ($26.043 paid per closing)*

STEP 6B: Add Across Incremental for Cumulative Paid Claims

(K) from (J)

Accident Year	Estimated Total $ Claims (Incl. Projected)				
	Age of Development (Months)				
	12	24	36	48	**SOLUTION**
2005					
2006					
2007					
2008	$ 3,409	$ 9,306	$ 13,379	$ 17,865	**$ 17,865**

$17,865=$3,409 + $9,306 + $13,379

b. (1.0 point) Compute the estimated IBNR for accident year 2008.

Step 7: Compute 2008 IBNR

2008 IBNR = 2008 Estimated Ultimate Claims - 2008 Reported claims as of 12/31/2008

2008 IBNR = 17,865 - 6,669 = $11,196.00

Question 5 discussion: Blooms: Comprehension; Difficulty 1 LO 3, KS: Assumptions of each estimation technique,

This method is appropriate when applied to lines of insurance for which most of the claims are reported in the first accident period. Therefore, claims-made coverages and report year analysis use the case O/S technique because the claims for a given AY are known at the end of the AY.

The assumption that IBNR claim activity is related to claims already reported (i.e., development on known claims versus pure IBNR) limits its use, and so it is not used extensively by actuaries.

Question 6 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS: Assumptions of each estimation technique,

Potential Limitations

1. Benchmarks may prove to be inaccurate in projecting future claims experience for the insurer.
2. It is inappropriate for the more recent, less mature years due to the increased variability of results related to the highly leveraged development factors.
3. Large claims in the case O/S data can distort the results of projections based on this method.

Question 7 discussion: Blooms: Comprehension; Difficulty 3, LO 3, KS: Mechanics associated with each technique (including organization of the data)

Using the case O/S development technique, what are the estimated unpaid claims as of 12/31/2008?

(3) = (1) - (2)

Example: 2006 at 36m
= 48,804 - 22,819
= 25,985

Report Year	Case Outstanding as of Months 12	24	36	48
2005	25,631	35,213	43,267	30,629
2006	23,535	35,005	25,985	
2007	15,948	19,867		
2008	15,223			

(4) = (2) - (2)prior

Example: 2006 at 36m
= 22,819-11,778
= 11,041

Report Year	Paid Claims (incremental) 12	24	36	48
2005	3,043	9,176	14,854	12,953
2006	3,531	8,247	11,041	
2007	3,529	8,336		
2008	3,409			

(5) = (4) / (3)prior

Example: 2006 at 36m
= 11,041/35,005
= 31.54%

Ratio: Paid Claims (incr) to PRIOR Case Outstanding — Year	12	24	36	48	60 or Ult.
2005	n/a	35.80%	42.18%	29.94%	
2006	n/a	35.04%	31.54%		
2007	n/a	52.27%			
2008	n/a				
Selected Three-Year Simple Averages		**43.7%**	**36.9%**	**29.9%**	100% given

(6) = (5) & projections
where projections
= selected ratio

Example: 2007 at 48m
= 29.94%

Complete the square: Ratios with Incremental Paids — Year	12	24	36	48	Final Ratio 60 or Ult.
2005	n/a	35.80%	42.18%	29.94%	**100.0%**
2006	n/a	35.04%	31.54%	**29.94%**	**100.0%**
2007	n/a	52.27%	**36.86%**	**29.94%**	**100.0%**
2008	n/a	**43.66%**	**36.86%**	**29.94%**	**100.0%**

CAREFUL: These ratios apply to Case Outstanding, so we also need to "complete the square" for Case Outstanding before we can actually use these ratios.

To do so, we use another ratio - the Case Outstanding at a given age, divided by the Case Outstanding at the prior age. NOTE: It may be tempting to try to use 1 minus the ratio above, (the incremental Paid / prior Case Outstanding), but that logic only considers the effect that payments have on Case Outstanding, and ignores other changes in estimates.

Question 7 discussion (continued):

(7) = (3) / (3)prior

Example: 2006 at 36m
= 25,985/35,005
= 74.23%

Ratio: Case Outstanding to PRIOR Case Outstanding					
Year	**12**	**24**	**36**	**48**	**60 or Ult.**
2005	n/a	137.38%	122.87%	70.79%	
2006	n/a	148.74%	74.23%		
2007	n/a	124.57%			
2008	n/a	0.00%			
Selected Three-Year Simple Averages		**136.65%**	**98.55%**	**70.79%**	0% definition

(8) = (7) & projections
where projections
= selected ratio

Example: 2007 at 48m
= 70.79%

Complete the square: Ratios Case Outstanding / Prior					0 at Ult.
Year	**12**	**24**	**36**	**48**	**60 or Ult.**
2005	n/a	137.38%	122.87%	70.79%	**0.0%**
2006	n/a	148.74%	74.23%	**70.79%**	**0.0%**
2007	n/a	124.57%	**98.55%**	**70.79%**	**0.0%**
2008	n/a	**136.65%**	**98.55%**	**70.79%**	**0.0%**

(9) = (3) & projections
where projections
*= (8) * (9) prior*

Example: 2007 at 48m
*.7079 * 19,579 = 13,860*
*[.9855 * 19,867 = 19,579]*

Complete the square: Case Outstanding & projections					0 at Ult.
Year	**12**	**24**	**36**	**48**	**60 or Ult.**
2005	25,631	35,213	43,267	30,629	**0**
2006	23,535	35,005	25,985	**18,395**	**0**
2007	15,948	19,867	**19,579**	**13,860**	**0**
2008	15,223	**20,803**	**20,502**	**14,513**	**0**

Be sure to go out until the is no more case outstanding.
Otherwise, the cumulative paid will not equal ultimate claims.

NOW: We can go use those ratios we found in step (6), and project out the future INCREMENTAL claim payments

(10) = (4) & projected
where projected
*= (6) * **(9) prior***

Example: 2007 at 48m
*.2994 * 19,579 = 5,862*

Complete the square: Incremental Paid & projections					Final Paid
Year	**12**	**24**	**36**	**48**	**60 or Ult.**
2005	3,043	9,176	14,854	12,953	30,629
2006	3,531	8,247	11,041	**7,779**	18,395
2007	3,529	8,336	**7,323**	**5,862**	13,860
2008	3,409	**6,646**	**7,668**	**6,138**	14,513

Question 7 discussion (continued):

Showing Ultimates: *as in Friedland*

To get to the Ultimate Claim amounts, we must use CUMULATIVE paids since the Estimated Total Claims Payments are the Estimated Ultimate Claims, by definition.

(11) = Sum across (10)

Year	*Cumulative Paid & Projections at Ultimate*					*Ultimate*
2005	*3,043*	*+ 9,176*	*+ 14,854*	*+ 12,953*	*+ 30,629*	***= 70,655***
2006	*3,531*	*+ 8,247*	*+ 11,041*	*+ 7,779*	*+ 18,395*	***= 48,993***
2007	*3,529*	*+ 8,336*	*+ 7,323*	*+ 5,862*	*+ 13,860*	***= 38,910***
2008	*3,409*	*+ 6,646*	*+ 7,668*	*+ 6,138*	*+ 14,513*	***= 38,374***
Total Estimate of Ultimate Claims using Case Outstanding Dev. Method						***196,933***

FINALLY: To get the total "unpaid claim estimate," do the subtraction below:

Year	***Estimated Ultimate Claims***	***Actual Paid to date***	***Total Unpaid Claims Estimate***
	(12) in (11)	*(13) in (2)*	*(14) = (12) - (13)*
2005	*70,655*	*40,026*	*30,629*
2006	*48,993*	*22,819*	*26,174*
2007	*38,910*	*11,865*	*27,045*
2008	*38,374*	*3,409*	*34,965*
Total			***118,814***

Shortcut: *If only asked for "Unpaid Claims Estimates," we can just add up the projected future payment amounts . . . No need to show the Ultimate claims.*

(10) Detail
Looking only at the Projected future payments gives us an <u>Unpaid</u> Claim Estimate

Year	***Incremental Paid: Projections only*** ***24***	***36***	***48***	***60 or Ult.***	*Sum of Projections*
2005				*30,629*	*30,629*
2006			*7,779*	*+18,395=*	*26,174*
2007		*7,323*	*+5,862*	*+13,860=*	*27,045*
2008	*6,646*	*+7,668*	*+6,138*	*+14,513=*	*34,965*
Est. Unpaid Claims using Case Outstanding Dev. Method					*118,814*

Question 8 discussion: Blooms: Comprehension; Difficulty 3, LO 4,

a. (1.5 points) Based on Berquist and Sherman's method, demonstrate that the relative level of the Case Outstanding adequacy has changed for accident year 2008.

a. Test for change in <u>Adequacy of Case Outstanding</u>

Calculate Average Case Outstanding per Open Claim

(A) = [Reported $ - Paid $ (cumulative)] / [Open Counts]

Accident Year	*Development Period (months)* 12	*24*	*36*			
2006	800	1,000	1,200			
2007	840	1,050				
2008	1,008					

Now, compare the growth % indications here to the implied trend %s from <u>paid</u> data.

Friedland says, "Berquist and Sherman note that the observed trends for the average paid claims are similar to industry benchmarks (at the time), and thus they conclude that the (different) trend rates for average case oustanding are indicative of changes

Calculate growth rate % in Average Case Outstanding per Open Claim

Average Case Outstanding $ per Open Claim Count (Severity)

(B) from (A)

Accident Year	*Development Period (months)* 12	*24*	*36*			
2007	*5.00%*	*5.00%*				
2008	***20.00%***					

Example: 1008 / 840 - 1 = 20%

8a : Test for change in <u>Adequacy of Case Outstanding - continued</u>

Given Average Paid Claim ($) per Closed Claim Count

Average Paid $ per Closed Claim Count (Severity)

(C)

Accident Year	*Development Period (months)* 12	*24*	*36*			
2006	*500*	*800*	*1,050*			
2007	*525*	*840*				
2008	*551*					

Calculate trend rate % in Average Paid Claim ($) per Closed Claim Count

Calculation of the Trend Factor we take to be "true"

(D) from (C)

Accident Year	*Development Period (months)* 12	*24*	*36*			
2007	*5.000%*	*5.000%*				
2006	***4.952%***					

Compare growth rate %s in average outstanding data (B) to the trend rate %s in the paid data (D).

*** The average open claim amount has risen from 5% to 20% compared to a 5% increase in average paid severities over time. This demonstrates why we may conclude that the relative level of case outstanding adequacy is changing. ***

Question 8 discussion (continued):

b. (2 points) Using Berquist and Sherman's technique for adjusting data to compensate for changing Case Outstanding adequacy, calculate the ultimate reported claims for accident year 2008.

Step 1: Begin by restating the average open severity using a 5% trend (De-trending)

Average Case Oustanding $ per Open Claim: ADJUSTED

Start with most recent diagonal given in (A) and DE-TREND at 5%

(E)	Accident Year	12	24	36	Example Calculation
	2006	*914.3*	*1,000*	***1,200***	*1,008 / 1.05 ^2^ = 914.3*
	2007	*960.0*	***1,050***		
	2008	***1,008***			

(Development Period (months))

Step 2: Multiply re-stated averages above by the open counts for re-stated Case Outstanding $

*Re-stated Total $ Case Outstanding = Adjusted Average Case Outstanding * Open Counts (#)*

*(F) = (E) * open counts (given)*	Accident Year	12	24	36	Example Calculation
	2006	*18,286*	*16,000*	*4,800*	*914.3 * 20 (given) = 18,286*
	2007	*23,040*	*12,600*		
	2008	*22,176*			

(Development Period (months))

Step 3: Add re-stated case outstanding $ to cumulative paid claim $ for Reported Claims

Adjusted Reported Claims = Re-stated Case Outstanding + Cumulative Paid Claims

(G) = (F) + Paid (given)	Accident Year	12	24	36	Example Calculation
	2006	*38,286*	*81,600*	*124,500*	*18,286 + 20,000 (given) = 38,286*
	2007	*49,290*	*84,840*		
	2008	*47,522*			

(Development Period (months))

b : Example with change <u>Adequacy of Case Outstanding - continued</u>

Step 4: Compute ATA factors for 12-36 months using the adjusted reported claims, and Use the <u>given 36 to ultimate CDF</u> to compute the 12 month age to ultimate CDF

ATA	12:24	12:36		Example Calculation
2007	*2.131*	*1.526*		*81,600 / 38,286 = 2.131*
2008	*1.721*			
Selected (Simple Avg)	*1.926*	*1.526*	*Reported CDF from 36 to ultimate is 1.15(given)*	

(Development Period (months))

CDF to Ultimate	*12-to-ult = 1.926 * 1.526 * 1.15 = 3.380*

*Finally, we estimate AY 2008 ultimate claims = 47,522 * 3.380 =* ***160,618*** **ANSWER**

Question 9 discussion: Blooms: Comprehension; Difficulty 3, LO 4

Using the Berquist and Sherman method described by Friedland, calculate an estimate of the ultimate Paid Claims for accident year 2007. Show all work.

Data

(A) Given

Accident Year	*Cumulative Claim Counts (#)*					*(A)*
	Age of Development (Months)					*Projected*
	12	*24*	*36*	*48*		*Ultimate*
2005	*32,500*	70,000	100,000	100,000		*100,000*
2006	*36,750*	78,750	105,000	0		*105,000*
2007	*41,250*	88,000	0	0		*110,000*
2008	*46,000*					*115,000*

(B) Given

Accident Year	*Cumulative Paid Claims ($000's)*					
	Age of Development (Months)					
	12	*24*	*36*	*48*		
2005	*243,750*	525,000	750,000	750,000		
2006	*275,626*	590,626	787,500	0		
2007	*309,376*	660,000	0	0		
2008	*345,000*	*0*	*0*	*0*		

1) Adjusting for changes in settlement rates ... Friedland states:

"Berquist and Sherman select the disposal rate along the latest diagonal as the basis for adjusting the closed claim count triangle." Accordingly, we find this diagonal:

(C) = Values of (A) along diagonal, divided by the corresponding Ultimate values in (A)

Accident Year	*Disposal Rates = Cumulative Claim Counts / Ultimate Claims Counts*				
	Age of Development (Months)				
	12	*24*	*36*	*48*	*Calculations*
2005				***100.0%***	*= 100,000 / 100,000*
2006			***100.0%***		*= 105,000 / 105,000*
2007		***80.0%***			*= 88,000 / 110,000*
2008	***40.0%***				*= 46,000 / 115,500*
Selected	***40.0%***	***80.0%***	***100.0%***	***100.0%***	

2) And use these Selected Disposal Rates to restate (adjust) the historical count data:

(D) = Ultimate Counts in (A), multiplied by the selected Disposal Rates in (C)

Accident Year	*ADJUSTED Cumulative Claim Counts (#)*				
	Age of Development (Months)				
	12	*24*	*36*	*48*	
2005	*40,000*	***80,000***	***100,000***	***100,000***	
2006	*42,000*	***84,000***	***105,000***		
2007	*44,000*	***88,000***			
2008	*46000*				

Question 9 discussion (continued):

3) To move from adjusted claim counts to adjusted claim dollars, Friedland notes:
The authors "identify a mathematical formula that approximates the relationship … "
*We a **ssume the relationship is linear**, based on the unadjusted data points (by year).*

Note: we will only calculate the factors we need for this exam question:
Since we only need an estimate for 2007 AY unpaid, which is at 24 months, we need enough data to develop a CDF from 24 to Ultimate. (2006 and 2007, 24 mo and after)

FOR 2006	Original AY 2006 Data		**ADJUSTED** AY 2006 Data	
	Counts #	Claim $000	Counts #	**Claims $000's (Cumulative)**
Age	From (A)	From (B)	From (D)	Linearly Interpolated from left
24	70,000	525,000	80,000	**600,000** see below
36	100,000	750,000	100,000	**750,000** as for unadjusted
48	100,000	750,000	100,000	**750,000** as for unadjusted

For example, adjusted paid losses at 24 months are calculated as:
525,000 + (80-70)/(100-70) x (750,000-525,000) = 600,000

FOR 2007	Original AY 2007 Data		**ADJUSTED** AY 2007 Data	
	Counts #	Claim $000	Counts #	**Claims $000's (Cumulative)**
Age	From (A)	From (B)	From (D)	Linearly Interpolated from left
24	78,750	590,626	84,000	**630,001** see below
36	105,000	787,500	105,000	**787,500** as for unadjusted

For example, adjusted paid losses at 24 months are calculated as:
590,626 + (84,000-78,750)/(105,000-78,750) x (787,500-590,626) = 630,000

(E) from calculations immediately above, we have ADJUSTED PAID ($) DATA

Accident Year	ADJUSTED Cumulative Paid Claims ($000's) — Age of Development (Months)			
	12	24	36	48
2005		**600,000**	**750,000**	**750,000**
2006		**630,001**	**787,500**	
2007				

4) Use ADJUSTED PAID LOSS DATA to develop a CDF to apply to AY 2007

(F) Based on the adjusted data in table (E)

ATA calculations	**24 to 36**	**36 to 48**	**48 to Ult.**
2006	1.25	1.00	
2007	1.25	n/a	
Selected (Simple Average)	1.25	1.00	1.00
CDF calculations	**at 24 mo**		
CDF to Ultimate	**1.25**		

5) Apply the CDF to AY 2007

Accident Year	Cumulative Paid Claim $000's — Age of Development (Months)					**ANSWER** Projected Ultimate
	12	24	36	48	**CDF**	
2007	Latest	**660,000**	multiplied by the selected 1.25 =			**825,000**

Question 10 discussion: Blooms: Comprehension; Difficulty 2 LO 4, KS: How internal operating changes affect estimates of unpaid claims: * Claims processing * Underwriting and policy provisions * Marketing * Coding of claim counts and/or claim related expenses * Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

* Using earned exposures instead of the number of claims when claim count data is of questionable accuracy or if there has been a major change in the definition of a claim count.

* Substituting policy year data for accident year data when there has been a significant change in policy limits or deductibles between successive policy years.

* Substituting report year data for accident year data when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the report year than with the accident date.

* Substituting accident quarter for accident year when the rate of growth of earned exposures changes markedly, causing distortions in development factors due to significant shifts in the average accident date within each exposure period.

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

1. It is required by law (e.g. NY Law states that every insurer shall maintain reserves in an amount estimated in the aggregate to provide for the payment of all losses or claims incurred on or prior to the date of settlement.
2. The NAIC requires that most P&C insurers in the U.S. obtain a Statement of Actuarial Opinion signed by a qualified actuary. See chapter 1

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

Defense and cost containment (DCC) and adjusting and other (A&O). Generally, DCC expenses include all defense litigation and medical cost containment expenses regardless of whether internal or external to the insurer; A&O expenses include all claims adjusting expenses, whether internal or external to the insurer.

See chapter 1

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

The insurer's balance sheet requires the insurer to record a point estimate of the unpaid claims, as required by the NAIC Further, Actuarial Standard of Practice No. 43 defines the actuarial central estimate as an estimate that represents an expected value over the range of reasonably possible outcomes.

See chapter 1

Question 14 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

The unpaid claim estimate is the result of the application of a particular estimation technique, and different estimation techniques will often generate different unpaid claim estimates. In addition, the unpaid claims estimate will likely change from one valuation date to another for the same portfolio.

The carried reserve for unpaid claims is the amount reported in a published statement or in an internal statement of financial condition.

See chapter 1

Question 15 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

One of the most important reasons for separating IBNR into its components is to test the adequacy of case outstanding over time. This can be an important management tool and a useful tool for the actuary when determining which methods are most appropriate for estimating unpaid claims.

See chapter 1

Question 16 discussion: Blooms: Comprehension; Difficulty 2, LO 3:

TPAs frequently handle a specific book of claims from beginning to end (i.e., from the initial report to the final payment). Insurers usually require the TPA to report details of the claims on a predetermined basis (e.g., monthly or quarterly). In certain circumstances, a TPA manages all the claims of an insurer, and the insurer only has a minimal number of claims personnel reviewing the activities of the TPA. The compensation for services of a TPA is generally based on a contract for the entire book of business and not by individual claim, though compensation varies among TPAs

An insurer may hire an independent adjuster (IA) to handle an individual claim or a group of claims. The insurer, who may have an active claims department, may need an IA to handle a specific type of claim or a claim in a particular region where the insurer does not have the necessary expertise. Also when a disaster occurs, such as a hurricane or earthquake, the insurer may hire a number of IAs (or a firm of IAs) to handle the large volume of claims. The compensation for the services of IAs is generally based on a fee per claim.

See chapter 2

Question 17 discussion: Blooms: Comprehension; Difficulty 2, LO 3:

The different types of claim transactions over the life of the claim could include:

* Establishment of the initial case outstanding estimate
* Notification to the reinsurer if the claim is expected to exceed the insurer's retention
* A partial claim payment to injured party
* Expense payment for independent adjuster
* Change in case outstanding estimate
* Claim payment (assumed to be final payment)
* Takedown of case outstanding and closure of claim
* Re-opening of the claim and establishment of a new case outstanding estimate
* Partial payment for defense litigation
* Final claim payment
* Final payment for defense litigation
* Closure of claim

See chapter 2

Question 18 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

1. Included with the claim amount in determining excess of loss coverage (which is the most common treatment)
2. Not included in the coverage
3. Included on a pro rata basis; the ratio of the excess portion of the claim to the total claim amount determines coverage for ALAE

See chapter 3

Question 19 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

Advantages of Report Year Aggregation

The number of claims is fixed at the close of the year (other than for claims reported but not recorded).

The RY approach substitutes a known quantity (i.e. the number of reported claim counts) for an estimate.

Thus, a RY approach will often result in more stable data and more readily determinable development patterns than an AY approach, since the number of AY claims is subject to change at each successive valuation.

Disadvantage of Report Year Aggregation

RY estimation techniques only measure development on known claims (and not pure IBNR)

See chapter 3

Question 20 discussion: Blooms: Comprehension; Difficulty 2, LO 3:

Advantages of PY Aggregation:

The key advantage is the true matching of claims and premiums.

* PY experience is very important when underwriting or pricing changes occur (e.g. a shift from full coverage to large deductible policies, a change in emphasis on certain classes of business, or an increase/decrease in the price charged leading to a change in expected claim ratios and possibly a change in the type of insured).

* PY aggregation is useful for self-insureds, who often issue a single policy.

Disadvantages of PY Aggregation

* The primary disadvantage is the extended time to gather complete data (i.e. it can take up to 24 months to gather all reported claims) and to reliably estimate ultimate claims.

* PY data can make it difficult to understand and isolate the affect of a single large event (e.g. a major catastrophe or court ruling), which changes how insurance contracts are interpreted.

See chapter 3

Question 21 discussion: Blooms: Comprehension; Difficulty 1, LO 3:

What are three questions would you ask the 'in-house' prior to conducting your reserve review?

1. Could we obtain copies of any and all actuarial studies done by consultants, auditors or internal actuaries?
2. What areas of disagreement are there between these different studies?
3. What specific background information did you take into account in making your selections?

See chapter 4

Question 22 discussion: Blooms: Comprehension; Difficulty 2, LO 3:

What are three questions would you ask those managing the reinsurance for the company prior to conducting your reserve review?

* Please provide details of reinsurance treaties for both assumed and ceded business.
* Please provide details of all reinsurance ceded treaties including:
  - i. Retention level or Q.S. %
  - ii. Reinsurers involved (including participation)
  - iii. Details of any sliding scale premium, commission, or profit commission (including currently booked amounts)
  - iv. Any problems or delays encountered in collecting reinsurance
* Please provide details of any internal or sister company reinsurance agreements (cover notes, relevant amounts, and by-line breakdowns).
* Have the reinsurance programs for next year been secured? If so, under what terms?

See chapter 4

Question 23 discussion: Blooms: Comprehension; Difficulty 2, LO 3:

What are three questions would you ask an underwriting executive for the company prior to conducting your reserve review?

1. What changes have occurred in your company's book of business and mix of business in the past 5-7 years? How are the risks insured today different from those of the past?
2. Do you underwrite any large risks which are not characteristic of your general book of business?
3. Have any significant changes occurred in your underwriting guidelines in recent years?
4. Has the proportion of business attributable to excess coverages for self-insurers changed in recent years? Can a distribution of such business be obtained by line, retention limit, class, etc.?

   Is a record of self-insured losses and claims available?
5. How many different programs or types of risk are premium and claims experience tracked and compiled into claim ratio runs?
6. Are any details of excess policies (e.g. attachment points, exclusions, per occurrence, sunset clauses, aggregate caps, etc.) available?
7. How frequent are experience summaries run? How far back are these available?
8. How are new programs priced? If you are relying on another insurer's filings, how similar are the underlying books of business?

See chapter 4

Exam 5B – Independently Authored Preparatory Test 4

General information about this exam

1. This test contains 23 computational and essay questions.
2. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.
3. Consider taking this exam after working all past CAS questions, associated with the articles below, first.
4. Many of the essay questions may require lengthy responses.
5. Make sure you have a sufficient number of blank sheets of paper to record your answers.

Articles covered on exam:

Article .... Author ....Syllabus Section

Chapter 7 – Development Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 8 – Expected Claims Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 9 – Bornhuetter-Ferguson Technique .... Friedland ....B: Estimating Claim Liabilities
Chapter 10 – Cape Cod Technique .... Friedland .... B: Estimating Claim Liabilities

Chapter 17 – Estimating Unpaid ULAE............................Friedland..............B: Estimating Claim Liabilities

Exam 5B - Independently Authored Preparatory Test 4

Question 1

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", answer the following questions:

a. List and briefly describe the key assumptions under the classical technique for setting ULAE reserves.

b. Assuming that ½ of ULAE are sustained when opening a claim and ½ is sustained when closing the claim, describe how the %'s of the ULAE ratio are applied and to what reserves to compute the ULAE reserve.

Question 2

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list the four steps involved in applying the classical technique to estimating unpaid ULAE

Question 3

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", answer the following questions.

a. One challenge of the classical technique is that "closing" a claim and "paying" a claim do not necessarily mean the same thing. Briefly describe an example of this and a method to correct this shortcoming.

b. Another challenge of the classical technique is the use of broad definition of IBNR. Briefly describe why this is a challenge and a way to correct this shortcoming.

Question 4

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", state Wendy Johnson's and Kay Kellogg Rahardjo's rationale for when the classical technique works and when it does not.

Question 5

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", answer the following questions:

a. Briefly describe Kittel's refinement to the classical technique (i.e. the weakness in the classical technique)

b. State the two key assumptions of Kittel refinement to the classical technique:

Question 6

(1.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", briefly describe the two key problems associated with the Kittel Refinement.

Question 7

(2.5 points) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", answer the following questions:

a. Briefly describe the four key assumptions underlying the Generalized Approach to computing ULAE reserves

b. Briefly describe what U_1, U_2, and U_3

Question 8

(2.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, the following are two methods to estimate unpaid ULAE for a group of AYs.

Method 1. Compute Unpaid ULAE as follows: Unpaid ULAE = (W* x L) - M

Method 2. Compute Unpaid ULAE as follows: Unpaid ULAE = M x (L/B – 1.00)

a. Briefly describe what the variables W*, L, B and M represent

b. Briefly describe the practical and conceptual problems and concerns with both methods

Question 9

(2.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, the following formula is used in Conger and Nolibos' preferred method to estimate unpaid ULAE for a group of AYs: Unpaid ULAE = W* x (L - B). Using this formula, the variables R(t), P(t), and C(t), and the U_1, U_2, and U_3 percentages, answer the following questions:

a. Rewrite the formulate to compute unpaid ULAE given in the problem.

b. Briefly describe what this method assumes.

Question 10

(2.5 points) According to Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, briefly describe four practical difficulties with the generalized approach

Question 11

(1.5 points) Using the procedure described by Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, and the data given below, compute the expected claim payments in calendar years 2005 – 2008.

Accident Year	Direct Earned Premium	Expected Payment Percentage in Calendar 2005	2006	2007	2008
2005	2,866,667	12%	15%	15%	15%
2006	2,833,333		12%	15%	15%
2007	2,946,667			12%	15%
2008	2,656,667				12%

- Expected claims ratio is 60% each year

Question 12

(1.5 points) Using the Mango-Allen Refinement to the Classical Technique as described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following:

Calendar	Paid	Paid Claims	
Year	ULAE	Actual	Expected
(1)	(2)	(3)	(4)
2005	36,667	835,633	206,400
2006	41,667	57,333	462,000
2007	46,667	273,767	725,160
2008	53,333	206,400	969,480

- The selected ULAE Ratio should be based on an all years' average ratio
- Case Outstanding at 12/31/08 = 213,750
- Total IBNR at 12/31/08 = 6,108,500
- Pure IBNR at 12/31/08 = 5% of AY 2008 Expected Claims. AY 2008 Expected Claims = 1,594,000

Compute:

a. Estimated Unpaid ULAE at 12/31/08 Using Total IBNR

b. Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR

Question 13

(1.5 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following:

Calendar Year	Paid ULAE	Paid Claims	Reported Claims
2005	7,274	32,632	72,693
2006	10,233	49,552	109,371
2007	11,172	73,163	123,310
2008	12,993	89,646	139,082

- The selected ULAE Ratio should be based on an all years' average ratio
- Case Outstanding at 12/31/08 = 248,311
- IBNR at 12/31/08 = 96,775

Compute:

a. Estimated Unpaid ULAE at 12/31/08 using the traditional paid to paid method.

b. Estimated Unpaid ULAE at 12/31/08 using Kittel's refined method.

Question 14

(4.5 points) Using the Conger and Nolibos generalized method with U_1= 60%, U_2= 40%, and U_3 = 0% as described by Friedland in "“Estimating Unpaid Claims Using Basic, and the data given below, answer the following:

Calendar Year (1)	Paid ULAE (2)	Ult on Claims Reported in Calendar Year (3)	Paid Claims (4)	Claims Basis (5)
2005	7,274	90,865	32,632	67,572
2006	10,233	131,155	49,552	98,514
2007	11,172	138,635	73,163	112,446
2008	12,993	149,940	89,646	125,822

- The selected ULAE Ratio should be based on an all years' average ratio, rounded to the nearest 10^{ths} place
- Total ultimate claims for all AYs = 514,760

Compute:

a. Estimated Unpaid ULAE at 12/31/08 using the expected claims method

b. Estimated Unpaid ULAE at 12/31/08 using the Bornhuetter-Ferguson method.

c. Estimated Unpaid ULAE at 12/31/08 using the development method.

Question 15

(4.0 points) Using the Conger and Nolibos simplified generalized method with

U_1= 60%, U_2= 40%, and U_3 = 0% as described by Friedland in "“Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Calendar Year (1)	Paid ULAE (2)	Acc Year Ultimate Claims (3)	Paid Claims (4)	Claims Basis (5)
2005	7,274	90,865	32,632	67,572
2006	10,233	131,155	49,552	98,514
2007	11,172	138,635	73,163	112,446
2008	12,993	149,940	89,646	125,822

- The selected ULAE Ratio should be based on an all years' average ratio, rounded to the nearest 10^{ths} place
- Total ultimate claims for all AYs = 514,760

Compute:

a. Estimated Unpaid ULAE at 12/31/08 assuming pure IBNR = 4% of Latest Accident Year Ultimate Claims

b. Estimated Unpaid ULAE at 12/31/08 assuming pure IBNR = 6% of Latest Accident Year Ultimate Claims

Exam 5B - Independently Authored Preparatory Test 4

Question 16

(4.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60
2003	45,163,102	52,497,731	55,468,551	57,015,411	57,565,344
2004	45,417,309	52,640,322	55,553,673	56,976,657	
2005	46,360,869	53,790,061	56,786,410		
2006	46,582,684	54,641,339			
2007	48,853,563				

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12-24	24 - 36	36 - 48	48 - 60	To Ult
2003	1.162	1.057	1.028	1.010	1.000
2004	1.159	1.055	1.026		
2005	1.160	1.056			
2006	1.173				
2007					

Compute:

a. (1.0 point). The geometric average of the age to age factors for the latest four years at 12-24 months

b. (1.0 point). Percent reported at 12 months, assuming selected cumulative loss development factors to ultimate are based on simple averages of the latest three years.

c. (1.0 point). Projected ultimate claims using the cumulative loss development factors computed in b. for accident years 2003 – 2007.

d. (1.0 point). IBNR for accident years 2003 – 2007.

Question 17

(4 points) You are given the following information:

Earned Premium	Accident Year	Reported Claims by Development Age: at age 12 mo	at age 24 mo	at age 36 mo	at age 48 mo
38,000	2005	9,700	19,400	28,200	32,400
40,000	2006	10,300	20,600	29,800	
42,000	2007	10,800	21,600		
44,000	2008	14,400			

Assume an expected Claim Ratio = 0.90 for all years.

Choose selected factors using a straight average of the age to age factors.

Assume no development past 48 months.

a. (1 point) Using the Development method, calculate the indicated IBNR for accident year 2008 as of December 31, 2008.

b. (0.5 point) Using the Bornhuetter-Ferguson method, calculate the indicated IBNR for accident year 2008 as of December 31, 2008.

c. (1 point) Using the Bornhuetter-Ferguson method, calculate the expected IBNR for Accident Year 2008 expected to be reported (emerge) during calendar year 2009.

Question 18

(3.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

You are asked to develop an estimate of unpaid claims for an insurer writing private passenger automobile bodily injury in one jurisdiction.

Accident Year	Claims at 12/31/098 Reported	Claims at 12/31/098 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	On-Level Earned Premium	Trend at 14.50% to 7/1/08	Factor to Adjust for Tort Reform
2004	16,500,000	11,200,000	1.200	1.750	32,000,000	1.719	0.750
2005	18,500,000	10,200,000	1.400	2.500	47,000,000	1.501	1.000
2006	16,500,000	6,000,000	1.800	5.000	50,000,000	1.311	1.000
2007	14,000,000	3,000,000	2.900	15.000	57,000,000	1.145	1.000
2008	8,700,000	750,000	4.000	90.000	62,000,000	1.000	1.000

Compute:

a. (1.0 point). Compute initial selected ultimate claims as the average of the reported and paid claim development projections.

b. (1.0 point). Compute the selected claim ratio for AY 2008 as the average of trended adjusted claim ratios for 2004 – 2008, excluding high and low ratios.

c. (1.0 point). Compute estimated IBNR for AY 2008

Question 19

(3.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

You are asked to develop an estimate of unpaid claims for an insurer writing private passenger automobile bodily injury in one jurisdiction.

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Earned Premium	Claim Ratio Selected
(1)	(2)	(3)	(4)	(5)
2004	70,288	52,811	99,322	87.1%
2005	70,655	40,026	138,151	78.3%
2006	48,804	22,819	107,578	65.8%
2007	31,732	11,865	62,438	63.8%
2008	18,632	3,409	47,797	82.5%
Total	240,111	130,930		

a. (2.0 points). Compute estimated IBNR for AYs 2004 - 2008

b. (1.0 points). Compute estimated total unpaid claims for AYs 2004 - 2008

Question 20

(3.0 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

You are asked to develop projected ultimate claims using the B-F method using paid and reported claims

Accident	Expected	CDF to Ultimate		Claims at 12/31/07	
Year	Claims	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)
2003	56,318,302	1.011	1.040	57,565,344	55,930,654
2004	59,646,290	1.023	1.085	56,976,657	53,774,672
2005	61,174,953	1.051	1.184	56,786,410	50,644,994
2006	61,926,981	1.110	1.404	54,641,339	43,606,497
2007	61,864,556	1.292	2.390	48,853,563	27,229,969
Total	300,931,082			274,823,313	231,186,786

a. (2.0 points). Compute projected ultimate claims using the B-F method using reported claims for AYs 2003 - 2007

b. (1.0 points). Compute projected ultimate claims using the B-F method using paid claims for AY 2007

Question 21

(3.0 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

	Age of	Expected ultimate Claims					
Accident	Accident Year	Using B-F Method with		Claims at 12/31/08		CDF to Ultimate	
Year	at 12/31/08	Reported	Paid	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State							
2004	60	893,397	893,397	884,463	857,661	1.000	1.000
2005	48	938,068	938,067	919,306	863,022	1.010	1.043
2006	36	984,970	984,970	935,722	827,375	1.042	1.143
2007	24	1,034,219	1,034,218	930,797	734,295	1.100	1.352
2008	12	1,085,930	1,085,929	836,166	456,090	1.286	2.286
Total		4,936,584	4,936,581	4,506,454	3,738,443		

a. (2.0 points). Compute projected ultimate claims using the Gunnar Benktander Method using reported claims for AYs 2004 - 2008

b. (1.0 points). Compute estimated IBNR using the Gunnar Benktander Method using reported claims for AYs 2004 - 2008

Question 22

(3.0 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Accident Year	Earned Premium	Age of Accident at 12/31/07	Reported Year Claims at 12/31/2007	Reported CDF to Ultimate
(1)	(2)	(3)	(4)	(5)
2003	86,643,542	60	57,565,344	1.000
2004	91,763,523	48	56,976,657	1.010
2005	94,115,312	36	56,786,410	1.037
2006	95,272,279	24	54,641,339	1.095
2007	95,176,240	12	48,853,563	1.274

a. (1.50 points). Compute estimated claim ratios using the Cape Cod Method for AYs 2003 – 2007.

b. (1.50 points). Compute projected ultimate claims using the Cape Code Method for AYs 2003 – 2007.

Question 23

(4.0 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

You are given detailed rate change information for the ABC insurance company as well as information regarding the affect of legal reform on the insurance product. You are asked to incorporate this information into the Cape Cod projection method. You are also asked to adjust the current reported claims for the influences of inflation (through claims trend factors) and tort reform.

Accident Year	Earned Premium	On-Level Adjustment	Reported Claims at 12/31/08	Pure Premium Trend	Tort Reform Factors	Reported CDF to Ultimate
2004	99,322	0.810	70,288	1.144	0.670	1.064
2005	138,151	0.704	70,655	1.106	0.670	1.085
2006	107,578	0.640	48,804	1.070	0.750	1.196
2007	62,438	0.800	31,732	1.034	1.000	1.512
2008	47,797	1.000	18,632	1.000	1.000	2.551
Total	455,286		240,111			

a. (2.50 points). Compute used-up on-level premium using the Cape Cod Method for AYs 2004 – 2008.

b. (1.50 points). Compute estimated unadjusted claim ratios using the Cape Code Method for AYs 2004 – 2008.

Solutions to Exam 5B - Independently Authored Preparatory Test 4

Question 1 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Organization of the data

a. Key Assumptions of Classical Technique

- The insurer's ULAE-to-claim relationship has reached a steady-state so that the ratio of paid ULAE-to-paid claims approximates ultimate ULAE-to-ultimate claims.
- The volume and cost of future claims management on not-yet-reported claims and reported-but-not-yet-closed claims will be proportional to IBNR and case O/S, respectively.

b. Assume that ½ of ULAE are sustained when opening a claim and ½ is sustained when closing the claim. Thus,

i. 50% of the ULAE ratio is applied to case O/S (since for known claims, ½ of the unallocated work was already completed at the time of opening);

ii. 100% of the ULAE ratio is applied to IBNR, since all unallocated work remains to be completed (i.e. the work associated with opening and closing the claims).

See chapter 17

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Organization of the data

4 steps in the classical technique for estimating unpaid ULAE:

1. Calculate ratios of historical CY paid ULAE-to-CY paid claims
2. Review historical paid ULAE-to-paid claims ratios for trends or patterns
3. Select a ratio of ULAE-to-claims applicable to future claims payments
4. Apply 50% of the selected ULAE ratio to case O/S and 100% of the selected ULAE ratio to IBNR

See chapter 17

Question 3 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Key assumptions of estimation techniques

a. closing" a claim and "paying" a claim

- For glass coverage, a single payment is the norm, and payment represents settlement (i.e. closure) of the claim, and therefore the end of the claims handling activity.
- For WC, a claim payment and closing of the claim often differ, since regular payments can replace lost wages for an extended period of time.

Address this challenge by adjusting the %'s applied to the case O/S and the IBNR. Example:

For an insurer with a portfolio of long-tail professional liability coverage, with substantial claims-handling work during the life of the claim, unpaid ULAE ratios of 25% are applied to case O/S and 75% to IBNR (assumes a greater % of expenses are related to closing the claims rather than opening claims).

b. Another challenge is the definition of IBNR.

The broad definition of IBNR includes liability for both claims that are not yet reported as well as future case development on known claims.

The narrow definition of IBNR is incurred but not yet reported (IBNYR, a.k.a. pure IBNR), while future case development on known claims is referred to as incurred but not enough reported (IBNER).

Using the classical technique, apply 100% of the ULAE ratio to IBNYR (pure IBNR) and 50% of the ULAE ratio to the sum of case reserves and IBNER.

See chapter 17

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

When the Classical Technique Works and When it Does Not

Johnson states that the classical technique "will only give good results for very short-tailed, stable lines of business."

Rahardjo states:

- The paid to paid method assumes that claims incur expenses only when initially opened and when closed, which is not true for liability claims.
- The paid to paid ratio itself is subject to distortion when a company is growing or shrinking or when a line of business is in "transition" (e.g. consider WC in the early 1990s as many large customers moved to deductible policies or towards self-insurance).

See chapter 17

Question 5 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

a. Kittel Refinement. Kittel describes a weakness in the classical technique:

The Loss Department doesn't just close claims but it also opens them.

Paid losses don't accurately represent the work done by the Loss Department since they do not take into account claims opened during the year which remain open at year end.

This can be significant when loss reserves vary from year to year (e.g. a growing line with rapidly inflating loss costs could have loss reserves increase at 30% - 40% per year).

b. Key Assumptions of Kittel Refinement to the Classical Technique:

- ULAE is sustained as claims are reported even if no claim payments are made.
- ULAE payments for a specific calendar year are related to both the reporting and payment of claims.

See chapter 17

Question 6 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

Problems associated with the Kittel Refinement

- The use of traditional 50/50 assumption regarding ULAE expenditures does not allow for allocation of ULAE costs between opening, maintaining, and closing claims which may vary from insurer to insurer.
- There is no potential for using different rates of inflation between ULAE and claims.

See chapter 17

Question 7 discussion: Blooms: Comprehension; Difficulty 2, LO 7, KS Estimation of unpaid ULAE

a. Key Assumptions of Generalized Approach

- Expenditure of ULAE resources is proportional to the dollars of claims being handled
- ULAE amounts spent <u>opening</u> claims are proportional to the ultimate cost of claims being reported.
- ULAE amounts spent <u>maintaining</u> claims are proportional to payments made.
- ULAE amounts spent <u>closing</u> claims are proportional to the ultimate cost of claims being closed.

b. Conger and Nolibos define $U_1 + U_2 + U_3 = 100\%$, where:

- U_1 is the % of ultimate ULAE spent opening claims
- U_2 is the % of ultimate ULAE spent maintaining claims
- U_3 is the % of ultimate ULAE spent closing claims

See chapter 17

Question 8 discussion: Blooms: Comprehension; Difficulty 2, LO 7, KS Estimation of unpaid ULAE

a. W* is the selected ultimate ULAE-to-claims ratio; L is the independently estimated ultimate claims for the same group of AYs; M is the total amount spent on ULAE during a time period T, defined as M = (U_1 x R x W) + (U_2 x P x W) + (U_3 x C x W), where:

- R is the ultimate cost of claims reported during T
- P is the claims paid during T
- C is the ultimate cost of claims closed during T
- W is the ratio of ultimate ULAE to ultimate claims (L)
- U_1, U_2, and U_1 are the %s of ultimate ULAE spent opening, maintaining and closing claims respectively

and B is the claims basis for the time period T is computed as B = (U_1 x R) + (U_2 x P) + (U_3 x C)

b1. Method 1 Practical and Conceptual Problems

- Practically, it may be difficult to quantify the historical paid ULAE that corresponds only to the AYs claims represented by L.
- Conceptually, this shares the potential distortions of an expected claims ratio approach to estimating unpaid claims (unpaid claims equal a predetermined expected claims ratio time earned premium less claims paid to date). The unpaid claim estimate is distorted if actual paid claims do not approach expected ultimate claims.

b2. Method 2 Practical Problems and Concerns:

- The practical difficulty of establishing the ULAE amounts paid that correspond to accidents occurring during a particular period
- This method may be overly responsive to random fluctuations in ULAE emergence.

See chapter 17

Question 9 discussion: Blooms: Comprehension; Difficulty 2, LO 7, KS Estimation of unpaid ULAE

a. Assume that:

R(t) – ultimate cost of claims known at time t

P(t) – total amount paid at time t

C(t) – ultimate cost of claims closed at time t

Compute unpaid ULAE = W* x {U_1 x [L – R(t)] + U_2 x [L – P(t)] + U_3 x [L – C(t)]},

Each component of the unpaid ULAE formula represents a provision for the ULAE associated with:

- Opening claims not yet reported
- Making payments on currently active claims and on those claims that will be reported in the future
- Closing “unclosed” claims (i.e. those claims that are open at time t and those claims that will be reported and opened in the future)

Rearranging the equation, one obtains: Unpaid ULAE = W* x (L - B)

b. This method assumes that the amount of ULAE paid to date and the unpaid ULAE are not directly related, except to the extent that these payments influence the selection of the ratio W*.

This is similar to the assumption underlying the BF technique in that an a priori provision of unpaid ULAE is calculated.

See chapter 17

Question 10 discussion: Blooms: Comprehension; Difficulty 2, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

Practical Difficulties with the Generalized Approach

- The estimation of R and C, the ultimate cost of reported and closed claims, is not simple.
- It is not known about the relative accuracy of the generalized method (as compared to other dollar-based methods) in an inflationary environment.
- The effect of reopened claims on the accuracy of the estimates of unpaid ULAE is not known.
- How to modify the approach to properly reflect the change over time in the quantity or cost of resources dedicated to the handling of a claim, as that claim ages is not known.

See chapter 17

Question 11 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Organization of the data

Accident Year	Direct Earned Premium	Expected Claims Ratio	Expected Claims	Expected Payment Percentage in Calendar 2005	2006	2007	2008	Expected Claims Paid in Calendar Year 2005	2006	2007	2008
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2005	2,866,667	60%	1,720,000	12%	15%	15%	15%	206,400	258,000	258,000	258,000
2006	2,833,333	60%	1,700,000		12%	15%	15%		204,000	255,000	255,000
2007	2,946,667	60%	1,768,000			12%	15%			212,160	265,200
2008	2,656,667	60%	1,594,000				12%				191,280
Total	11,303,333		6,782,000					**206,400**	**462,000**	**725,160**	**969,480**

Column Notes:
(4) = [(2) x (3)].
(9) = [(4) x (5)].
(10) = [(4) x (6)].
(11) = [(4) x (7)].
(12) = [(4) x (8)].

See chapter 17

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Estimation of unpaid ULAE

Calendar Year	Paid ULAE	Paid Claims Actual	Paid Claims Expected	ULAE Ratio Paid ULAE-to-Paid Claims Actual	ULAE Ratio Paid ULAE-to-Paid Claims Expected
(1)	(2)	(3)	(4)	(5)	(6)
2005	36,667	835,633	206,400	0.044	0.178
2006	41,667	57,333	462,000	0.727	0.090
2007	46,667	273,767	725,160	0.170	0.064
2008	53,333	206,400	969,480	0.258	0.055
Total	178,333	1,373,133	2,363,040	0.130	0.075

(7) Selected ULAE Ratio	0.075
(8) Case Outstanding at 12/31/08	213,750
(9) Total IBNR at 12/31/08	6,108,500
(10) Pure IBNR at 12/31/08	79,700
(11) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	**469,060**
(12) Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR	**241,570**

(5) = [(2) / (3)].
(6) = [(2) / (4)].
(7) = is based on (6) total
(10) Estimated assuming pure IBNR = 5% * 1,594,000 (5% of AY 2008 expected claims.)
(11) = {[(7) x 50% x (8)] + [(7) x 100% x (9)]}.
(12) = {[(7) x 50% x ((8) + (9) - (10))] + [(7) x 100% x (10)]}.
See chapter 17

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Estimation of unpaid ULAE

Calendar Year	Paid ULAE	Paid Claims	Reported Claims	Average of Paid and Rptd Claims	ULAE Ratio-Paid ULAE to Paid Claims Traditional	ULAE Ratio-Paid ULAE to Avg Paid & Rptd Claims Kittel
2005	7,274	32,632	72,693	52,662	0.223	0.138
2006	10,233	49,552	109,371	79,462	0.207	0.129
2007	11,172	73,163	123,310	98,236	0.153	0.114
2008	12,993	89,646	139,082	114,364	0.145	0.114
	41,672	244,993	444,456	344,724	0.170	0.121

	Traditional	Kittel
(8) Selected ULAE Ratio	0.170	0.121
(9) Case Outstanding at 12/31/08	248,311	248,311
(10) IBNR at 12/31/08	96,775	96,775
(11) Estimated Unpaid ULAE at 12/31/08	**37,579**	**26,707**

(6) = [(2) / (3)].
(7) = [(2) / (5)].
(11) = {[(8) x 50% x (9)] + [(8) x 100% x (10)]}.
See chapter 17

Question 14 discussion: Blooms: Comprehension; Difficulty 3, LO 7, KS Estimation of unpaid ULAE

Calendar Year (1)	Paid ULAE (2)	Ult on Claims Reported in Calendar Year (3)	Paid Claims (4)	Claims Basis (5)	ULAE Ratio (6)
2005	7,274	90,865	32,632	67,572	0.108
2006	10,233	131,155	49,552	98,514	0.104
2007	11,172	138,635	73,163	112,446	0.099
2008	12,993	149,940	89,646	125,822	0.103
Total	41,672	510,595	244,993	404,354	0.103

(7) Selected ULAE Ratio	0.100
(8) Ultimate Claims	514,760
(9) Indicated Unpaid ULAE Using:	
(a) Expected Claim Method	**9,804**
(b) Bornhuetter-Ferguson Method	**11,041**
(c) Development Method	**11,378**

<u>Column and Line Notes</u>:

(5) = {[(3) x 60%] + [(4) x 40%]}.

(6) = [(2) / (5)].

(7) Selected based on ULAE ratios in (6).

(9a) = {[(7) x (8)] - (Total in (2))}.

(9b) = {(7) x [(8) - (Total in (5))]}.

(9c) = {{[(8) / (Total in (5))] - 1.00} x (Total in (2))}.

See chapter 17

Question 15 discussion: Blooms: Comprehension; Difficulty 3, LO 7, KS Estimation of unpaid ULAE

Calendar Year (1)	Paid ULAE (2)	Acc Year Ultimate Claims (3)	Paid Claims (4)	Claims Basis (5)	ULAE Ratio (6)=(2)/(5)
2005	7,274	90,865	32,632	67,572	0.1077
2006	10,233	131,155	49,552	98,514	0.1039
2007	11,172	138,635	73,163	112,446	0.0994
2008	12,993	149,940	89,646	125,822	0.1033
Total	41,672	510,595	244,993	404,354	0.1031

(7) Selected ULAE Ratio	**0.100**
(8) Ultimate Claims	514,760
(9) Estimated Pure IBNR Based on	
(a) 4% of Latest Accident Year Ultimate Claims	5,998
(b) 6% of Latest Accident Year Ultimate Claims	8,996
(10) Indicated Unpaid ULAE Using	
(a) 4% of Latest Accident Year Ultimate Claims	**11,151**
(b) 6% of Latest Accident Year Ultimate Claims	**11,330**

Column and Line Notes:
(5) = {[(3) x 60%] + [(4) x 40%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(9a) = [4% x (accident year 2008 ultimate claims in (3))].
(9b) = [6% x (accident year 2008 ultimate claims in (3))].
(10a) = (7) x {[60% x (9a)] + {40% x [(8) - (Total in (4))]}}.
(10b) = (7) x {[60% x (9b)] + {40% x [(8) - (Total in (4))]}}.

See chapter 17

Question 16 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

Compute:

a. (1.0 point). The geometric average for the latest four years at 12-24 months = $(1.173 \times 1.160 \times 1.159 \times 1.162)^{.25} = 1.163$.

b. (1.0 point). Percent reported at 12 months, assuming selected cumulative loss development factors to ultimate are based on simple averages of the latest three years.

	Development Factor Selection				
	12-24	24 - 36	36 - 48	48 - 60	To Ult
Selected	1.164	1.056	1.027	1.010	1.000
CDF to Ultimate	1.274	1.095	1.037	1.010	1.000
Percent Reported	78.5%	91.4%	96.5%	99.0%	100.0%

c. (1.0 point). Projected ultimate claims using the cumulative loss development factors computed in b. for accident years 2003 – 2007.

d. (1.0 point). IBNR for accident years 2003 – 2007.

Accident Year	Age of Year	Claims at 12/31/07 Reported	CDF to Ultimate Reported	Projected Ultimate Claims Using Dev. Method with Reported	IBNR
(1)	(2)	(3)	(4)	(5)=(3)*(4)	(6)=(5)-(3)
2003	60	57,565,344	1.000	57,565,344	0
2004	48	56,976,657	1.010	57,526,216	549,559
2005	36	56,786,410	1.037	58,867,822	2,081,412
2006	24	54,641,339	1.095	59,809,264	5,167,925
2007	12	48,853,563	1.274	62,251,442	13,397,879
Total		274,823,313		296,020,088	21,196,775

See chapter 7

Question 17– Chapter 7, 9 and 15 discussion Blooms: Comprehension; Difficulty 3,

a. (1 point) Using the Development method, calculate the indicated IBNR for accident year 2008 as of December 31, 2008.

		Reported Claims by Development Age			
Earned Premium	**Accident Year**	**at age 12 mo**	**at age 24 mo**	**at age 36 mo**	**at age 48 mo**
38,000	2005	9,700	19,400	28,200	32,400
40,000	2006	10,300	20,600	29,800	
42,000	2007	10,800	21,600		
44,000	2008	14,400			

ATA factors by AY:

AY	*12:24 mo*	*24:36 mo*	*36:48 mo*	*See tail factor*	
2005	*2.000*	*1.454*	*1.149*		
2006	*2.000*	*1.447*			
2007	*2.000*				

	12: 24 mo	***24: 36 mo***	***36:48 mo***		
ATA: Simple Average (all yr)	*2.00*	*1.45*	*1.15*		
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***given***
Reported CDF to Ultimate	*3.33*	*1.67*	*1.15*	*1.00*	*tail*

Accident Year	***Age of Data at 12/31/04***	***Reported Claims at 12/31/04***	***Reported CDF to Ultimate***	***Expected Ultimate Claims***	***IBNR (broadly defined)***	***OR:*** Shortcut	***IBNR (broadly defined)***
	(1)	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*		*(5)=(2)*[(3) - 1.0]*
2005	*48 months*	*32,400*	*1.00*	*32,400*	*0*		*0*
2006	*36 months*	*29,800*	*1.15*	*34,238*	*4,438*		*4,438*
2007	*24 months*	*21,600*	*1.67*	*35,987*	*14,387*		*14,387*
2008	*12 months*	*14,400*	*3.33*	*47,983*	***33,583***		***33,583***
Total					*52,409*		*52,409*

Note: Only the calculations for Accident Year 2008 are required:

*14,400 * (3.33 - 1) =* ***33,583***

b. (0.5 point) Using the Bornhuetter-Ferguson method, calculate the indicated IBNR for accident year 2008 as of December 31, 2008.

Selected ATA factors		*Reported Ultimate CDF*		*Exp. % Unreported*	*Accident*
	(1)		*(2) = product of (1)*	*(3) = 1.0 - 1.0 / (2)*	*Year*
Tail at 48 months	*1.00*	*at 48 mo.*	*1.00*	*0.0%*	*2005*
36 - 48 months	*1.15*	*at 36 mo.*	*1.15*	*13.0%*	*2006*
24 - 36 months	*1.45*	*at 24 mo.*	*1.67*	*40.0%*	*2007*
12 - 24 months	*2.00*	*at 12 mo.*	*3.33*	*70.0%*	*2008*

(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF

Accident Year	***Earned Premium***	***A priori Expected Claim Ratio***	***A priori Expected Claims***	***"IBNR" Expected Unreport***	*Or shortcut using Est. Expected Claims x Percent Unreported*	***IBNR (broadly defined)***
	(4) given	*(5) given*	*(6)=(4)*(5)*	*(7)=(6)*(3)*	=(Premium)*(Exp Claims %)*[1-1/CDF]	
2005	*38,000*	*90.0%*	*34,200*	*0*		*0*
2006	*40,000*	*90.0%*	*36,000*	*4,667*		*4,667*
2007	*42,000*	*90.0%*	*37,800*	*15,112*		*15,112*
2008	*44,000*	*90.0%*	*39,600*	***27,716***		***27,716***
Total				*47,494*		*47,494*

Note: Only the calculations for Accident Year 2008 are required:

*22,000 * 90% * (1 - 1/3.33) = 19,800 * 70% =* ***27,716***

Question 17 – Chapter 7, 9 and 15 discussion Blooms: Comprehension; Difficulty 1, LO 3, KS

c. (1 point) Using the Bornhuetter-Ferguson method, calculate the expected IBNR for Accident Year 2008 expected to be reported (emerge) during calendar year 2009.

	Selected ATA factors	Reported Ultimate CDF		Exp. % Unreported	Accident
	(1)		(2) = product of (1)	(3) = 1.0 - 1.0 / (2)	Year
Tail at 48 months	1.00	at 48 mo.	1.00	0.0%	2005
36 - 48 months	1.15	at 36 mo.	1.15	13.0%	2006
24 - 36 months	1.45	at 24 mo.	1.67	40.0%	2007
12 - 24 months	2.00	at 12 mo.	3.33	70.0%	2008

(3) The Percent Unreported = 1 minus inverse of Ultimate Reported CDF

Accident Year	Earned Premium	A priori Expected Claim Ratio	A priori Expected Claims	"IBNR" Expected Unreport	Or shortcut using Est. Expected Claims x Percent Unreported	IBNR (broadly defined)
	(4) given	(5) given	(6)=(4)*(5)	(7)=(6)*(3)	(7)=(3)*(4)*[1.0-1.0/CDF]	
2005	38,000	90.0%	34,200	0		0
2006	40,000	90.0%	36,000	4,667		4,667
2007	42,000	90.0%	37,800	15,112		15,112
2008	44,000	90.0%	39,600	**27,716**		**27,716**
Total				47,494		47,494

Note: Only the calculations for Accident Year 2008 are required:

44,000 * 90% * (1 - 1/3.33) = 19,800 * 70% = **27,716**

c) Details shown for completeness

Acc Year	Estimated IBNR	Ages in NEXT yr (CY 2009)	Percent Reported at 1/1/09	Percent Reported at 12/31/09	Percent Unreported at 1/1/09	Percent of current IBNR expected to emerge between 1/1 - 12/31/09	Est. IBNR to emerge during '09
	(7)	(8) FYI	(9) See (3)	(10) see(3)	(11)= 1-(9)	(12) = [(10)-(9)] / (11)	(13)=(7)*(12)
2005	0	48 to 60	100.00%	100.00%	0.00%	n/a	0
2006	4,667	36 to 48	87.04%	100.00%	12.96%	100.00%	4,667
2007	15,112	24 to 36	60.02%	87.04%	39.98%	67.58%	10,212
2008	27,716	12 to 24	30.01%	60.02%	69.99%	42.88%	**11,884**
Total							26,763

* Here the period we evaluate for emerged losses is the year immediately following our original estimate

But, for exam purposes: **Only the calculations for Accident Year 2008 are required:**

Solution to c: 27,716 * (60.02% - 30.01%) / (1 - 30.01%) = **11,884**

OR since B-F, can also use shortcut with A-prior Expected Claims for AY 2008:

39,600 * (60.02% - 30.01%) = **11,884**

Solutions to Exam 5B - Independently Authored Preparatory Test 4

Question 18 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

a. (1.0 point). Compute initial selected ultimate claims as the average of the reported and paid claim development projections.

Accident	Claims at 12/31/098		CDF to Ultimate		Projected Ultiamate Claims Based On		Initial Selected Ultimate
Year	Reported	Paid	Reported	Paid	Reported	Paid	Claims
(1)	(2)	(3)	(4)	(5)	(6) = [(2) x (4)]	(7) = [(3) x(5)]	(8) =[(6)+(7)]/2
2004	16,500,000	11,200,000	1.200	1.750	19,800,000	19,600,000	**19,700,000**
2005	18,500,000	10,200,000	1.400	2.500	25,900,000	25,500,000	**25,700,000**
2006	16,500,000	6,000,000	1.800	5.000	29,700,000	30,000,000	**29,850,000**
2007	14,000,000	3,000,000	2.900	15.000	40,600,000	45,000,000	**42,800,000**
2008	8,700,000	750,000	4.000	90.000	34,800,000	67,500,000	**51,150,000**

b. (1.0 point). Compute the selected claim ratio for AY 2008 as the average of trended adjusted claim ratios for 2004 – 2008, excluding high and low ratios.

c. (1.0 point). Compute estimated IBNR for AY 2008

Initial Selected Ultimate Claims	On-Level Earned Premium	Trend at 14.50% to 7/1/08	Adjusted for Tort Reform	Trended Adj. Ultimate Claims	Trended Adjusted Claim Ratio
(8) =[(6)+(7)]/2	(9)	(10)	(11)	(12) = [(8) x(10) x(11)]	(13) = [(12) / (9))]
19,700,000	32,000,000	1.719	0.750	25,398,225	79.4%
25,700,000	47,000,000	1.501	1.000	38,575,700	82.1%
29,850,000	50,000,000	1.311	1.000	39,133,350	78.3%
42,800,000	57,000,000	1.145	1.000	49,006,000	86.0%
51,150,000	62,000,000	1.000	1.000	51,150,000	82.5%
(14) Average Claim Ratio at 7/1/2008 Cost Level					
Average 2004 to 2008 Excluding High and Low				80.9%	
(15) Selected Claim Ratio at 7/1/2008 Cost Level				**80.9%**	
(16) Expected Claims for 2008 Accident Year				50,158,000	(16) = [(15) x (9) for 2008].
(17) Unpaid Claim Estimate for 2008 Accident Year					
Total				49,408,000	(17) tot = [(16) - (3) for 2008].
IBNR				**41,458,000**	(17) IBNR = [(16) - (2) for 2008].

See Chapter 8

Question 19 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

a. (2.0 points). Compute estimated IBNR for AYs 2004 - 2008

b. (1.0 points). Compute estimated total unpaid claims for AYs 2004 - 2008

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Earned Premium	Claim Ratio Selected	Expected Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Expected Claims Method: IBNR	Unpaid Claim Estimate Based on Expected Claims Method: Total
(1)	(2)	(3)	(4)	(5)	(6)=(4)*(5)	(7)=[(2)-(3)]	(8) = [(6)-(2))	(9) = [(6) - (3)]
2004	70,288	52,811	99,322	87.1%	86,509	17,477	**16,221**	**33,698**
2005	70,655	40,026	138,151	78.3%	108,172	30,629	**37,517**	**68,146**
2006	48,804	22,819	107,578	65.8%	70,786	25,985	**21,982**	**47,967**
2007	31,732	11,865	62,438	63.8%	39,835	19,867	**8,103**	**27,970**
2008	18,632	3,409	47,797	82.5%	39,433	15,223	**20,801**	**36,024**
Total	240,111	130,930			344,736	109,181	**104,625**	**213,806**

See Chapter 8

Question 20 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

a. (2.0 points). Compute projected ultimate claims using the B-F method using reported claims for AYs 2003 - 2007

b. (1.0 points). Compute projected ultimate claims using the B-F method using paid claims for AY 2007

Accident Year	Expected Claims	CDF to Ultimate Reported	CDF to Ultimate Paid	Percentage Unreported	Percentage Unpaid	Expected Claims Unreported	Expected Claims Unpaid	Claims at 12/31/07 Reported	Claims at 12/31/07 Paid	Projected Ultimate Claims using B-F Method with Reported	Projected Ultimate Claims using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2003	56,318,302	1.011	1.040	1.09%	3.85%	613,869	2,168,255	57,565,344	55,930,654	**58,179,213**	58,098,909
2004	59,646,290	1.023	1.085	2.25%	7.83%	1,342,042	4,670,305	56,976,657	53,774,672	**58,318,699**	58,444,977
2005	61,174,953	1.051	1.184	4.85%	15.54%	2,966,985	9,506,588	56,786,410	50,644,994	**59,753,395**	60,151,582
2006	61,926,981	1.110	1.404	9.91%	28.77%	6,136,964	17,816,393	54,641,339	43,606,497	**60,778,303**	61,422,890
2007	61,864,556	1.292	2.390	22.60%	58.16%	13,981,390	35,980,426	48,853,563	27,229,969	**62,834,953**	**63,210,395**
Total	300,931,082					25,041,250	70,141,965	274,823,313	231,186,786		

Column Notes:
(5) =[1.00 - (1.00 / (3))].
(6) =[1.00 - (1.00 / (4))].
(7) = [(2) x(5)]
(8) =[(2) x (6)]
(11) = [(7) + (9]
(12)= [(8)+ (10)].

See Chapter 9

Question 21 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

Question 21 below is restated for convenience purposes only

(3.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Accident Year	Age of Accident Year at 12/31/08	Expected ultimate Claims Using B-F Method with Reported	Paid	Claims at 12/31/08 Reported	Paid	CDF to Ultimate Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State							
2004	60	893,397	893,397	884,463	857,661	1.000	1.000
2005	48	938,068	938,067	919,306	863,022	1.010	1.043
2006	36	984,970	984,970	935,722	827,375	1.042	1.143
2007	24	1,034,219	1,034,218	930,797	734,295	1.100	1.352
2008	12	1,085,930	1,085,929	836,166	456,090	1.286	2.286
Total		4,936,584	4,936,581	4,506,454	3,738,443		

a. (2.0 points). Compute projected ultimate claims using the Gunnar Benktander Method using reported claims for AYs 2004 - 2008

b. (1.0 points). Compute estimated IBNR using the Gunnar Benktander Method using reported claims for AYs 2004 - 2008

Solution to question 21

Accident Year	Age of Accident Year at 12/31/08	Expected ultimate Claims Using B-F Method with Reported	Paid	Claims at 12/31/08 Reported	Paid	CDF to Ultimate Reported	Paid	Expected Percentage Unreported	Unpaid	Projected Ultimate Claims Using G-B Method with Reported	Paid	Estimated IBNR Using G-B Method with Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Steady-State													
2004	60	893,397	893,397	884,463	857,661	1.000	1.000	0.0%	0.0%	884,463	857,661	0	-26,802
2005	48	938,068	938,067	919,306	863,022	1.010	1.043	1.0%	4.2%	928,782	902,108	9,476	-17,198
2006	36	984,970	984,970	935,722	827,375	1.042	1.143	4.0%	12.5%	975,519	950,496	39,797	14,774
2007	24	1,034,219	1,034,218	930,797	734,295	1.100	1.352	9.1%	26.0%	1,024,817	1,003,622	94,020	72,825
2008	12	1,085,930	1,085,929	836,166	456,090	1.286	2.286	22.2%	56.2%	1,077,484	1,066,925	241,318	230,759
Total		4,936,584	4,936,581	4,506,454	3,738,443					4,891,064	4,780,812	384,610	274,358

(9) = [1.00 - (1.00 / (7))].

(10) = [1.00 - (1.00 / (8))]

(11) = [((3) x (9)) + (5)]

(12) = [((4) x (10)) + (6)]

(13) = [(11) - (5)].

(14) = [(12) - (5)].

See Chapter 9

Question 22 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

a. (1.5 points). Compute estimated claim ratios using the Cape Cod Method for AYs 2003 – 2007.

Accident Year	Earned Premium	Age of Accident at 12/31/07	Reported Year Claims at 12/31/2007	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6) = [1.00 / (5)]	(7) = [(2) x (6)]	(8) = [(4) / (7)]
2003	86,643,542	60	57,565,344	1.000	100.0%	86,643,542	66.4%
2004	91,763,523	48	56,976,657	1.010	99.0%	90,886,888	62.7%
2005	94,115,312	36	56,786,410	1.037	96.5%	90,787,641	62.5%
2006	95,272,279	24	54,641,339	1.095	91.4%	87,040,109	62.8%
2007	95,176,240	12	48,853,563	1.274	78.5%	74,692,221	65.4%
Total	462,970,896		274,823,313			430,050,401	63.9%

b. (1.5 points). Compute projected ultimate claims using the Cape Code Method for AYs 2003 – 2007.

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/2007	Promected Ultimate Claims
(1)	(2)	(3)	(4)	(4) = [(2) x (3)]	(6)=1.0- (1.0/(5))	(7) = [(4) x (6)]	(8)	(9) = [(7) + (8)]
2003	86,643,542	63.9%	55,369,476	1.000	0.0%	0	57,565,344	57,565,344
2004	91,763,523	63.9%	58,641,395	1.010	1.0%	560,213	56,976,657	57,536,870
2005	94,115,312	63.9%	60,144,303	1.037	3.5%	2,126,545	56,786,410	58,912,955
2006	95,272,279	63.9%	60,883,662	1.095	8.6%	5,260,761	54,641,339	59,902,100
2007	95,176,240	63.9%	60,822,289	1.274	21.5%	13,090,293	48,853,563	61,943,856
Total	462,970,896		295,861,125			21,037,812	274,823,313	295,861,125

See Chapter 10

Question 23 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

a. (2.50 points). Compute used-up on-level premium using the Cape Cod Method for AYs 2004 – 2008.

b. (1.50 points). Compute estimated unadjusted claim ratios using the Cape Code Method for AYs 2004 – 2008.

Accident Year	Earned Premium	On-Level Adjustment	On-Level Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Pure Premium Trend	Tort Reform Factors	Adjusted Claims at 12/31/08
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2004	99,322	0.810	80,451	60	70,288	1.144	0.670	53,884
2005	138,151	0.704	97,258	48	70,655	1.106	0.670	52,371
2006	107,578	0.640	68,850	36	48,804	1.070	0.750	39,153
2007	62,438	0.800	49,950	24	31,732	1.034	1.000	32,819
2008	47,797	1.000	47,797	12	18,632	1.000	1.000	18,632
Total	455,286		344,306		240,111			196,859

Reported CDF to Ultimate	% of Ultimate Reported	Used Up On-Level Premium	Claim Ratios Estimated Adjusted	Claim Ratios Selected Adjusted	Claim Ratios Estimated Unadjusted
(10)	(11)	(12)	(13)	(14)	(15)
1.064	94.0%	75,640	71.2%	71.7%	75.7%
1.085	92.2%	89,650	58.4%	71.7%	68.1%
1.196	83.6%	57,590	68.0%	71.7%	57.2%
1.512	66.1%	33,029	99.4%	71.7%	55.4%
2.551	39.2%	18,734	99.5%	71.7%	71.7%
		274,643	71.7%		

(4) = [(2) x (3)].

(9) = [(6) x (7) x (8)].

(11)=[1.00 /(10)].

(12) = [(4) x (11)].

(13) = [(9) / (12)].

(14) = [Total in (13)].

(15) = [(14) x (3) / (7) / (8)].

We use the label "Estimated Adjusted Claim Ratios" to indicate that the reported claims are adjusted for inflation and tort reform. We rely on the claim ratio for all years combined, 71.7%, from Column (13) (also shown in Column (14) for each year) as our starting point for developing estimated unadjusted claim ratios in Column (15). These claim ratios, which are adjusted back to the rate level, inflationary level, and tort environment for each accident year, become our starting point for projecting expected claims.

See Chapter 10

Exam 5B – Independently Authored Preparatory Test 5

General information about this exam

1. This test contains 20 computational and essay questions.
2. The recommend time for this exam is 2:30:00. Make sure you have sufficient time to take this practice test.
3. Consider taking this exam after working all past CAS questions, associated with the articles below, first.
4. Many of the essay questions may require lengthy responses.
5. Make sure you have a sufficient number of blank sheets of paper to record your answers.

Articles covered on exam:

Article	Author	Syllabus Section
Chapter 9 – Bornhuetter-Ferguson Technique	Friedland	B: Estimating Claim Liabilities
Chapter 11 – Frequency-Severity Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 12 – Case Outstanding Development Technique	Friedland	B: Estimating Claim Liabilities
Chapter 13 – Berquist-Sherman Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 14 – Recoveries: Salvage & Subro and Reins	Friedland	B: Estimating Claim Liabilities
Chapter 15 – Evaluation of Techniques	Friedland	B: Estimating Claim Liabilities
Chapter 16 – Estimating Unpaid Claim Adj Expenses	Friedland	B: Estimating Claim Liabilities
ASOP No. 43 – Unpaid Claim Estimates	AAA	B: Estimating Claim Liabilities

Exam 5B - Independently Authored Preparatory Test 5

Question 1

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", list two advantages to using the ratio method compared to the development method when developing projected ultimate claims for Salvage and Subrogation.

Question 2

(1.0 point) According to Friedland in ""Estimating Unpaid Claims Using Basic Techniques", one of the areas of reasonableness in the net and gross or ceded and gross analyses is to ensuring net IBNR in each AY is generally not greater than gross IBNR.

Describe two times when the net IBNR will be greater than the gross IBNR.

Question 3

(2 points) You are given the following information:

Accident Year	Selected Ultimate Loss
2004	$620,000
2005	580,000
2006	600,000

Age in Months	Incurred Development to Ultimate
12	2.20
24	1.65
36	1.35
48	1.10
60	1.05

What is the total amount of incurred loss that is expected to emerge during calendar year 2007 on accident years 2004 through 2006?

Question 4

(1.5 points) Based on the following information:

- Accident Year 2003 earned premium = $2,000
- Accident Year 2003 expected loss ratio= 75%

Loss Development Factors

12-24	2.00
24-36	1.25
36-48	1.10
48-60	1.00

Based on the Bornhuetter-Ferguson expected loss method, what is the expected loss emergence in calendar year 2006 for accident year 2003 losses?

Question 5

(1.5 point) According to Friedland in “Estimating Unpaid Claims Using Basic Techniques”, briefly describe three acceptable ways to select ultimate claims.

Question 6

(1.0 point) According to Friedland in ““Estimating Unpaid Claims Using Basic Techniques”, Wiser's final phase to his four-phase approach to estimating unpaid claims is to monitor projections of the development of unpaid claims over subsequent calendar periods. Briefly describe what actions the actuary takes in this phase.

Question 7

(2.0 points) Based on Friedland in ““Estimating Unpaid Claims Using Basic Techniques”, you are given the following information:

Accident Year	Selected Ultimate Claims	Expected % Reported at 12/31/2007	Expected % Reported at 12/31/2008	Reported Claims at 12/31/2007	Reported Claims at 12/31/2008
(1)	(2)	(3)	(4)	(5)	(6)
2005	2814	100.0%	100.0%	2814	2885
2006	2,952	99.9%	100.0%	2,949	3,030
2007	2,798	88.0%	99.9%	2,463	2,733
Total	28,913			28,575	28,983

Using selected ultimate claims and the selected reporting pattern above to compare actual reported claims one year later (i.e. 12/31/2008) with our expected claims for the year, compute the following:

a. (1 point). Expected reported claims for accident year 2007 during calendar year 2008

b. (1 point). Expected reported claims for accident year 2006 during calendar year 2008

Question 8

(4.0 points). Based on Friedland in "“Estimating Unpaid Claims Using Basic Techniques”, you are given the following information based on U.S. PP Auto Increasing Claims Ratio example:

	Reported Claims including ALAE ($000's omitted)					
Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2003	982,737	1,148,654	1,212,468	1,250,756	1,263,519	1,263,519
2004	1,179,284	1,378,385	1,454,961	1,500,908	1,516,223	
2005	1,315,640	1,537,760	1,623,191	1,674,450		
2006	1,462,682	1,709,627	1,804,607			
2007	1,621,139	1,894,836				
2008	1,791,785					

Accident Year	Paid Claims through 12/31/2008	Earned Premium
2003	1,250,756	1,823,259
2004	1,470,276	1,914,423
2005	1,571,933	2,010,144
2006	1,595,652	2,110,650
2007	1,494,816	2,216,183
2008	977,337	2,326,992

- Select 3-yr volume weighted ATA factors.
- Assume reported CDF-to-Ultimate of 1.01 at 72 Months, and 1.0 at 84 months.

This insurer operates in an environment of:

Increasing claim ratios: 70% in AY 2003, 80% in 2004, 85% in 2005, 90% in 2006, 95% in 2007, 100% in AY 2008

No change in Case Outstanding adequacy levels.

a. Using the Reported Development method, estimate Ultimate Claims.

b. Using the Reported Development method, estimate IBNR (broadly defined).

c. Using the Reported Development method, estimate total unpaid claims, including Case O/S.

d. Based on your answers above, what is the expected amount of IBNR to be reported in Calendar Year 2009, on claims for Accidents Years 2008 and prior?

e. Given the operating environment of this insurer, does this technique seem appropriate?

Question 9

(4.0 point) Based on Friedland in ““Estimating Unpaid Claims Using Basic Techniques”, you are given the following data extracted from the Auto Property Damage example in Chapter 16: Allocated Claim Adjustment Expenses (ALAE):

Paid ALAE ($000's omitted)						
Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2003	1,144	1,311	1,461	1,562	1,604	1,628
2004	1,114	1,260	1,382	1,440	1,484	
2005	1,126	1,323	1,412	1,481		
2006	1,272	1,596	1,698			
2007	1,548	2,181				
2008	1,904					

Reported ALAE ($000's omitted)						
Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report
2003	1,514	1,422	1,553	1,638	1,643	1,715
2004	1,486	1,373	1,464	1,502	1,548	
2005	1,578	1,422	1,502	1,548		
2006	1,976	1,710	1,797			
2007	2,746	2,394				
2008	3,112					

Paid Claims only ($000's omitted) i.e. excluding							Selected Ult.
Accident Year	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report	Claims Only by AY
2003	223,310	237,138	242,735	243,834	244,203	244,886	326,602
2004	212,064	223,736	227,594	228,344	228,920		305,592
2005	196,540	224,256	229,343	229,731			306,362
2006	214,274	256,998	263,403				354,242
2007	228,674	257,258					353,120
2008	248,940						390,970

For parts a - c, use 3-year volume-weighted averages in selecting age-to-age factors.

Assume a reported CDF-to-Ultimate tail of 1.01 at 72 Months.

Assume a paid CDF-to-Ultimate tail of 1.035 at 72 Months.

9a. Using the Reported Development method, estimate Ultimate ALAE.

9b. Using the Reported Development method, estimate unpaid ALAE.

9d. Using the Paid Development method, estimate unpaid ALAE.

9c. Using the Paid Development method, estimate unpaid ALAE.

9e. Using the Ratio method, estimate Ultimate ALAE

For selections, use a 3-year simple average of ratios and assume the CDF to ultimate is 1.05 at 72 months.

9f. Using the Additive method, estimate Ultimate A

For selections, use a 3-year simple average of ratios and assume the additive CDF to ultimate for this ratio is .06% at 72 months.

Question 10

(1.5 point) Based on Friedland in “Estimating Unpaid Claims Using Basic Techniques”, list and briefly describe three advantages and two disadvantages to using the Ratio Method to develop ALAE.

Question 11

There is no question 11

Question 12

(1.5 points). According to ASOP 43, “P&C Unpaid Claim Estimates”, when considering the scope of the unpaid claim estimate, the actuary should identify the following the intended measure of the unpaid claim estimate.

a. (.75 points) Identify several examples of measures for the unpaid claim estimate.

b. (.75 points) What does the standard say about using the terms “best estimate” and “actuarial estimate” when describing the intended measure?

Question 13

(1.5 points). According to ASOP 43, “P&C Unpaid Claim Estimates”, the actuary should consider changes in conditions with regard to claims, losses, or exposures, that are likely to be insufficiently reflected in the experience data or in the assumptions used to estimate the unpaid claims.

a. (.75 points) Identify two types of changes that are likely to have a material effect on the results of the actuary’s unpaid claim estimate analysis.

b. (.75 points) How should the actuary obtain supporting information to validate the presence of these changes?

Question 14

(4.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

As the company actuary in the workers compensation unit, your goal is to determine the appropriate frequency (i.e., number of claims per exposure unit) for the latest two accident years. Since payroll is an inflation-sensitive exposure base, we must adjust the payroll for each accident year to a common time period. Assume a 2.5% annual inflation rate for payroll for all years in the experience period and trend all historical payroll to the cost level of accident year 2008 (1.0 level).

Similarly, the claim counts should be adjusted using trend factors to reflect changes in counts. Assume a -1.0% annual trend in the number of claims and trend all counts to cost level of accident year 2008 (1.0 level).

Accident Year	Selected Ultimate Claim Cnts	Payroll ($00)
2004	1,734	280,000
2005	1,637	350,000
2006	2,966	790,000
2007	2,888	780,000
2008	2,651	740,000
Total	11,875	2,940,000

Compute

a. The selected frequency at 2008 level

b. The selected frequency at 2007 level

Question 15

(3.0 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

You have been asked to use a frequency-severity approach to project ultimate claims and the unpaid claim estimate for the latest two accident years. The selected frequency below was obtained by a frequency analysis comparing the ultimate claim counts by accident year to the traditional exposure base used for WC.

The following data is from a self-insurer of U.S. workers compensation.

	Accident Year	
	2007	2008
Payroll ($00)	780,000	740,000
Selected Frequency	0.37%	0.36%
Selected Severity	5,674	6,100
Reported Claims at 12/31/08	14,400,000	10,300,000
Case Outstanding at 12/31/08	5,357,000	6,130,000

Compute the unpaid claim estimate at 12/31/08 for AY's 2007 and 2008.

Question 16

(1.5 points) Using the procedure described by Friedland in ““Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Assume the only data available for a self-insurer of general liability coverage is case outstanding.

You have been asked to use the standard development technique with case outstanding to project an estimate of total unpaid claims for a self-insured entity of general liability coverage.

You will use an industry-based reporting and payment development patterns to derive case outstanding development patterns. You implicitly assume that claims recorded to date for the self-insurer will develop in a similar manner in the future as our industry benchmark (i.e., the historical industry experience is indicative of the future experience for the self-insurer).

Accident Year	Case Outstanding at 12/31/08	CDF to Ultimate Reported	CDF to Ultimate Paid
1999	650,000	1.020	1.067
2000	800,000	1.030	1.109
2001	850,000	1.051	1.187
2002	975,000	1.077	1.306
2003	1,000,000	1.131	1.489
Total	4,275,000		

Compute the unpaid claim estimate for AYs 1999 – 2003.

Question 17

(1.5 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Case Outstanding and Incremental Paid Claims ($000)

Accident	Case Outstanding as of (months)				
Year	12	24	36	48	60
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690
2004	21,047,539	11,150,459	6,316,995	3,201,985	
2005	21,260,172	11,087,832	6,141,416		
2006	20,973,908	11,034,842			
2007	21,623,594				

Accident	Incremental paid Claims as of (months)				
Year	12	24	36	48	60
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453
2004	24,369,770	17,120,093	7,746,815	4,537,994	
2005	25,100,697	17,601,532	7,942,765		
2006	25,608,776	17,997,721			
2007	27,229,969				

Assume the Selected Ratio of Incremental Paid Claims to Previous Case Outstanding factor from 60-Ult = 1.0

Assume that the Selected Ratio of Case Outstanding to Previous Case Outstanding factor from 60-Ult = 1.0

Compute: Cumulative Paid Claims at ultimate (i.e. 72 months) for AYs 2003 - 2007

Question 18 – Chapter 13

(1.5 points) Using the procedure described by Friedland in "“Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Accident	Unadjusted Reported Claims				
Year	12	24	36	48	60
1972	8,732,000	18,633,000	32,143,000	57,196,000	61,163,000
1973	11,228,000	19,967,000	50,143,000	73,733,000	
1974	8,706,000	33,459,000	63,477,000		
1975	12,928,000	48,904,000			
1976	15,791,000				

Accident	Unadjusted Paid Claims as of (months)				
Year	12	24	36	48	60
1,972	50,000	786,000	3,810,000	9,771,000	18,518,000
1,973	213,000	833,000	3,599,000	11,292,000	
1,974	172,000	1,587,000	6,267,000		
1,975	210,000	1,565,000			
1,976	209,000				

Accident	Open Claim Counts as of (months)				
Year	12	24	36	48	60
1972	1,043	1,561	1,828	1,894	1,522
1973	1,088	1,388	1,540	1,877	
1974	1,033	1,418	1,663		
1975	1,138	1,472			
1976	1,196				

- Selected Annual Severity Trend Rate = 1.15

Using the Berquist-Sherman Technique, compute Adjusted Reported Claims triangle

Question 19 – Chapter 13

(2.5 points) Using the procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Accident Year	Paid Claims as of (months) 12	24	36	48	60
1972	2,503	8,173	11,810	14,176	15,383
1973	2,838	8,712	12,728	15,278	
1974	2,405	7,858	11,771		
1975	2,759	9,182			
1976	2,801				

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60
1972	4,497	7,842	8,747	9,254	9,469
1973	4,419	7,665	8,659	9,093	
1974	3,486	6,214	6,916		
1975	3,516	6,226			
1976	3,230				

Accident Year	Reported Claim Counts as of (months) 12	24	36	48	60
1972	7,858	9,474	9,615	9,664	9,680
1973	7,808	9,376	9,513	9,562	
1974	6,278	7,614	7,741		
1975	6,446	7,884			
1976	6,115				

Assume the selected reported claim counts factor from 60-Ult = 1.001.

Using the Berquist and Sherman disposal rate method, compute the adjusted closed claim counts triangle

Question 20 – Chapter 13

(2.5 points) Using the procedure Berquist Sherman procedure described by Friedland in ""Estimating Unpaid Claims Using Basic, and the data given below, answer the following questions.

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	**4,079**	**6,616**	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident Year	Parameter a for Two-Point Exponential Fit 12	24	36	48	60	72	84	96
1969		**356**	124	132	198	286	1,034	459
1970		438	181	***215***	353	778	88	
1971		464	244	337	493	370		
1972		510	337	506	421			
1973		616	468	333				
1974		530	220					
1975		580						
1976								

Accident Year	Paid Claims ($000) as of (months) 12	24	36	48	60	72	84	96
1969	**1,904**	**5,398**	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

Accident Year	Parameter b for Two-Point Exponential Fit 12	24	36	48	60	72	84	96
1969		**0.000411**	0.000570	0.000562	0.000508	0.000459	0.000294	0.000398
1970		0.000368	0.000490	***0.000468***	0.000409	0.000315	0.000568	
1971		0.000338	0.000416	0.000381	0.000341	0.000370		
1972		0.000354	0.000407	0.000360	0.000380			
1973		0.000346	0.000381	0.000421				
1974		0.000434	0.000576					
1975		0.000444						
1976								

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	**3,332**	6,038	6,932	7,415	7,643	0	0	0
1970	3,699	6,703	7,695	***8,231***	8,484	0	0	
1971	4,237	7,678	8,815	9,429	9,718	0		
1972	4,128	7,480	8,588	9,187	9,469			
1973	4,086	7,404	8,500	9,093				
1974	3,324	6,024	6,916					
1975	3,430	6,215						
1976	3,181							

Example: The exponential regression for AY 1969 between ages 12 and 24, such that *X= (4,079; 6,616) and Y= (1,904; 5,398),* would result in *a = 356* and *b = 0.000411*, which we place in the age 24 cell.

Compute: adjusted paid claims for AY 1970 at age 48

Compute: adjusted paid claims for year 1969 at age 12

Solutions to Exam 5B - Independently Authored Preparatory Test 5

Question 1 discussion: Blooms: Comprehension; Difficulty 1, LO 4, KS How internal operating changes affect estimates of unpaid claims: * Claims processing * Underwriting and policy provisions * Marketing * Coding of claim counts and/or claim related expenses * Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

Advantages to using the ratio approach:

1. Development factors are not as highly leveraged as those based on received S&S dollars.
2. Relates to selecting ultimate S&S ratio(s) for the most recent year(s) in the experience period.

See chapter 14

Question 2 discussion: Blooms: Comprehension; Difficulty 1, LO 4, KS How internal operating changes affect estimates of unpaid claims: * Claims processing * Underwriting and policy provisions * Marketing * Coding of claim counts and/or claim related expenses * Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

1. When an estimate of uncollectible reinsurance is included in the net IBNR but not in the gross IBNR and there are significant billed reinsurance amounts for which significant collectibility issues exist.
2. For a runoff book with reinsurance disputes for items such as asbestos.

See chapter 14

Question 3 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS Mechanics associated with each technique (including organization of the data)

Loss emergence during CY 2007 from AY's 2004 - 2006

Accident Year	Selected Ultimate Loss	LDFs to Ultimate	% Unreported at 12/31/06
	(1)	(2)	(3)=1.0 - 1.0/(2)
2003		1.100	0.0909
2004	620,000	1.350	0.2593
2005	580,000	1.650	0.3939
2006	600,000	2.200	0.5455

Accident Year	Selected Ultimate Loss	% Reported at 12/31/06	% Reported at 12/31/07	% Reported during CY 2007	Expected Inc.Loss emergence during CY 2007
	(4) = (1)	(5)=1.0-(3)	(6) based on (3), (5)	(7) = (6) - (5)	(8) = (4) * (7)
2004	620,000	74.07%	90.91%	16.84%	104,377
2005	580,000	60.61%	74.07%	13.47%	78,114
2006	600,000	45.45%	60.61%	15.15%	90,909
Total					**273,401**

See chapter 15

Question 4 discussion: Blooms: Comprehension; Difficulty 1, LO 1, KS Organization of data: calendar year, accident year, policy year, underwriting year, report year

Interval	Age-to-Age Factors (1)	Age-to-Ultimate Factors (2) based on (1)	Percent Reported (3)=1.00/(2)	Percent Unreported (4)=1-(3)	Estimated IBNR Losses (5)=(4) x 1500	Time Index (6)
12-24	2.00	2.75	36.36%	63.64%	955	12/31/03
24-36	1.25	1.38	72.73%	27.27%	409	12/31/04
36-48	1.10	1.10	90.91%	9.09%	136	12/31/05
48-60	1.00	1.00	100.00%	0.00%	0	12/31/06

Accident Year 2003 earned premium	2,000
Accident Year 2003 expected loss ratio	75%
Accident Year 2003 expected losses	1500
Calendar Year 2006 emergence	**$136**

Question 5 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS Key terms: case outstanding, paid claims, reported claims, incurred but not reported, ultimate claims, claims related expenses, reported and closed claim counts, claim counts closed with no payment, insurance recoverables, exposures, experience period, maturity or age, and components of unpaid claim estimates

1. Select one method and use it for all years. The B/S adjusted reported claim (both case and paid adjustments) method may be a reasonable selection for all years (for an insurer like XYZ).
2. Select different methods for different AYs. For example, select the B/S adjusted reported claim method for AY 1998 - 2006 and the BF method for 2007 and 2008.
3. Use a weighted average based on assigned weights to the various methods; these weights may be consistent for all years or may vary by AY.

See chapter 15

Question 6 discussion Blooms: Comprehension; Difficulty 1, LO 3, KS The claim process

Computing deviations of actual development from projected development of claims or claim counts are useful to evaluate the accuracy of the unpaid claim estimate. Therefore, comparing actual-to-expected claims helps the actuary to evaluate the appropriateness of prior selections and make revisions as necessary if actual claims do not emerge as expected.

See chapter 15

Question 7 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS The claim process

For each AY, expected reported claims in the calendar year are equal to:

[(ultimate claims selected at 12/31/2007 - actual reported claims at 12/31/2007) / (% unreported at 12/31/2007)] x (% reported at 12/31/2008 - % reported at 12/31/2007)]

The % unreported is computed as [1.00 - (1.00 / cumulative claim development factor)].

The expected reported claims for accident year 2007 during calendar year 2008 are equal to:

AY_{07} Expected $Claim_{CY08}$ = {[($2,798 - $2,463) / (1 - 0.880)] x (0.999 - 0.880)} = $332

The expected reported claims for accident year 2006 during calendar year 2008 are equal to:

AY_{06} Expected $Claim_{CY08}$ = {[($2,952 - $2,949) / (1- 0.999)] x (1.000 - 0.999)} = $3

See chapter 15

Question 8 discussion: Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

Step 2: Calculate and Select Development Factors

	1st to 2nd	2nd to 3rd	3rd to 4th	4th to 5th	5th to 6th	Tail at
Age-to-Age on reported	***12:24 mo,***	***24:36 mo***	***36:48 mo***	***48:60 mo***	***60:72 mo***	***72 months***
3-yr volume-wtd avg.	*1.169*	***1.056****	*1.032*	*1.010*	*1.000*	
	at 12 mo	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***	
Reported CDF to Ult.	*1.299*	***1.111*****	*1.053*	*1.020*	*1.010*	**1.01**

**Example of Age-to-Age calculation for 2nd to 3rd report, using 3-year volume-weighted average:*
(1,804,607+1,632,191+1,454,961)/(1,709,627+1,537,760+1,378,385)=1.056 as shown
***Example of Ultimate CDF calculation for claims at 24 months of development:*
*(1.056 for 2nd-to-3rd) * (1.032 for 3rd-to-4th) * (1.01 for 4th-to-5th) * (1.01 tail) = 1.111*

Steps 3 & 4: Develop the claims & compute estimates

Acciden Year	*Age of Data at 12/31/2008*	*Reported Claims 12/31/08*	*Reported CDF to Ultimate*	*Estimated Ultimate Claims*	*IBNR (broadly defined)*	*OR: Shortcut*	*IBNR (broadly defined)*
	(1) FYI	*(2)*	*(3) above*	*(4)=(2)*(3)*	*(5)=(4)-(2)*	*(5)=(2)*[(3) - 1.0]*	
2003	*72 months*	*1,263,519*	*1.01*	*1,276,154*	*12,635*		12,635
2004	*60 months*	*1,516,223*	*1.010*	*1,531,385*	*15,162*		15,162
2005	*48 months*	*1,674,450*	*1.020*	*1,708,452*	*34,002*		34,002
2006	*36 months*	*1,804,607*	*1.053*	*1,899,396*	*94,790*		94,790
2007	*24 months*	*1,894,836*	*1.111***	*2,105,163*	*210,327*		210,327
2008	*12 months*	*1,791,785*	*1.299*	*2,327,528*	*535,744*		535,744
Total		***Answer A***		***10,848,078***	***902,660***	***Answer B***	***902,660***

For unpaid, subtract: Ultimate - Paid:

Accident Year	*Estimated Ultimate Claims above*	*Paid Claims given*	*Total Est. Unpaid Claims difference*
2003	*1,276,154*	*-1,250,756=*	*25,399*
2004	*1,531,385*	*-1,470,276=*	*61,109*
2005	*1,708,452*	*-1,571,933=*	*136,519*
2006	*1,899,396*	*-1,595,652=*	*303,744*
2007	*2,105,163*	*-1,494,816=*	*610,347*
2008	*2,327,528*	*-977,337=*	*1,350,191*
Total	***Answer C***		***2,487,309***

OR, add Case Outstanding to est. IBNR:

IBNR (broadly defined) (i)	*Case O/S =Reported minus Paid (ii)*	*Total Est. Unpaid Claims (ii)=(i) + (ii)*
12,635	*+12,764=*	*25,399*
15,162	*+45,947=*	*61,109*
34,002	*+102,518=*	*136,519*
94,790	*+208,955=*	*303,744*
210,327	*+400,020=*	*610,347*
535,744	*+814,448=*	*1,350,191*
Answer C		***2,487,309***

Example (ii) Case O/S 2008 = 1,791,785 - 977,337 = 814,448

Solution to d) Emergence during CY 2009 for AY's 2008 and prior, using Development Method on Reported Claims

		Step 1 (proceeding the safe way, using our answer to part b)					*Step 2*
Acc Year	***Estimated IBNR at 12/31/08***	***Ages in NEXT yr (CY 2009)***	***Percent Reported at 1/1/09***	***Percent Reported at 12/31/09***	***Percent Unreported at 1/1/09***	***% of IBNR to emerge b/t 1/1 - 12/31/09***	***Est. IBNR to emerge during '09***
	(1) from b	*(2) FYI*	*(3)=1/CDF*	*(4)=1/CDF*	*(5)=1.0-(3)*	*(5)*	*(7)=(1)*(6)*
2003	*12,635*	*72-84*	*99.01%*	***100.00%***	*0.990%*	*100.000%*	*12,635*
2004	*15,162*	*60-72***	*99.01%*	***99.01%***	*0.990%*	*0.000%*	*0*
2005	*34,002*	*48-60*	*98.01%*	***99.01%***	*1.990%*	*50.252%*	*17,086*
2006	*94,790*	*36-48*	*95.01%*	***98.01%***	*4.991%*	*60.120%*	*56,988*
2007	*210,327*	*24-36*	*90.01%*	***95.01%***	*9.991%*	*50.050%*	*105,269*
2008	*535,744*	*12-24*	*76.98%*	***90.01%***	*23.018%*	*56.594%*	*303,200*
Total	*902,660*						***495,178***

*** Note: since the selected ultimate CDFs are equal for 60 months and 72 months, there is no emergence here!*

Step 1 (proceeding via short-cut, for development method only...)					*Step 2*
Acc Year	***Reported Claims at 12/31/08***	***Ages in NEXT yr (CY 2009)***	***Selected ATA factor for ages***	***Subtract Subtract ATA-1***	***Est. IBNR to emerge during '09***
	(1) given	*(2) FYI*	*(3) above*	*(4)=(3)-(1)*	*(5)=(1)*(4)*
2003	*1,263,519*	*72-84*	*1.01*	*0.01*	*12,635*
2004	*1,516,223*	*60-72***	*1.00*	*0.00*	*0*
2005	*1,674,450*	*48-60*	*1.01*	*0.01*	*17,086*
2006	*1,804,607*	*36-48*	*1.03*	*0.03*	*56,988*
2007	*1,894,836*	*24-36*	*1.06*	*0.06*	*105,269*
2008	*1,791,785*	*12-24*	*1.17*	*0.17*	*303,200*
Total					***495,178***

*** Note: since the ATA for 60 to 72 months = 1.0, there is no emergence here!*

Solution to e) Given the operating environment of this insurer, is this technique appropriate to use?

Start by assuming there is no reason to dis-credit the method other than via the 2 comments given:

1) We're told "No change in Case Outstanding adequacy levels," so we shouldn't need to worry there.
2) We're given a set of claims ratios that accurately reflects the company's position:

70% in AY 2003, 80% in 2004, 85% in 2005, 90% in 2006, 95% in 2007, 100% in AY 2008

... If the Ultimate Claim projections are not consistent, then we may need to consider other methods.

Let's test: Recall Friedland mentions analysis of Claim Ratio Estimates in "Evaluation of Techniques."

Accident Year	Estimated Ultimate Claims (a)	Earned Premium	Implied Claim Ratio
	(i)	(ii) given	(iii)=(i)/(ii)
2003	1,276,154	1,823,259	69.99%
2004	1,531,385	1,914,423	79.99%
2005	1,708,452	2,010,144	84.99%
2006	1,899,396	2,110,650	89.99%
2007	2,105,163	2,216,183	94.99%
2008	2,327,528	2,326,992	100.02%

All implied Claim Ratios are consistent with those given in the question. So, we conclude that the Development Method was a good choice here.

Solutions to Exam 5B - Independently Authored Preparatory Test 5

Question 9 discussion:

Solution to a) Using the Reported Development method, estimate Ultimate ALAE
Solution to b) Using the Reported Development method, estimate Upaid ALAE

	1st to 2nd	2nd to 3rd	3rd to 4th	4th to 5th	5th to 6th	Tail at
Age-to-Age on reported	12:24 mo	24:36 mo	36:48 mo	48:60 mo	60:72 mo	72 months
3-yr volume-wtd avg.	0.877	1.057	1.038	1.016	1.044	
	at 12 mo	at 24 mo	at 36 mo 1	at 48 mo	at 60 mo	
Reported CDF to Ult.	1.031	1.175	1.112	1.071	1.054	1.01

Accident Year	Age of Data at 12/31/2008	Reported ALAE at 12/31/2008	Reported CDF to Ultimate	Estimated Ultimate ALAE ALAE	Paid ALAE at 12/31/2008	Estimated Unpaid ALAE
	(1) FYI	(2)	(3) above	(4)=(2)*(3)	(5) given	(6)=(4)-(5)
2003	72 months	1,715	1.01	1,732	1,628	104
2004	60 months	1,548	1.054	1,632	1483.5	149
2005	48 months	1,548	1.071	1,659	1480.5	178
2006	36 months	1,797	1.112	1,998	1,698	300
2007	24 months	2,394	1.175	2,814	2,181	633
2008	12 months	3,112	1.031	3,208	1,904	1,304
Total		Answer A		13,041	Answer B	2,667

Solution to c) Using the Paid Development method, estimate Ultimate ALAE
Solution to d) Using the Paid Development mentod, estimate Unpaid ALAE

	1st to 2nd	2nd to 3rd	3rd to 4th	4th to 5th	5th to 6th	Tail at
Age-to-Age on paid	12:24 mo	24:36 mo	36:48 mo	48:60 mo	60:72 mo	72 months
3-yr volume-wtd avg.	1.292	1.075	1.054	1.028	1.015	
	at 12 mo	at 24 mo	at 36 mo	at 48 mo	at 60 mo	
Paid CDF to Ult.	1.581	1.223	1.138	1.080	1.050	1.035

Accident Year	Age of Data at 12/31/2008	Paid ALAE at 12/31/2008	Paid CDF to Ultimate	Estimated Ultimate ALAE		Estimated Unpaid ALAE
	(1) FYI	(2)	(3)	(4)=(2)*(3)		(5)=(4)-(2)
2003	72 months	1,628	1.035	1,684		57
2004	60 months	1483.5	1.050	1,558		75
2005	48 months	1480.5	1.080	1,600		119
2006	36 months	1,698	1.138	1,933		235
2007	24 months	2,181	1.223	2,668		487
2008	12 months	1904	1.581	3,010		1,106
Total		Answer C		12,454	Answer D	2,079

Question 9 discussion: Blooms: Comprehension; Difficulty 3, LO 7, KS Estimation of unpaid ALAE

Solution to e) using the Ratio method, estimate Ultimate ALAE

Step 1: Create a triangle of the ratio of paid ALAE, over Paid Claims *only* (excl ALAE)

Ratio: [Paid ALAE] / [Paid Claims excluding ALAE]						
AY	***at 12 mos.***	***at 24 mos.***	***at 36 mos.***	***at 48mos.***	***at 60 mos.***	***at 72 mos.***
2003	0.51%	0.55%	0.60%	0.64%	0.66%	0.66%
2004	0.53%	0.56%	0.61%	0.63%	0.65%	
2005	0.57%	0.59%	0.62%	0.64%		
2006	0.59%	0.62%	0.64%			
2007	0.68%	0.85%				
2008	0.76%					

Step 2: Calculate and Select Development Factors for the Ratio examined in step 1.

AY	***12:24 mo***	***24:36 mo***	***36:48 mo***	***48:60 mo***	***60:72 mo***	
2003	*1.079*	*1.089*	*1.064*	*1.025*	*1.012*	
2004	*1.072*	*1.078*	*1.039*	*1.028*		
2005	*1.030*	*1.043*	*1.047*			
2006	*1.046*	*1.038*				
2007	*1.252*					*Tail at 72 mo*

ATA	***12:24 mo***	***24:36 mo***	***36:48 mo***	***48:60 mo***	***60:72 mo***	
3-yr avg	*1.109*	*1.053*	*1.050*	*1.026*	*1.012*	
CDF	***at 12 mo***	***at 24 mo at***	***36 mo***	***at 48 mo***	***at 60 mo***	***at 72mo***
to Ult.	1.338	1.206	1.145	1.091	1.063	1.050

Steps 3 & 4: *DEVELOP the ratio & apply it to Ultimate Claims for Projected Ultimate ALAE*

Accident Year	*Age of Data at 12/31/2008 (1) FYI*	*Ratio as of 12/31/2008 (2) above*	*Selected CDF to Ultimate (3) above*	*Ultimate Ratio to use (4) =(2)*(3)*	*Selected Ult. Claims only (excl ALAE) (5) given*	*Projected Ultimate ALAE (6)=(4)*(5)*
2003	*72 months*	*0.66%*	*1.050*	*0.007*	*326,602*	*2,279*
2004	*60 months*	*0.65%*	*1.063*	*0.007*	*305,592*	*2,105*
2005	*48 months*	*0.64%*	*1.091*	*0.007*	*306,362*	*2,154*
2006	*36 months*	*0.64%*	*1.145*	*0.007*	*354,242*	*2,616*
2007	*24 months*	*0.85%*	*1.206*	*0.010*	*353,120*	*3,611*
2008	*12 months*	*0.76%*	*1.338*	*0.010*	*390,970*	*4,002*
Total		***DON'T FORGET THIS STEP***				***16,766***

Note: Structurally, this process is analogous to the Ratio method for S&S in Chapter 14.
Next, we will see that the Additive Method is very similar, but the development factors based on addition, instead of the multiplication we usually perform. See 3f immediately below for an illustration.

Question 9 discussion:

Solution to f) Using the Additive method, estimate Ultimate ALAE.

Step 1: Create a triangle of the ratios -- SAME AS FOR RATIO METHOD

			Ratio: [Paid ALAE] / [Paid Claims excluding ALAE]			
AY	***at 12 mo***	***at 24 mo***	***at 36 mo***	***at 48 mo***	***at 60 mo***	***at 72 mo***
2003	0.51%	0.55%	0.60%	0.64%	0.66%	0.66%
2004	0.53%	0.56%	0.61%	0.63%	0.65%	
2005	0.57%	0.59%	0.62%	0.64%		
2006	0.59%	0.62%	0.64%			
2007	0.68%	0.85%				
2008	0.76%					

Step 2: Calculate and Select Development Factors using DIFFERENCES

(While we'd normally divide the value for one-age to the prior, here we Subtract)

AY	***12:24 mo***	***24:36 mo***	***36:48 mo***	***48:60 mo***	***60:72 mo***	
2003	*0.04%*	*0.05%*	*0.04%*	*0.02%*	*0.01%*	
2004	*0.04%*	*0.04%*	*0.02%*	*0.02%*		
2005	*0.02%*	*0.03%*	*0.03%*			
2006	*0.03%*	*0.02%*				*Tail at 72 mo*
2007	*0.17%*					

ATA	***12:24 mo***	***24:36 mo***	***36:48 mo***	***48:60 mo***	***60:72 mo***	
3-yr avg	*0.07%*	*0.03%*	*0.03%*	*0.02%*	*0.01%*	
CDF to Ult.	**at 12 mo**	**at 24 mo**	**at 36 mo**	**at 48 mo**	**at 60 mo**	**at 72mo**
ADDITIVE*	*0.22%*	*0.15%*	*0.12%*	*0.08%*	*0.07%*	0.06%

**Careful: For the Additive CDF, we literally add up the ATA factors (based on differences) ...*
For example at 36 months: .12% = .03% + .01% + .02% + .06% ... not multiplying as usual

Steps 3 & 4: DEVELOP the ratio & apply it to Ultimate Claims for Projected Ultimate ALAE

Accident Year	*Age of Data at 12/31/2008 (1) FYI*	*Ratio as of 12/31/2008 (2) above*	*Selected CDF to Ultimate (3) above*	*Ultimate Ratio to use (4)=(2) + (3)*	SelectedUlt. Claims only (excel ALAE) (5) given	Projected Ultimate ALAE (6)=(4)*(5)
2003	*72 months*	*0.66%*	*0.06%*	*0.72%*	326,602	2,367
2004	*60 months*	0.65%	*0.07%*	*0.72%*	305,592	2,188
2005	*48 months*	*0.64%*	*0.08%*	*0.73%*	306,362	2,234
2006	*36 months*	*0.64%*	*0.12%*	*0.76%*	354,242	2,692
2007	*24 months*	*0.85%*	*0.15%*	*0.99%*	353,120	3,510
2008	*12 months*	0.76%	0.22%	*0.98%*	390,970	3,842
Total		Don't Forget to **ADD** Here				16,832

Question 10 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

1. The development technique using paid ALAE.
2. The development technique using reported ALAE (when case outstanding for ALAE exists), which for Auto Property Damage Insurer maintains.
3. The development of the ratio of paid ALAE-to-paid claims only.

See chapter 16

Question 12 discussion: Blooms: Comprehension; Difficulty 1, LO 7, KS Strengths and weaknesses of the estimation techniques for claim related expenses

Advantages:

1. It recognizes the relationship between ALAE and claims only.
2. The ratio development factors are not as highly leveraged as those based on paid ALAE dollars. Age-to-age factors based on the simple average of the latest 3 years is selected.

   This method produces projected ultimate ALAE less than the reported and paid ALAE projections (a key reason for this is the absence of a tail factor).
3. The ability to interject actuarial judgment in the projection analysis, especially for the selection of the ultimate ALAE ratio for the most recent year(s) in the experience period.

Disadvantages:

1. Any error in the estimate of ultimate claims only could affect the estimate of ultimate ALAE.
2. When large amounts of ALAE are spent on claims that ultimately settle with no claim payment, the projection process is distorted.

See chapter 16

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS Standards of Practice, ASOP Nos. 9 and 43

a. Examples of types of measures for the unpaid claim estimate include high estimate, low estimate, median, mean, mode, actuarial central estimate, mean plus risk margin, actuarial central estimate plus risk margin, or specified percentile.

b. The terms “best estimate” and “actuarial estimate” are not sufficient descriptions of the intended measure, since they describe the source or the quality of the estimate but not the objective of the estimate.

Question 13 discussion: Blooms: Comprehension; Difficulty 1, LO 3, KS Standards of Practice, ASOP Nos. 9 and 43

a. Examples include reinsurance program changes and changes in the practices by the entity’s claims personnel to the extent such changes are likely to have a material effect on the results of the actuary’s unpaid claim estimate analysis.

b. Obtain supporting information from the principal or the principal’s duly authorized representative and may rely upon their representations unless, in the actuary’s professional judgment, they appear to be unreasonable.

Question 14 discussion Blooms: Comprehension; Difficulty 3, LO 3, KS Mechanics associated with each technique (including organization of the data)

	Claim Counts						
Accident Year	Selected Ultimate	Trend to 2008 at -1.00%	Trend Ultimate	Payroll ($00)	Trend 2008 at 2.50%	Trended Payroll ($00)	Trended Ultimate Frequency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2004	1,734	0.961	1,665	280,000	1.104	309,068	0.54%
2005	1,637	0.970	1,589	350,000	1.077	376,912	0.42%
2006	2,966	0.980	2,907	790,000	1.051	829,994	0.35%
2007	2,888	0.990	2,859	780,000	1.025	799,500	0.36%
2008	2,651	1.000	2,651	740,000	1.000	740,000	0.36%
Total	11,875		11,670	2,940,000		3,055,473	0.38%
			(9) Selected frequency at 2008 level				0.36%
			(10) Selected frequency at 2007 level				0.37%

(3) Assume -1% annual claim count trend.

(4) =[(2) * (3)]

(6) Assume 2.50% annual payroll trend.

(7) = [(5) x (6)].

(8) = [(4) / (7)].

(9) Judgmentally selected.

(10) = { (9) * [1 + (annual payroll trend of 2.50%)] / [1 + (annual claim count trend of -1.00%)] } .

Divide the ultimate trended claim counts in Column (4), by the trended payroll in Column (7). After examining the frequency rates by accident year in Column (8), we recognize a change in frequency between the earliest years in the experience period and the most recent years.

See chapter 11

Question 15 discussion Blooms: Comprehension; Difficulty 2, LO 3, KS The claim process

Compute the unpaid Claim Estimate at 12/31/08 for AY's 2007 and 2008

	Accident Year	
	2007	2008
(1) Payroll ($00)	780,000	740,000
(2) Selected Frequency	0.37%	0.36%
(3) Projected Ultimate Claim Counts	2,886	2,664
(4) Selected Severity	5,674	6,100
(5) Projected Ultimate Claims	16,376,372	16,250,400
(6) Reported Claims at 12/31/08	14,400,000	10,300,000
(7) Case Outstanding at 12/31/08	5,357,000	6,130,000
(8) Estimated IBNR at 12/31/08	1,976,372	5,950,400
(9) Unpaid Claim Estimate at 12/31/08	7,333,372	12,080,400

Line Notes:

(3) = [(1) * (2)]

(5) = [(3) * (4)]

(8) = [(5) - (6)]

(9) = [(7) + (8)]

Calculate the projected ultimate claims for accident years 2007 and 2008. The self-insured organization provided us with the payroll for both accident years. We multiply the payroll by the selected frequency rates to determine the projected ultimate number of claims (Line (3)). We then multiply the ultimate number of claims by the selected severities to derive the projected ultimate claims (Line (5)).

(3) = [(1) * (2)]

(5) = [(3) * (4)]

(8) = [(5) - (6)]

(9) = [(7) + (8)]

See chapter 11

Question 16 discussion Blooms: Comprehension; Difficulty 1, LO 3 KS KS The claim process

Compute the unpaid claim estimate for AYs 1999 – 2003.

	Case	CDF to Ultimate			Unpaid
Accident	Outstanding			Case	Claim
Year	at 12/31/08	Reported	Paid	Outstanding	Estimate
(1)	(2)	(3)	(4)	(5)	(6)
1999	650,000	1.020	1.067	1.454	945,128
2000	800,000	1.030	1.109	1.421	1,136,911
2001	850,000	1.051	1.187	1.445	1,228,356
2002	975,000	1.077	1.306	1.439	1,403,157
2003	1,000,000	1.131	1.489	1.545	1,544,858
Total	4,275,000				6,258,410

Column Notes:

(2) Based on data from Self-Insurer Case Outstanding Only.

(5) = { [((3) - 1.0) * (4)]/ ((4) -(3))} +1

(6) = [(2) * (5)].

See chapter 12

Question 17 discussion Step 1: Compute the following ratios

Accident Year	Ratio of Incremental Paid Claims to Previous Case Outstanding as of (months) 12	24	36	48	60	To Ult
2003		0.821	0.691	0.705	0.684	
2004		0.813	0.695	0.718		
2005		0.828	0.716			
2006		0.858				
2007						

Averages of the Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	To Ult
Latest 3		0.833	0.701	0.712	0.684	

Selected Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	To Ult
Selected		0.833	0.701	0.712	0.684	1.000

Step 2: Compute the following ratios

Accident Year	Ratio of Case Outstanding to Previous Case Outstanding as of (months) 12	24	36	48	60	To Ult
2003		0.527	0.577	0.536	0.476	
2004		0.530	0.567	0.507		
2005		0.522	0.554			
2006		0.526				
2007						

Averages of the Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	To Ult
Latest 3		0.526	0.566	0.522	0.476	

Selected Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	To Ult
Selected		0.526	0.566	0.522	0.476	1.000

Step 3: Complete the square for the following triangles

Accident Year	Case Outstanding as of (months) 12	24	36	48	60	To Ult
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690	0
2004	21,047,539	11,150,459	6,316,995	3,201,985	1,524,145	0
2005	21,260,172	11,087,832	6,141,416	3,205,819	1,525,970	0
2006	20,973,908	11,034,842	6,245,721	3,260,266	1,551,887	0
2007	21,623,594	11,374,010	6,437,690	3,360,474	1,599,586	0

Accident Year	Incremental Paid Claims as of (months 12	24	36	48	60	To Ult
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453	1,634,690
2004	24,369,770	17,120,093	7,746,815	4,537,994	2,190,158	1,524,145
2005	25,100,697	17,601,532	7,942,765	4,372,688	2,192,780	1,525,970
2006	25,608,776	17,997,721	7,735,424	4,446,953	2,230,022	1,551,887
2007	27,229,969	18,012,454	7,973,181	4,583,635	2,298,564	1,599,586

Accident Year	Cumulative Paid Claims as of (months) 12	24	36	48	60	72
2003	24,084,451	41,399,612	49,070,332	53,584,201	55,930,654	57,565,344
2004	24,369,770	41,489,863	49,236,678	53,774,672	55,964,830	57,488,975
2005	25,100,697	42,702,229	50,644,994	55,017,682	57,210,462	58,736,432
2006	25,608,776	43,606,497	51,341,921	55,788,874	58,018,896	59,570,783
2007	27,229,969	45,242,423	53,215,604	57,799,239	60,097,804	61,697,389

AY 2007 projected case O/S at 24 months: $11,374,010 equals 0.526 (selected ratio at 24 months) * $21,623,594 (case O/S at 12 months)

AY 2006 incremental paid claims at 36 months: $7,735,424 = 0.701 (selected ratio at 36 months) * $11,034,842 (case O/S at 24 months). Cumulative paid at 72 for AY 2003 = 57,565,344 = 55,930,654 + 1,634,690

Question 18 discussion Blooms: Comprehension; Difficulty 1, LO 4, KS How internal operating changes affect estimates of unpaid claims: * Claims processing…Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

Compute: Adjusted Reported Claims triangle

Step 1: Compute unadjusted case outstanding and unadjusted average case outstanding

8,682,000 = 8,732,000 – 50,000. 8,324 = 8,682,000 / 1,043

Accident	Unadjusted Case Outstanding as of (months)				
Year	12	24	36	48	60
1972	8,682,000	17,847,000	28,333,000	47,425,000	42,645,000
1973	11,015,000	19,134,000	46,544,000	62,441,000	
1974	8,534,000	31,872,000	57,210,000		
1975	12,718,000	47,339,000			
1976	15,582,000				

Accident	Open Claim Counts as of (months)				
Year	12	24	36	48	60
1972	1,043	1,561	1,828	1,894	1,522
1973	1,088	1,388	1,540	1,877	
1974	1,033	1,418	1,663		
1975	1,138	1,472			
1976	1,196				

Accident	Unadjusted Average Case Outstanding as of (months)				
Year	12	24	36	48	60
1972	8,324	11,433	15,499	25,040	28,019
1973	10,124	13,785	30,223	33,266	
1974	8,261	22,477	34,402		
1975	11,176	32,160			
1976	13,028				

Step 2 Compute the following: Adj Avg Case O/S at 12 mos for AY 1975 = 11,328 = 13,028/1.15.

13,102,402 = Open counts * Adj Av Case O/S + Unad Paid Claims = [1,138 * 11,329 + 210,000]

Accident	Adjusted Average Case Outstanding as of (months)				
Year	12	24	36	48	60
1972	7,449	21,145	26,013	28,927	28,019
1973	8,566	24,317	29,915	33,266	
1974	9,851	27,965	34,402		
1975	11,329	32,160			
1976	13,028				

Selected Annual Severity Trend Rate 15%

Accident	Adjusted Reported Claims as of (months)				
Year	12	24	36	48	60
1972	7,819,307	33,793,345	51,361,764	64,559,286	61,163,000
1973	9,532,808	34,584,996	49,668,100	73,733,000	
1974	10,348,083	41,241,370	63,477,000		
1975	13,102,402	48,904,000			
1976	15,791,000				

See chapter 13

Question 19 discussion Blooms: Comprehension; Difficulty 2, LO 7, KS How internal operating changes affect estimates of unpaid claims: * Claims processing… * Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

Step 1: Compute CDFs to ultimate for reported claim counts and compute projected ultimate claims

PART 2 - Age-to-Age Factors - Reported Claim Counts

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	To Ult
1972	1.206	1.015	1.005	1.002	
1973	1.201	1.015	1.005		
1974	1.213	1.017			
1975	1.223				

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	To Ult
Selected - Simple Avg	1.211	1.015	1.005	1.002	1.001
CDF to Ultimate	1.239	1.023	1.008	1.003	1.001
Percent Reported	80.7%	97.7%	99.2%	99.7%	99.9%

Accident Year	Age of Accident Year at 12/31/76	Reported Claim Counts at 12/31/76	CDF to Ultimate	Projected Ultimate Claim Counts
(1)	(2)	(3)	(4)	(5) = [(3) x (4)]
1972	60	9,680	1.001	9,690
1973	48	9,562	1.003	9,591
1974	36	7,741	1.008	7,803
1975	24	7,884	1.023	8,066
1976	12	6,115	1.239	7,577
Total		40,982		42,726

Step 2: Compute disposal rates, select disposal rates by age, and use them to compute adj closed claim counts.

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	Projected Ultimate Claim Counts
1972	0.464	0.809	0.903	0.955	0.977	9,690
1973	0.461	0.799	0.903	0.948		9,591
1974	0.447	0.796	0.886			7,803
1975	0.436	0.772				8,066
1976	0.426	=3,230/7,575 = closed claim cnts/projected ult cnts				7,577

Selected Disposal Rate by Maturity Age

	12	24	36	48	60
	0.426	0.772	0.886	0.948	0.977

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60
1972	4,128	7,481	8,588	9,187	9,469
1973	4,086	7,404	8,501	9,093	
1974	3,324	6,024	6,916		
1975	3,436	6,227	=.772 * 8,068 = sel disposal rate * projected ult cnts		
1976	3,228				

See chapter 13

Question 20 discussion Blooms: Comprehension; Difficulty 2, LO 4 KS How internal operating changes affect estimates of unpaid claims: * Claims processing * Underwriting and policy provisions * Marketing * Coding of claim counts and/or claim related expenses * Treatment of recoveries such as policyholder deductibles and salvage and subrogation * Reinsurance

Compute: adjusted paid claims for AY 1970 at age 48

Compute: adjusted paid claims for year 1969 at age 12

Adjusting the paid claims:

* If the number of adjusted closed claims is within the range of any regression in its specific accident year, we use <u>interpolation</u>. Example:

  Since AY 1970 at age 48 has 8,231 adjusted closed claims, which is within the range of unadjusted closed claims between ages 36 and 48 (7,899; 8,291), the paid claims for AY 1970 at age 48 would be adjusted based on such regression with a = 215 and b = 0.000468.

  Thus, the adjusted paid claims for AY 1970 at age 48 are equal to {215 x [$e^{(0.000468 \times 8{,}231)}$] } = 10,156.

* If the number of adjusted closed claims is not within the range of all regression in its specific AY, then <u>extrapolation</u> is used to the regression that has the closest range. Example:

  AY 1969 at age 12 has 3,334 adjusted closed claim counts, in which the regression between ages 12 and 24 has the closest unadjusted closed claim count range (4,079; 6,616) among all regressions in year 1969.

  Thus, adjusted paid claims for year 1969 at age 12 is calculated as {356 x [$e^{(0.000411 \times 3{,}334)}$]} =1,402

See chapter 13

Accident Year	Closed Claim Counts as of (months 12	24	36	48	60	72	84	96
1969	**4,079**	**6,616**	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident Year	Parameter a for Two-Point Exponential Fit 12	**24**	36	48	60	72	84	96
1969		**356**	124	132	198	286	1,034	459
1970		438	181	***215***	353	778	88	
1971		464	244	337	493	370		
1972		510	337	506	421			
1973		616	468	333				
1974		530	220					
1975		580						
1976								

Accident Year	Paid Claims ($000) as of (months) 12	24	36	48	60	Accident 72	84	96
1969	**1,904**	**5,398**	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

Year	Parameter b for Two-Point Exponential Fit 12	**24**	36	48	60	72	84	96
1969		**0.000411**	0.000570	0.000562	0.000508	0.000459	0.000294	0.000398
1970		0.000368	0.000490	***0.000468***	0.000409	0.000315	0.000568	
1971		0.000338	0.000416	0.000381	0.000341	0.000370		
1972		0.000354	0.000407	0.000360	0.000380			
1973		0.000346	0.000381	0.000421				
1974		0.000434	0.000576					
1975		0.000444						
1976								

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	<u>**3,332**</u>	6,038	6,932	7,415	7,643	0	0	0
1970	3,699	6,703	7,695	***8,231***	8,484	0	0	
1971	4,237	7,678	8,815	9,429	9,718	0		
1972	4,128	7,480	8,588	9,187	9,469			
1973	4,086	7,404	8,500	9,093				
1974	3,324	6,024	6,916					
1975	3,430	6,215						
1976	3,181							

Accident Year	Adjusted Paid Claims ($000) as of (months) 12	24	36	48	60	72	84	96
1969	1,401	4,257	6,463	8,496	9,578	286	1,034	10,256
1970	1,708	5,157	7,864	10,125	11,300	778	12,031	
1971	1,941	6,213	9,594	12,232	13,549	14,235		
1972	2,197	7,192	11,071	13,836	15,383			
1973	2,529	7,961	11,981	15,278				
1974	2,242	7,236	11,771					
1975	2,655	9,182						
1976	2,801							