1. **Learning Objectives:**
   1. The candidate will understand the key considerations for general insurance actuarial analysis.

**Learning Outcomes:**
(1d) Recognize differences in how data are aggregated and segregated.
(1k) Estimate written, earned and unearned premiums.
(1l) Adjust historical earned premiums to current rate levels.

**Sources:**

**Commentary on Question:**
The question is testing the ability of the candidate to understand certain details of individual insurance policies and to make correct calculations of earned exposures, earned premium, and unearned premium at various points in time. The candidate also needs to know how to apply a rate level change correctly.

**Solution:**
(a) Calculate the total earned exposure units and total earned premium in each of the four calendar quarters in 2013.

**Commentary on Question:**
To calculate earned exposure the candidate needs to calculate by policy the number of months in 2013 that each policy was in effect for each quarter, then calculate fractional exposure relative to the twelve months in a year. The earned premium then equals earned exposure multiplied by policy premium. The question asks specifically for earned exposure totals and earned premium totals for each quarter.
1. Continued

There are three insurance policies to consider:

- **Policy 14902** has written premium of 1,680, became effective 09/01/2012 and was cancelled 2/28/2013. In 1st quarter 2013 the policy earned two months of exposure (1/6 of a year, 2/3 of a quarter). The earned premium for 1st quarter 2013 is therefore 280 = 1,680 × (1/6). Due to the policy cancellation in February, all other quarters of 2013 have 0 earned exposure and 0 earned premium.

- **Policy 14903** has written premium of 1,680, became effective 12/16/2013 and expired 12/15/2013. In 1st, 2nd and 3rd quarter of 2013 the policy earned 1/4 unit of exposure, with the remaining 5/24 of exposure earned in 4th quarter 2013. The earned premium is as follows:
  - 1st quarter through 3rd quarter 2013, 420 = 1,680 × 1/4.

- **Policy 14904** has written premium = 2,016 (1680 × 1.2 to adjust for the rate level change effective January 1, 2013). The policy became effective 6/16/2013 and has earned exposure and earned premium as follows for the four quarters of 2013:
  - 1st quarter, 0 earned exposure and 0 earned premium
  - 2nd quarter, 1/24 earned exposure, and earned premium = 84 (2,016 × 1/24)
  - 3rd quarter and 4th quarter, 1/4 earned exposure and earned premium = 504 (2,016 × 1/4)

- **Totals by quarter of 2013** for the three policies are as follows:
  - 1st quarter: earned exposure = 5/24 (1/6 + 1/4) and earned premium = 700 (280 + 420)
  - 2nd quarter: earned exposure = 7/24 (1/4 + 1/24) and earned premium = 504 (420 + 84)
  - 3rd quarter: earned exposure = 1/2 (1/4 + 1/4) and earned premium = 924 (420 + 504)
  - 4th quarter: earned exposure = 11/24 (5/24 + 1/4) and earned premium = 854 (350 + 504)

(b) Calculate the total unearned premium at December 31, 2012 and December 31, 2013.

**Commentary on Question:**

*There are two ways to calculate unearned premium:*

1. **By policy**, given the policy details. *It is important to note that at year end, the candidate must calculate the full unearned portion even for policies that cancel early the next year.*

2. **Using the formula**, \( UEP = WP - EP. \) *Again care must be taken with the cancellation and also with the years in which written premium earned.*
1. Continued

For 2012 unearned premium consider the unearned portion of policies 14902 and 14903:
- Policy 14902 has 8/12 or 2/3 unearned, UEP = 1680 × 2/3 = 1,120
- Policy 14903 has 11.5/12 or 23/24 unearned, UEP = 1680 × 23/24 = 1610
- Total UEP at December 31, 2012 = 2,730 (1,120 + 1,610)

At the end of 2013 only one policy has unearned premium:
- Policy 14904 has 5.5/12 or 11/24 unearned, UEP = 2,016 × 11/24 = 924
- Total UEP at December 31, 2013 = 924
2. **Learning Objectives:**
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**
(2a) Use loss development triangles for investigative testing.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 13 and 19

**Commentary on Question:**
*This question is concerned with identifying potential issues with data triangles, and what adjustments can be made to those triangles prior to estimating ultimate claims.*

**Solution:**
(a) Describe the patterns that would be expected in the triangle of average reported claims (i.e., reported severities) and in the triangle of the ratios of closed to reported counts in a stable environment.

**Commentary on Question:**
*Need to state the expected pattern and also state that the pattern is down each column to get full credit.*

Triangle of average reported claims: expect changes down the column (each maturity) to be consistent with inflation.
Triangle of ratios of closed to reported counts: expect values down each column to be approximately the same (level).

(b) Determine whether the above triangle of average case estimates is representative of a stable environment.

**Commentary on Question:**
*It is not necessary to calculate the change in average case reserve triangle to get full credit.*

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Change in Average Case Reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2008-2009</td>
<td>4.8%</td>
</tr>
<tr>
<td>2009-2010</td>
<td>11.1%</td>
</tr>
<tr>
<td>2010-2011</td>
<td>3.6%</td>
</tr>
<tr>
<td>2011-2012</td>
<td>14.7%</td>
</tr>
</tbody>
</table>

The triangle is not representative of a stable environment as the changes down each column are not consistent with changes of 9%, especially the most recent diagonal.
2. Continued

(c) Identify two reasons why historical reported claims may not be appropriate for use in a traditional development-based projection method.

**Commentary on Question:**
*Four situations are presented. Any two are acceptable.*

1. There may be a change in the adequacy of case estimates.
2. There may be a change in the rate of settlement of claims.
3. There may be changes due to tort reform.
4. There may be large claims.

(d) Describe an approach, for each of the two reasons identified in (c), that the actuary can implement for use in a development-based projection.

**Commentary on Question:**
*Approach must relate to the reason identified in part (c).*

Reason: change in adequacy of case reserves

Approach: Use Berquist-Sherman method for change in case reserve adequacy.

Reason: change in the rate of settlement of claims

Approach: Use Berquist-Sherman method for change in the rate of settlement of claims.

Reason: changes due to tort reform

Approach: Adjust historical case estimates for the changes due to tort reform so that case reserves are on the same basis pre- and post-tort reform.

Reason: large claims

Approach: Make an adjustment in the development method, such as removing large claims when calculating development factors and adding the large claims back into the case estimates (thereby assuming the case estimates set by claim management professionals are a better indicator of the ultimate values).
3. **Learning Objectives:**
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

**Learning Outcomes:**
(4d) Calculate premium trend and apply it to project premiums.

**Sources:**
Fundamentals of General Insurance, Actuarial Analysis, J. Friedland, Chapter 26

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**
(a) Describe the purpose of premium trend and on-level factors.

**Commentary on Question:**
*Reference to both purposes of premium trend factors is needed for full credit.*

Premium trend factors adjust for inflation-sensitive exposure bases and changes in the mix of exposures. On-level factors adjust for rate changes.

(b) Calculate premium trend factors to apply to each of the four years in the experience period.

**Commentary on Question:**
*Direct comparison of the average limits differentials in the experience period and forecast period is also acceptable. Some adjustment for the anomalous data in 2012 is needed for full credit.*

Average limits differentials: 2010—53% × 1.00 + 47% × 1.50 = 1.235, 2011—50% × 1.00 + 50% × 1.50 = 1.250, 2012—65% × 1.00 + 35% × 1.50 = 1.175, 2013—48% × 1.00 + 52% × 1.50 = 1.260, 2015—45% × 1.00 + 55% × 1.50 = 1.275. Excluding 2012, which is an outlier, the annual trend in the average limits differential appears to be around 1%. Combining this with the 5% annual trend in the inflation-sensitive exposure base of sales revenue, the premium trend factors are 1.05^5 × 1.01^5 = 1.341 for 2010, 1.05^4 × 1.01^4 = 1.265 for 2011, and 1.05^2 × 1.01^2 = 1.125 for 2013. 2012 will be disregarded in the rate analysis, so a premium trend factor will not be needed for this year.

(c) Assign weights to each year in the experience period and describe the rationale for such weights.

**Commentary on Question:**
*Identifying 2012 as an outlier and giving it reduced or zero weight is required for full credit. Anything reasonable for the other three years is acceptable.*
3. **Continued**

Experience from 2012 will be disregarded and the other three years will be given equal weight. The company appears to have written a large block of business for 2012 only. Its limits profile is clearly different from the rest of the company’s book of business, and other characteristics may be different as well. There is nothing in the information provided for the other three years that indicates that any of those years should be weighted more than the others.

(d) Explain how the premium trend factors would be affected by the following:

(i) A 10% rate increase that is implemented at the beginning of 2014.

(ii) The introduction of a loyalty discount program at the beginning of 2015.

**Commentary on Question:**

*Suggesting that the introduction of a loyalty discount program could be considered a rate change that would not affect premium trend factors also received full credit.*

Premium trend factors are not affected by rate changes. The loyalty discount program would decrease premiums, so the premium trend factors would decrease.
4. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 18

**Commentary on Question:**

_The question is testing the mechanics of the Cape Cod method of estimating ultimate claims, situations that would cause a difference in the estimate of ultimate claims when using paid versus reported claims, and how to incorporate professional judgment in the Cape Cod method. The candidate also needs to understand the major difference between the Bornhuetter Ferguson and Cape Cod projection methods._

**Solution:**

(a) Calculate the projected ultimate claims using the Cape Cod method with paid claims.

**Commentary on Question:**

_The overall adjusted expected claim ratio needs to be applied to each accident year to estimate the expected paid claims, instead of determining a claim ratio for each accident year separately._

(b) Explain two situations that could result in such a difference in Cape Cod projections based on paid and reported claims.

**Commentary on Question:**

_Four situations are presented. Any two are acceptable._
4. Continued

1. Change in the adequacy of case reserves
2. Change in the settlement rates resulting in higher or lower paid claims than in past
3. Unusual reporting of large claims that are not yet paid
4. Change in environment (internal or external) that is reflected in case estimates but not yet seen in paid claims that lag the reporting of claims

(c) Describe how the actuary can incorporate professional judgment in the Cape Cod method.

Commentary on Question:

Four are presented. Any two are acceptable.

Possible answers include:
- Length of the experience period chosen
- Selecting the decay factor to use for the generalized Cape Cod method
- Trend selection used
- Development pattern selected

(d) Explain the major difference between the Bornhuetter Ferguson and Cape Cod projection methods.

Determination of expected claims differs between the 2 methods:
- BF method requires an a priori estimate
- Cape Cod method is based on earned premium, claims, development pattern, and trend
5. **Learning Objectives:**

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(5b) Calculate expenses used in ratemaking analyses.

(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 29 and 31

**Commentary on Question:**

*This question tests the ability to allocate fixed expenses by coverage and calculate overall rate indications. The candidate needs to be able to explain reasons why allocating fixed expenses to all coverages is more appropriate.*

**Solution:**

(a) Determine the revised indicated rate change for both the mandatory coverage and optional coverage by allocating all fixed expenses to the mandatory coverage.

**Commentary on Question:**

*There is not enough information provided in the question to calculate indications using a pure premium approach. Therefore, need to use the claim ratio approach.*

<table>
<thead>
<tr>
<th>Mandatory Coverage</th>
<th>Optional Coverage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>T trended earned premium at current rate level (000) [given]</td>
<td>3,260</td>
<td>2,190</td>
</tr>
<tr>
<td>2 Fixed expenses as a ratio to premium at current rate level [given]</td>
<td>11.5%</td>
<td>11.5%</td>
</tr>
<tr>
<td>3 Fixed expenses - amount [(1) × (2)]</td>
<td>374.90</td>
<td>251.85</td>
</tr>
<tr>
<td>4 Total amount of fixed expenses allocated to line</td>
<td>626.75</td>
<td>0</td>
</tr>
<tr>
<td>5 Fixed expenses as a ratio to premium at current rate level [(4)/(1)]</td>
<td>19.23%</td>
<td>0.00%</td>
</tr>
<tr>
<td>6 Variable expenses as a % of premium [given]</td>
<td>10.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>7 Profit and contingencies as a % of premium [given]</td>
<td>5.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>8 Claim ratio including ULAE [(ult. claims) × (1 + ULAE ratio) / (1)]</td>
<td>74.54%</td>
<td>83.59%</td>
</tr>
<tr>
<td>9 PCR [1 - (6) - (7)]/[1 + (5)/(8)]</td>
<td>67.57%</td>
<td>85.00%</td>
</tr>
<tr>
<td>10 Indicated Rate Change [(8)/(9) - 1]</td>
<td>10.31%</td>
<td>–1.66%</td>
</tr>
</tbody>
</table>
5. Continued

(b) Draft a response to the regulator outlining why you believe your expense allocation method is more appropriate.

- Since fixed expenses include such expenses as office expenses and staff salary, such expenses should be shared by all policies equally regardless of the coverage(s) purchased.
- If expenses are allocated to the mandatory coverage only, customers who want to purchase policies with mandatory coverage only would select against our company due to an uncompetitive premium.
6. Learning Objectives:
2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

Learning Outcomes:
(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

Sources:
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 19

Commentary on Question:
This question is concerned with determining adjusted closed counts from observed data using the Berquist-Sherman method, and using an exponential formula to estimate adjusted paid claims.

Solution:
(a) Describe two situations where Berquist-Sherman methods are most commonly implemented.

Two situations where Berquist-Sherman methods are most commonly used are…

When there has been a significant change in the adequacy of case estimates in the most recent periods; and

When there has been a significant change in the rate of settlement of claims in the most recent periods.

(b) Recommend disposal ratios for each maturity age.

The best recommended disposal ratios under the Berquist-Sherman method are the disposal ratios of closed counts at the current point in time to the selected ultimate counts. The following table shows calculation of ratios across the data set, with the bottom row indicating the recommended selected disposal ratios.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Ratio Closed Counts to Selected Ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2009</td>
<td>0.68</td>
</tr>
<tr>
<td>2010</td>
<td>0.67</td>
</tr>
<tr>
<td>2011</td>
<td>0.68</td>
</tr>
<tr>
<td>2012</td>
<td>0.60</td>
</tr>
<tr>
<td>Selected</td>
<td>0.60</td>
</tr>
</tbody>
</table>
6. Continued

(c) Calculate the development triangle of adjusted closed counts using your recommended ratios from (b).

Adjusted closed counts are determined by using the above selected disposal ratios and applying them to ultimate claims. This leads to the following development triangle of adjusted closed counts.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Adjusted Closed Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2009</td>
<td>1,570</td>
</tr>
<tr>
<td>2010</td>
<td>1,680</td>
</tr>
<tr>
<td>2011</td>
<td>1,763</td>
</tr>
<tr>
<td>2012</td>
<td>1,860</td>
</tr>
</tbody>
</table>

For example, the adjusted closed counts for Accident Year 2011 at month 12 would be 2,938 of ultimate counts, multiplied by the 0.60 disposal ratio to arrive at 1,763 of adjusted closed counts.

(d) Calculate adjusted paid claims at December 31, 2011 for accident year 2009 using the information above and the adjusted closed count triangle.

Adjusted paid claims are determined as a function of the entry in the adjusted closed count table for Accident Year 2009 at 36 months, which is 2,355.

\[2,345.11 \times e^{0.00047 \times 2,355} = 7,094\]
Learning Objectives:
7. The candidate will understand the nature and application of catastrophe models used to manage risks from natural disasters.

Learning Outcomes:
(7a) Describe the structure of catastrophe models.

Sources:
Catastrophe Modeling: A New Approach to Managing Risk, Grossi, P. and Kunreuther, H., Sections 4.2 – 4.4

Commentary on Question:
This question is concerned with types of uncertainty in catastrophe models.

Solution:
(a) Provide an example of each type of uncertainty with regard to earthquake models and explain why each example reflects that type of uncertainty.

Commentary on Question:
There are several examples of each type of uncertainty. Only one is needed to earn credit and there may be others beyond those listed below that are also creditworthy.

In earthquake models aleatory uncertainty is reflected in the probability distribution of the frequency of earthquakes, the probability distribution of the location, magnitude and direction of earthquakes, and the probability distribution of the amount of damage caused, given the above. In each case the error is due to the randomness reflected in the probability distribution.

Regarding epistemic uncertainty, for earthquake losses there is limited data on which to base an exceedance probability curve. There may also be limited or poor data on construction quality, building values and repair costs. There may be incomplete information regarding the topography or soil composition. As a result, the models are likely to be wrong.

(b) Describe which of these types of uncertainty can be reduced by collecting more data, and illustrate your response using your example from part (a).

Commentary on Question:
The response should relate to the example in part (a). The solution below responds to the items listed in that solution.
7. Continued

Epistemic uncertainty can be reduced by collecting more data. For exceedance probability curves, parameter estimates can be improved with more data. For construction quality, building values, repair costs, topography or soil composition, more data will lead to more accurate models of how the exposures are distributed among various levels of that factor.

(c) Explain how logic trees can be used to reflect epistemic uncertainty in the construction of exceedance probability curves.

**Commentary on Question:**

*For this question it is necessary to cover both how trees are constructed and how they are used to reflect uncertainty.*

Construct a set of assumptions, where each set covers all the parameters of the model. For a given set of assumptions, run the model and develop an EP curve. Weight each assumption set with subjective probabilities. An average EP curve can then be constructed using the weights. In addition, looking at the fifth and ninety-fifth percentiles of EP curves (using the probabilities and ordering the curves from worst to most favorable) provides a ninety percent confidence interval for the true curve.
8. Learning Objectives:
3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

Learning Outcomes:
(3a) Estimate unpaid unallocated loss adjustment expenses.

Sources:
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 22

Commentary on Question:
This question tests the estimation of unallocated loss adjustment expenses. Candidates need to know the application of the classical paid-to-paid method, the Kittel refinement, and the Mango-Allen smoothing adjustment.

Solution:
(a) Describe two of the key assumptions of the classical paid-to-paid method.

Commentary on Question:
Only two assumptions are needed for full credit.

1. Payments for ULAE are proportional to payments for claims.
2. The timing of payments for ULAE follows the timing of payments for claims.
3. The insurer’s relationship of paid ULAE to paid claims has achieved a steady state such that the paid-to-paid ratio is a reasonable approximation of the relationship between ultimate ULAE and ultimate claims.
4. The historical relationship between paid ULAE and paid claims represents the relationship expected between future ULAE and future claim payments.
5. The ULAE associated with open and pure IBNR claims are proportional to the case estimates and IBNR claims.

(b) Estimate unpaid ULAE as of December 31, 2012 using the classical paid-to-paid method and a multiplier of 50%. Justify any selections.

Commentary on Question:
Any selected ULAE ratio is acceptable as long as a reasonable justification is provided.

ULAE Ratio = (500 + 800 + 1,000) / (7,000 + 7,000 + 8,000) = 0.105
Unpaid ULAE = 0.105 × 3,000 + 0.105 × 0.5 × 5,000 = 578

The data is not credible enough to assume a trend in the ULAE ratio, so a weighted average was selected.
8. Continued

(c) Describe the Kittel refinement to the classical paid-to-paid method and the weakness it is designed to address.

The Kittel refinement substitutes the average of paid and reported claims for paid claims in the denominator of the formula for the estimated ULAE ratio.

It is designed to take into account the fact that ULAE is associated with the reporting of claims, in addition to the payment of claims.

(d) Explain the weakness of the classical paid-to-paid method that the Mango-Allen smoothing adjustment is designed to address and identify a situation in which it would be useful.

Commentary on Question:
Identification of only one situation is needed for full credit.

By using expected claims instead of actual claims in the denominator of the formula for the estimated ULAE ratio, it takes some of the volatility out of the estimate.

It is useful with long-tail lines, changing exposure volumes, new insurers, and for situations where distortions are present due to large claims or sparsity of claims.

(e) Estimate unpaid ULAE as of December 31, 2012 using the classical paid-to-paid method, a multiplier of 50%, and the Mango-Allen smoothing adjustment.

\[
\text{ULAE Ratio} = \frac{(500 + 800 + 1,000)}{(5,000 + 8,000 + 10,000)} = 0.100 \\
\text{Unpaid ULAE} = 0.100 \times 3,000 + 0.100 \times 0.5 \times 5,000 = 550
\]

(f) Compare the significance of ULAE for reinsurers to that of primary insurers and explain the reason for any difference.

ULAE is less significant for reinsurers than for primary insurers.

Primary insurers typically retain ULAE and do not cede it to reinsurers, and reinsurers have a limited role in the claim-handling process.
9. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5g) Calculate risk classification changes and territorial changes.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 32

**Commentary on Question:**
This question tests the candidate’s understanding of classification ratemaking. It requires the candidate to incorporate credibility and also understand distributional bias.

**Solution:**
(a) Calculate the indicated class relativities for the risk characteristic *color of car*.

**Commentary on Question:**
Preliminary claim ratio indicated relativity (column 5) must be calculated relative to the total to be on the same basis as the complement, so that the credibility weighted indicated relativities are calculated properly.

<table>
<thead>
<tr>
<th>Car Color</th>
<th>EP @ Average Curr Rate</th>
<th>Trended Ultimate Claims</th>
<th>Wtd Avg Claim Ratio</th>
<th>Claim Ratio Relativity Indicated</th>
<th>Ultimate Counts</th>
<th>Credibility Complement</th>
<th>Credibility-Weighted Ind. Rel.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>White</td>
<td>568,000</td>
<td>449,000</td>
<td>79.0%</td>
<td>1.044</td>
<td>775</td>
<td>71.0%</td>
<td>1.000</td>
</tr>
<tr>
<td>Black</td>
<td>780,000</td>
<td>606,000</td>
<td>77.7%</td>
<td>1.026</td>
<td>935</td>
<td>78.0%</td>
<td>1.000</td>
</tr>
<tr>
<td>Other</td>
<td>1,150,000</td>
<td>837,000</td>
<td>72.8%</td>
<td>0.961</td>
<td>1,635</td>
<td>100.0%</td>
<td>1.000</td>
</tr>
<tr>
<td>Total</td>
<td>2,498,000</td>
<td>1,892,000</td>
<td>75.7%</td>
<td>1.000</td>
<td>3,345</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: 
(4) = (3) / (2) 
(5) = (4) / (4)TOTAL 
(7) = Squareroot{(6) / 1,537}; max of 1.0 
(9) = (5)(7) + [1-(7)](8)

(b) Explain what is implied by a complement of credibility of 1.

Complement of 1 implies that the balance of credibility assumes there is no difference for car color for ratemaking.

(c) Determine the *color of car* classification relativities and the revised base rate assuming a base class of *other*, given that the current base rate is 475.
9. Continued

Commentary on Question:
Not adjusting the base rate would introduce an overall increase of 3.6%. As a result, need to divide the base rate by 1.036.

<table>
<thead>
<tr>
<th>Car Color</th>
<th>EP @ Average Curr Rate</th>
<th>Credibility-Weighted Relativity to Base</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>White</td>
<td>568,000</td>
<td>1.031</td>
</tr>
<tr>
<td>Black</td>
<td>780,000</td>
<td>1.020</td>
</tr>
<tr>
<td>Other</td>
<td>1,150,000</td>
<td>0.961</td>
</tr>
<tr>
<td>Total</td>
<td>2,498,000</td>
<td></td>
</tr>
</tbody>
</table>

(4) Current Base Rate: 475.00
(5) Revised Base Rate: 458.58 \( \frac{(4) / (3)\text{total}} \)

(d) Describe how you could check the risk characteristic color of car for distributional bias relative to another risk characteristic such as territory.

Check to see if the distribution of each territory within each car color is the same. There is distributional bias if they are not consistent by car color.
10. **Learning Objectives:**
3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3e) Evaluate premium liabilities.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 24

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**
(a) Select expected claim ratios for each line of business, gross and net of reinsurance, that will be used in the determination of premium liabilities. Justify each selection.

**Commentary on Question:**
*Any reasonable selections which take into account the 1-in-100 year nature of the hurricane that affected the 2012 property experience are acceptable.*

Property gross of reinsurance—55% (average of 60% in 2011 and 50% in 2013, unusual catastrophe year of 2012 will be ignored)

Property net of reinsurance—55% (average of 55% in 2011 and 55% in 2013, unusual catastrophe year of 2012 will be ignored)

Liability gross of reinsurance—90% (average of 2011-13)

Liability net of reinsurance—95% (average of 2011-13)

(b) Calculate the net premium liabilities for Acme as of December 31, 2013 given the selected expected claim ratios in (a) and the information provided.

**Commentary on Question:**
*Inclusion of all three terms in the formula is needed for full credit.*

Property portion of net premium liabilities—100,000 × n (expected claims) + 0.10 × 120,000 × g (ULAE) + 0.05 × 120,000 (maintenance expenses), where g and n are gross and net expected claim ratios from part (a). With g and n both 55%, this yields 67,600. (Commission of 15% has already been paid and so is not included.)

Liability portion of net premium liabilities—same formula as property. With g equal to 90% and n equal to 95%, this yields 111,800.

67,600 + 111,800 = 179,400.
10. Continued

(c) Explain the purpose of a premium deficiency reserve.

**Commentary on Question:**
*A one sentence explanation is sufficient for full credit.*

A premium deficiency reserve is a liability to account for any excess of net premium liabilities over the unearned premium reserve.

(d) Determine, based on your calculations in (b), Acme’s premium deficiency reserve as of December 31, 2013.

**Commentary on Question:**
*Any reasonable expected claim ratio selections lead to the conclusion that a premium deficiency reserve is not needed.*

No premium deficiency reserve is needed because the total company net unearned premium of 200,000 exceeds the net premium liabilities of 179,400.

(e) Explain how premium liabilities for Acme would change if some of the liability policies are written using sales as an exposure base that are subject to audit following the end of the policy period.

**Commentary on Question:**
*A one sentence explanation is sufficient for full credit.*

Premium liabilities would be adjusted up or down, depending on whether aggregate audit premiums are expected to be negative or positive, respectively.
11. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 14, 16, and 17

**Commentary on Question:**

This question tests the ability to estimate ultimate claims using the development method, the expected method, the Bornhuetter Ferguson method, and the Benktander method. The candidate needs to understand how to check the reasonableness of the inputs for the Bornhuetter Ferguson method as well as select estimates of ultimate claims.

**Solution:**

(a) Develop an estimate of ultimate claims for 2008 and 2012 using the following methods:

(i) Development method

(ii) Expected method

(iii) Bornhuetter Ferguson method

(iv) Benktander method, one iteration

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Actual Reported Claims (1)</th>
<th>A Priori Expected Claims (2)</th>
<th>Reported CDF (3)</th>
<th>Development Method (4) = (1)x(3)</th>
<th>Expected Method (5) = (2)</th>
<th>BF Method (6)=(1) + (2)x[1 - 1/(3)]</th>
<th>Benktander Method (7)=(1) + (6)x[1 - 1/(3)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>57,800</td>
<td>62,000</td>
<td>1.00</td>
<td>57,800</td>
<td>62,000</td>
<td>57,800</td>
<td>57,800</td>
</tr>
<tr>
<td>2012</td>
<td>19,300</td>
<td>52,100</td>
<td>2.00</td>
<td>38,600</td>
<td>52,100</td>
<td>45,350</td>
<td>41,975</td>
</tr>
</tbody>
</table>

(b) Evaluate the reasonableness of the inputs for the Bornhuetter Ferguson method.

**Commentary on Question:**

*Only 2008 & 2012 calculations required for full credit.*
11. Continued

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Actual Reported Claims (1)</th>
<th>A Priori Expected Claims (2)</th>
<th>Reported CDF (3)</th>
<th>Expected % Developed (4) = 1/(3)</th>
<th>Expected Claims Developed (5) = (2)x(4)</th>
<th>Difference Actual vs. Expected (6) = (1)-(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>57,800</td>
<td>62,000</td>
<td>1.00</td>
<td>100.0%</td>
<td>62,000</td>
<td>(4,200)</td>
</tr>
<tr>
<td>2009</td>
<td>53,100</td>
<td>59,500</td>
<td>1.05</td>
<td>95.2%</td>
<td>56,667</td>
<td>(3,567)</td>
</tr>
<tr>
<td>2010</td>
<td>25,200</td>
<td>51,000</td>
<td>1.10</td>
<td>90.9%</td>
<td>46,364</td>
<td>(21,164)</td>
</tr>
<tr>
<td>2011</td>
<td>20,600</td>
<td>49,000</td>
<td>1.50</td>
<td>66.7%</td>
<td>32,667</td>
<td>(12,067)</td>
</tr>
<tr>
<td>2012</td>
<td>19,300</td>
<td>52,100</td>
<td>2.00</td>
<td>50.0%</td>
<td>26,050</td>
<td>(6,750)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(47,747)</td>
</tr>
</tbody>
</table>

Conclusion: Inputs are not reasonable.
Reason: Actual is significantly lower than expected for both years (all years as well), suggesting that the inputs are not reasonable and further investigation is recommended.

(c) Select estimates of ultimate claims for 2008 and 2012 and justify your selections.

Commentary on Question:
Due to the significant difference in actual versus expected claims, the A Priori estimate would be inappropriate as a selection.

2008:
- Select 57,800.
- Reason: Claims are fully developed for 2008 (reported CDF = 1.0) and there is no evidence that further change will occur.

2012:
- Select BF estimate of 45,350.
- Reason: Immature so select a blended method.
12. **Learning Objectives:**

1. The candidate will understand the key considerations for general insurance actuarial analysis.

**Learning Outcomes:**

(1g) Identify trend adjustments and describe the relationship between trend and loss development.

**Sources:**


**Commentary on Question:**

*No calculations are required for full credit because the trend factors can be read directly off the graph.*

**Solution:**

(a) Illustrate this inflationary trend effect on the layer from 0 to 50 and the layer from 50 to 100 using a graph with cumulative claim frequency along the $x$-axis and claim size along the $y$-axis.
12. Continued

(b) Determine the inflationary trend factors that apply to each of the following layers using the graph from (a):

(i)  0 to 50

(ii) 50 to 100

(iii) 0 to 100

Trend factor for 0 to 50 layer is \((C+D)/D = 7/6 = 1.167\).

Trend factor for 50 to 100 layer is \((A+B)/B = 5/2 = 2.500\).

Trend factor for 0 to 100 is \((A+B+C+D)/(B+D) = 3/2 = 1.500\).
13. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5k) Calculate rates for claims-made coverage.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 34

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**
(a) Calculate the expected claims on an occurrence policy sold in 2013.

**Commentary on Question:**
*A matrix approach similar to that shown in the text leading to an approximate answer would also receive full credit.*

\[
500 \times (0.2)^0 \times (1.10)^0 + 500 \times (0.2)^1 \times (1.10)^1 + 500 \times (0.2)^2 \times (1.10)^2 + \ldots = \\
\frac{500}{1 - 0.2 \times 1.10} = 641
\]

(b) Calculate the second-year claims-made step factor.

**Commentary on Question:**
*An equation is sufficient for full credit.*

\[
\frac{500 + 100}{625} = 0.96
\]

(c) Calculate the second-year claims-made tail factor.

**Commentary on Question:**
*A matrix approach similar to that shown in the text leading to an approximate answer would also receive full credit.*

\[
\frac{(500 \times 0.2 \times 1.10 + 100 \times 0.2 \times 1.10)/(1 - 0.2 \times 1.10)}{(500 + 100)} = 0.28
\]

(d) Identify the gap in coverage that can arise when changing from claims-made coverage with one insurer to claims-made coverage with a different insurer.

**Commentary on Question:**
*A one sentence explanation is sufficient for full credit.*
13. Continued

Claims occurring prior to the retroactive date of the new policy will not be covered.

(e) Explain how the gap in (d) can be addressed.

Commentary on Question:
Only one solution for the gap is needed for full credit.

Tail coverage may be purchased from the former insurer, or prior acts (or nose) coverage may be purchased from the new insurer, with a retroactive date no later than the retroactive date that applied with the former insurer.
14. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 14

**Commentary on Question:**

*This question tests the ability to estimate ultimate claims using the development method. Candidates need to know the criteria to consider when selecting age-to-age development factors, and also adjust the estimate when there is a large claim.*

**Solution:**

(a) Calculate three alternative average age-to-age factors for the interval 12-24, based on:

(i) Volume weighted 3-year

(ii) Medial 5×1

(iii) Geometric 3-year

Volume weighted 3-year:

\[
\frac{(10,081+7,541+7,201)}{(8,366+6,380+5,962)} = \frac{24,823}{20,708} = 1.199
\]

Medial 5×1: (average most recent 5, excluding high & low) average

\[
(1.190, 1.197, 1.205) = 1.197
\]

Geometric 3-year: \[(1.205 \times 1.182 \times 1.208)^{1/3} = 1.198\]

(b) List three considerations in selecting age-to-age factors.

**Commentary on Question:**

*Nine considerations are presented. Any three are acceptable.*

- Volume and credibility of insurer's experience
- Stability of factors at each maturity interval
- Any discernible trends when comparing short-term to long-term averages
- Number of recent factors that are greater than or less than the various averages
- Factors preceding or following the interval
- Any known changes that affect future development
- Influence of large claims
14. Continued

- Relevance of other information such as industry benchmarks
- Selected factors from prior actuarial work

(c) Calculate the percentage of incremental reported claims expected between 48 and 60 months.

**Commentary on Question:**
*Only the calculation of the 48-ultimate and 60-ultimate values are needed to get full credit.*

<table>
<thead>
<tr>
<th></th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
<th>48-60</th>
<th>60-72</th>
<th>72-84</th>
<th>84-Ult</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Age-to-age</td>
<td>1.198</td>
<td>1.121</td>
<td>1.058</td>
<td>1.042</td>
<td>1.033</td>
<td>1.023</td>
<td>1.023</td>
</tr>
<tr>
<td>(2) Age-to-Ult</td>
<td>1.601</td>
<td>1.336</td>
<td>1.192</td>
<td>1.126</td>
<td>1.081</td>
<td>1.047</td>
<td>1.023</td>
</tr>
<tr>
<td>(3) % Reported [1 / (2)]</td>
<td>62.5%</td>
<td>74.8%</td>
<td>83.9%</td>
<td>88.8%</td>
<td>92.5%</td>
<td>95.6%</td>
<td>97.8%</td>
</tr>
</tbody>
</table>

Incremental % reported between 48 & 60 months: 92.5% - 88.8% = 3.7%

(d) Calculate the ultimate claims for this accident year both with and without a large claim adjustment.

Need 12-Ult factor: from part (c), 12-Ult factor = 1.601
With NO adjustment: $10,190 \times 1.601 = 16,314$
WITH adjustment: $(10,190 - 4,000) \times 1.601 + 4,000 = 13,910$

(e) State an assumption underlying each approach in (d).

With NO adjustment:
Assumption is that the 4,000 claim is:
(i) Not unusual, and
(ii) Is representative of historical claims experience.

WITH adjustment:
Assumption is:
(i) Case estimate developed by claim adjuster is the best estimate of unusual claim, and
(ii) An actuarial-based estimate is not appropriate.
15. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5j) Perform individual risk rating using standard plans.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 35

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**
(a) State the two basic principles on which prospective experience rating plans are based.

**Commentary on Question:**
*A brief sentence covering each principle is sufficient for full credit.*

The larger the insured, the more reliable the historical claims will be as a predictor of future claims. Frequency is a better predictor of future claims than severity.

(b) Propose an experience rating formula and explain how it takes into account these two basic principles.

**Commentary on Question:**
*Any formula is acceptable as long as an explanation is provided to show how the formula takes into account the two principles.*

\[
\frac{\text{Actual Primary Claims}}{\text{Expected Primary Claims}} \times Z + (1 - Z)
\]

Larger insureds are given greater credibility and the use of primary claims emphasizes frequency over severity.

(c) Recommend whether, from WC Plumbing's perspective, it would be a good candidate for retrospective rating and justify your recommendation.

**Commentary on Question:**
*The recommendation needs to reference both reasons to obtain full credit.*

A retrospective rating plan is not appropriate for this company for two reasons. The substantial operating loss in the latest year indicates that the company has financial problems, and the fact that the company had only three claims probably indicates that it is not large enough for a retrospective rating plan to be advisable.
16. **Learning Objectives:**

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(5b) Calculate expenses used in ratemaking analyses.

(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 29 and 31

**Commentary on Question:**

*This question tests the selection of a fixed expense ratio to be used for ratemaking and the resulting indication. The candidate needs to understand how various changes can lead to distortions when selecting a fixed expense percentage applied to a projected average premium for ratemaking.*

**Solution:**

(a) Select a fixed and variable expense ratio as a percentage of direct earned premiums to be used for ratemaking purposes assuming that historically 30% of general and other acquisition expenses are considered to be fixed expenses. Justify your selection.

**Commentary on Question:**

Candidate needs to recognize that 2009 (possibly 2008) is an anomalous year and should be excluded from the selection of the expense ratios.

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>General and Other Acquisition Expenses</th>
<th>Direct Earned Premiums</th>
<th>Total General &amp; Other Acq. Expenses %</th>
<th>30% Fixed Expense Percentage</th>
<th>70% Variable Expense Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>108,000</td>
<td>691,000</td>
<td>15.63%</td>
<td>4.69%</td>
<td>10.94%</td>
</tr>
<tr>
<td>2009</td>
<td>138,000</td>
<td>725,000</td>
<td>19.03%</td>
<td>5.71%</td>
<td>13.32%</td>
</tr>
<tr>
<td>2010</td>
<td>115,000</td>
<td>770,000</td>
<td>14.94%</td>
<td>4.48%</td>
<td>10.45%</td>
</tr>
<tr>
<td>2011</td>
<td>126,000</td>
<td>834,000</td>
<td>15.11%</td>
<td>4.53%</td>
<td>10.58%</td>
</tr>
<tr>
<td>2012</td>
<td>130,000</td>
<td>866,000</td>
<td>15.01%</td>
<td>4.50%</td>
<td>10.51%</td>
</tr>
<tr>
<td>Total</td>
<td>617,000</td>
<td>3,886,000</td>
<td>15.88%</td>
<td>4.76%</td>
<td>11.11%</td>
</tr>
<tr>
<td>Average all years excluding 2009</td>
<td>15.17%</td>
<td>4.55%</td>
<td>10.62%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of 2010, 2011 &amp; 2012 only</td>
<td>15.02%</td>
<td>4.51%</td>
<td>10.51%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Selected ratios: 4.55% 10.60%
16. Continued

(b) Calculate the indicated rate and indicated rate change given the selected fixed expense ratio from (a).

Commentary on Question:
The question is set up to solve using the pure premium method, although enough information is provided so that the claim ratio method could also be used.

Pure Premium Method:
1 Weighted Average Trended Pure Premium 476.00
2 ULAE as a Ratio to Claims 8.0%
3 Selected Fixed Expense Ratio as a % of Premium 4.55%
4 Total Fixed Expenses \([3] \times 895,000\) 40,722.50
5 Fixed Expenses per Vehicle \([4] / 1,150\) 35.41
6 Commissions 12.0%
7 Premium Taxes 2.0%
8 Licenses 1.0%
9 Selected General Variable Expenses as a % of Premium 10.60%
10 Total Variable Expenses [sum of (6) through (9)]: 25.6%
11 Profit and Contingencies Factor: 3.0%
12 Indicated Rate \([1 \times (1 + (2)) + (5)] / \{1 – (10) – (11)\}\): 769.60
13 Current Rate \([895,000 / 1,150]\): 778.26
14 Indicated Rate Change \([12] / (13) – 1\): -1.11%

(c) Explain how each of these situations can affect the level of fixed expenses in a ratemaking analysis and recommend a solution for each to avoid potential distortion.

Commentary on Question:
Candidate needs to explain how each situation can affect the level of fixed expenses and also recommend a solution to get full credit.

Distortions caused by recent rate changes:
- How the level of fixed expenses is affected: A recent rate increase will mean the historical ratio will be applied to a higher current premium resulting in too high a provision for fixed expenses.
- Solution: Adjust historical premium to on level in the expense analysis.

Distortions caused by shifts in mix of business:
- How the level of fixed expenses is affected: Changes in mix of business will have a different effect on premiums and expenses such that the expenses estimated for ratemaking are either overstated or understated.
- Solution: Adjust historical premium and expenses with trend in the expense analysis.
17. **Learning Objectives:**
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**
(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 15

**Commentary on Question:**
*This question is concerned with projecting ultimate claims through frequency-severity methods, and recognizing seasonality.*

**Solution:**
Project ultimate claims for Spring 2013 and Summer 2013 using a frequency-severity method given the information above, and justify all selections.

The first step is to project ultimate counts. It is clear from the data that the age-to-age factors vary by the accident period of Summer, Fall and Spring, so count development should recognize this. Development of claims without the recognition of seasonality would not receive full credit for this question. The following shows the development of age-to-ultimate factors:

### Average Age-to-Age factors:

<table>
<thead>
<tr>
<th>Accident Period</th>
<th>4-8</th>
<th>8-12</th>
<th>12-16</th>
<th>16-20</th>
<th>20-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>2.01</td>
<td>1.44</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Fall</td>
<td>3.01</td>
<td>2.46</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Spring</td>
<td>1.60</td>
<td>1.83</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Selected Age-to-Age factors:

<table>
<thead>
<tr>
<th>Accident Period</th>
<th>4-8</th>
<th>8-12</th>
<th>12-Ult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>2.00</td>
<td>1.45</td>
<td>1.00</td>
</tr>
<tr>
<td>Fall</td>
<td>3.00</td>
<td>2.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Spring</td>
<td>1.60</td>
<td>1.83</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Calculated Age-to-Ultimate factors:

<table>
<thead>
<tr>
<th>Accident Period</th>
<th>4-Ult</th>
<th>8-Ult</th>
<th>12-Ult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>2.90</td>
<td>1.45</td>
<td>1.00</td>
</tr>
<tr>
<td>Fall</td>
<td>7.50</td>
<td>2.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Spring</td>
<td>2.93</td>
<td>1.83</td>
<td>1.00</td>
</tr>
</tbody>
</table>
17. Continued

The next step would be to arrive at an overall claim frequency by comparing ultimate counts to exposures.

<table>
<thead>
<tr>
<th>Accident Period</th>
<th>Ultimate Counts</th>
<th>Exposures</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summertime 2010</td>
<td>7,079</td>
<td>250,000</td>
<td>2.83%</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>10,287</td>
<td>350,000</td>
<td>2.94%</td>
</tr>
<tr>
<td>Spring 2011</td>
<td>8,672</td>
<td>300,000</td>
<td>2.89%</td>
</tr>
<tr>
<td>Summer 2011</td>
<td>7,614</td>
<td>262,500</td>
<td>2.90%</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>10,696</td>
<td>367,500</td>
<td>2.91%</td>
</tr>
<tr>
<td>Spring 2012</td>
<td>9,293</td>
<td>315,000</td>
<td>2.95%</td>
</tr>
<tr>
<td>Summer 2012</td>
<td>7,912</td>
<td>270,000</td>
<td>2.93%</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>11,339</td>
<td>378,000</td>
<td>3.00%</td>
</tr>
<tr>
<td>Spring 2013</td>
<td>5,163</td>
<td>324,000</td>
<td>2.92%</td>
</tr>
<tr>
<td>Summer 2013</td>
<td>2,761</td>
<td>277,500</td>
<td>2.89%</td>
</tr>
</tbody>
</table>

Average - All years: 2.92%
Selected Frequency: 2.9%

Finally, to arrive at ultimate claims for the two accident periods, selected ultimate counts need to be multiplied by ultimate severities. Using the 2.90% selected frequency, selected ultimate counts are determined by multiplying exposures by 2.90%. The following table derives the projected ultimate claims:

<table>
<thead>
<tr>
<th>Accident Period</th>
<th>Selected Ultimate Counts</th>
<th>Ultimate Severity</th>
<th>Projected Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2013</td>
<td>9,396</td>
<td>2,460</td>
<td>23,114,160</td>
</tr>
<tr>
<td>Summer 2013</td>
<td>8,048</td>
<td>2,480</td>
<td>19,959,040</td>
</tr>
</tbody>
</table>
18. Learning Objectives:
7. The candidate will understand the nature and application of catastrophe models used to manage risks from natural disasters.

Learning Outcomes:
(7b) Apply catastrophe models to insurance ratemaking, portfolio management, and risk financing.

Sources:
Catastrophe Modeling: A New Approach to Managing Risk, Grossi, P. and Kunreuther, H., Section 7.3

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a) Define basis risk and describe how it can occur in this context.

Commentary on Question:
The solution quotes the definition from the text. The most important item is to note that the risk is the potential mismatch between the hedging and actual cash flows.

The text definition is “Basis risk arises in derivative products as a result of uncertainty associated with ability of the cash flows of the hedging instrument to exactly offset the cash flows from the instrument being hedged.” In the case of hurricane catastrophe hedging, the payment to the insurance company may not be a function of the actual losses incurred but rather a function of other items that correlate with actual losses but do not exactly match them.

(b) State if there is basis risk for BCI with each of these securitization types. If there is no basis risk, explain why not, and if there is basis risk, explain how that securitization type creates basis risk.

Commentary on Question:
Where there is basis risk it is necessary to explain how the risk is created by that securitization type. Just stating it creates a mismatch is not sufficient.

(i) Indemnity-based securitization – Losses are paid based on the actual company losses. There is no basis risk because by definition the indemnity matches the losses.
(ii) Index-based transaction – Because the index is based on average industry losses rather than BCI’s losses, there is a possibility of basis risk.
(iii) Parametric indices – With the payment depending on the physical parameters of the loss event, basis risk arises when the actual damages and resultant losses do not correlate with the parameters.
18. Continued

(iv) Notional portfolio – With payments based on a hypothetical portfolio of policies rather than the company’s actual portfolio of policies, there can be basis risk.

(c) Indicate an action BCI can take to reduce basis risk for two of the securitization types that you identified as having basis risk.

Commentary on Question:
The action should be something that is within BCI’s control. The model solution responds to all three cases; candidates need to only provide two responses.

(ii) Before issuing such a security, a company should verify that its losses are highly correlated with industry losses. This can be done by reviewing past results and comparing the company’s exposure to the industry average.

(iii) The risk can be reduced by having a model that accurately links the event to the company’s losses. Then triggers can be set that maximize the correlation.

(iv) The risk is minimized when the notional portfolio closely resembles the actual portfolio.
19. **Learning Objectives:**
6. The candidate will understand the need for monitoring, documentation, and communication.

**Learning Outcomes:**
(6a) Monitor financial reporting results and pricing changes.

**Sources:**
*Fundamentals of General Insurance Actuarial Practice*, J. Friedland, Chapter 36

**Commentary on Question:**
Commentary listed underneath question component.

**Solution:**
(a) Show that Tony’s calculation for accident year 2010 is correct, based on the methodology he used.

**Commentary on Question:**
The description of Tony’s methodology allows for the use of several interpolation formulas, but regardless of the specific formula used, the result should be the same. The model solution presents two possible approaches.

April 30 is 1/3 of the way through the year so the interpolated percent reported is $(2/3)(96.2) + (1/3)(98.1) = 96.833$. The expected count is $0.96833(2800) = 2711$. Note that this is a simplification of the formula in the book that can only be used when the percent reported is the ratio of observed to selected. Using the book’s formula, the solution is:

$$2694 + \frac{2800 - 2694}{1 - 0.962}(0.96833 - 0.962) = 2711.$$ 

(b) Write a brief note to Tony explaining why it may have been more appropriate to use the cumulative development factors from one specific method for this task.

**Commentary on Question:**
The answer to this question is independent of the specific situation faced by Tony. The answer should be to the general situation.

The final selection of ultimate counts may depend upon factors that are specific to the prior experience. Values for specific accident years may be adjusted to reflect changing circumstances either in the external environment or in company processes. As a result, the selected CDFs for adjacent accident years may not align in a reasonable manner. It may even be the case that the earlier accident year has a smaller CDF. Thus the interpolation could produce values that lead to a smaller number of expected reported counts. Using the likely smoother pattern from a formulaic method lessens the likelihood of such a distortion.
19. Continued

(c) Provide two questions you would pose to your company colleagues in an investigation of this observation.

**Commentary on Question:**

*There are many questions that could be asked. The model solution lists several, but there are others that could receive credit. To qualify, the question must refer to something that can affect some accident years without affecting others.*

- Has there been a change in the external environment (such as tort reform) that is delaying claim closing?
- Has there been a change in the internal systems of the company that affects only claims from the past two years?
- Has there been a change in the type of business written?
- Has there been a change in underwriting processes?
- Has there been a significant error in the reporting process?
- Has there been a significant loss event that distorted the patterns?
20. **Learning Objectives:**

1. The candidate will understand the key considerations for general insurance actuarial analysis.

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(1b) Identify different types of data used for actuarial analysis.

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 4 and 16

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) Describe two situations for which the expected method would be a preferred approach for projecting ultimate claims.

**Commentary on Question:**

*Four situations are presented. Any two are acceptable.*

- Introduction of new products
- Entry into a new geographical area where there is no historical data
- There have been significant changes internal to the insurer or external, such that existing relationships and patterns are not a reliable guide to the future
- There are immature accident years, particularly for long-tailed business

(b) Define exposure base and leading indicator.

An **exposure base** is a measure that is known or accurately estimated in advance and that varies directly with the quantity being estimated.

A **leading indicator** is not known in advance, but is directly correlated with the quantity being measured.

(c) Describe two desirable characteristics of exposures for actuarial work.

**Commentary on Question:**

*Six characteristics are presented. Any two are acceptable.*
20. Continued

- It should accurately reflect the overall exposure to loss
- It should be simple to compile
- It should not be subject to manipulation
- It should accurately reflect differences in exposure to loss
- It should consider any pre-existing exposure base established within the industry
- A leading indicator is preferred
- A leading indicator should require few adjustments
- It should use the latest information

(d) Calculate the expected claims for 2008 using the expected method with the following approaches:

(i) Expected claim ratio

(ii) Pure premium

The following initial calculations precede the two approaches:

- The premium on-level factor for 2008 is $1 - 0.1(0.4) = 0.96$
- The trend factor is $1.024^4 = 1.0995$
- The tort reform factor for 2008 is $0.7$

The calculation for the expected claim ratio approach is:

$$\frac{\text{(selected expected claim ratio}_{2012}) \times \text{(premium on-level factor}_{2008})}{\text{(trend factor}_{2008}) \times \text{(tort reform factor}_{2008})} \times \text{(2008 earned premium)}$$

$$= \frac{0.75 \times 0.96}{1.0995 \times 0.7} \times 24,540,000 = 22,956,928$$

The calculation for the pure premium approach is:

$$\frac{\text{(selected pure premium}_{2012})}{\text{(trend factor}_{2008}) \times \text{(tort reform factor}_{2008})} \times \text{(2008 earned vehicles)}$$

$$= \frac{220}{1.0995 \times 0.7} \times 87,600 = 25,039,953$$
21. **Learning Objectives:**

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(5h) Calculate deductible factors, increased limits factors, and coinsurance penalties.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 33

**Commentary on Question:**

The question deals with calculating deductible factors and explaining the underlying assumptions for a calculation based on claims and counts by layer. Candidates need to understand how to test deductible factors for consistency.

**Solution:**

(a) Calculate the indicated deductible factors for deductibles of 250 and 750 relative to a base of zero deductible.

- To calculate the 250 deductible factor, first calculate the claims eliminated by layer:
  - Claims in the 0–250 layer = 30,000 eliminated completely
  - In the next two layers the first 250 of each claim is eliminated = $250 \times (300+100) = 100,000$
  - Indicated deductible factor = $1 - \frac{\text{total claims eliminated}}{\text{total claims}} = 1 - \frac{130,000}{330,000} = 0.606$

- To calculate the 750 deductible factor, first calculate the claims eliminated by layer:
  - Claims in the first and second layers = 180,000 (30,000+150,000) eliminated completely
  - In the next layer the first 750 of each claim is eliminated = $750 \times 100 = 75,000$
  - Indicated deductible factor = $1 - \frac{\text{total claims eliminated}}{\text{total claims}} = 1 - \frac{180,000+75,000}{330,000} = 0.227$

(b) State two assumptions that you needed to make in using the information above to perform the calculation in part (a).

**Commentary on Question:**

Listed below are several assumptions. Any two are acceptable for full credit.

- The frequency distribution is the same for each deductible considered.
- Expenses apply as a percentage of premiums for the calculated deductibles.
21. Continued

- Counts and claims are at ultimate values, trended appropriately for the forecast period.
- The given information (which may be based on industry data or historical company data) is reflective of future experience (i.e., no significant changes in either the internal or external environment).
- The information given on counts and claims treats ALAE in a manner consistent with the product to be priced/sold in the future.
- Data provided is ground-up and uncensored.
- Changing deductible will have no impact on insured behavior.

(c) Determine the range into which the deductible factor for a 500 deductible must fall in order to be consistent with the deductible factors calculated in part (a) and explain your reasoning.

The selected deductible factor needs to be between the 250 and the 750 deductible factors and needs to be less than the average of the two factors (i.e., \(0.227 < F(500) < 0.606\) and \(F(500) < (0.227+0.606)/2 = 0.417\)) to be consistent with decreasing marginal change in deductible factors. Thus, \(0.227 < F(500) < 0.417\).
1. Learning Objectives:

1. The candidate will understand the key considerations for general insurance actuarial analysis.

Learning Outcomes:

(1k) Estimate written, earned and unearned premiums.

Sources:


Commentary on Question:

The question tests the ability of the candidate to understand certain details of individual insurance policies and to make correct calculations of earned exposures, earned premiums, and written premiums for various policies. The candidate also needs to understand when premiums are not earned evenly throughout a year.

Solution:

(a) Calculate earned and written premium for calendar years 2012 and 2013. No Name does not treat multi-year policies as multiple annual policies.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>Annual</td>
<td>5,000</td>
<td>100%</td>
<td>100%</td>
<td>5,000</td>
<td>0</td>
<td>5,000</td>
<td>0</td>
<td>5,000</td>
<td>0</td>
</tr>
<tr>
<td>4/1/2012</td>
<td>Annual</td>
<td>1,000</td>
<td>100%</td>
<td>75%</td>
<td>1,000</td>
<td>0</td>
<td>750</td>
<td>25%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7/1/2012</td>
<td>6-month</td>
<td>500</td>
<td>100%</td>
<td>100%</td>
<td>500</td>
<td>0</td>
<td>500</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10/1/2012</td>
<td>2-year</td>
<td>5,000</td>
<td>100%</td>
<td>12.5%</td>
<td>5,000</td>
<td>0</td>
<td>625</td>
<td>50%</td>
<td>2,500</td>
<td>0</td>
</tr>
<tr>
<td>1/1/2013</td>
<td>Annual</td>
<td>2,000</td>
<td>100%</td>
<td>0%</td>
<td>2,000</td>
<td>0</td>
<td>2,000</td>
<td>100%</td>
<td>2,000</td>
<td>0</td>
</tr>
<tr>
<td>7/1/2013</td>
<td>Annual</td>
<td>1,500</td>
<td>100%</td>
<td>0%</td>
<td>1,500</td>
<td>0</td>
<td>750</td>
<td>50%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11,500</td>
<td></td>
<td>3,500</td>
<td>6,875</td>
</tr>
</tbody>
</table>

(b) Explain how the calculation of written and earned premium might be different if No Name Insurance Company wrote motorcycle policies in a winter climate instead of general liability policies.

Commentary on Question:

Candidates need to recognize that the earning pattern would be different but the written premiums would not.
1. Continued

Motorcycles written in a winter climate would typically only have exposure to loss in the spring, summer and fall months. As a result, the insurer might recognize this difference by modifying the even earnings throughout the policy term. Written premium would be unaffected.
2. Learning Objectives:
2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

6. The candidate will understand the need for monitoring, documentation, and communication.

Learning Outcomes:
(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

(6a) Monitor financial reporting results and pricing changes.

Sources:

Commentary on Question:
This question tests the fundamental understanding of estimating unpaid claims, expected claims and ultimate claims using the expected method and the Bornhuetter Ferguson method. Candidates also need to be able to estimate expected reported claims for an interim period between actuarial analyses using the approach in Friedland Chapter 36.

Solution:
(a) Estimate the unpaid claims for accident year 2013 using the development method with simple all-year average development factors.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
<th>48-60</th>
<th>Tail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>2.00</td>
<td>1.20</td>
<td>1.06</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>2.20</td>
<td>1.18</td>
<td>1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>2.00</td>
<td>1.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>2.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>2.10</td>
<td>1.19</td>
<td>1.07</td>
<td>1.02</td>
<td>1.00</td>
</tr>
<tr>
<td>CDF</td>
<td>2.727</td>
<td>1.299</td>
<td>1.091</td>
<td>1.020</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Ultimate claims for 2013: $130 \times 2.727 = 355$
Paid to date $= 75$
2013 Unpaid $= 355 - 75 = 280$
2. **Continued**

(b) Calculate the accident year 2012 claims expected to be reported in 2014 using the development factors from part (a).

2012 reported claims @ Dec 31, 2013: 242  
24-36 month development factor: 1.19  
Projected 2012 reported claims @ Dec 31, 2014 (242×1.19): 288  
2012 reported claims during the next 12 months (288 – 242): 46

(c) State the two primary assumptions of the development method.

Historical experience is predictive of future experience.  
Activity observed to date is relevant for projecting future activity.

(d) Estimate the ultimate claims for accident year 2012 using the Bornhuetter Ferguson method with an expected claim ratio of 60%.

24-ult factor: 1.299  
% reported: 1/1.299 = 77%  
% unreported: 1 – 77% = 23%  
Expected claim ratio: 60%  
Unreported: 520×60%×23% = 72  
Reported: 242  
AY2012 BF Method Ultimate = 72 + 242 = 314

(e) Describe two situations when the Bornhuetter Ferguson method may be preferable to the development method.

**Commentary on Question:**

*Any two of the following situations are acceptable.*

- For immature experience periods
- Following the introduction of new GI products when limited or no historical experience is available
- Following entry into a new geographical area for which limited or no historical data exists
- If there have been wide-ranging changes, either internally at the insurer or in the external environment, such that historical relationships and development patterns are not a reliable guide to the future

(f) Compare actual reported claims to expected reported claims for accident year 2012 and comment on the reasonableness of the Bornhuetter Ferguson method.
2.  Continued

**Commentary on Question:**
*Candidate needs to understand the reasonableness of the inputs for the Bornhuetter Ferguson method can be tested by comparing actual reported to expected reported.*

Actual reported for 2012 @ 24 months: 242
24-ult development factor: 1.299
% reported: 1/1.299 = 77%
Earned premium: 520
Expected reported = 520×77%×60% = 240
Difference = 242 – 240 = 2

Expected and actual reported are very close. Therefore it supports the input (development pattern and expected value) for BF method.

(g) Calculate the difference between the actual and expected reported claims from December 31, 2013 through March 31, 2014 for accident year 2013, using linear interpolation of the expected percent reported.

**Commentary on Question:**
*Candidates need to follow the approach outlined in section 36.3 of the Friedland text for the solution.*

Expected reported at 3/31/2014 = 0.75×0.37 + 0.25×0.77 = 0.47
Actual Difference = 178 – 130 = 48
Expected Difference: \( (320 − 130) \times \frac{0.47 − 0.37}{1 − 0.37} = 30.2 \)
Difference: 48 – 30.2 = 17.8

(h) Identify two questions you might ask in your further investigation based on the results from part (g).

**Commentary on Question:**
*Only two questions are needed to earn credit and there may be others beyond those listed below that are acceptable.*

- Was there a legal decision that affected claims in all years?
- Were claims found that had not been entered properly in the system?
- Is there an expectation that issues have been resolved or is this adverse experience likely to continue for subsequent quarters?
3. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5h) Calculate deductible factors, increased limits factors, and coinsurance penalties.

**Sources:**

**Commentary on Question:**
*This question is testing the candidate’s ability to calculate increased limits factors for capped claims data, as well as how to test for consistency in increased limits factors and why consistency is important.*

**Solution:**
(a) Calculate the increased limits factors for the 2,000,000 and 3,000,000 policy limits, assuming a 1,000,000 basic limit.

Calculate increased limits factors (ILFs) using the formula:
$$\text{ILF}(L) = \frac{\text{Expected Severity}(L)}{\text{Expected Severity}(B)}$$

where L is the limit for which we are determining the ILF and B is the basic limit.

- For the 2,000,000 limit as follows:
  o First calculate the Expected Severity (Basic Limit) or limited average severity (LAS) using data from all policy limits expressed in millions
    $$\text{LAS}(1) = \frac{858 + 629 + (305 \times 1) + 625 + (330 + 32) \times 1}{3,333 + 2,900 + 305 + 3,100 + 330 + 32} = 0.278$$
  o Next, calculate the LAS for the layer from 1 to 2 using only policy limits data from policies at 2 and 3 limits as follows:
    $$\text{LAS}(1 \text{ to } 2) = \frac{470 + 533 - (305 + 330) \times 1 + (32 \times 1)}{2,900 + 305 + 3,100 + 330 + 32} = 0.060$$
    o Then, the LAS(2) = 0.278 + 0.060 = 0.338
  - Continuing for the 3,000,000 limit, calculate the LAS for the layer from 2 to 3 using only policy limits data from policies at 3 limits:
    $$\text{LAS}(2 \text{ to } 3) = \frac{77 - (32 \times 2)}{3,100 + 330 + 32} = 0.004$$
    o Then, the LAS(3) = 0.338 + 0.004 = 0.342

- The increased limits factors are then calculated as follows:
  o $\text{ILF}(2) = \frac{\text{LAS}(2)}{\text{LAS}(1)} = \frac{0.338}{0.278} = 1.216$
  o $\text{ILF}(3) = \frac{\text{LAS}(3)}{\text{LAS}(1)} = \frac{0.342}{0.278} = 1.230$

(b) Determine the range into which a 4,000,000 increased limits factor should fall, considering consistency with the factors determined in part (a).
3. Continued

The incremental increase per million from 3 to 4 should be less than the incremental increase from 2 to 3. Thus, ILF(4) should be greater than 1.230 and less than 1.244 (1.230 + 1.230 – 1.216). Therefore one endpoint of the range is the lowest point or 1.230, and the other endpoint is the highest point or 1.244.

(c) Explain why consistency is important for increased limits factors.

Consistency reflects both a decreasing claim (survival) probability as claim size increases and the practical consideration that the incremental price should decrease as the limit increases.

(d) Explain why it is important to know whether claims have been capped or not in determining increased limits factors.

With uncensored claims data (i.e., claims that have not been capped), there is no consideration of the policy limits at which the policies generating claims have been written. The LAS and ILF can be calculated directly from the distribution considering only the layers involved. However, in practice, claim databases typically show the impact of policy features (deductibles, limits) rather than the full uncensored value of the claims. The use of capped data presents a distortion to the distribution used for calculation. The impact of the distortion can be significant. The method in part (a) shows an example of a calculation using capped data for which policy limits are known. If the policy limits were not known and we only had capped data in total, the resulting calculations would be more inaccurate.
4. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

**Commentary on Question:**
*This question tests the mechanics and understanding of the frequency-severity claims closure method.*

**Solution:**

(a) Estimate total unpaid claims as of December 31, 2013 using the claims closure method.

<table>
<thead>
<tr>
<th>Incremental Paid Severity</th>
<th>AY</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>1,290</td>
<td>5,482</td>
<td>15,325</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>958</td>
<td>4,084</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>1,794</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Incremental Paid Severity = Incremental Paid Claims ÷ Incremental Closed Counts

<table>
<thead>
<tr>
<th>Incremental Paid Severity Adjusted to 2013 Levels</th>
<th>AY</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>1,382</td>
<td>5,872</td>
<td>16,417</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>992</td>
<td>4,227</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>1,794</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Avg:</strong></td>
<td><strong>1,389</strong></td>
<td><strong>5,050</strong></td>
<td><strong>16,417</strong></td>
<td></td>
</tr>
</tbody>
</table>

i.e. 4,227 = 4,084×1.035

Complete bottom of incremental paid severity:

<table>
<thead>
<tr>
<th>Incremental Paid Severity</th>
<th>AY</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>1,290</td>
<td>5,482</td>
<td>15,325</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>958</td>
<td>4,084</td>
<td>15,862</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>1,794</td>
<td>5,050</td>
<td>16,417</td>
</tr>
</tbody>
</table>

i.e. 15,862 = 16,417÷1.035
4. Continued

Complete bottom of incremental closed counts:

<table>
<thead>
<tr>
<th>AY</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>Selected Ultimate Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>600</td>
<td>280</td>
<td>120</td>
<td>1,000</td>
</tr>
<tr>
<td>2012</td>
<td>660</td>
<td>308</td>
<td>132</td>
<td>1,100</td>
</tr>
<tr>
<td>2013</td>
<td>720</td>
<td>336</td>
<td>144</td>
<td>1,200</td>
</tr>
</tbody>
</table>

% Closed  
60.0%  
70.0%  
100.0%  
i.e. 0.7 \times (1,200 - 720) = 336; \ 1,100 - 660 - 308 = 132

Complete bottom of incremental paid claims:

<table>
<thead>
<tr>
<th>AY</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>774,000</td>
<td>1,535,000</td>
<td>1,839,000</td>
</tr>
<tr>
<td>2012</td>
<td>632,000</td>
<td>1,258,000</td>
<td>2,093,784</td>
</tr>
<tr>
<td>2013</td>
<td>1,292,000</td>
<td>1,696,800</td>
<td>2,364,048</td>
</tr>
</tbody>
</table>

i.e. 336 \times 5,050 = 1,696,800

Total Unpaid Claims @ Dec 31, 2013:
2012: 2,093,784  
2013: 1,696,800 + 2,364,048 = 4,060,848

(b) Discuss how the following additional information would affect your estimate in part (a):

(i) New legislation lengthens the statute of limitations.

(ii) The company introduces a new system to accelerate claims processing and settlement.

(i) New legislation lengthens the statute of limitations:
- expect proportion closed to be lower at earlier months of development
- since incremental paid severity is higher at later months of development, unpaid claims estimate should be higher since more claims would be expected to be closed at later maturities.

(ii) Company introduces a new system to accelerate claims processing and settlement:
- expect proportion closed to be higher at earlier months of development
- since incremental paid severity is higher at later months of development, unpaid claims estimate should be lower since more claims would be expected to be closed at earlier maturities.
4. Continued

(c) Describe a situation in which a frequency and severity method is preferred to other projection methods.

**Commentary on Question:**
*Any one of the following is acceptable.*

- For immature experience periods
- Following the introduction of new GI products when limited or no historical experience is available
- Following entry into a new geographical area for which limited or no historical data exists
- If there have been wide-ranging changes, either internally at the insurer or in the external environment, such that historical relationships and development patterns are not a reliable guide to the future
5. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5j) Perform individual risk rating using standard plans.

**Sources:**

**Commentary on Question:**
*This question tests the graphical understanding of retrospective rating.*

**Solution:**
(a) Describe the insurance savings and insurance charge.

The insurance savings at entry ratio \( r \) is the expected amount by which the risk's actual loss falls short of \( r \) times the expected loss, divided by the expected loss.

The insurance charge at entry ratio \( r \) is the expected amount by which the risk's actual loss exceeds \( r \) times the expected loss, divided by the expected loss.

(b) Draw a graph with cumulative claim frequency along the x-axis and entry ratio along the y-axis, and identify the areas on the graph corresponding to \( \psi(r) \) and \( \phi(r) \).

![Graph](image-url)
5. Continued

(c) Explain how the graph demonstrates the validity of the fundamental relation above.

\[ \psi(r) = \phi(r) + r \text{ (the lower rectangle) } - 1 \text{ (the area under the curve)} \]

(d) Define \( \psi(r) \) for the limiting case where losses are all equal.

\[ \psi(r) = 0, \quad r \leq 1 \quad \text{and} \quad \psi(r) = r - 1, \quad r > 1 \]
6. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**


**Commentary on Question:**

_This question requires candidates to apply different methods for estimating ultimate salvage._

**Solution:**

Estimate ultimate salvage for accident year 2013 using two different methods.

**Commentary on Question:**

<Any two of the three methods provided are acceptable. Other methods are possible._

**Method A: Development of Salvage Claims**

Reported Salvage – Personal Property

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3.00</td>
<td>1.70</td>
<td>1.30</td>
</tr>
<tr>
<td>2011</td>
<td>3.00</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.00</td>
<td>1.70</td>
<td>1.30</td>
</tr>
<tr>
<td>CDF</td>
<td>7.625</td>
<td>2.542</td>
<td>1.495</td>
</tr>
</tbody>
</table>

Ultimate salvage for 2013: \(35 \times 3.00 \times 1.70 \times 1.30 \times 1.15 = 35 \times 7.625 = 267\)

**Method B: Ratio of Salvage Reported to Reported Claims Gross of Salvage - Multiplicative**

Reported Claims Gross of Salvage – Personal Property

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1.90</td>
<td>1.11</td>
<td>1.01</td>
</tr>
<tr>
<td>2011</td>
<td>1.90</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>1.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1.90</td>
<td>1.11</td>
<td>1.01</td>
</tr>
</tbody>
</table>

2013 Ultimate claims = \(579 \times 1.90 \times 1.11 \times 1.01 = 1,233\)
6. Continued

Ratio of Salvage to Reported Claims Gross of Salvage:

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.042</td>
<td>0.066</td>
<td>0.101</td>
<td>0.130</td>
</tr>
<tr>
<td>2011</td>
<td>0.042</td>
<td>0.066</td>
<td>0.101</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.042</td>
<td>0.066</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>0.060</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(i.e. 69 / 1,047 = .066)

Age-to-Age Factors based on salvage ratios:

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1.58</td>
<td>1.53</td>
<td>1.29</td>
</tr>
<tr>
<td>2011</td>
<td>1.58</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>1.58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average: 1.58 1.53 1.29 1.15

CDF: 3.586 2.270 1.484 1.150

Accident Year | Ratio at 31-Dec-13 | CDF | Ultimate Ratio |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.130</td>
<td>1.150</td>
<td>0.150</td>
</tr>
<tr>
<td>2011</td>
<td>0.101</td>
<td>1.484</td>
<td>0.150</td>
</tr>
<tr>
<td>2012</td>
<td>0.066</td>
<td>2.270</td>
<td>0.150</td>
</tr>
<tr>
<td>2013</td>
<td>0.060</td>
<td>3.586</td>
<td>0.217</td>
</tr>
</tbody>
</table>

Selected ultimate ratio: 0.150

Estimated salvage = ultimate ratio × ultimate reported gross = 0.15×1,233 = 185

**Method C: Ratio of Salvage Reported to Reported Claims Gross of Salvage - Additive**

2013 Ultimate claims = 579×1.90×1.11×1.01 = 1,233 (same derivation as Method B)

Ratio of Salvage to Reported Claims Gross of Salvage: (same as Method B)

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.042</td>
<td>0.066</td>
<td>0.101</td>
<td>0.130</td>
</tr>
<tr>
<td>2011</td>
<td>0.042</td>
<td>0.066</td>
<td>0.101</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.042</td>
<td>0.066</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>0.060</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(i.e. 69 / 1,047 = .066)
6. Continued

Additive Age-to-Age Factors based on salvage ratios:

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.024</td>
<td>0.035</td>
<td>0.029</td>
</tr>
<tr>
<td>2011</td>
<td>0.024</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.024</td>
<td>0.035</td>
<td>0.029</td>
</tr>
<tr>
<td>CDF</td>
<td>0.108</td>
<td>0.084</td>
<td>0.049</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Ratio at 31-Dec-13</th>
<th>CDF</th>
<th>Ultimate Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.130</td>
<td>0.020</td>
<td>0.150</td>
</tr>
<tr>
<td>2011</td>
<td>0.101</td>
<td>0.049</td>
<td>0.150</td>
</tr>
<tr>
<td>2012</td>
<td>0.066</td>
<td>0.084</td>
<td>0.150</td>
</tr>
<tr>
<td>2013</td>
<td>0.060</td>
<td>0.108</td>
<td>0.168</td>
</tr>
</tbody>
</table>

Selected ultimate ratio: 0.150
(2013 seems an outlier, as a result use the 0.15 ratio)

Estimated salvage = ultimate ratio × ultimate reported gross = 0.15×1,233 = 185
7. **Learning Objectives:**
   3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3a) Estimate unpaid unallocated loss adjustment expenses.

**Sources:**

**Commentary on Question:**
*This question tests the understanding and the mechanics of estimating unpaid unallocated loss adjustment expenses using several methods.*

**Solution:**
(a) Provide two examples of expense items that are typically unallocated loss adjustment expenses (ULAE) and two examples of expense items that are typically allocated loss adjustment expenses (ALAE).

**Commentary on Question:**
*Any two of the ULAE examples and any two of the ALAE examples are acceptable.*

**ULAE**
- Salaries of claim personnel
- Management/administration cost of claims department
- Cost of facilities related to claims department

**ALAE**
- Fees for investigation
- Defense attorneys fees
- Cost of medical evaluations
- Cost of expert reviews
- Cost of witnesses
- Cost of record copying

(b) Explain one weakness of the classical paid-to-paid ULAE estimation method using the data from the table above.

**Commentary on Question:**
*Three explanations are given. Any one is acceptable.*
7. Continued

- The classical paid-to-paid method is most appropriate for insurers operating in a steady-state environment. In the data the exposure is decreasing, and a ratio calculated on the ratio of paid ULAE to paid claims will tend to understate the true ULAE ratio. We see that the ULAE ratio increases from 9.2% to 11.0% in the given experience period.
- During times of exposure growth, the ULAE ratio is overstated because the numerator is more reactive to the increasing exposures than the denominator.
- During inflationary periods, the classical paid-to-paid method overstates the true ULAE ratio because the influence of inflation is greater on the numerator than it is on the denominator.

(c) Estimate unpaid ULAE as of December 31, 2013 for Simple Insurance Company using the Kittel refinement to the classical paid-to-paid method.

- Select a ratio of ULAE to claims 
  \[
  \frac{(2 \times \text{ULAE})}{(\text{CY Paid Claims} + \text{CY Reported Claims})} 
  \]
  - The three-year average ratio is 10% but the ratio is increasing from 8.8% in 2011 to 11.6% in 2013. Select 11%.
- Calculate unpaid ULAE:
  - Unpaid ULAE = selected ULAE ratio \times ((0.5 \times \text{case estimates}) + \text{IBNR})
  - Unpaid ULAE = 0.11 \times ((0.5 \times 900) + 1,000) = 159.50

(d) Explain the major steps in determining unpaid ULAE using a count-based method.

- Estimate counts
- Select an average ULAE per weighted count
- Project unpaid ULAE
8. Learning Objectives:
7. The candidate will understand the nature and application of catastrophe models used to manage risks from natural disasters.

Learning Outcomes:
(7b) Apply catastrophe models to insurance ratemaking, portfolio management, and risk financing.

Sources:

Commentary on Question:
This question is concerned with insurance portfolio management in catastrophe models.

Solution:
(a) Show that the two probabilities that total losses exceed 250 were correctly calculated.

With 3 removed:
- Events 3 (0.002) and 5 (0.001) exceed 250. Total is 0.003.

With 4 removed:
- Events 1 (0.003) and 3 (0.002) exceed 250. Total is 0.005.

(b) Recommend which of the two portfolios should be dropped. Justify your choice.

Commentary on Question:
Candidate can receive credit for either choosing portfolio 3 or 4. Full credit requires justification for the choice. Choosing portfolio 3 because it has the greatest reduction in probability is not sufficient for full credit.

The following is a justification for removing portfolio 4.

- Mean – favors removing 4 as more business is retained.  
  Note: a smaller mean may look better as less is at stake, but SSIC is giving away business in that case.
- Standard deviation – favors removing 3 as variability is reduced.
- Probability – favors removing 3 as probability of high loss is reduced.
- Removing 3 leaves a 900 loss at 0.001; removing 4 leaves a 600 loss at 0.003. The former is more risky.
- The coefficients of variation are 11.86 and 10.89, favors removing 4. The coefficient of variation is a more reliable risk measure than the standard deviation. Removing portfolio 4 removes a key risk yet allows more business to be retained.
8. Continued

(c) Describe each of the following special issues regarding portfolio risk. For each issue, indicate if it is addressed by the analysis performed in part (b) and then support your answer.

(i) Data quality
(ii) Uncertainty modeling
(iii) Impact of correlation

**Commentary on Question:**
*Candidate needs to provide description for each special issue and also for noting how it is addressed.*

(i) Data Quality
   - Definition: Inaccuracies in the inventory component will lead to errors in the loss amount for each event.
   - Addressed? No. The calculations assume the values are accurate.

(ii) Uncertainty modeling
   - Definition: Use the full distribution, not just the mean.
   - Addressed? Yes. The full set of relevant probabilities is used.

(iii) Impact of correlation
   - Definition: Highly correlated portfolios can increase risk and thus strategies must account for correlation.
   - Addressed? Yes. While no correlations are calculated, dependencies are reflected.
9. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5k) Calculate rates for claims-made coverage.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 34.

**Commentary on Question:**
*This question tests the understanding of claims-made ratemaking, and how to calculate the tail factor for a mature claims-made policy.*

**Solution:**
(a) Define retroactive date for policies written on a claims-made basis.

Claims-made coverage is insurance only for events reported during a policy period, subject to a retroactive date.

The retroactive date is the occurrence date after which coverage is in effect for occurrences reported during the term of a claims-made policy.

(b) Give an example of an insurance product for which claims-made coverage is prevalent *and* explain why this type of coverage is appropriate for that type of risk.

Example: Professional liability.
Why appropriate? There can be a significant delay between the occurrence of the claim and its reporting to the insurer.

(c) Compare claims-made and occurrence coverage on the following features:

(i) Cost, given that the underlying frequency and severity are increasing.

(ii) Precision in pricing, given sudden unpredictable changes in trend or reporting pattern.

(iii) Opportunity to earn investment income.
9. Continued

(i) Claims-made would cost less.
(ii) Claims-made would be more precise.
(iii) Claims-made would present less opportunity for investment income.

(d) Explain how coverage gaps can occur for insureds purchasing claims-made coverage by providing two examples.

Commentary on Question:
Any two of the following are acceptable.

- When an insured switches from claims-made with one company to claims made with another, there may be unreported occurrences not covered by either policy.
- When an insured with claims-made coverage switches to occurrence, claims reported after the expiration of the claims-made coverage that occurred before the inception of the occurrence coverage are not covered.
- When an insured with claims-made coverage discontinues coverage, there is no coverage for claims reported after the coverage ends.

(e) Calculate the tail factor for a mature claims-made policy given a pure premium of 1,000 for occurrence coverage, a 10% annual pure premium trend, and a claims reporting pattern of 50%, 30%, 20%.

\[
\begin{array}{c|c|c|c}
\text{Lag} & n & n+1 & n+2 \\
\hline
0 & 500.00 & & \\
1 & 272.73 & 300.00 & \\
2 & 165.29 & 181.82 & 200.00 \\
\end{array}
\]

(i.e. 181.82 = 1,000×0.20÷1.1)

Tail factor for mature claims-made policy:
\[
\frac{300 + 181.82 + 200}{500 + 272.73 + 165.29} = 0.73
\]
10. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

**Commentary on Question:**

*This question tests the mechanics of the Berquist-Sherman adjustments when there have been changes to case reserves and also the understanding of the Berquist-Sherman adjustments needed when there have been changes to case reserves and settlement rates.*

**Solution:**

(a) Calculate the projected ultimate claims using the Berquist-Sherman method for XYZ Insurer.

**Step 1: Calculate adjusted average case estimates**

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Adjusted Average Case Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2011</td>
<td>6,531</td>
</tr>
<tr>
<td>2012</td>
<td>6,857</td>
</tr>
<tr>
<td>2013</td>
<td>7,200</td>
</tr>
</tbody>
</table>

(i.e. 7,200 ÷ 1.05 = 6,857)

**Step 2: Calculate adjusted reported claims**

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Adjusted Reported Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2011</td>
<td>1,981,510</td>
</tr>
<tr>
<td>2012</td>
<td>2,175,680</td>
</tr>
<tr>
<td>2013</td>
<td>2,370,000</td>
</tr>
</tbody>
</table>

(i.e. 2,175,680 = 6,857 × 240 + 530,000)

**Step 3: Calculate development factors**

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12-24</th>
<th>24-36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1.639</td>
<td>1.193</td>
</tr>
<tr>
<td>2012</td>
<td>1.492</td>
<td></td>
</tr>
</tbody>
</table>

(i.e. 1.639 = 3,248,400 ÷ 1,981,510. Bondy method: tail factor = last development factor.)
10. Continued

Step 4: Calculate projected ultimate claims

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Reported Claims</th>
<th>CDF</th>
<th>Projected Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>3,875,800</td>
<td>1.193</td>
<td>4,623,829</td>
</tr>
<tr>
<td>2012</td>
<td>3,245,500</td>
<td>1.423</td>
<td>4,618,347</td>
</tr>
<tr>
<td>2013</td>
<td>2,370,000</td>
<td>2.229</td>
<td>5,282,730</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>14,524,906</td>
</tr>
</tbody>
</table>

(b) Explain how you create the reported claims triangle with the Berquist-Sherman adjustments for changes in both case estimates and settlement rates.

First, determine adjusted open counts:

\[ \text{Adjusted Open Counts} = (\text{Original reported counts}) - (\text{Closed counts adjusted as part of the adjustment for settlement rates}) \]

Second, adjusted reported claims:

\[ \text{Adjusted Reported Claims} = (\text{Adjusted Open Counts}) \times (\text{Adjusted Average Case Estimates}) + (\text{Adjusted Paid Claims}) \]
11. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**


**Commentary on Question:**

The question tests the mechanics of the Cape Cod method of estimating ultimate claims. Candidates also need to understand the key components of the actuarial control cycle and how the actuarial control cycle can be illustrated by the estimation of trend rates used in the reserving and ratemaking processes.

**Solution:**

(a) Estimate the ultimate claims for this line of business using the Cape Cod method.

**Commentary on Question:**

Candidate must use the used-up exposures in determining the pure premium based on adjusted claims to get full credit. Column (8) in the table below only determines the expected claims. Ultimate claims (column 11) are determined by adding the reported claims (column 5) to the expected unreported claims (column 10).

- Cumulative development factors:

<table>
<thead>
<tr>
<th>Development Period</th>
<th>Age-to-Age Development Factor</th>
<th>Age-to-Ultimate Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-24</td>
<td>1.50</td>
<td>2.302</td>
</tr>
<tr>
<td>24-36</td>
<td>1.28</td>
<td>1.534</td>
</tr>
<tr>
<td>36-48</td>
<td>1.13</td>
<td>1.199</td>
</tr>
<tr>
<td>48-60</td>
<td>1.04</td>
<td>1.061</td>
</tr>
<tr>
<td>Tail factor</td>
<td>1.02</td>
<td>1.020</td>
</tr>
</tbody>
</table>

Pure Premium Trend: $1.022 \times 1.045 - 1 = 6.8\%$
11. Continued

Ultimate claims:

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>CDF</th>
<th>Expected % Reported</th>
<th>Earned Exposures</th>
<th>Used-Up Earned Exposures</th>
<th>Reported Claims</th>
<th>Pure Premium Trend @6.8%</th>
<th>Adjusted Reported Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1.19</td>
<td>83.4%</td>
<td>5,580</td>
<td>4,655</td>
<td>702</td>
<td>1.141</td>
<td>801</td>
</tr>
<tr>
<td></td>
<td>1.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td>65.2%</td>
<td>5,670</td>
<td>3,695</td>
<td>545</td>
<td>1.068</td>
<td>582</td>
</tr>
<tr>
<td></td>
<td>2.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>43.4%</td>
<td>5,460</td>
<td>2,372</td>
<td>515</td>
<td>1.000</td>
<td>515</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>10,723</td>
<td>1,762</td>
<td></td>
<td></td>
<td>1,898</td>
</tr>
</tbody>
</table>

(A) Pure Premium based on Adjusted Claims: 177

\[ \text{Total} \times \frac{\text{(7)}}{\text{(4)}} \]

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Expected Claims</th>
<th>Expected % Unreported</th>
<th>Expected Unreported</th>
<th>Projected Ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>866</td>
<td>16.6%</td>
<td>143</td>
<td>845</td>
</tr>
<tr>
<td>2012</td>
<td>940</td>
<td>34.8%</td>
<td>327</td>
<td>872</td>
</tr>
<tr>
<td>2013</td>
<td>966</td>
<td>56.6%</td>
<td>547</td>
<td>1,062</td>
</tr>
<tr>
<td>Total</td>
<td>2,772</td>
<td>1,017</td>
<td>2,779</td>
<td></td>
</tr>
</tbody>
</table>

(b) Identify the three key components of the actuarial control cycle and illustrate with the selection and use of trend rates in reserving and ratemaking.

Three components of the control cycle:
- Define the problem
- Design the solution
- Monitor the results

Actuaries require an estimate of ultimate claims for pricing; but actuaries projecting ultimate claims require an estimate of trend, which is typically derived during the pricing analysis.

The circular nature of these requirements and the information sharing are important aspects of the actuarial control cycle.
12. **Learning Objectives:**
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**
(2d) Identify the various changing conditions that affect the determination of ultimate claims.

**Sources:**

**Commentary on Question:**
*This question tests the understanding of how various methods of estimating ultimate claims are affected by changing conditions.*

**Solution:**
(a) Explain whether you expect the estimate of ultimate claims to understate, overstate or be similar to actual ultimate claims for book of business 1, for the following methods:

(i) The expected method

(ii) The development method on reported claims

(iii) The Bornhuetter Ferguson method on reported claims

**Commentary on Question:**
*Candidates need to state whether the estimate of ultimate claims would understate, overstate or be similar to actual claims, as well as provide the explanation.*

(i) Expected method:
   - Expected to understate claims under this scenario.
   - Reason: This method is responsive to a change in volume but is not responsive to a change in the overall performance of claims.

(ii) Development method:
   - Expect this method would be similar to actual ultimate claims.
   - Reason: The deteriorating claims would be accounted for with the development method.

(iii) Bornhuetter Ferguson method:
   - The projected ultimate claims from the BF method will be understated.
   - Reason: The estimate of ultimate claims = actual observed experience + expected unobserved (“undeveloped”) experience. Therefore, the projected ultimate claims from the BF method will be understated if claims are deteriorating without an explicit increase in the expected claim ratio.
12. Continued

(b) Explain whether you expect the estimate of ultimate claims to understate, overstate or be similar to actual ultimate claims for book of business 2, for the following methods:

(i) The expected method

(ii) The development method on reported claims

(iii) The Bornhuetter Ferguson method on reported claims

Commentary on Question:
Candidate need to state whether the estimate of ultimate claims would understate, overstate or be similar to actual claims, as well as provide the explanation.

(i) Expected method:
   - Expect this method would be similar to actual ultimate claims.
   - Reason: This method is not affected by a change in case estimates.

(ii) Development method:
   - Expect the development method to overstate actual ultimate claims.
   - Reason: A higher proportion of ultimate claims are now reported earlier than in the past, and lower cumulative development factors would be required to project the reported claims to an ultimate basis.

(iii) Bornhuetter Ferguson method:
   - Expect the BF method to overstate actual ultimate claims.
   - Reason: (similar to development method) A higher proportion of ultimate claims are now reported earlier than in the past, and lower cumulative development factors would be required to project the unreported claims.
13. Learning Objectives:
1. The candidate will understand the key considerations for general insurance actuarial analysis.

Learning Outcomes:
(1l) Adjust historical earned premiums to current rate levels.

Sources:

Commentary on Question:
This question tests the fundamental understanding of how to adjust premiums to current rate level.

Solution:
(a) State the key assumption that underlies the parallelogram method.

The key assumption is that exposures are uniformly distributed over time.

(b) Calculate the on-level factor to be used to adjust calendar year 2011 earned premium to current rates.

Figure for 2011:

```
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2011</td>
</tr>
</tbody>
</table>

A = 1.0

B = 1.07

July 1, 2011
+7% change
```
13. Continued

- Area for B = 0.5×0.5×0.05 = 0.125
- Area for A = 1 − 0.125 = 0.875
- Weighted average rate level for 2011 = (1.0×0.875) + (1.07×0.125) = 1.00875
- New discount impact needs to be included in rate level relative value: impact is a decrease in overall premium of 20%×10% = 2%
- Current rate level relative value = 1×1.07×0.98×0.97 = 1.017142
- On-level factor = 1.017142÷1.00875 = 1.00832

(c) Explain how you would recognize a state-mandated change in minimum policy limits in the on-level calculation

For a state-mandated change in minimum policy limits, the average premium would increase or decrease to reflect such a change but there is also the expectation that claims would increase or decrease as well as policyholders would receive more or less coverage. As a result, the change should have no effect on the on-level calculation.
14. Learning Objectives:
   1. The candidate will understand the key considerations for general insurance actuarial analysis.

Learning Outcomes:

(1j) Create a claims development triangle from claims transaction data.

Sources:

Commentary on Question:
This question tests the fundamental understanding of how claims triangles are constructed.

Solution:
Restate the four data triangles to include the transactions from the subsequently provided claim transaction data.

Commentary on Question:
Summarizing the claim data for each claim is helpful in determining the changes necessary to the four data triangles.

Summary of cumulative claim data for Claim #1: Accident Year = 2010, reported in 2010, closed in 2012.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid to date</td>
<td>50</td>
<td>150</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Case estimate</td>
<td>150</td>
<td>60</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reported claims</td>
<td>200</td>
<td>210</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Reported count</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Closed count</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Summary of cumulative claim data for Claim #2: Accident Year = 2010, reported in 2011, closed in 2011.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid to date</td>
<td>0</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Case estimate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reported claims</td>
<td>0</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Reported count</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Closed count</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
14. Continued

Summary of cumulative claim data for Claim #3: Accident Year = 2011, reported in 2012, still open at December 31, 2013.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Dec 31, 2011</th>
<th>Dec 31, 2012</th>
<th>Dec 31, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid to date</td>
<td>0</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Case estimate</td>
<td>0</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Reported claims</td>
<td>0</td>
<td>290</td>
<td>290</td>
</tr>
<tr>
<td>Reported count</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Closed count</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Restated triangles (Note: only accident years 2010 and 2011 have changes):

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Paid Claims</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2,200</td>
<td>4,750</td>
<td>6,780</td>
<td>7,950</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>2,460</td>
<td>5,330</td>
<td>7,590</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>2,370</td>
<td>4,890</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>3,260</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(i.e. 4,750 = 4,510 + 150 + 90)

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Reported Claims</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>7,210</td>
<td>8,810</td>
<td>9,860</td>
<td>10,190</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>8,320</td>
<td>10,630</td>
<td>11,440</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>9,610</td>
<td>11,620</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>9,620</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(i.e. 10,630 = 10,340 + 290)

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Closed Counts</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>22</td>
<td>40</td>
<td>56</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>20</td>
<td>44</td>
<td>62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>25</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Reported Counts</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>77</td>
<td>81</td>
<td>84</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>82</td>
<td>94</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>98</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
15. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

Learning Outcomes:
(4d) Calculate premium trend and apply it to project premiums.

Sources:

Commentary on Question:
This question tests the fundamental trend adjustments to premium.

Solution:
(a) Explain the purpose of premium trend adjustments

The purpose of premium trend adjustments is to adjust premium from historical periods to a future rating period. Adjustments account for inflation-sensitive exposures and changes in mix of business and rating characteristics.

(b) Calculate and select an annual trend due to the shift in policy limits.

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Experience Period</th>
<th>Weighted Average Increased Limits Factor</th>
<th>Annual Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>0.24×0.90 + 0.52×1.00 + 0.24×1.15 = 1.012</td>
<td>0.49%</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>0.22×0.90 + 0.52×1.00 + 0.26×1.15 = 1.017</td>
<td>0.49%</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>0.20×0.90 + 0.52×1.00 + 0.28×1.15 = 1.022</td>
<td>0.49%</td>
</tr>
</tbody>
</table>

Selected trend 0.49%

(c) Calculate the trend factor to be used for 2012 earned premium using the annual trend selected in part (b).

Commentary on Question:
The provided solution interpolates between the two dates. It is also an acceptable solution to interpolate between two trend factors.

Average earned date in experience period = 7/1/2012
Average earned date in forecast period for annual policies = 9/1/2015
Average earned date in forecast period for 6-month policies = 6/1/2015
Average earned date in forecast period:
→ 67% of 9/1/2015 & 33% of 6/1/2015 = 8/1/2015
Trending period in years = 7/1/2012 to 8/1/2015 = 3 + 1/12 = 3.083 years
Premium trend factor = \(1.0049^{3.083} = 1.015\)
16. Learning Objectives:
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

Learning Outcomes:
(5g) Calculate risk classification changes and territorial changes.

Sources:
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 32.

Commentary on Question:
This question tests the candidate’s understanding of classification ratemaking. It requires the candidate to incorporate credibility and also understand the inputs to a minimum bias calculation.

Solution:
(a) Calculate the indicated rating relativities using the pure premium one-way analysis procedure. The indicated relativities should be shown so that the base territory A has no change.

<table>
<thead>
<tr>
<th>Territory</th>
<th>Written Exposures</th>
<th>Trended</th>
<th>Indicated</th>
<th>Ultimate</th>
<th>Counts</th>
<th>Credibility</th>
<th>Complement</th>
<th>PP Relativity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>A</td>
<td>15,200</td>
<td>450.00</td>
<td>0.949</td>
<td>1.200</td>
<td>100.0%</td>
<td>1.000</td>
<td>0.988</td>
<td>0.949</td>
</tr>
<tr>
<td>B</td>
<td>12,400</td>
<td>475.00</td>
<td>1.002</td>
<td>729</td>
<td>90.0%</td>
<td>0.950</td>
<td>0.939</td>
<td>0.996</td>
</tr>
<tr>
<td>C</td>
<td>10,700</td>
<td>507.00</td>
<td>1.070</td>
<td>635</td>
<td>84.0%</td>
<td>1.100</td>
<td>1.087</td>
<td>1.072</td>
</tr>
<tr>
<td>Total</td>
<td>38,300</td>
<td>474.02</td>
<td>1.000</td>
<td>2,564</td>
<td>1.012</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
(4) = (3) / (3)_{Total}  
(6) = \sqrt{900 / (5)}; max of 1.0  
(7)_{Total} = \text{Sum}((2)'(7)' / (2)'_{Total})  
(8) = (7)_{Total} / (7)  
(9) = (4)(6) + \left[ 1-(6) \right](8)  
(10) = (9) / (9)_{A}

(b) Calculate the first set of age-of-home factors using the minimum bias procedure. Use the existing territory relativities as inputs to the calculation.

Commentary on Question:
This part of the question follows the approach outlined in section 32.10.3 of the Friedland text.
16. **Continued**

Total Expected Claims:
Age of Home:
0-15 years: \(7,600 \times 390 + 4,960 \times 400 + 6,420 \times 461 = 7,907,620\)
16+ years: \(7,600 \times 510 + 7,440 \times 525 + 4,280 \times 576 = 10,247,280\)

First iteration of values for Age of Home:
0-15 years: \(\frac{7,907,620}{(7,600 \times 1.00 + 4,960 \times 0.95 + 6,420 \times 1.10) / 474.02} = 0.861\)
16+ years: \(\frac{10,247,280}{(7,600 \times 1.00 + 7,440 \times 0.95 + 4,280 \times 1.10) / 474.02} = 1.116\)

(c) Explain why you expect the rating factors for territory calculated using the one-way procedure to be the same or different than the rating factors for territory calculated using the minimum bias procedure. In your response, give two reasons.

The values are expected to be different between the two procedures. Reasons:
- There is distributional bias (the distribution of age of home in each territory is not the same).
- Credibility is considered in the one-way procedure and is not considered in the minimum bias procedure.
17. **Learning Objectives:**
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**
(2a) Use loss development triangles for investigative testing.

**Sources:**

**Commentary on Question:**
*This question is concerned with identifying potential issues with data triangles and what diagnostic tests can be used on data triangles.*

**Solution:**
(a) State two observations about the pattern of the ratios of paid claims to reported claims in the above table.
   
   - Ratio for the first half of each year is always significantly higher than the second half in the first 6 months development.
   - The ratio for the most recent diagonal is significantly lower.

(b) Explain a possible cause of each observation from part (a).

**Commentary on Question:**
*The observation and possible cause need to be correctly identified. For example, the ratio for the first half of each year always being significantly higher than the second half is the observation. The possible cause of this observation is seasonality.*

   - First half of year ratio higher implies seasonality.
   - Most recent diagonal lower suggests possible reserve strengthening or possibly change in the settlement pattern.

(c) State two other diagnostics you would review to confirm your observations from part (a), and describe the patterns you expect to see for each diagnostic.

**Commentary on Question:**
*Other diagnostics, not provided below, are acceptable. Candidates need to state the diagnostic and then describe the pattern that is expected.*

*Average reported claims:*
In a stable environment, expect values to be relatively consistent at each maturity age, with changes down each column (from accident year to accident year) limited to the rate of trend only.
17. Continued

*Ratios of closed to reported counts:*
Used in conjunction with the ratios of paid to reported claims. Expect a similar pattern to exist between the ratios of closed to reported counts and the ratios of paid to reported claims in a stable environment.

(d) State two examples of actions that could result in shifts in the average reported claims.

**Commentary on Question:**
*Five are provided; any two are acceptable.*

- New procedures for the payment of claims such as direct deposit to a claimant's bank account instead of issuance of checks.
- New philosophies about establishment of case estimates such as explicit consideration of S&S recoveries.
- Changes in the distribution of policy limits purchased by insureds.
- Changes in the use of partial settlements or ex gratia payments.
- Shifts in the attitude toward defense of questionable claim files.
18. **Learning Objectives:**
3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3a) Estimate unpaid unallocated loss adjustment expenses.
(3c) Evaluate the estimates of ultimate claims to determine claim liabilities for financial reporting.
(3d) Describe components of premium liabilities.
(3e) Evaluate premium liabilities.

**Sources:**

**Commentary on Question:**
*This question tests the estimation of unpaid claims, unpaid unallocated loss adjustment expenses and premium liabilities.*

**Solution:**
(a) Calculate total unpaid claims as of December 31, 2013, including unpaid ULAE.

\[
\text{Case estimates } [88,300 - 72,400] = 15,900 \\
\text{Indicated IBNR } [\text{total ultimate - 88,300}] = 13,850 \\
\text{ULAE } [\{8\% \times (2)\} + \{8\% \times 50\% \times (1)\}] = 1,744 \\
\text{Total unpaid claims } [(1) + (2) + (3)] = 31,494
\]

(b) State two points the actuary should consider when selecting claim ratios to be used for calculating premium liabilities.

In selecting claim ratios, the actuary should consider:
- Any recent actions internally at the insurer, such as recent rate changes, and
- Any external factors (such as trend) that could influence the claim experience over the next year.

(c) Calculate the premium liabilities as of December 31, 2013.

**Commentary on Question:**
*Premium liabilities are determined using the expected claims from the unearned premiums and not the unpaid claims determined in part (a).*
18. Continued

First need to selected claim ratio and general expense ratio:

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Claim Ratio</th>
<th>General Expense Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>72.0%</td>
<td>14.50%</td>
</tr>
<tr>
<td>2012</td>
<td>73.0%</td>
<td>14.29%</td>
</tr>
<tr>
<td>2013</td>
<td>71.0%</td>
<td>14.40%</td>
</tr>
<tr>
<td>Total</td>
<td>72.0%</td>
<td>14.40%</td>
</tr>
<tr>
<td>Selected:</td>
<td>72.0%</td>
<td>14.40%</td>
</tr>
</tbody>
</table>

Unearned premiums: 32,600
Expected claim ratio: 72%
Expected claims = 32,600 × 0.72 = 23,472
ULAE ratio: 8.0%
Expected ULAE = 23,472 × 0.08 = 1,878
Total expected claims and LAE = 23,472 + 1,878 = 25,350
Selected maintenance expense ratio = 0.144 × 0.250 = 3.6%
Maintenance expenses = 32,600 × 0.036 = 1,174
Total claims and expenses (Premium Liabilities) = 25,350 + 1,174 = 26,523
Equity in unearned premium = 32,600 – 26,523 = 6,077

(d) Determine either the premium deficiency reserve or the equity in the unearned premium.

Equity in unearned premium = Unearned premium – Premium liabilities
= 32,600 – 26,523 = 6,077
Since it is positive, there is no premium deficiency.
19. **Learning Objectives:**

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

7. The candidate will understand the nature and application of catastrophe models used to manage risks from natural disasters.

**Learning Outcomes:**

(5d) Calculate loadings for catastrophes and large claims.

(7a) Describe the structure of catastrophe models.

**Sources:**


**Commentary on Question:**

This question tests the understanding of the structure of catastrophe models, as well as establishing claim loadings.

**Solution:**

(a) Describe each of the components.

- Hazard module: The module assigns probabilities of an event by location. It also provides a model for the severity and propagation of an event.

- Inventory module: The nature of the buildings in the area as a detailed census. Construction type is the most important characteristic.

- Vulnerability module: Estimates the level of building damage expected for differing severities of event.

(b) Indicate similarities (if any) and differences (if any) between the CommCo and HomeCo implementations of an earthquake model for each component. Justify each of your answers.

- Hazard module:
  - No difference. The events are identical regardless of the insurance coverage.

- Inventory module:
  - Completely different. One is an inventory of homes and the other of businesses.
19. Continued

Vulnerability module:
- There will be similarities as the module is based on construction types and other building characteristics.

(c) Compare the analyses required to establish the claims loading for hurricane and non-hurricane weather claims for HomeCo.

Non-hurricane weather claims loading:
- Analyze historical claims data to estimate loading

Hurricane claims loading:
- Rely on estimates from a catastrophe model (i.e. simulation model).
- Models simulate the event, translate into a damage ratio & damage ratios are applied to current or projected amounts of insurance and produce the expected catastrophe loss estimate.
20. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5i) Calculate rates for large accounts.

**Sources:**

**Commentary on Question:**
*This question tests the understanding of experience rating plans.*

**Solution:**
(a) Define the following forms of general insurance rating:

(i) Manual

(ii) Schedule

(iii) Prospective experience

(iv) Retrospective experience

(i) Manual rating: Deriving a premium solely from multiplying the exposures by the manual rate and any applicable rating factors.

(ii) Schedule rating: A program in which manual rates are adjusted, either upward (debits) or downward (credits), to reflect the insured’s risk characteristics such as its safety program, financial strength, and overall management capabilities. The judgmental rating factors are used to distinguish a specific insured from the average insured in its class using characteristics that are not already recognized in the rating process.

(iii) Prospective experience rating: Rating where the premium depends on historical experience prior to the policy period and a rating formula.

(iv) Retrospective experience rating: Rating where the premium charged in a policy period depends upon the claims experience in the policy period and a rating formula. There is usually a deposit premium with the final premium subject to a minimum and maximum.
20. Continued

(b) Explain why retrospective experience rating is typically not appropriate for insureds with small premium size or poor claims experience.

Commentary on Question:
A brief sentence covering each is sufficient for full credit.

Insureds with small premium size are likely to have variable claims experience and one large loss may result in a maximum premium.

Insureds with poor claims experience will pay greater than average premium and could have losses resulting in a maximum premium.

(c) Determine allocation percentages for Centre and Exurb based on the agreed allocation procedure after the change in claims definition described above, given the additional information below:

<table>
<thead>
<tr>
<th>Pool Participant</th>
<th>Population Estimate</th>
<th>Ultimate Claims (Including ALAE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>435,600</td>
<td>550,000</td>
</tr>
<tr>
<td>Exurb</td>
<td>250,000</td>
<td>700,000</td>
</tr>
<tr>
<td>Total</td>
<td>685,600</td>
<td>1,250,000</td>
</tr>
</tbody>
</table>

Calculate the credibility for both participants:
- Centre: \((435,600/1,000,000)^{0.5}\) = 0.66
- Exurb: \((250,000/1,000,000)^{0.5}\) = 0.50

Calculate the experience modification for each participant using the formula experience modification factor,

\[\text{experience modification factor} = \left(\frac{\% \text{ claims}}{\% \text{ exposure}} \times \text{credibility}\right) \times (1 - \text{credibility})\]

- Centre:
  \[\frac{(550,000 \div 1,250,000)}{(435,600 \div 685,600)} \times 0.66 + 0.34 = 0.797\]
- Exurb:
  \[\frac{(700,000 \div 1,250,000)}{(250,000 \div 685,600)} \times 0.50 + 0.50 = 1.268\]

Calculate the percentage allocated claims for Centre using the formula,

\[\text{percentage allocated claims} = \left(\frac{\text{experience mod Centre} \times \% \text{ exposure Centre}}{((\text{Experience mod Centre} \times \% \text{ exposure Centre}) + (\text{Experience mod Exurb} \times \% \text{ Exposure Exurb}))}\right)\]

- Centre:
  \[\frac{0.797 \times 0.635}{(0.797 \times 0.635) + (1.268 \times 0.365)} = 52.2\%\]
20. **Continued**

Calculate the allocation for Exurb by subtracting the portion for Centre from 100%:

- Exurb: $100% - 52.2\% = 47.8\%$

(d) Explain the importance of understanding the distribution of ALAE in the allocation of retained claims and expenses to participants in self-insurance pools.

The distribution of ALAE for participants may be different from the distribution of claims excluding ALAE. Thus, the calculated experience modification factors can be different depending on the treatment of ALAE in the definition of claims.
21. **Learning Objectives:**

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(5b) Calculate expenses used in ratemaking analyses.

(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

**Sources:**


**Commentary on Question:**

*This question tests the allocation of fixed and variable expenses and the calculation of overall rate indications. The candidate needs to be able to explain the importance of recognizing the appropriate split of fixed and variable expenses.*

**Solution:**

(a) Explain the importance of recognizing the appropriate split between fixed and variable expenses in ratemaking.

**Commentary on Question:**

*Any of the following points are acceptable.*

- U.S. Standards specifically require actuaries to consider whether expenses should be split into fixed and variable components.
- Rates based solely on variable expenses can lead to inadequate expense provisions for those insureds with a relatively low premium and excessive provisions for those insureds with an exceptionally high premium.
- On an aggregate basis, using an all-variable expense approach will cause the fixed expense provision to be overstated/(understated) when the pricing indicates an increase/(decrease) in the rates.

(b) Calculate the indicated rate under the initial assumption for the split of general and other acquisition expenses.

Initial indicated rate:

\[
\frac{350 \times 1.09 + 100}{1 - 0.16 - 0.06 - 0.05} = 659.59
\]

(c) Calculate the revised fixed and variable general and other acquisition expenses.
21. Continued

Variable portion of general & other acquisition (initial) = 6% of premium = 0.06 × 125,000,000 = 7,500,000
Variable was initially assumed to be 1/3 of total general & other acquisition, therefore total general & other acquisition = 3×7,500,000 = 22,500,000

Revised split: variable = 2/3, fixed = 1/3:
Variable = 2 × previous = 12%
Fixed = \(\frac{22,500,000 \times \frac{1}{3}}{250,000}\) = 30 per exposure

(d) Calculate the revised rate indication using the revised fixed and variable general and other acquisition expenses in part (c).

**Commentary on Question:**
*Candidate needs to recognize that the initial total fixed expense per exposure (100) includes fixed expenses other than general and other acquisition expenses, in this case, 40 = 100 – 60.*

Original fixed general & other acquisition expense = 30 × 2 = 60 per exposure
Revised total fixed expense = 30 + (100 – 60) = 70 per exposure
Revised indicated rate = \(\frac{350 \times 1.09 + 70}{1 - 0.16 - 0.12 - 0.05}\) = 673.88
22. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

Learning Outcomes:
(4b) Calculate loss trend and apply it to project ultimate claims.

Sources:

Commentary on Question:
*This question tests the claim trend calculation and how portfolio changes can affect both frequency and severity.*

Solution:
(a) Explain how portfolio changes in policy deductibles can affect both frequency and severity.

Frequency: Shifts in a portfolio toward higher deductibles will tend to decrease frequency, and shifts in a portfolio toward lower deductibles will tend to increase frequency.

Severity: There is no fixed relationship between the level of deductible and the severity.

(b) Describe two options to consider when experience is not fully credible for trending.

*Commentary on Question:*
*Three are provided. Any two are acceptable.*

- Rely on industry data for a similar line of business in a similar jurisdiction.
- Combine the insurer’s experience in specific states or provinces with the experience of a larger region.
- Combine the insurer’s experience with that of other insurers in a group under common ownership.

(c) Calculate the pure premium trend factors for each year in the experience period.

Pure premium trend = \((1 - .012)(1 + .058) - 1\) = 4.53%.
Average accident dates for experience period: average accident date for each accident year, or July 1 each year.
Average accident date for forecast period: average accident date for policies written between June 1, 2014 and May 31, 2015 = March 1, 2015.
22. Continued

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Experience Period</th>
<th>Forecast Period</th>
<th>Trending Period in Months</th>
<th>PP Trend Factor @ 4.53%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>7/1/2012</td>
<td>3/1/2015</td>
<td>32</td>
<td>1.125</td>
</tr>
<tr>
<td>2013</td>
<td>7/1/2013</td>
<td>3/1/2015</td>
<td>20</td>
<td>1.077</td>
</tr>
</tbody>
</table>

i.e., $1.0453^{32/12} = 1.125$

(d) Explain how the trend factors calculated in part (c) would be calculated if you are pricing a single large policy that renews on June 1, 2014 for a two-year term.

Since this is only one policy, the average accident date for the forecast period is the average of the period that runs from June 1, 2014 through May 31, 2016, or June 1, 2015. The average accident dates for the experience period are unchanged. The resulting trending periods in months will be 35 and 23, for 2012 and 2013, respectively.
1. **Learning Objectives:**
   1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**
(1a) Understand and apply the concepts of insurance accounting.

**Sources:**

NAIC Statement of Statutory Accounting Principles 3, “Accounting Changes and Corrections of Errors”

**Solution:**
(a) Describe the difference between cash accounting and accrual accounting.

   In cash accounting, income is recognized when cash is received, expenses are recognized when they are paid. In accrual accounting, income is shifted to better match earning patterns. Expenses can be shifted to reflect the income. Premium revenue is accrued, unearned premiums are deducted from written premium to form earned premium, which is revenue for earnings measurement. Losses are recognized when they are incurred, not when they are paid.

(b) Define the following accounting concepts and describe how they should be disclosed in statutory financial statements:

   (i) Change in accounting principle

   (ii) Change in accounting estimate
1. Continued

(i) A change in accounting principle results from the adoption of an accepted accounting principle, or method of applying the principle, which differs from the principles or methods previously used for reporting purposes. The cumulative effect of changes in accounting principles shall be reported as adjustments to surplus in the period of the change. The cumulative effect is the difference between the amount of capital and surplus at the beginning of the year and the amount of capital and surplus that would have been reported at that date if the new accounting principle had been applied retroactively for all prior periods.

(ii) Changes in accounting estimates are necessary consequences of periodic presentations of financial statements that require estimating the effects of future events. Accounting estimates change as new events occur, as more experience is acquired, or as additional information is obtained. A change in accounting estimate shall be included in the statement of income in the period when the change becomes known.

If the effect of a change in accounting principle is inseparable from the effect of a change in accounting estimate, then the change shall be considered as a change in accounting estimate for purposes of applying the accounting principles.

(c) Describe the Deferred Policy Acquisition Cost (DPAC) asset under GAAP.

GAAP capitalizes a DPAC asset at policy inception to represent the underwriting and acquisition expenses paid at policy inception and amortizes it over the policy term as the premiums are earned.

(d) Calculate the DPAC as of the following dates under both statutory accounting and IFRS 4:

(i) August 1, 2013

(ii) October 1, 2013

(iii) December 1, 2013
1. Continued

Deferred expenses are 0 under Statutory Accounting at all times.

While not specifically referred to as DPAC in IFRS 4, expenses in IFRS 4 are linked to the loss incurral pattern creating deferred expenses (i.e., DPAC).

(i) Aug. 1, 2013: 0% of the expenses are written off, deferred expenses = 1,200
(ii) Oct. 1, 2013: 50% of the expenses are written off, deferred expenses = 600
(iii) Dec. 1, 2013: 100% of the expenses are written off, deferred expenses = 0
2. **Learning Objectives:**
   1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**
(1e) Understand and apply the concepts of reinsurance accounting.

**Sources:**
General Insurance Financial Reporting Topics, Society of Actuaries, Part 5 (Accounting for Reinsurance Contracts)

Brehm, P. and Ruhm, D., “Risk Transfer Testing of Reinsurance Contracts”

**Solution:**
(a) Explain why the “10% - 10% rule” is not considered appropriate for determining the existence of sufficient risk transfer.

The rule does not take into account a high loss amount offsetting a low probability of loss. Certain reinsurance contracts that most clearly transfer risk do not satisfy the 10% probability of loss. Examples of such contracts are catastrophe covers and higher layer excess-of-loss treaties. The 10% - 10% rule is no longer a preferred approach by either regulators or the actuarial community to measure risk transfer.

(b) Describe the ERD method for measuring risk transfer.

The ERD measure is derived from the probability distribution of net economic outcomes. ERD = \( p \frac{T}{P} \) where \( p \) = probability of net income loss; \( T \) = average severity of net economic loss, when it occurs; and \( P \) = expected premium.

The critical point in the distribution is economic breakeven, where net gain is exactly zero. The part of the distribution below breakeven, where net economic loss occurs, is the risk zone.

(c) Calculate the ERD.

<table>
<thead>
<tr>
<th>Reinsured loss</th>
<th>Probability</th>
<th>Net gain/loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>94%</td>
<td>16M</td>
</tr>
<tr>
<td>100M</td>
<td>3%</td>
<td>( 16M - 100M/1.03 ) = (-81.1M)</td>
</tr>
<tr>
<td>250M</td>
<td>2%</td>
<td>( 16M - 250M/1.03 ) = (-226.7M)</td>
</tr>
<tr>
<td>500M</td>
<td>1%</td>
<td>( 16M - 500M/1.03 ) = (-469.4M)</td>
</tr>
</tbody>
</table>

\[ p = 3\% + 2\% + 1\% = 6\%, \quad P = 16 \]

\[ T = (81.1M \times 3\% + 226.7M \times 2\% + 469.4M \times 1\%)/6\% = 194.4M \]

\[ \rightarrow \text{ERD} = 6\% \times 194.4/16 = 72.9\% \]
3. **Learning Objectives:**

2. The candidate will understand the analysis of a general insurer’s financial health through prescribed formulas, ratios and other solvency regulation methods.

**Learning Outcomes:**

(2b) Understand and apply the elements of the NAIC RBC formula.

(2h) Compare different solvency standards.

(2i) Discuss the function of credit rating agencies and their impact on general insurers.

**Sources:**

General Insurance Financial Reporting Topics, Society of Actuaries, Part 12 (Solvency Monitoring) and Part 13 (General Insurance Financial Ratings)

**Solution:**

(a) Describe a benefit that rating agencies provide to insurance company policyholders.

Policyholders depend on the financial strength of insurers to fulfill long-term promises, but lack the expertise, resources, and time to examine insurers themselves. Rating agencies hire financial analysts, actuaries, and economists to assess the financial strength of insurers.

(b) Explain why an insurance company may want to receive a rating from more than one rating agency.

**Commentary on Question:**

*Three reasons are shown in the model solution. Only two are required for full credit.*

- The insurer may want to issue debt through a holding company and seeks a rating from an agency with more experience in debt ratings.
- The insurer may be publicly traded and wants a rating from an agency better known to investors.
- The insurer may be dissatisfied with its current rating and believes the second rating will be higher.
3. **Continued**

(c) Identify two differences between the BCAR formula for net required capital and the RBC formula.

**Commentary on Question:**
*Many differences exist. Five differences are shown in the model solution. Only two differences are required for full credit.*

- NAIC RBC formula uses a “worst case” year over a limited time frame as the measure to calibrate reserving and new business risks (roughly a 87.5% VaR). BCAR uses a 1% EPD measure (for all risks).
- NAIC RBC has a conditional rule for moving half of credit risk into reserving risk. BCAR always splits the credit risk charge.
- NAIC RBC does not include interest rate risk. BCAR includes it.
- BCAR adjusts written premium (WP) and reserving risk for age and size of insurer. NAIC RBC does not.
- BCAR includes a reserve deficiency factor in the reserving risk charge. NAIC RBC does not.

(d) Calculate CCI’s 2013 RBC written premium risk charge.

Company adjustment (Cadj) by line = (co. average/industry average)
PL: 0.80/0.70 = 1.1429 and
AL: 0.85/0.75 = 1.1333

Company adjusted RBC adverse scenario L&LAE by line (CadjA)
PL: 1.05 × (1 + 1.1429)/2 = 1.125
AL: 0.90 × (1 + 1.1333)/2 = 0.96

Basic WP RBC Charge (BWC)
= (CadjA × investment income factor + co. expense – 1.0) × WP
PL: (1.125 × 0.9 + 0.2 – 1) × 12M = 2.55M
AL: (0.96 × 0.95 + 0.2 – 1) × 4M = 0.45M
Total BWC = 2.55 + 0.45 = 3.0M

Premium Concentration Factor (PCF)
= 0.7 + 0.3 × (WP from largest lob/total WP)
PCF = 0.925 (= 0.7 + 0.3 × (12/16))

WP RBC Charge before XS Growth Charge = BWC × PCF = 3.0 × 0.925 = 2.77M
3. Continued

XS Growth rate by LOB (4 year average growth xs 10%) = XSG
PL: Average(10/10, 10/10, 12/10) – 1 = 6.7% → XSG = 0%
AL: Average(4/2.5, 4/4, 4/4) – 1 = 20% → XSG = 10%

XSG Charge = 22.5% × NWP × XSG
PL: 0 and
AL: 22.5% × 4 × 10% = 0.09M

WP RBC Charge = WP RBC Charge before XS Growth + XSG Charge
= 2.77 + 0.09 = 2.86M

(e) Calculate CCI’s 2013 RBC ratio.

\[ RBC = R0 + (R1^2 + R2^2 + R3^2 + R4^2 + R5^2)^{0.5} \]
\[ = 0 + (0.1^2 + 0.5^2 + 0^2 + 10^2 + 2.86^2)^{0.5} = 10.4M \]

ACL = RBC/2 = 5.2M

RBC Ratio = Total Adjusted Capital/ACL = 6/5.2 = 115.4%

(f) Identify the action level indicated by the RBC ratio calculated in part (e) and specify any actions that are required of CCI and the regulator.

Since RBC ratio is between 100% and 150% it is the Regulatory Action Level.

Action by Company:
Must submit a plan to the insurance commissioner of the domiciliary state.

Plan must explain how the company will obtain capital or reduce operations/risk exposure to meet RBC standards.

Action by Regulator:
Commissioner has the right to take corrective actions against the company (e.g., new business restrictions). Action is discretionary.
4. Learning Objectives:
5. The candidate will be able to understand tort law and insurance law with respect to its impact on the general insurance industry.

Learning Outcomes:
(5a) Describe and interpret the key elements of tort law and the underlying principles of insurance law.

(5d) Understand mass torts/class action suits and discuss their impact on the general insurance industry.

(5e) Describe and interpret legal cases/issues from *Important Legal Cases with Respect to the U.S. General Insurance Industry*.

Sources:
Excerpts from Business Law for Insurance Professionals, Institutes Custom Publishing, Assignment 1 (Contract Law: Insurance Applications) and Assignment 2 (Tort Law)


Rose, B. and Falletta, C., “Wyeth v. Levine: Where Do We Go From Here?”

Solution:
(a) Define *contract of adhesion*.

A contract of adhesion is one in which one party must either accept the agreement as written by the other party or reject it.

(b) Explain how an interpretation of the policy as a premises liability policy may lead to increased payments by the insurer.

In a premises liability situation, each claim is entitled to compensation, regardless of how many such claims there are. There is no aggregate limit.

(c) Explain how interpreting the policy as a *contract of adhesion* may lead to such an interpretation.

Contracts of adhesion are generally interpreted as being favorable to the insured. Because the insured must take or leave the policy terms, any ambiguities are resolved in favor of the insured.
4. Continued

(d) Identify three major differences between asbestos and other mass torts that have led to significant asbestos claims.

**Commentary on Question:**
*There exist a number of major differences. Four differences are shown in the model solution. Only three differences are required for full credit.*

- The number of defendants is much larger in asbestos.
- Exposure may be to several sources and thus multiple defendants may be at fault in a single case.
- Cases proceed even if there has been no impairment.
- Multiple insurance companies may be declared to have covered a single claimant’s case.

(e) One possible defense against a products liability lawsuit is compliance with statutes and regulations. Describe this defense.

A manufacturer could claim that because its product complied with statutes and regulations it must be appropriate for use.

(f) Describe the situation in the case Wyeth v. Levine, state the ruling and provide the reasoning for that ruling.

Situation: A drug carried a risk that it might be injected into an artery rather than a vein. The label warned against this possibility but the plaintiff claimed that there was insufficient warning of the risks of such injection. Wyeth claimed that the label was mandated by the FDA and could not be altered and that a jury should not be able to overrule the FDA’s expert judgment.

Ruling: The Court found for the plaintiff.

Reasoning: Under FDA rules, the label could have been strengthened without formal approval. There was no clear evidence that the FDA would have objected. The Court also ruled that Congress did not intend the FDA to be the exclusive means of ensuring drug safety.
5. Learning Objectives:
4. The candidate will be able to describe the current and historical regulatory environment.

Learning Outcomes:
(4b) Describe and interpret the current state of general insurance regulation in the U.S. and its development.

(4d) Discuss market conduct regulation.

Sources:
Insurance Regulation, The Institutes, Chapter 2 (Development of Insurance Regulation) and Chapter 7 (Underwriting Regulation)

Edmunds, T., “Insurance and the discrimination laws: motor and travel insurance”

Solution:
(a) Identify the type of organization that the South-Eastern Underwriters Association (SEUA) was and describe its market conduct that led to the landmark SEUA decision in 1944.

SEUA was a rating bureau (or compact). It set premiums and commissions and actively enforced its terms with regard to member and nonmember insurers.

(b) Define fair discrimination in an insurance context and provide an example.

Commentary on Question:
Many different examples are possible. One example is provided in the model solution as a guide to a full credit response.

Fair discrimination is applying different standards and prices to insureds based on differences in loss potential.

An example of fair discrimination is charging more for a personal liability policy where the insured has a swimming pool relative to a policy where there is no pool, all other factors being the same. The discrimination is fair because an insured having a pool adds more potential for serious accidents, which leads to a higher probability of liability and thus higher insured costs.
(c) The European Court of Justice has banned the use of gender in pricing insurance products in the European Union. Critique this decision and provide a concurring or dissenting opinion.

**Commentary on Question:**
*Widely varying responses are possible for full credit. Grading of this type of question takes into account how clearly the information is presented in the response as well as the content of the response. The response should be in the form of a concurring or dissenting opinion, not simply a listing of the arguments on both sides. Two model solutions are shown as examples of full credit responses.*

*Sample solution 1 (concurring opinion):*
The ECJ, in its decision to ban the use of gender in pricing insurance products in the EU, strengthens the notion of social equity by making insurers subject to the Equality Act. Society generally does not allow discrimination by gender. Insurers should not have an exemption from following discrimination laws.

Insurers may argue from the point of view of actuarial equity noting the existence of cost differences by gender for certain insurance products. But this is not a sufficient reason to allow discrimination. If insurers could prove a cost difference between races or religious backgrounds, it would still be both legally and socially unacceptable for insurers to discriminate on this basis. Discrimination by gender is not socially acceptable and against discrimination laws.

*Sample solution 2 (dissenting opinion):*
The ECJ, in its decision to ban the use of gender in pricing insurance products in the EU, strengthens the notion of social equity by making insurers subject to the Equality Act. Insurers had historically been given some exemptions from the Equality Act. Many in society are willing to permit discrimination by gender in insurance pricing when it represents fair discrimination, reflecting true cost differences, i.e., actuarial equity.

The ECJ ruling will, on average, increase insurance costs. Insurance pricing that reflects actual price differences by gender creates more accurate rating. Less accurate rating is riskier and invites adverse selection; insurers will require more capital to support the increased risk and require a greater return, thereby increasing rates. Insurers will also need to invest in new rating variables to replace gender so rates reflect costs as much as possible.
5. Continued

(d) Recommend two responses that an automobile insurer in the European Union should consider in response to the European Court of Justice ban on the use of gender in insurance pricing.

Commentary on Question:
Many different responses are possible. Three responses are provided in the model solution. Only two are required for full credit.

- Introduce factors into risk classification structure to substitute for predictive value of gender
- Target marketing toward women
- Move toward usage-based insurance

(e) Identify two aspects of an insurer’s operations, other than potential unfair discrimination in rating or underwriting, that may be within the scope of an examination.

Commentary on Question:
Many aspects are within the scope of an examination. Three are provided in the model solution. Only two are required for full credit.

- Certificate of authority
- Internal audit program
- Computer systems
6. Learning Objectives:
1. The candidate will understand the elements of financial reporting for general insurance companies.

Learning Outcomes:
(1h) Estimate the premium asset for retrospectively rated polices for financial reporting.

Sources:

Solution:
(a) Explain why premium booked through 42 months should or should not be used to calculate the results of third retro adjustments.

Premium booked through 42 months should not be used. It takes time to do the retro calculation and record adjusted premiums, so there is a time lag between the recording of losses and the recording of premiums.

(b) Explain why the first PDLD ratio is generally greater than unity and why the PDLD ratios tend to decrease with later adjustments.

The basic premium is included in the first retro premium computation and the loss conversion factor and tax multiplier are applied to the loss. As time goes on, more of the loss is limited by the retro maximum or per accident limitation.

(c) Calculate the premium asset on retrospectively rated policies as of December 31, 2013 arising from policy years 2010, 2011 and 2012.

1\textsuperscript{st} CPDLD ratio = \( \frac{50\% \times 1.75 + 30\% \times 0.75 + 20\% \times 0.50}{50\% + 30\% + 20\%} \)
\quad = 1.20

2\textsuperscript{nd} CPDLD ratio = \( \frac{30\% \times 0.75 + 20\% \times 0.50}{30\% + 20\%} \)
\quad = 0.65

3\textsuperscript{rd} CPDLD ratio = \( \frac{20\% \times 0.50}{20\%} \)
\quad = 0.50

2010 Premium Asset = 0.50 \times 20,000 = 10,000
2011 Premium Asset = 0.65 \times 50,000 = 32,500
2012 Premium Asset = 1.20 \times 100,000 = 120,000 – 122,500 = –2,500
Total Premium Asset = 10,000 + 32,500 – 2,500 = 40,000
7. Learning Objectives:
3. The candidate will be able to apply the standards of practice regarding the responsibilities of the actuary as defined by regulators and the American Academy of Actuaries.

Learning Outcomes:
(3a) Describe, interpret and apply the applicable Standards of Practice.

(3d) Describe and apply the concept of materiality.

Sources:
Actuarial Standard of Practice
• No. 41, Actuarial Communications
• No. 43, Property/Casualty Unpaid Claim Estimates

American Academy of Actuaries, “Materiality, Concepts on Professionalism”

Solution:
Describe the issues raised by this scenario. Include references to:

(i) Materiality

(ii) Actuarial Standard of Practice No. 41, Actuarial Communications

Commentary on Question:
Widely varying responses are possible for full credit. Grading of this type of question takes into account how clearly the information is presented in the response as well as the content of the response.

The response should address several issues raised by the scenario, either directly or indirectly, that would be of concern to the consulting actuary. It should demonstrate familiarity with the AAA discussion paper on materiality and ASOP 41 as they relate to these issues.

No credit is given for statements made without any reference to the scenario presented. Three paragraphs are sufficient for full credit. The model solution shown is just one example of the style and content that represents a full credit response. A full credit response may contain less information than what is shown in this model solution.
7. **Continued**

In any actuarial assignment, the actuary must consider the principal and the intended users of the work. This is noted in both ASOP 41 and ASOP 43. For my assignment to peer review CLIC’s unpaid claim estimates, the principal is CLIC. However, intended users of the assignment can include the insurance supervisor, the SEC and investors, especially with the possibility of a takeover. This must be taken into account when the materiality standard is selected. Since the difference between the estimates from the two methods is significant, it should be considered a material difference.

My peer review assignment was constrained by time. ASOP 41 does allow standards to be followed to the extent reasonably possible within constraints such as time. This would suggest that there is some allowable relaxation in the application of all applicable standards. However, ASOP 41 notes that this may not be appropriate if the findings may receive broad distribution. There is certainly the possibility that this peer review may receive broad distribution with a potential takeover so care should be taken to strictly follow all applicable ASOPs. Furthermore, all recorded communications must be considered to be discoverable in legal proceedings. With the possibility of a takeover, great care must be taken to ensure that there is full compliance with all applicable ASOPs.

As per ASOP 41, my findings must contain a disclosure that there was a constraint on time and a reliance on the results of one method being supplied by another source (the principal of the assignment). ASOP 43 requires the following:

- Consideration of the use of multiple methods
- Consideration of the appropriateness of the chosen methods

Given the material difference in estimates between the method selected and the chain ladder method, and the fact that the chain ladder approach had been relied upon in the past, my findings should consider the reasons for the difference between the methods and attempt to ascertain which is more appropriate. My peer review finding also concludes that that the chief actuary at CLIC, subject to the ASOPs, should not make a significant change in methodology with a material effect on the estimates without disclosing the change and the appropriateness of the change in the report of CLIC’s unpaid claims.
8. **Learning Objectives:**
   1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**

(1f) Understand and apply the elements of discounting for general insurance loss reserves.

(1g) Demonstrate knowledge of taxation for general insurers in the U.S.

**Sources:**

**Solution:**

(a) Calculate the tax basis average reserve discount factor for the loss and loss adjustment expense reserve as of Dec. 31, 2013.

For accident year (AY) 2012, use a 2.5% discount rate as it is fixed for the AY.

As of year end (YE) 2013 these reserves are entering the second year following the year of occurrence. According to the payment pattern they should all be paid off in 2014. Therefore the AY 2012 discount factor at YE 2013 is \((1.025)^{-0.5} = 0.9877\).

For AY 2013, use a 4% discount rate. As of YE 2013 these reserves are entering the first year following the year of occurrence. Payment pattern has 50% being paid off after the year of occurrence in the pattern \((30\% \text{ then } 20\%)\). AY 2013 discount factor at YE 2013 is \([(1.04)^{-0.5} \times (30%/50%) + (1.04)^{-1.5} \times (20%/50%) = 0.9655\).

For reserves at 12/31/2013, the tax basis average reserve discount factor is \((3.4 \times 0.9655 + 1.2 \times 0.9877)/4.6 = 0.9713\).

(b) Calculate regular taxable income for NIC in 2013.

Taxable investment income is the sum of:
- taxable interest income = 400,000
- the prorated portion of tax exempt interest income = 15\% \times 600,000 = 90,000
- the taxable portion of dividends received = 30\% \times 200,000 = 60,000
- the prorated portion of the DRD = 15\% \times (200,000 – 60,000) = 21,000
- realized capital gains = 100,000

Taxable investment income = 671,000 (= 400,000 + 90,000 + 60,000 + 21,000 + 100,000)
8. Continued

Taxable UW income equals statutory UW income plus 20% of the change in the UEPR plus the change in the loss reserve discount.
- statutory UW income is given = $-400,000
- unearned premium reserve change is $200,000, of which 20% is $40,000.
- reserve discount is $4M \times (1 - 98\%) = 80,000 at Dec. 31, 2012 and $4.6M \times (1 - 97.13\%) = 132,000 at Dec. 31, 2013 → a change of $132,000 - 80,000 = $52,000.

Taxable UW Income = $-400,000 + 40,000 + 52,000 = $-308,000

Regular Taxable Income = taxable UW Income + taxable investment income
= $-308,000 + 671,000
= 363,000

(c) General insurers tend to include a greater proportion of municipal bonds in their investment portfolios than other investors. Explain the rationale for this.

Commentary on Question:
Widely varying responses are possible for full credit as there are a number of reasons for this.

General insurers have far higher ratios of after-tax to pre-tax cash flows than other financial sector companies, with incentives to invest in tax-exempt securities such as municipal bonds.
9. **Learning Objectives:**
   1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**

(1e) Understand and apply the concepts of reinsurance accounting.

**Sources:**

General Insurance Financial Reporting Topics, Society of Actuaries, Part 5 (Accounting for Reinsurance Contracts)

NAIC Statement of Statutory Accounting Principles 62 Revised, “Property and Casualty Reinsurance”

**Solution:**

(a) Determine the likely range of values that AA should be willing to accept for the loss commutation.

If AA settled first, the expected recovery is $50\% \times 0 + 50\% \times 60 = 30$, which is the fair value (FV) for the claim.

If AA settled second, there are two possibilities, depending on the BB settlement:

- 50% BB settles for 0, reinsurer has assets of 100 → expected recovery for AA is $50\% \times 0 + 50\% \times 60 = 30$
- 50% BB settles for 60, reinsurer has assets of 40 → expected recovery for AA is $50\% \times 0 + 50\% \times 40 = 20$
- Average is 25

Expected recoverable amount is $50\% \times 30 + 50\% \times 25 = 27.5$ (assuming AA and BB have equal probability of settling first)

Range is expected recoverable amount to FV → 27.5 to 30

(b) Determine the likely range of values that AA should be willing to accept for the loss commutation if:

- AA now believes that its ceded claim has a 30% probability of a zero loss payment and a 70% probability of a 60 million loss payment.
- AA continues to believe BB’s ceded claim has a 50% probability of a zero loss payment and a 50% probability of a 60 million loss payment.
9. Continued

If AA settled first, the expected recovery is $30\% \times 0 + 70\% \times 60 = 42$, the FV.
If AA settled second, there are two possibilities, depending on the BB settlement:
- 50% BB settles for 0, reinsurer has assets of 100
  → expected recovery for AA is $30\% \times 0 + 70\% \times 60 = 42$
- 50% BB settles for 60, reinsurer has assets of 40
  → expected recovery for AA is $30\% \times 0 + 70\% \times 40 = 28$
- Average is 35

Expected recoverable amount is $50\% \times 42 + 50\% \times 35 = 38.5$ (assuming AA and BB have equal probability of settling first)
Range is expected recoverable amount to FV → 38.5 to 42

(c) Explain the merits of AA being the first to commute in the scenario described in part (b) versus waiting for either claim to settle first before making a decision.

Commentary on Question:
*Widely varying responses are possible for full credit. The following is an example of a full credit response.*

Commuting first leaves less to chance, but any benefit is dependent on AA’s negotiating skills. If AA can get close to fair value, it should commute first. If the reinsurer won’t commute above 35, it should wait. By waiting, it may get full recovery at 60 if BB’s claim is zero. Also, if AA waits, BB may commute at 30 leaving enough assets for full recovery of AA’s claim.

(d) Describe the statutory accounting treatment of the commutation transaction for the cedent, making reference to the effect on assets and income.

The ceding entity immediately eliminates the reinsurance recoverable recorded against the ultimate loss reserve and records the cash received as a negative paid loss. Any net gain or loss shall be reported in underwriting income in the statement of income.

Committed balances shall be written off through the accounts, exhibits, and schedules in which they were originally recorded.
10. **Learning Objectives:**
   2. The candidate will understand the analysis of a general insurer’s financial health through prescribed formulas, ratios and other solvency regulation methods.

**Learning Outcomes:**
(2e) Understand the development and principles of solvency regulation, including that in the U.S., Canada and the E.U.
(2f) Demonstrate knowledge of the E.U. Solvency II standard formula solvency capital requirement.
(2h) Compare different solvency standards.

**Sources:**
General Insurance Financial Reporting Topics, Society of Actuaries, Part 12 (Solvency Monitoring)

Vaughan, T., “The Implications of Solvency II for U.S. Insurance Regulation”

**Solution:**
(a) Identify the implicit risk margins for reserving risk and written premium risk used in statutory accounting in the U.S.

   For reserving risk: Implicit margin is the use of undiscounted loss reserves where the margin is the difference between undiscounted and fair value discounted.

   For written premium risk: Gross unearned premium reserves are shown as a liability. Prepaid acquisition costs are an implicit margin.

(b) Describe one advantage and one disadvantage of using implicit risk margins in statutory accounting.

**Commentary on Question:**
_The following represents a full credit response. Other advantages and disadvantages exist._

Advantage: Implicit margins provide the legal authority for insurance supervisors to intervene before an insurer’s market value falls below the flat minimum.

Disadvantage: Implicit margins are not transparent. The insurance supervisor may not know the total actual margin for the insurer.
10. Continued

(c) Identify and describe these tests including any applicability to Solvency II.

Statistical Quality Test:
- Must have high quality data, reasonable assumptions and accurate parameters.
- For Solvency II, actuaries, statisticians, and economists spent years gathering data, selecting distributions, and estimating parameters.

Calibration Test:
- An internal capital model allows the insurer to substitute its own model, not to replace the solvency goal.
- For Solvency II, the model must be calibrated to a 99.5% VaR.

Use Test:
- Internal capital models encourage the insurer to identify, assess, and manage its risks.
- The Solvency II use test requires the insurer to ensure that the internal model, its methodologies, and results are embedded in the risk strategy and operational processes of the insurer.

(d) Describe two differences between Solvency II and U.S. financial regulation with respect to the use of internal capital models.

Commentary on Question:

_Many differences exist. Three differences are shown in the model solution. Only two are required for full credit_

- The U.S. is introducing internal models in an incremental way and maintaining a number of controls as they are introduced. In contrast, Solvency II encourages internal models for the entire framework.
- In the U.S., regulators have largely relied upon the company’s actuaries to attest to the appropriateness of the models and their results. There has been discussion held to examine creation of a centralized review office for internal models. In Solvency II, supervisors will review internal models before granting permission to use the models.
- In the U.S., internal models are generally used to address a risk not well-captured in the factor-based formula. Solvency II considers internal models superior and encourages their use for all risks.
11. **Learning Objectives:**

2. The candidate will understand the analysis of a general insurer’s financial health through prescribed formulas, ratios and other solvency regulation methods.

**Learning Outcomes:**

(2e) Understand the development and principles of solvency regulation, including that in the U.S., Canada and the E.U.

(2g) Demonstrate knowledge of ORSA and its implementations.

(2h) Compare different solvency standards.

**Sources:**

NAIC

- “The United States Insurance Financial Solvency Framework”
- “NAIC Own Risk and Solvency Assessment (ORSA) Guidance Manual”

General Insurance Financial Reporting Topics, Society of Actuaries, Part 12 (Solvency Monitoring)

Vaughan, T., “The Implications of Solvency II for U.S. Insurance Regulation”

**Solution:**

(a) Compare the following Core Principles, including the purpose of the assessment, the type of information assessed, and the frequency of the assessment:

(i) Off-site Monitoring and Analysis

(ii) On-site Risk-focused Examinations

**Commentary on Question:**

*For types of information assessed, there are many potential correct responses. Two are shown for each of (i) and (ii) in the model solution. Two types of information assessed for each of (i) and (ii) are expected for full credit.*

(i) Off-Site Purpose:
Assess on an on-going basis the financial condition of the insurer as of the valuation date and to identify and assess current and prospective risks through risk-focused surveillance.

Frequency:
quartely basis

Types of Information Assessed:
regulatory financial reports, rate/policy filings
11. Continued

(ii) On-Site Purpose:
Allow state regulators to evaluate and assess the solvency of insurers as of the valuation date and to develop a forward-looking view of an insurer's risks and its risk management practices. Focus is on the areas of greatest risk to an insurer.

Frequency:
Full scope once every five years. Results of off-site analysis indicating issues may make this more frequent.

Type of Information Assessed:
Corporate governance practices in place to identify/mitigate risk, internal control processes

(b) Identify a potential (or planned) enhancement to NAIC RBC suggested by Solvency II with respect to:

(i) Calibration of the RBC system

(ii) Catastrophe risk

Commentary on Question:
There are a number of possible responses for full credit. The following is an example of a full credit response.

(i) Calibration: move to a strict definition of a particular statistical level of safety (e.g., TVaR). Solvency II uses 99.5% VaR.

(ii) Catastrophe risk: Planned catastrophe risk charge to be added to the NAIC RBC formula based upon commercially available models using a 1-in-100 year standard. Solvency II includes catastrophe risks in its SCR.

(c) Describe two ways in which an actuary can assist a general insurance company with its NAIC ORSA.

Commentary on Question:
Many different responses are possible for full credit. The following is an example of a full credit response.
11. **Continued**

An actuary can assist in the ORSA report in many ways including reinsurance structure and strategic planning.

For reinsurance structure, the actuary can produce models testing various different reinsurance structures, looking at a cost-benefit analysis, extent of risk transfer and effect on capital under various stress tests.

For strategic planning, the actuary can develop a model that simulates the base plan producing percentiles for results, probability of ruin and other statistics. Various plausible modifications and stress tests can be run on the model to analyze the strategic plan.

(d) Contrast the approaches of the NAIC ORSA and the Solvency II ORSA with respect to required capital.

Results from NAIC ORSA will not affect RBC requirements.

Under Pillar 2 of Solvency II, ORSA results can directly lead to capital add-ons.
12. Learning Objectives:
1. The candidate will understand the elements of financial reporting for general insurance companies.

Learning Outcomes:
(1a) Understand and apply the concepts of insurance accounting.
(1c) Describe the elements of the NAIC Annual Statement.
(1d) Complete and interpret selected pages/schedules in the NAIC Annual Statement as included in the resources.

Sources:
General Insurance Financial Reporting Topics, Society of Actuaries, Part 7 (Statutory Loss Accounting and Schedule P)
NAIC 2012 Annual Statement

Solution:
(a) Calculate the allocation by accident year of AGI’s paid AAO expenses in calendar year 2013 using the old statutory procedure for Schedule P reporting.

Percentage paid loss in 2013 by accident year (AY) is as follows:

- 2010 0%
- 2011 7.5% (150/2000)
- 2012 27.5% (550/2000)
- 2013 65% (1300/2000)

Allocate 50% of AAO to AY using above computed percentages. In addition to this, allocate 45% of AAO to AY 2013 and 5% of AAO to AY 2012.

Therefore the allocation by AY of AGI’s paid AAO expenses in calendar year 2013 using the old statutory procedure for Schedule P reporting is as follows:

- 2010 0
- 2011 9,000 (= 7.5% × 50% × 240,000)
- 2012 45,000 (= 27.5% × 50% × 240,000 + 5% × 240,000)
- 2013 186,000 (= 65% × 50% × 240,000 + 45% × 240,000)

(b) Calculate the allocation by accident year of AGI’s paid AAO expenses in calendar year 2013 using the method of distributing AAO by claim counts. Assume the following relativities of AAO expense by type of claim for the application of this method:

<table>
<thead>
<tr>
<th>Claim Type</th>
<th>Relativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported claim</td>
<td>4</td>
</tr>
<tr>
<td>Claim closed with payment</td>
<td>3</td>
</tr>
<tr>
<td>Claim closed with no payment</td>
<td>2</td>
</tr>
<tr>
<td>Outstanding claim</td>
<td>1</td>
</tr>
</tbody>
</table>
12. Continued

First, calculate weighted claims by AY:

2010  0
2011  10  (= 1×4 + 2×3 + 0×2 + 0×1)
2012  119 (= 15×4 + 19×3 + 0×2 + 2×1)
2013  1,160 (= 170×4 + 151×3 + 8×2 + 11×1)

Total weighted claims = 10 + 119 + 1,160 = 1,289

It follows that the weights applying to each AY are:

2010  0%
2011  0.8%  (= 10/1,289)
2012  9.2%  (= 119/1,289)
2013  90.0% (= 1,160/1,289)

Multiply these weights by AY by the total AAO of 240,000 to get the allocation of AAO by AY.

2010  0
2011  1,920 (= 0.8% × 240,000)
2012  22,080 (= 9.2% × 240,000)
2013  216,000 (= 90.0% × 240,000)

(c) Explain why an AAO allocation method using claim counts should be more accurate than the old statutory procedure for Schedule P reporting.

The old procedure uses paid loss amounts to allocate AAO. However, many AAO expenses are routine costs that do not vary much by size of loss.

All claims must be recorded, files must be set up, and accidents must be investigated. Large claims do receive more attention than small claims, but the differences may not be as great as that implied by the differences in claim amounts.
13. **Learning Objectives:**

4. The candidate will be able to describe the current and historical regulatory environment.

**Learning Outcomes:**

(4b) Describe and interpret the current state of general insurance regulation in the U.S. and its development.

(4i) Understand the regulation of reinsurance.

**Sources:**

Insurance Regulation, The Institutes, Chapter 12 (Insolvency Regulation)

Vaughan, T., “The Economic Crisis and Lessons from (and for) U.S. Insurance Regulation”


**Solution:**

(a) Identify two common reasons for insurer insolvency.

**Commentary on Question:**

*There are many common reasons for insurer insolvency. Three are shown in the model solution. Only two are required for full credit.*

- Rapid premium growth
- Inadequate rates
- Fraud

(b) Describe two regulatory actions that an insurance commissioner may take if fact-finding reveals that policyholders or the general public may be adversely affected by an insurer’s financial condition.

**Commentary on Question:**

*A number actions are possible (mandatory corrective action, administrative supervision, receiverships, rehabilitation, and liquidation). Only two are required for full credit.*
13. Continued

Mandatory corrective action: In serious situations, the insurance commissioner is authorized to order an insurer to take specified corrective actions. These actions may include: take actions to reduce liabilities, limit new business, and document adequacy of its premium rates.

Receivership: If the insurer’s condition is severe it may be placed in receivership. Receivership is a type of bankruptcy in which the court appoints a receiver (the state insurance commissioner) to run the insurer. The receiver makes sure that the insurer’s policyholder obligations are fulfilled to the extent possible.

(c) Describe the characteristics of the U.S. regulatory system that may have contributed to the relatively strong performance of insurance companies in the recent financial crisis.

Commentary on Question:

There are a number of potential characteristics that may have contributed to the relatively strong performance of insurance companies in the recent financial crisis. Four characteristics are shown in the model solution. Only two are required for full credit.

Duplication: The state-based system creates duplicative regulatory oversight. This duplicative effort, while creating additional costs, creates greater scrutiny whereby more regulators have a chance to detect problems.

Peer Review and Peer Pressure: The state-based system has a peer review system (e.g., NAIC accreditation program) to promote sound insurance regulation. Peer pressure from other state regulators also provides a state regulator with incentives for effective insurance regulation.

Diversity and Compromise: The state-based system requires compromise among diverse views. This compromise ensures that there will not be a move toward excessive deregulation or overregulation.

Market Discipline and Moral Hazard: Under the state regulatory system, there is difficulty accessing federal government funds. This lack of a federal safety net may create more market discipline as there can be an increase in moral hazard with the expectation of a federal government bailout.

(d) Identify how the Dodd-Frank Act changes the regulation of reinsurer solvency.

States that are NAIC accredited or have financial solvency requirements substantially similar to those imposed by the NAIC are solely responsible for regulating the financial solvency of reinsurers domiciled in their state.
14. Learning Objectives:
4. The candidate will be able to describe the current and historical regulatory environment.

Learning Outcomes:
(4f) Describe the development of general insurance programs controlled by government or collective insurance industry organizations.

(4g) Describe the mechanisms of operation for government and/or collective insurance industry controlled programs as included in the resources.

Sources:

Solution:
(a) Identify two reasons for government involvement in the provision of workers compensation insurance.

Commentary on Question:
Four reasons are shown in the model solution. Only two are required for full credit.

- Residual market needs
- Compulsory insurance
- Efficiency and convenience
- Collateral social purpose

(b) Compare the roles of U.S. state governments with those of Canadian provincial governments in the provision of workers compensation.

U.S.: This varies by state. It is mostly private insurers, with some competitive and monopolistic state funds. Residual market mechanisms vary by state.

Canada: All provinces have monopolistic government-run insurers for workers compensation. A residual market mechanism is not required.
14. Continued

(c) Identify the primary reason why the National Flood Insurance Program (NFIP) was created in 1968.

Private insurers considered flood risk uninsurable.

(d) Identify one purpose of the NFIP, other than providing flood insurance.

Commentary on Question:
Two purposes are shown in the model solution. Only one is required for full credit.

- Flood risk identification
- Flood plain management

(e) Describe two key differences between private-sector insurance and the NFIP.

Commentary on Question:
There are a number of key differences. Four differences are shown in the model solution. Only two differences are required for full credit.

- Private sector insurance is motivated to provide coverage at a profit. NFIP is motivated to identify flood risks, offer flood insurance and work with communities regarding flood plain management.
- In private sector insurance, litigation arises over ambiguities in policy language. A general principle in contract law is that ambiguities in the contract must be construed against the drafter. NFIP policy language is provided by federal statute whereby the insured may not be able to assert that he/she did not understand the policy.
- Types of coverage and limits offered differ between private sector insurance and the NFIP. NFIP limits are restricted, whereas private insurance limits can go as high as a company is willing to sell. NFIP policies are actual cash value whereas private insurance policies have replacement cost as an option.
- Private sector rates are typically actuarially sound. NFIP rates can be subsidized.
14.  Continued

(f)  The Biggert-Waters Flood Insurance Reform Act of 2012 made changes to the NFIP that may improve its financial position. Explain two of these changes.

**Commentary on Question:**
There are a number of changes. Four changes are shown in the model solution. Only two changes are required for full credit.

- The Act phases out subsidies for vacation and second homes, as well as businesses, severe repetitive loss properties or substantially improved/damaged properties. Rates for these properties are to increase 25% per year until they reach the full actuarial cost.

- The Act requires a premium rate adjustment to any property located in an NFIP-participating area to accurately reflect the current risk of flood. Any increase in the risk premium is to be phased in over a five-year period at a rate of 20%.

- The Act imposes minimum deductibles on flood claims that vary by pre-FIRM / post-FIRM status and the insured amount. Post-FIRM minimum deductibles are lower than pre-FIRM minimum deductibles.

- The Act requires FEMA to establish a reserve fund to help meet future obligations of the NFIP in higher-than-average loss years. The reserve fund will phase in a reserve ratio or balance equal to 1% of the sum of the total potential loss exposure of all outstanding flood insurance policies in force during the prior fiscal year.
15. **Learning Objectives:**

5. The candidate will be able to understand tort law and insurance law with respect to its impact on the general insurance industry.

**Learning Outcomes:**

(5a) Describe and interpret the key elements of tort law and the underlying principles of insurance law.

**Sources:**

Excerpts from Business Law for Insurance Professionals, Institutes Custom Publishing, Assignment 2 (Tort Law) and Assignment 3 (The International Legal Environment)

**Solution:**

(a) Identify the three other essential elements of negligence.

- Breach of duty
- Proximate cause
- Actual injury or damage

(b) Provide an example of a situation where three of the four essential elements are present, but the fourth is not.

**Commentary on Question:**

*Widely varying responses are possible for full credit. Grading of this type of question takes into account how clearly the situation is presented in the response as well as the validity of the response. A full credit response should describe a situation, and then go through the four essential elements noting how the three are present but one is absent. The following is an example of a full credit response.*

Consider a situation where:

- Motorist A hits Motorist B from behind causing minimal damage to Motorist B’s rear bumper.
- Motorist B becomes agitated and then drives off and slams into a tree sustaining bodily injury and damage to the front of the vehicle.
- Motorist B sues Motorist A for bodily injury and damage to the front of the vehicle.

Legal duty of care: This element is met. Motorist A has a legal duty of care to operate the vehicle in a safe manner.

Breach of duty: This element is met. The duty was breached when Motorist A’s vehicle hit Motorist B’s vehicle.
Actual injury or damage: This element is met. Motorist B suffers an actual injury and the vehicle sustained actual damage.

Proximate cause: This condition is not met. The damage and injury suffered by Motorist B were not due to the actions of Motorist A. Motorist B made a decision after a minor incident to drive while in a distracted state which caused the actual injury and damage.

(c) Contrast the role of a judge in a common law system with the role of a judge in a civil law system.

Common law relies on a judge’s reasoning for the final decision.

Under civil law, a judge finds correct legislative provisions to apply and performs little interpretation.

(d) Evaluate the liability of the motorist and the truck owner.

The motorist may be partially liable for the truck driver’s injuries as a result of negligence. The truck owner may be strictly or statutorily liable for all injuries and runoff into river because the truck was transporting an explosive and toxic substance that escaped into the environment.

(e) Provide two examples of intentional torts.

Commentary on Question:
There are many examples of intentional torts. Four are shown in the model solution. Only two are required for full credit.

- Battery
- Assault
- False imprisonment and arrest
- Intentional infliction of emotional distress
16. **Learning Objectives:**

1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**

(1b) Compare different financial reporting standards for general insurers including: U.S. Statutory Account Principles (SAP), U.S. Generally Accepted Accounting Principles (GAAP), Canadian Generally Accepted Accounting Principles (CGAAP), Solvency II and International Financial Reporting Standards (IFRS).

(1c) Describe the elements of the NAIC Annual Statement.

(1d) Complete and interpret selected pages/schedules in the NAIC Annual Statement as included in the resources.

(1e) Understand and apply the concepts of reinsurance accounting.

**Sources:**

General Insurance Financial Reporting Topics, Society of Actuaries, Part 6 (Schedule F, Statutory Credit for Reinsurance)

NAIC 2012 Annual Statement

**Solution:**

(a) Calculate BZIC’s total Schedule F provision for reinsurance.

Reinsurer BRC:

- Reinsurer BRC is unauthorized.
- The total unsecured recoverables are total recoverables minus collateral (letters of credit + funds withheld) 
  \[ = 200M \text{ – (15M + 50M)} = 135M \]
- Collateral does not apply to overdue recoverables or amounts in dispute.
- The loss recoverables more than 90 days past due are 60M and amounts in dispute are 15M. Amounts in dispute are part of total recoverables but not of overdue recoverables.
- The total provision for reinsurance is: total unsecured recoverables + the lesser of (20% of overdue recoverables + 20% of amounts in dispute) and collateral.
- BRC Schedule F Provision is
  \[ 135M + \text{minimum}(20\% \times (60M + 15M), 65M) \]
  \[ = 150M \]
16. Continued

Reinsurer MRE:

- Reinsurer MRE is authorized, so we determine whether it is slow-paying.
- The test ratio is the loss recoverables more than 90 days past due divided by the total loss recoverables (on claims not in dispute) plus the payments received in the past 90 days.
  - Recoverables more than 90 days past due = 10M
  - Total recoverables on paid loss and ALAE = 70M
  - Amount in dispute = 10M
  - Recoverables received in the past 90 days = 8M
  - The test ratio is \( \frac{10M}{70M - 10M + 8M} = \frac{10}{68} = 14.7\% < 20\% \), so the insurer is not slow-paying.
- The provision for reinsurance is 20% of overdue recoverables + 20% of amounts in dispute.
- MRE Schedule F Provision is
  \[ 20\% \times 10M + 20\% \times 10M = 4M. \]
  Total Schedule F Provision is 150M + 4M = 154M.

(b) Describe the GAAP approach to estimating the potential uncollectibility of reinsurance recoverables with respect to the balance sheet.

In GAAP financial statements, counterparty credit risk is estimated by the insurer and subtracted from the reinsurance recoverable asset.
17. Learning Objectives:
1. The candidate will understand the elements of financial reporting for general insurance companies.

Learning Outcomes:
(1a) Understand and apply the concepts of insurance accounting.

(1c) Describe the elements of the NAIC Annual Statement.

Sources:
General Insurance Financial Reporting Topics, Society of Actuaries, Part 4 (Accounting Perspectives for Non-Admitted Assets) and Part 10 (Statutory Surplus: Computation, Pricing, and Valuation)

NAIC Statement of Statutory Accounting Principles 65, “Property and Casualty Contracts”

Solution:
(a) Identify three assets that are classified as non-admitted assets in statutory accounting and for each of the three assets identified explain why statutory accounting treats them as non-admitted.

Commentary on Question:
There are a number of assets that are classified as non-admitted. Four assets are shown in the model solution. Only three are required for full credit.

- Common stocks above 25% of total assets or 100% of statutory surplus are non-admitted. This serves to mitigate investment risk.
- Equipment, office furniture, automobiles and deferred tax assets have high value in use for the insurer and no credit risk or volatility risk, but have low resale value. They are non-admitted to reflect the assets’ inability to fund claim payments.
- Receivables more than 90 days past due are non-admitted to provide a conservative view of counterparty credit risk.
- Non-admitted portion of accrued retrospective premiums (usually 10% of the unsecured portion). This provides a conservative view of counterparty credit risk

(b) Describe the other method.

Write off the non-admitted asset as an expense in the income statement.
17. **Continued**

(c) Explain why an increase in non-admitted assets decreases statutory surplus.

Consider total assets as a fixed amount, so an increase in the non-admitted portion is a decrease in the admitted portion.

(d) Identify two direct charges (or credits) to statutory surplus, other than the change in non-admitted assets.

**Commentary on Question:**

*There are a number of direct charges (or credits) to statutory surplus. Four are shown in the model solution. Two are required for full credit.*

- Change in the provision for reinsurance
- Unrealized capital gains
- Stockholder dividends
- Capital contributions

(e) Describe the relationship between invested capital and statutory surplus for a general insurance company.

Invested capital is statutory surplus plus the capital embedded in gross unearned premium reserves and full value loss reserves.

(f) Describe the accounting treatment of policyholder dividends in statutory accounting with respect to their recognition as a liability and when they are recognized in the statement of income.

Dividends to policyholders immediately become liabilities of the reporting entity when they are declared by the board of directors and shall be recorded as a liability. Incurred policyholder dividends are reported in the statement of income.
18. **Learning Objectives:**

1. The candidate will understand the elements of financial reporting for general insurance companies.

**Learning Outcomes:**

(1c) Describe the elements of the NAIC Annual Statement.

(1d) Complete and interpret selected pages/schedules in the NAIC Annual Statement as included in the resources.

**Sources:**

General Insurance Financial Reporting Topics, Society of Actuaries, Part 8 (Measuring Total Income for General Insurers)

**Solution:**

(a) Calculate GIC’s investment gain ratio for the 2013 Insurance Expense Exhibit (IEE).

The net investment gain is the sum of two entries on the statement of earnings: net investment income plus realized capital gains.

The insurer’s investment gain ratio is its net investment gain divided by investable assets, or

\[
\text{Net investment gain} / \left[ \text{Mean net loss and LAE reserves (LR) + Mean net UEPRs} - \text{Mean net agents' balances (AB) + Mean policyholders' surplus (PHS)} \right].
\]

Investment gain ratio (IGR)

\[
= (525 + -10)/((2,750 + 3,450 + 1,500 + 1,900 - 500 - 650 + 1,900 + 2,500)/2)
\]

\[
= 515/6,425 = 8.0\%.
\]

(b) Calculate GIC’s allocated mean surplus by line of business using the IEE method of allocation.

Allocate the company's mean surplus to line of business in proportion to:
Mean net loss and LAE reserves + Mean net UEPR + Earned premium for the year.

Total = (2,750 + 3,450 + 1,500 + 1,900)/2 + 3,800 = 8,600

CAUTO Liability (2,200 + 3,000 + 1,000 + 1,300)/2 + 2,600 = 6,350

CAUTO Liability % = 6,350/8,600 = 73.8%
18. Continued

Mean Surplus = (1,900 + 2,500)/2 = 2,200
CAUTO Liability allocated surplus = 73.8% × 2,200 = 1,624
FIRE allocated surplus = 2,200 – 1,624 = 576

(c) Calculate GIC’s allocated investment gain by line of business for the 2013 IEE.

The IG by line of business (lob) on funds attributable to insurance transactions is:

\[ IG_{it} = IGR \times \{ LR_{lob} + UEPR_{lob} \times [1 – (PPE_{lob}/WP_{lob})] – AB_{lob} \} \]

The IG by line of business attributable to capital and surplus is:

\[ IG_{cs} = [ IGR \times (LR_{lob} + UEPR_{lob} + PHS_{lob} – AB_{lob}) ] – IG_{it} \]

Therefore IG by LOB is \[ IGR \times (LR_{lob} + UEPR_{lob} + PHS_{lob} – AB_{lob}) \].

CAUTO Liability IG is:

\[ 8.0\% \times (((2,200 + 3,000)/2) + ((1,000 + 1,300)/2) + 1624 – ((300 + 500)/2)) \]

= 399.

Since total IG is 515 (= 525 – 10), FIRE IG is 515 – 399 = 116.
19. **Learning Objectives:**

1. The candidate will understand the elements of financial reporting for general insurance companies.

2. The candidate will understand the analysis of a general insurer’s financial health through prescribed formulas, ratios and other solvency regulation methods.

**Learning Outcomes:**

(1c) Describe the elements of the NAIC Annual Statement.

(1d) Complete and interpret selected pages/schedules in the NAIC Annual Statement as included in the resources.

(2c) Calculate and interpret the results of financial health ratios.

**Sources:**

General Insurance Financial Reporting Topics, Society of Actuaries, Part 7 (Statutory Loss Accounting and Schedule P) and Part 9 (Notes to Financial Statements)

NAIC “Insurance Regulatory Information System (IRIS) Ratios Manual”

**Solution:**

(a) Calculate JENRI’s 2013 IRIS ratio for P/C Reserve Ratio 12 (Two-Year Reserve Development to Policyholders’ Surplus).

For 2013, the two-year development ratio uses accident years (AY) up to 2011 and Policyholders’ Surplus (PHS) as of year-end 2011.

Two-year development by AY is as follows:

- 2008 30 (= 450 – 420)
- 2009 75 (= 1,580 – 1,505)
- 2010 550 (= 1,800 – 1,250)
- 2011 390 (= 1,850 – 1,460)

Total two-year development = 1,045.

IRIS Ratio 12 = Total two-year development / PHS 2011 = 1,045/4,750 = 22.0%
19. Continued

(b) Assess the results of the ratio calculated in part (a) making reference to the usual range for the ratio, areas for further analysis and the Statement of Actuarial Opinion (SAO).

- The usual range for the ratio includes results less than 20 percent.
- JENRI’s result represents an exceptional score showing two-year adverse development of over 20%.
- Since this is an exceptional score on a loss reserve adequacy test, it must be commented on in the Statement of Actuarial Opinion.
- Four or more exceptional scores on IRIS tests serve as a warning of potential financial weakness and may trigger a financial examination.
- Further analysis should focus on which lines of business and which accident years resulted in the deficiency.

(c) Adverse results on the IRIS reserve ratio tests can be an indication of inadequate reserves. However, there are other possible reasons for adverse results. Identify two other possible reasons.

**Commentary on Question:**

*Many reasons are possible. Four reasons are shown in the model solution. Only two are required for full credit.*

- Large rate increases
- Changes in mix of business from long tail to short tail
- Strengthening of deficient loss and LAE reserves held at the end of the second prior year-end
- Rapid business growth

(d) Explain why a disclosure of loss reserve discounts is also required in the Notes to Financial Statements of the NAIC Annual Statement.

Non-tabular discounts are explicitly disclosed in Schedule P, but tabular discounts can only be inferred by a comparison of two parts of Schedule P.

The IRS requires explicit disclosure of all discounting in the annual statement. The Note provides this information explicitly.
20. **Learning Objectives:**
5. The candidate will be able to understand tort law and insurance law with respect to its impact on the general insurance industry.

**Learning Outcomes:**

(5a) Describe and interpret the key elements of tort law and the underlying principles of insurance law.

(5b) Discuss the influence of the U.S. tort litigation environment in Canada.

(5c) Discuss the issues of tort trends and tort reform as it applies to the general insurance industry.

**Sources:**
Excerpts from Business Law for Insurance Professionals, Institutes Custom Publishing, Assignment 2 (Tort Law)


Kent, N., “Insurer Bad Faith Damages: A USA-Canada Comparison”

**Solution:**

(a) Define the term bad faith in a tort context.

Tort causing another person severe emotional distress through one’s extreme or outrageous acts.

(b) Provide an example of a situation in which a general insurer can be alleged to have acted in bad faith.

**Commentary on Question:**

*Many examples are possible. Three examples are shown in the model solution. Only one example is required for full credit.*

Insured alleging bad faith of the insurer for:

- Negligent denial of a claim
- Failure to process or pay a claim without reasonable cause
- Failure to protect the insured’s rights
20. Continued

(c) Identify two defenses to suits alleging bad faith.

**Commentary on Question:**
*Four defenses are shown in the model solution. Only two are required for full credit.*

- No intent or recklessness
- No outrageous or extreme conduct
- No breach of implied duty of good faith and fair dealings
- No valid insurance contract existed

(d) Compare the treatment of bad faith claims against insurers in the U.S. court system with their treatment in the Canadian court system with respect to punitive damages.

**Commentary on Question:**
*Widely varying responses are possible. Five comparisons are made below. At least three comparisons are required for full credit. Alternatively, a full credit response can consist of a comparison of Whiten v. Pilot in Canada to Campbell v. State Farm in the United States.*

- The Supreme Court of Canada limited punitive damages to 1 million dollars, while there is no such limit in the United States.
- The U.S. has had mega-million dollar punitive damage awards for bad faith (though with reductions on appeal) where the average is 7 to 10 million dollars.
- U.S. awards can be a large multiple of the compensatory damages award. However, where the compensatory damages awarded to the insured plaintiff are significant, the U.S. Supreme Court has suggested that a 1:1 ratio would be appropriate.
- Punitive damages are fairly common for bad faith in the U.S.; in Canada they are the exception.
- In a departure from the U.S. Supreme Court, the Supreme Court of Canada rejected the adoption of a ratio between punitive and compensatory damages.

(e) Identify a type of tort reform that should lessen the financial impact on U.S. insurers found responsible for acting in bad faith.

**Commentary on Question:**
*Two types are shown in the model solution. One is required for full credit.*

- Punitive damages reform
- Noneconomic damages reform
20. Continued

(f) Explain how the type of tort reform you identified in part (e) would lessen the financial impact on insurers found responsible for acting in bad faith. Use an actual state-enacted tort reform law as the basis for the explanation.

Commentary on Question:
A full credit response for this part is expected to explain the effect of the tort reform identified in part (e) with an appropriate example. Widely varying responses are possible. An example of a full credit response is provided using punitive damages reform as the type identified in (e).

Punitive damages reform focuses on capping punitive damage awards and/or applying stricter criteria on when punitive damages are awarded. Bad faith claims against insurers often include a claim for punitive damages. By putting restrictions on the amount payable for punitive damages, punitive damages reform directly lessens the financial impact on insurers found responsible for acting in bad faith. For example, the state of New Jersey enacted a punitive damages reform that limits most punitive damages to the greater of $350,000 or five times the compensatory damages award. This reform will directly reduce the amount payable by insurers found responsible for acting in bad faith.
21. Learning Objectives:
3. The candidate will be able to apply the standards of practice regarding the responsibilities of the actuary as defined by regulators and the American Academy of Actuaries.

Learning Outcomes:
(3a) Describe, interpret and apply the applicable Standards of Practice.

(3b) Describe, interpret and apply the responsibilities of the actuary with respect to the Statement of Actuarial Opinion and the Actuarial Report.

Sources:

Actuarial Standards of Practice, No. 36, Statements of Actuarial Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves


Solution:
(a) Explain which category of opinion the Appointed Actuary for OIC should provide in the SAO.

Determination of Reasonable Provision.
The stated reserve amount is within the actuary’s range of reasonable reserve estimates.

(b) Identify the amounts listed in the tables above that are required to be disclosed in the SAO and which amounts are not to be disclosed in the SAO. Provide an explanation.

Commentary on Question:
Identification as to where these amounts are recorded in the SAO (i.e., Exhibits A or B) is not required for full credit.

Company estimate of 115 (Exhibit A), Pool amount of 12 (Exhibit B) and materiality standard of 10 (Exhibit B) are in the SAO as these represent the amounts opined on and the materiality standard for these amounts.

SAO must exclude the actuary’s estimates because it is a public document and the actuary’s estimates are considered to be proprietary.
21. Continued

(c) Describe any disclosures that need to be included in the SAO regarding the risk of material adverse deviation, making reference to any applicable Actuarial Standards of Practice.

**Commentary on Question:**
The notation of the section within ASOP 36 (i.e., 4.2.e) is not required for full credit.

- Need to disclose that there exists a risk of material adverse deviation because of rapid growth in two lines of business.
- This is from ASOP 36. (4.2.e)

(d) Explain which category of opinion the Appointed Actuary for OIC should provide if OIC’s carried reserves were 135 million.

**Determination of Redundant or Excessive Provision.**
- This is due to the fact that the amount of carried reserves (135) is greater than the upper end of the range of reasonable estimates.

(e) Describe the purpose of the Actuarial Opinion Summary and identify the amounts listed in the tables above that are required to be disclosed in it.

- The Actuarial Opinion Summary (AOS) is a supplemental filing, separate from the Annual Statement and the SAO.
- The SAO and Annual Statement are public documents that should not provide proprietary information. The purpose of the AOS is to contain significant proprietary information regarding the actuarial opinion.
- The AOS should not be filed with the NAIC and should be kept separate from any copy of the SAO.
- From the tables, the AOS is to include the range of reasonable estimates, the point estimate and the company’s carried reserves.
21. Continued

(f) Explain which category of opinion the Appointed Actuary for OIC should provide for the SAO in this situation where an estimate from the industry involuntary pool is not available.

Qualified Opinion.
The reserves for a certain material item (pool) are in question because they cannot be reasonably estimated by the Appointed Actuary.

Materiality can be assumed because the prior year’s amount was above the materiality standard.

(g) Describe two factors the actuary should consider in judging whether or not to make use of another’s analyses or opinions.

Commentary on Question:
Four factors are shown in the model solution. Only two are required for full credit.

- The amount of the reserves covered by another's analyses or opinions in comparison to the total reserves subject to the actuary's opinion
- The nature of the exposure and coverage
- The way in which reasonably likely variations in estimates covered by another's analyses or opinions may affect the actuary's opinion on the total reserves subject to the actuary's opinion
- The credentials of the individual(s) that prepared the analyses or opinions
22. Learning Objectives:
4. The candidate will be able to describe the current and historical regulatory environment.

Learning Outcomes:
(4e) Discuss the issues regarding usage based insurance and telematics in automobile insurance.

Sources:
Cappelletti, A., “Usage-Based Insurance and Telematics”

Solution:
(a) State two benefits of a Pay-As-You-Drive system of insurance.

Commentary on Question:
Four benefits are shown in the model solution. Only two are required for full credit.

- Increased accuracy of the rates
- Potential for policyholders to control costs
- Increased affordability for high risk drivers who drive less
- Reduction to overall level of driving as policyholders seek to reduce their premiums

(b) Describe two ways a Pay-How-You-Drive system of insurance can be useful to either policyholders or insurance companies, other than providing more refined insurance pricing.

Commentary on Question:
Widely varying responses are possible. Below is an example of a full credit response.

Pay-How-You-Drive can be useful to policyholders as it can:
- Assist a driver immediately after an accident (e.g., airbag deployment information is transmitted to the insurer, the insurer can then send assistance and begin the claims handling process)
- Track a vehicle after it has been reported stolen

(c) Explain how anti-selection can occur when the introduction of a usage-based insurance (UBI) telematics program is optional in a jurisdiction.

Lower risk drivers are the most likely to sign up for UBI telematics policy.

Aggressive and higher mileage drivers are less likely to sign up for a UBI telematics policy.
22. **Continued**

(d) Explain how premiums will be affected for UBI telematics policies as well as for non-UBI telematics policies when there is anti-selection.

UBI telematics policies: Premiums are based on usage so they should be unaffected by the anti-selection.

Non-UBI telematics policies: Lowest risk policyholders are more likely to opt for UBI telematics policies. Therefore, average loss cost per non-UBI telematics policy will increase, thus increasing the non-UBI telematics policy premiums.
1. **Learning Objectives:**
4. The candidate will understand how to apply the fundamental techniques of reinsurance pricing.

**Learning Outcomes:**
(4a) Calculate the price for a proportional treaty.
(4b) Calculate the price for a property per risk excess treaty.

**Sources:**
Basics of Reinsurance Pricing, D. R. Clark

**Solution:**
(a) Explain why Property R Us may have purchased surplus share reinsurance instead of quota share reinsurance.

A key difference between the two types of reinsurance is that surplus share reinsurance limits the retention per risk while quota share, being proportional, has no limit. Property R Us is a small company and so will likely prefer surplus share as it limits its exposure and allows larger amounts of coverage to be sold.

(b) Calculate the expected commission.

There are four terms to be calculated and added. They are:

- 0.2 probability x 0.2 commission = 0.04
- (1/3)x0.6 probability x 0.25 commission = 0.05 (This represents the 1:1 sliding scale from 20% to 30% where the average commission is 0.25 and the probability of being between 20% and 30% is 1/3 of the 60% probability of the loss ratio interval of 40-70%.)
- (2/3)x0.6 probability x 0.35 commission = 0.14 (Similarly, this represents the 0.5:1 sliding scale from 30% to 40% where the average is 0.35 and the probability of being between 30% and 40% is 2/3 of the 60% probability of the loss ratio interval of 40-70%.)
- 0.2 probability x 0.4 commission = 0.08

The sum is the expected commission of 0.31.
1. Continued

(c) State whether the expected commission will increase or decrease as Property R Us grows its business and writes more risks. Support your conclusion.

**Commentary on Question:**
*There are two components to a full answer. The first is the effect on the distribution and the second is how the change in the distribution affects the commission.*

As more business is written the mean will not change but the variance will decrease. Hence the loss ratios will be more concentrated around the mean of a 55% loss ratio. In the extreme, at this loss ratio, the commission is 32.5%, which is an increase from the original 31%.

(d) Explain how an exposure curve can be used to price risks with an insured value of 1,000,000 for the property per risk treaty.

An exposure factor corresponding to 50-100% of insured value on the exposure curve is applied to the subject premium net of the surplus share treaty.
2. Learning Objectives:
5. The candidate will understand methodologies for determining an underwriting profit margin.

Learning Outcomes:
(5a) Calculate an underwriting profit margin using the target total rate of return model.
(5b) Calculate an underwriting profit margin using the capital asset pricing model.
(5c) Calculate an underwriting profit margin using the risk adjusted discount technique.

Sources:

Solution:
(a) Calculate the premium for this policy using the Risk Adjusted Discount Technique.

The equation is
\[
P = \frac{80}{0.98} + 20 + \frac{(P - 20)(0.35)}{1.01} - \frac{80(0.35)}{0.98} + \frac{50 + P - 20)(0.01)(0.35)}{1.01}.
\]

The solution is \( P = 101.90 \).

(b) Evaluate Rocky’s suggestion.

Rocky’s assertion is false. Underwriting profit margin will not be decreased by paying an immediate dividend to shareholders. The change will increase leverage and thus increase the risk premium.

(c) Explain the purpose of the funds generating coefficient in the Capital Asset Pricing Model applied to insurance.

The funds generating coefficient measures the average time the insurer holds premiums. It provides an offset in the formula for the underwriting profit margin.
3. Learning Objectives:
1. The candidate will understand how to use basic loss development models to estimate the standard deviation of an estimator of unpaid claims.

Learning Outcomes:
(1a) Identify the assumptions underlying the chain ladder estimation method.

(1b) Test for the validity of these assumptions.

(1c) Identify alternative models that should be considered depending on the results of the tests.

(1d) Estimate the standard deviation of a chain ladder estimator of unpaid claims.

Sources:
Measuring the Variability of Chain Ladder Reserve Estimates, T. Mack and Testing the Assumptions of Age-to-Age Factors, G. G. Venter

Solution:
(a) Describe this assumption in words.

The expected cumulative claims at lag \( k+1 \) are proportional to those at lag \( k \). The constant of proportionality depends only on the lag, and not on the accident year.

(b) Describe a reserving situation in which this assumption may not hold.

Commentary on Question:
The solution below lists two possible responses. Only one is needed for full credit.

A change in underwriting or marketing practices in one accident year can change the rate at which claims develop and so the factor will not be the same over all accident years.

A change in the claims handling process can have a calendar year effect with the factor for a given lag depending on how the accident year plus lag relates to the year of the change.

(c) Determine if this plot provides evidence that this assumption holds. Support your answer.

Commentary on Question:
There are two observations regarding the plot provided. Both are needed to receive full credit.
3. **Continued**

The first item to check is if the line adequately describes the points. The points appear to be distributed randomly around the line.

There should be no pattern of the deviations by accident year (which is why the points are labeled with the accident year). No pattern is evident.

These two observations are consistent with the assumption holding.

(d) Describe, using words and/or formulas as appropriate, the other two statistical assumptions identified by Mack.

**Commentary on Question:**
*A formula for the second assumption is also acceptable.*

One assumption is the independence of the accident years. The other is that the variance of cumulative claims at lag $k+1$ is proportional to cumulative claims at lag $k$ with the constant depending only on the lag.

(e) Rank the four models from best fitting to worst fitting using one of the three methods Venter suggests for accounting for the number of estimated parameters when comparing sums of squared errors. Indicate if your results support Mack’s assumption.

**Commentary on Question:**
*While Venter offered three methods, all candidates chose to work with the same method. It is the only one presented in this model solution.*

The formula is to divide the sum of squared errors by the square of $n - p$. The four values are:

1: $1,869,591/(45-9)^2 = 1,443$
2: $1,120,615/(45-18)^2 = 1,537^*$
3: $1,696,523/(45-9)^2 = 1,309$
4: $1,029,484/(45-18)^2 = 1,412^*$

*$p = 17$ is also reasonable for models 2 and 4.*

Small values are better, so Model 3 is best, followed by 4, 1, and 2.

Mack’s assumption is represented by Model 1 and so this analysis does not support the assumption because two other models provide a better fit.
3. Continued

(f) Describe two other tests Venter recommends for determining the viability of using the chain ladder method.

**Commentary on Question:**
Venter recommends several tests as listed below. Any two can earn full credit.

- Residuals should appear random when plotting against cumulative losses.
- Residuals should be stable against accident year.
- Sample correlations of factors by accident year for adjacent lags should be near zero.
- A regression test can be used to test if diagonal dummy variables are significant.
- Factors should be significant after dividing by their standard deviations.

(g) Calculate the variance of the chain ladder estimate of the reserve for claims from accident year 3.

**Commentary on Question:**
The formula is on Page 116 of Mack.

\[
C_{3,10}^2 \sum_{k=8}^{9} \frac{\alpha_k^2}{f_k^2} \left( \frac{1}{C_{t,k}} + \frac{1}{\sum_{j=1}^{n-4} C_{j,k}} \right) \\
= C_{3,10}^2 \left[ \frac{\alpha_8^2}{f_8^2} \left( \frac{1}{C_{3,8}} + \frac{1}{C_{1,8} + C_{2,8}} \right) + \frac{\alpha_9^2}{f_9^2} \left( \frac{1}{C_{3,9}} + \frac{1}{C_{1,9}} \right) \right] \\
= 5.378^2 \left[ \frac{1.13}{1.077^2} \left( \frac{1}{4.909} + \frac{1}{3.606 + 4.914} \right) + \frac{0.44}{1.017^2} \left( \frac{1}{5.285} + \frac{1}{3.834} \right) \right] \\
= 14,584
\]
4. **Learning Objectives:**
2. The candidate will understand the considerations in selecting a risk margin for unpaid claims.

**Learning Outcomes:**
(2a) Describe a risk margin analysis framework.

(2b) Identify the sources of uncertainty underlying an estimate of unpaid claims.

(2c) Describe methods to assess this uncertainty.

**Sources:**

**Solution:**
(a) Describe the following sources of uncertainty:

(i) Independent Risk
(ii) Internal Systemic Risk
(ii) External Systemic Risk

Independent Risk: Randomness inherent in the insurance process.

Internal Systemic Risk: Uncertainty arising from the model being an imperfect reflection of reality.

External Systemic Risk: Risks that are outside the modeling process.

(b) Identify the source of uncertainty in part (a) to which each of the following belongs:

(i) Random Claim Fluctuations
(ii) Unexpected Future Legal Changes
(iii) Parameter Selection Error

**Commentary on Question:**
*No explanation is required, correct matching is sufficient.*

Random claim fluctuations – Independent risk
Unexpected future legal changes – External systemic risk
Parameter selection error – Internal systemic risk
4. Continued

(c) Calculate the combined coefficient of variation for all sources of uncertainty.

Solution is the square root of $0.05^2 + 0.08^2 + 0.15^2$ which is 0.177 or 17.7%.

(d) Calculate the amount of the risk margin.

The calculation is $0.177(0.674)(100,000,000) = 11,929,800$.

(e) Describe two areas of additional analysis that you may conduct to provide further comfort regarding the outcomes from the deployment of this framework.

Commentary on Question:

*Any two of the five listed below are sufficient for full credit.*

- Sensitivity testing
- Scenario testing
- Internal benchmarking
- External benchmarking
- Hindsight analysis
5. **Learning Objectives:**
1. The candidate will understand how to use basic loss development models to estimate the standard deviation of an estimator of unpaid claims.

**Learning Outcomes:**
1. (1e) Apply a parametric model of loss development.
2. (1f) Estimate the standard deviation of a parametric estimator of unpaid claims.

**Sources:**
LDF Curve Fitting and Stochastic Reserving: A Maximum Likelihood Approach, D. R. Clark

**Solution:**
(a) Provide the term within this function corresponding to 0-12 months of development in accident year 2011, using Clark’s LDF method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-\frac{x}{\theta}}$.

The requested term is

$$4,000 \ln \left( \frac{ULT_{2011} \left( 1 - e^{\frac{6}{\theta}} \right)}{ULT_{2011} \left( 1 - e^{\frac{2}{\theta}} \right)} \right).$$

(b) Provide the two terms associated with accident year 2012 in the estimate of the scale factor, $\sigma^2$.

**Commentary on Question:**
*The two terms can be presented separately and earn full credit.*

The two terms are

$$\frac{(5,000 - 4,142)^2}{4,142} + \frac{(2,000 - 2,858)^2}{2,858}.$$

(c) Identify the number of degrees of freedom associated with the estimate of $\sigma^2$.

The degrees of freedom are the number of observations (6) less the number of parameters (4). Thus there are 2 degrees of freedom.
5. **Continued**

(d) Calculate the maximum likelihood estimate of accident year 2011 ultimate losses, $ULT_{2011}$.  

The MLE is 

$$\frac{8,000}{1 - e^{-\frac{8187}{7.94}}} = 8,187$$  

(e) Estimate the process standard deviation of the accident year 2011 reserve.  

The estimate is $(187 \times 318)^{0.5} = 244$.  

(f) Provide an expression for the estimate of the parameter variance of the 2011 reserve using matrix notation. (Do not compute the result.)  

The expression is 

$$\begin{pmatrix} e^{-\frac{8187}{7.94}} & 30 \cdot e^{-\frac{8187}{7.94}} & \frac{2694151}{295} & 295 \cdot e^{\frac{8187}{7.94}} \\ 30 \cdot e^{-\frac{8187}{7.94}} & e^{-\frac{8187}{7.94}} & 8187 \cdot e^{-\frac{8187}{7.94}} & 8187 \cdot e^{-\frac{8187}{7.94}} \\ \frac{2694151}{295} & 295 \cdot e^{\frac{8187}{7.94}} & e^{\frac{8187}{7.94}} & \frac{2694151}{295} \cdot e^{\frac{8187}{7.94}} \\ 295 \cdot e^{\frac{8187}{7.94}} & 8187 \cdot e^{-\frac{8187}{7.94}} & \frac{2694151}{295} \cdot e^{\frac{8187}{7.94}} & e^{\frac{8187}{7.94}} \end{pmatrix}.$$  

(g) Compare Clark’s stochastic reserving model to the chain ladder model with respect to the assumption of independence of incremental losses within an accident year.  

Incremental losses within an accident year are assumed to be independent in Clark’s model. The chain ladder model does not assume independence.
6. **Learning Objectives:**

3. The candidate will understand how to use a credibility model with parameters that shift over time.

**Learning Outcomes:**

(3a) Identify the components of a credibility model with shifting risk parameters.

(3c) Estimate the parameters of the model.

(3d) Compare various models that might be used.

**Sources:**

Credibility with Shifting Risk Parameters, S. A. Klugman

**Solution:**

(a) Explain why the ARIMA(0,1,1) model cannot be extended to a Bühlmann-Straub credibility framework.

The 1 in the model’s second term indicates that the model is for the differences of observations. With no constant, every jurisdiction has a mean difference of zero. Thus there is no ability to model the variance of the hypothetical means.

(b) Explain why this pattern of autocorrelations suggests that neither an MA(1) nor an AR(1) model is likely to be appropriate.

The AR(1) model has geometrically decreasing autocorrelations and the MA(1) model has a non-zero autocorrelation at lag 1 and zero elsewhere. The autocorrelation estimates do not follow either of these patterns.

(c) Set up, but do not solve, the matrix equation for the vector of credibility weights, \( Z_1, \ldots, Z_7 \), to apply to the seven annual observations where the goal is to forecast the pure premium two years ahead (year 9).

**Commentary on Question:**

*It is not necessary to show the sums to receive full credit, provided the entries are correct.*
6. Continued

The matrix and vector for the linear equations are

\[
\begin{bmatrix}
100 + 10 & 10 & 25 + 10 & 10 & 10 & 10 & 10 \\
10 & 110 & 10 & 35 & 10 & 10 & 10 \\
25 + 10 & 10 & 110 & 10 & 35 & 10 & 10 \\
10 & 35 & 10 & 110 & 10 & 35 & 10 \\
10 & 10 & 35 & 10 & 110 & 10 & 35 \\
10 & 10 & 10 & 35 & 10 & 110 & 10 \\
10 & 10 & 10 & 10 & 35 & 10 & 110 \\
\end{bmatrix}
\begin{bmatrix}
10 \\
10 \\
10 \\
10 \\
10 \\
10 \\
25 + 10 \\
\end{bmatrix}
\]

and

\[
\begin{bmatrix}
10 \\
10 \\
10 \\
10 \\
10 \\
10 \\
25 + 10 \\
\end{bmatrix}
\]

respectively.

(d) Explain why separate parameter estimates would now be required for \( \sigma^2 \) and \( \delta_0 \).

The general formula for the diagonal term is \( \sigma^2 / w_i + \delta_0 + \tau^2 \). With varying weights there is no common value on the diagonal.
7. **Learning Objectives:**

5. The candidate will understand methodologies for determining an underwriting profit margin.

**Learning Outcomes:**

(5d) Allocate an underwriting profit margin (risk load) among different accounts.

**Sources:**

An Application of Game Theory: Property Catastrophe Risk Load, D. F. Mango

**Solution:**

(a) Explain why neither the Marginal Variance nor Marginal Surplus methods for calculating risk load are renewal additive.

Renewal additivity for a risk load method requires that the renewal risk loads for individual accounts X and Y sum to the risk load for the combined account X+Y. The Marginal Surplus method allocates the risk load proportionally to the standard deviation, which is subadditive. The Marginal Variance method allocates the risk load proportionally to the variance, which is superadditive provided there is a positive covariance.

(b) Calculate the risk load for each account using the Shapley method.

The steps are as follows:

The variances of X and Y are 14,477,500 and 88,300 and the variance of X+Y is 16,822,800 (these are obtained by summing the last three columns, respectively). The covariance is \((16,822,800 - 14,477,500 - 88,300)/2 = 1,128,500\).

Adding the covariance to each variance gives 15,606,000 and 1,216,800. Multiplying each by 0.000025 gives the risk loads of 390.15 and 30.42.

(c) Explain how the Covariance Share method differs from the Shapley method.

The Shapley method allocates the covariance equally between the accounts while the Covariance Share method allocates the covariance in proportion to the loss size.
8. **Learning Objectives:**
4. The candidate will understand how to apply the fundamental techniques of reinsurance pricing.

**Learning Outcomes:**
(4c) Calculate the price for a casualty per occurrence excess treaty.

(4d) Apply an aggregate distribution model to a reinsurance pricing scenario.

**Sources:**
Basics of Reinsurance Pricing, D. R. Clark

**Solution:**
(a) Calculate the expected losses in the layer using an exposure rating approach with an expected loss ratio of 60% and the following increased limits factors:

The first entry is below the layer and so makes no contribution. For the other four entries the contributions are:

- $5,000,000(1.2 – 1.0)/1.2 = 833,333$
- $15,000,000(1.35 – 1.0)/1.35 = 3,888,889$
- $10,000,000(1.35 – 1.0)/1.56 = 2,243,590$
- $2,000,000(1.56 – 1.35)/(1.56 – 1.0) = 750,000$

The total is $7,715,812$. Multiplying by the expected loss ratio of 0.6 gives the answer, $4,629,487$.

(b) Explain why applying a loading of 20% of layer losses to account for ALAE in the layer is problematical.

Applying 20% assumes that ALAE is a constant percentage of each loss. However, ALAE generally decreases as a percentage of loss as the size of loss increases. Thus, 20% is likely to be too high in the reinsurance layer.

(c) Explain one method for calculating probabilities when using a collective risk model approximation to the aggregate distribution to set the terms of the swing plan.

**Commentary on Question:**
*Any one of the three methods listed is sufficient for full credit.*

- Recursive calculation, such as the Panjer recursion formula
- Numerical methods, such as Heckman-Meyers inversion
- Simulation, generating the number of losses followed by the amount of an individual loss
8. Continued

(d) Recommend whether or not this ceding company should purchase any other casualty per occurrence excess coverage. Justify your answer.

Coverage for the layer 500,000 excess of 1,000,000 should be considered because it is exposed by the policies with a limit of 1,500,000. Clash coverage above this should also be considered.
SOA Scored Exams

CASTF has requested of the CAS a copy of a scored exam where the candidate received a score of “10”, “6” and “5”. This was requested for the following exams: Introduction to Ratemaking and Reserving Exam (IRR), Financial and Regulatory Environment Exam (FRE), Financial Economics Module (FE) and Advanced Topics in General Insurance Exam (AT).

The volume of candidates at this early stage of SOA GI track is low. At this time we have had no scores of “10” for any of IRR, FRE or AT. We can’t supply and exam scoring “10” for any of the requested exams.

At this time, we will be able to provide a “6” and a “5” paper for IRR.

With respect to FRE and AT, there has only been one completed exam sitting where the grading process is complete. FRE had one candidate passing and AT had two candidates passing. Names of passing candidates have been published. Distributing the complete scored exam for a passing candidate for these exams would not be on an anonymous basis. This would raise concerns over confidentiality and violate the passing candidates’ privacy. This review process should only be on an anonymous basis. Anonymity cannot be assumed to exist when there are 3 or fewer passing candidates with their names published. At this time, the SOA cannot release scored exams for FRE or AT.

FE is a module, not a traditional pen and paper exam. Module assessments are confidential; the focus of a module is the learning experience. Note that the FE is a common module for a number of exam tracks, it is not GI specific, and the topics included within it are not used to meet any regulatory requirements. For these reasons, the SOA cannot release any FE assessments.
Complete paper for candidate 52293.

Passing paper that score a low “6” on the Spring 2014 sitting for SOA GI IRR Exam.
### (a) 

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Expiry Date</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>12/31/2012</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>5,000</td>
</tr>
<tr>
<td>4/1/2012</td>
<td>3/31/2013</td>
<td>75%</td>
<td>25%</td>
<td>0%</td>
<td>1,000</td>
</tr>
<tr>
<td>7/1/2012</td>
<td>12/31/2012</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>500</td>
</tr>
<tr>
<td>10/1/2012</td>
<td>9/30/2014</td>
<td>12.5%</td>
<td>50%</td>
<td>37.5%</td>
<td>5,000</td>
</tr>
<tr>
<td>1/1/2013</td>
<td>12/31/2013</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>2,000</td>
</tr>
<tr>
<td>7/1/2013</td>
<td>6/30/2014</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>1,500</td>
</tr>
</tbody>
</table>

### Earned Premium

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>CY 2012</th>
<th>CY 2013</th>
<th>CY 2012 Earned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>5,000</td>
<td>0</td>
<td>CY 2012 Earned Premium</td>
</tr>
<tr>
<td>4/1/2012</td>
<td>750</td>
<td>250</td>
<td>Percentage of Premium Earned in CY 2012</td>
</tr>
<tr>
<td>7/1/2012</td>
<td>500</td>
<td>0</td>
<td>CY 2012 Earned Premium</td>
</tr>
<tr>
<td>10/1/2012</td>
<td>625</td>
<td>2,500</td>
<td>100% * 5,000</td>
</tr>
<tr>
<td>1/1/2013</td>
<td>0</td>
<td>2,000</td>
<td>500</td>
</tr>
<tr>
<td>7/1/2013</td>
<td>0</td>
<td>750</td>
<td></td>
</tr>
</tbody>
</table>

Calender 2012 Earned Premium = 6,875
Calender 2012 Earned Premium = 5,500
1(a)  

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Calendar Year 2012 Written Premium</th>
<th>Calendar Year 2013 Written Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>5000</td>
<td>0</td>
</tr>
<tr>
<td>4/1/2012</td>
<td>1000</td>
<td>0</td>
</tr>
<tr>
<td>7/1/2012</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>10/1/2012</td>
<td>5000</td>
<td>0</td>
</tr>
<tr>
<td>1/1/2013</td>
<td>0</td>
<td>2000</td>
</tr>
<tr>
<td>7/1/2013</td>
<td>0</td>
<td>1500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11,500</td>
<td>3,500</td>
</tr>
</tbody>
</table>

Written premium is the total premium allocated to the year the policy is effective.

Calendar Year 2012 Written Premium = 11,500

Calendar Year 2013 Written Premium = 3,500

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Expiry Date</th>
<th>% Premium Earned in</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>12/31/2012</td>
<td></td>
</tr>
<tr>
<td>4/1/2012</td>
<td>3/31/2013</td>
<td></td>
</tr>
<tr>
<td>7/1/2012</td>
<td>6/30/2013</td>
<td></td>
</tr>
<tr>
<td>10/1/2012</td>
<td>9/30/2013</td>
<td></td>
</tr>
<tr>
<td>1/1/2013</td>
<td>12/31/2013</td>
<td></td>
</tr>
<tr>
<td>7/1/2013</td>
<td>6/30/2014</td>
<td></td>
</tr>
</tbody>
</table>
1(b) If No Name Insurance writes motorcycle policies in a winter climate, the expected aspect of seasonality would be expected in their business. People tend to buy or renew their motorcycle policies during summer time. Hence, the distribution of exposure is not uniform across the calendar year, it will see significant the distribution of policies will significantly skewed towards the summer months. In terms of written premium, it's not expected to see any significant changes as the policies are still written & become effective in the same calendar year. However, as the policies are not uniformly written over the calendar year, the earning pattern would be different.
a) taking simple all-year average development factors,

<table>
<thead>
<tr>
<th></th>
<th>12-24</th>
<th>24-36</th>
<th>36-48</th>
<th>48-60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected LDF</td>
<td>( \frac{2+2+2+2}{4} )</td>
<td>( \frac{1.2+1.18+1.19}{3} )</td>
<td>( \frac{1.06+1.05}{2} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td>1.19</td>
<td>1.07</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Cumulative LDF

<table>
<thead>
<tr>
<th></th>
<th>2.1 \times 1.19 \times 1.07 \times 1.02</th>
<th>1.19 \times 1.07 \times 1.02</th>
<th>1.06 \times 1.02</th>
<th>1.02</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.7274086</td>
<td>1.298766</td>
<td>1.0914</td>
<td>1.02</td>
</tr>
</tbody>
</table>

LOD = loss development factor

Accident Year 2013 estimated ultimate claim

= reported claims as at Dec 31, 2013 \( \times \) cumulative LDF

= 130 \( \times \) 2.7274086

= 355

Unpaid Claims for AY 2013 as at Dec 31, 2013

= Ultimate Claim \( - \) Claim paid as Dec 31, 2013

= 355 - 75

= 280

b) \( \text{Percentage ratio reported} = \frac{1}{\text{Cumulative LDF}} \)

\( \frac{12-24}{24-36} \)

Percentage reported
(b) Accident year 2012 claims expected to be reported in 2014

\[ \text{\(242 \times 1.19 = 242\)} \]

\[ \text{\(45.98\)} \]

(c) 2 primary assumptions of development method
- Historical experience is predictive of future experience
- Activities observed to date are relevant in projecting future activities

(d) Estimated Ultimate Claims for AY 2012

\[ \text{Actual reported + % Unreported \times Earned Premium \times Expected Claim Ratio} \]

\[ \text{\(242 + (1 - \frac{1}{1.298766}) \times 520 \times 60\%\)} \]

\[ \text{\(313.77\)} \]

(e) Bornhuetter Ferguson (BF) method may be preferable to development method when there are changes in the adequacy of case reserve. BF method is also preferable to development method \(\approx\) in when insurer launch a new product.
(f) AY 2012 BF expected claim = 520 * 60%

= 312

AY 2012 percentage reported as at Dec 31, 2013 = \(\frac{1}{1.298766}\)

= 76.996%

Expected reported claim as at Dec 31, 2013 = 76.996% * 312

= 240

Actual reported claim as at Dec 31, 2013 = 242

It is clear that the actual reported claims to expected reported claims for accident year 2012 are very close. Hence, the Bornhuetter Ferguson method is reasonable.

(g) Assuming Expected percent reported at Dec 31, 2013 is based on actual percentage reported.

Actual reported for AY 2013 as at Dec 31, 2013 = 37% * 320

= 118

Actual reported from Dec 31, 2013 through Mar 31, 2014 = 178 - 118

= 60
9) Expected % reported at Mar 31, 2014
\[ \frac{2}{3} (0.42) + \left( \frac{1}{3} \right) \]
\[ = \frac{2}{3} (0.37) + \left( \frac{1}{3} \right) (0.77) \]
\[ = 50.33\% \]

Expected claim reported from Dec 31, 2013 through Mar 31, 2014
\[ = 50.33\% \times 320 \]
\[ = 161 \]

Difference between actual vs expected
\[ = 178 - 161 \]
\[ = 17 \]

b) 2 questions I might ask are
- Has there been changes to the underwriting practice?
- Are there any large losses being reported in the first quarter of 2014 for accident year 2013?
(a) LAS = Limited average severity

\[
\text{total count} = 10,000
\]

\[
\text{LAS (1 million)} = \frac{858,000,000 + 629,000,000 + 625,000,000 + (305 + 330 + 32) \times 1,000,000}{10,000}
\]

\[
= \frac{2,779,000}{10,000}
\]

\[
= 277.900
\]

\[
\text{LAS 1 million - 2 million range}
\]

\[
= \left[\frac{470,000,000 + 533,000,000 + 32 \times (1000000)}{2100 + 305 + 3100 + 330 + 32}\right]
\]

\[
= \frac{1,035,000,000}{6,667}
\]

\[
= 155.242
\]

\[
\text{LAS 2 million - 3 million range}
\]

\[
= \frac{77,000,000}{(3100 + 330 + 32)}
\]

\[
= \frac{77,000,000}{3462}
\]

\[
= 22.241
\]

\[
\text{LAS (2 million)} = 277.900 + 155.242 = 433.142
\]

\[
\text{LAS (3 million)} = 277.900 + 155.242 + 22.241 = 455.383
\]

\[\]

\[\]
(a) ILF = Increased limit factor

\[
\text{ILF} \quad \text{1 million to 2 million} = \frac{\text{LAS (2 million)}}{\text{LAS (1 million)}} = \frac{433142}{277900} = 1.5586
\]

\[
\text{ILF} \quad \text{1 million to 3 million} = \frac{\text{LAS (3 million)}}{\text{LAS (1 million)}} = \frac{455383}{277900} = 1.6387
\]

\[
\text{ILF} \quad \text{2 million to 3 million} = \frac{455383}{433142} = 1.0513
\]

(b) Let ILF increase at a decreasing rate. The increased limit factor from 2 million to 3 million is 1.0513. Hence, in order to be consistent, the increase in ILF from 3 million to 4 million should be lower than 1.0513. The 4 million increased limit factor should be in the range of

\[
1.6387 < 4 \text{ million increased limit factor } < 1.6387(1.0513)
\]

\[
1.6387 < 4 \text{ million increased limit factor } < 1.7227
\]
C) Consistency is important for increased limit factors so that insured is not overcharged. If the limit increases, the amount of large claim that actually hit the limit higher limit intuitively, claims will go to fill up the lower limit before hitting the higher limit. The amount of claim that actually hit the higher limit is comparatively low. Hence increased limit factor should increase at a decreasing rate. Otherwise, the price will not be competitive.

d) If the claims is capped, the same we lost the information above the cap and the resulting increased limit factor will be understated. For instance, if a claim with $2 million but $ was capped at $5 million, the resulting increased limit factor would be 1.5 instead of 2 assuming the basic limit is $1 million and there's only 1 claim.
<table>
<thead>
<tr>
<th>Year</th>
<th>Incremental</th>
<th>Closed</th>
<th>Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>600</td>
<td>280</td>
<td>120</td>
</tr>
<tr>
<td>2012</td>
<td>660</td>
<td>308</td>
<td>132</td>
</tr>
<tr>
<td>2013</td>
<td>720</td>
<td>336</td>
<td>144</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Incremental</th>
<th>Claim Paid</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1290</td>
<td>5482</td>
<td>15325</td>
</tr>
<tr>
<td>2012</td>
<td>958</td>
<td>4084</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>1794</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(b)  

(i) New legislation lengthens statute of limitations. It would extend the period for claims reporting. Consequently, ultimate claim may increase.

(ii) 

(Cc)
a) Insurance savings is the saving to the insurer for limiting retrospective premium no lower than minimum premium.

Insurance charge is the cost to the insurer for capping retrospective premium at no more than maximum premium.

b)

![Diagram]

\[ A = \psi(r) \]
\[ C = \phi(r) \]
c) \[ B + C = 1 \]
\[ A + B = 1 \]

\[ \frac{E[L]}{E} = B + C = 1 \]
\[ \psi(r) = A \]
\[ \phi(r) = C \]
\[ r = A + B \]

\[ A = \frac{1}{2} \cdot f + A \]
\[ f = (B + C) - (A + B) = 1 \]
\[ A = r + C - 1 = A + B + C - (B + C) \]
\[ = e^{-A} \]

(d) 

```
entry ratio
```

```
\( \psi(r) \)
```

```
0 1
```

```
F(y)
```
a) ULAE : claims department staff salary, rent and utility.
   ALAE : adjustor fees, lawyer fee.

b) 

c) Kittle ULAE ratio = Paid ULAE / average of paid & reported.

<table>
<thead>
<tr>
<th>CY</th>
<th>ULAE ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>110 / \sqrt{\frac{1200 + 1300}{2}} = 0.044 0.088</td>
</tr>
<tr>
<td>2012</td>
<td>110 / \sqrt{\frac{1100 + 1100}{2}} = 0.1</td>
</tr>
<tr>
<td>2013</td>
<td>110 / \sqrt{\frac{1000 + 900}{2}} = 0.1158</td>
</tr>
</tbody>
</table>

The ULAE is showing an increasing trend, but in favor of stability, the simple 2 year average was selected.

Selected ULAE ratio = \frac{0.044 + 0.1158}{2} = 0.0779

Unpaid ULAE = 0.0779 \times 1000 + 0.5 \times 0.0779 \times 900

= 156
d) estimate closed count, reported count, open count.
   Compute weighted average count.
   Compute average UFE per weighted count.
a) Retroactive date is the latest accident date for which coverage is provided.

b) 

c) (i) Cost estimated. 
     The rate priced using claim-made basis is closer to the actual rate cost.

     (ii) The rate priced using claims made basis is not affected by change in reporting trend whereas occurrence coverage is affected.

     (iii) Investment income earned on claims made policy is always lower than occurrence coverage policy due to shorter lag between claim settlement.

d) Coverage gap occurs when the retroactive date is not of new policy is not after the retroactive date of previous policy.
(e) Tail factor = \( \frac{300(1.1) + 200(1.1)^2}{1000} \)

\[ = 0.572 \]
(Q) Cumulative age-to-age factor:

\[ 12 - UH = 1.5 \times 1.28 \times 1.13 \times 1.04 \times 1.02 \]
\[ = 2.3015 \]
\[ 24 - UH = 1.28 \times 1.13 \times 1.04 \times 1.02 \]
\[ = 1.5343 \]
\[ 36 - UH = 1.13 \times 1.04 \times 1.02 \]
\[ = 1.1987 \]

\[
\% \text{ Used} = \frac{1}{\text{Cumulative age-to-age factor}}.
\]

<table>
<thead>
<tr>
<th>AY</th>
<th>Earned Exposure</th>
<th>% Used</th>
<th>Earned Exposure</th>
<th>Reported Claim Severity</th>
<th>Trend factor</th>
<th>Tended Claim Pure Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>5580</td>
<td>83.42%</td>
<td>4655</td>
<td>12570.000</td>
<td>1.1406</td>
<td>80070.1</td>
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<tr>
<td>2012</td>
<td>5670</td>
<td>65.18%</td>
<td>3695</td>
<td>46545.000</td>
<td>1.06799</td>
<td>58205.5</td>
</tr>
<tr>
<td>2013</td>
<td>5460</td>
<td>43.45%</td>
<td>2372</td>
<td>45155.000</td>
<td>1</td>
<td>515000</td>
</tr>
</tbody>
</table>

\[
\frac{10722}{1897756} = 177
\]
(a) selected trending pure premium = 177

<table>
<thead>
<tr>
<th>AY</th>
<th>Earned Exposure</th>
<th>Detrend Factor</th>
<th>Pure Premium at historical level</th>
<th>UH claim</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>5580</td>
<td>1/1.1406</td>
<td>155</td>
<td>864900</td>
</tr>
<tr>
<td>2012</td>
<td>5670</td>
<td>1/1.06799</td>
<td>166</td>
<td>941220</td>
</tr>
<tr>
<td>2013</td>
<td>5460</td>
<td>1</td>
<td>177</td>
<td>966420</td>
</tr>
</tbody>
</table>

Pure Premium at historical level = Selected PP * Detrend Factor
Ultimate claim = Earned exposure * PP at historical level.

(b) 3 key components of actuarial control cycle

- identify the problem - identify the need for use of trend
- monitor result - monitor the result of reserving and rate making
a) Book of business 1,

a (i) The expected method

Ultimate claim will be understated. Expected method does not automatically respond to changes in claim experience. Since claim is deteriorating, but expected ultimate claims remain unchanged, the estimate of ultimate claim is understated.

a (ii) The development method.

Development method respond to deteriorating in claims in the form of high actual claim and higher age-to-age factor. In this case, development method's projected ultimate claim is similar to actual ultimate claim.

a (iii) The Bornhuetter Ferguson method (BF).

BF method is essentially the blend of expected method & development method. If we are looking at mature accident year where further development is not expected, BF method's estimated ultimate claim is equal the same as the one estimated using development method. For less mature accident year, the actual reported or paid claim would respond to deterioration in claims in the form of higher reported or paid claim.
(iii) However, the expected unreported portion of BF method would remain unchanged unless the expected loss is judgementally changed. In this case, BF method would likely to understate the ultimate claims but understate by a small margin as compared to the expected method.

b (i) Expected method would produce ultimate claims that are similar to actual ultimate claims. Strengthening of case reserve would mean claims are reported earlier but the ultimate claim experience does change. The expect ultimate claim of expected method doesn't change.

b (ii) The development method would overstate the ultimate claim. Due to strengthening of case estimate, the reported to-date-to-date is higher, the claims reported in later development year would decrease, however, without adjustment, higher reported claim will be multiplied by the same cumulative age-to-age factor, resulting in higher than overstatement of ultimate claim.
b (iii) BF method would also overstate the ultimate claim but by a lower margin as compared to development method. Due to strengthening of case reserve, the claims reported to date is higher than what it used to be the usual level, in the case the future claims should reduce, however, the expected future claims under BF remains unchanged, hence resulting in overstatement of ultimate claim.
a) Policy are written uniformly over the experience period. Policy are earned uniformly over policy term.

b) 

<table>
<thead>
<tr>
<th>CY11</th>
<th>CY12</th>
<th>CY13</th>
<th>CY14</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JUIL</td>
<td>JUL1</td>
<td>APR1</td>
<td>APR1</td>
</tr>
</tbody>
</table>

Part A

<table>
<thead>
<tr>
<th>CY11</th>
<th>CY12</th>
<th>CY13</th>
<th>CY14</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.07</td>
<td>0.963</td>
<td>0.93411</td>
</tr>
<tr>
<td>JUIL</td>
<td>MAY1</td>
<td>APR1</td>
<td>MAY1</td>
</tr>
</tbody>
</table>

CY11 weighted average relative rate = \( \frac{1}{3} (0.5)(0.5)(1.07) + (1 - \frac{1}{3}(0.5)(0.5)) \)

= 1.00875

Part A, CY, assuming an on-level factor is used for pricing purposes.

Current rate = 20% \( (0.93411) + 80% \( 1.0379 \)

= 1.017142

On-level factor = \( \frac{1.017142}{1.00875} \) = 1.0083
C) State mandated change is represented by a straight line across the effective date. All in-force policies will remain unchanged. Assuming change in minimum policy limit does not result in change in average rate, it only result in change in distribution of exposure. In this case, there is no changes to the on-level calculation.
<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative Paid Claims</th>
<th>Cumulative Reported Claims</th>
<th>Cumulative Reported Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AY 12 24 36 48</td>
<td>AY 12 24 36 48</td>
<td>AY 12 24 36 48</td>
</tr>
<tr>
<td>2010</td>
<td>2200 4700 6540 7650</td>
<td>7150 8420 9500 9890</td>
<td>77 80 82 83</td>
</tr>
<tr>
<td>2011</td>
<td>2460 5250 7450</td>
<td>8320 10490 11150</td>
<td>82 9294 94</td>
</tr>
<tr>
<td>2012</td>
<td>2370 4890</td>
<td>9610 11620</td>
<td>98 108</td>
</tr>
<tr>
<td>2013</td>
<td>3260</td>
<td>9620</td>
<td>90</td>
</tr>
<tr>
<td>Year</td>
<td>Attributed</td>
<td>Cumulative</td>
<td>Closed</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>2010</td>
<td>22</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>2011</td>
<td>20</td>
<td>44</td>
<td>62</td>
</tr>
<tr>
<td>2012</td>
<td>25</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
a) Premium trend adjustment aim to adjust premium for changes in mix of business to enable "apple to apple" comparison.

b) Experience Period | Weighted ILF | Trend
--- | --- | ---
2011 | 0.24(0.9) + 0.52(1) + 0.24(1.15) = 1.012 | 0.49% |
2012 | 0.22(0.9) + 0.52(1) + 0.26(1.15) = 1.017 | 0.49% |
2013 | 0.20(0.9) + 0.52(1) + 0.28(1.15) = 1.022 | 0.49% |

selected trend = 0.49%.

c) Average earned date for 1 year policy = September 1, 2015
Average earned date for 6 months policy = May 1, 2015
Average earned date = \( \frac{2}{3}(12) + \frac{1}{3}(9) \) = 11

average earned date is 11 months after September 1, 2014.

<table>
<thead>
<tr>
<th>Experience Period</th>
<th>Trend Period (month)</th>
<th>Trend Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>49</td>
<td>( (1.0049)^{49/12} = 1.020 )</td>
</tr>
<tr>
<td>2012</td>
<td>37</td>
<td>( (1.0049)^{37/12} = 1.015 )</td>
</tr>
<tr>
<td>2013</td>
<td>25</td>
<td>( (1.0049)^{25/12} = 1.010 )</td>
</tr>
</tbody>
</table>
(a) average weighted pure premium = \( \frac{450(15200)+12400(475)+507(10700)}{15200 + 12400 + 10700} \)

\[ = \frac{18154900}{38300} \]

\[ = 474.4 \]

<table>
<thead>
<tr>
<th>Territory</th>
<th>Trended PP</th>
<th>relativity</th>
<th>Complement of Credibility</th>
<th>Rebalanced complement of Credibility</th>
<th>Credibility</th>
<th>Credibility weighted relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>450</td>
<td>0.94914</td>
<td>1.00</td>
<td>0.99</td>
<td>1</td>
<td>0.94914</td>
</tr>
<tr>
<td>B</td>
<td>475</td>
<td>1.0021</td>
<td>0.95</td>
<td>0.94 ( \sqrt{\frac{0.729}{0.001}} = 0.9 )</td>
<td>0.9959</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>507</td>
<td>1.0696</td>
<td>1.10</td>
<td>1.09 ( \sqrt{\frac{0.635}{0.001}} = 0.84 )</td>
<td>1.0729</td>
<td></td>
</tr>
<tr>
<td></td>
<td>474</td>
<td>1.01</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Using A as base territory:

\( (2) = \) trended PP \( \div 474 \)

\( (3) = (3)(6) + (5)(1 - 6) \)

<table>
<thead>
<tr>
<th>Territory</th>
<th>relativity (5)</th>
<th>(8) = (7) ( \div (7)_A )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1.13</td>
<td></td>
</tr>
</tbody>
</table>
b) 

C) The differences are due to:
   - distributional bias
   - dependence
a) at development month 6, the ratio of paid claims to reported claims in the first half of the year is always higher.

The reported ratio of paid claims to reported claims in the latest accident year (both first & second half) is lower than historical ratio.

b) The first observation is due to seasonality. The second observation can be caused by strengthening of case reserve.

c) Check the ratio of closed count to reported count. The trend should be similar to ratio of paid claims to reported claims.

The next diagnostic test is to review the average case reserve. The average reported severity shows increase in the latest accident year should be higher than that of historical years. Review the average reported claims. The average reported claims for AY 2013 is expected to be higher than previous accident years.
d) strengthening of case reserve
   change in distribution of policy. e.g. writing policy
   with higher limit.
a) Total unpaid claim = $32470 + 34680 + 35000 - 72400$
   \[= 29750\]

Total unpaid including ULAE = $29750(1.08)$
   \[= 32130\]

unpaid ULAE = $0.08(\text{IBNR}) + 0.08(\text{multiplier})(\text{case reserve})$
   \[= 0.08(13850) + 0.08(0.5)(88300 - 72400)\]
   \[= 1744\]

Total unpaid claim + ULAE = $29750 + 1744 = 31494$

b) Selecting claim ratios for premium liabilities
   - premium trend
   - pure premium trend
   - change in distribution or mix of business

C) AY Loss Ratio
   
<table>
<thead>
<tr>
<th>AY</th>
<th>Loss Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>72%</td>
</tr>
<tr>
<td>2012</td>
<td>73%</td>
</tr>
<tr>
<td>2013</td>
<td>71%</td>
</tr>
</tbody>
</table>

Selected loss ratio = \[
\frac{72\% + 73\% + 71\%}{3} = 72\%
\]

Premium liability = UPR \*(Loss ratio \*(1+ULAE ratio))
   \[= 32600 \* 77.76\%
   \[= 25349\]

d) \( UPR = 32600 \)

Premium liability = 25349

equity in unearned reserve = 32600 - 25349

= 7251
(a) Hazard module describes the hazard, for instance tornado, earthquake that contribute to loss.

Inventory module describes the information of the insured property such as building height, age of building, value of dwelling, value of content and so on.

Vulnerability module describe the expected damage to the property when subject to external forces at varying intensity.

(b) Hazard module should be similar for both Comm Co and HomeCo because it deals with the external forces that causes the damage. Inventory module is expected to be different for Comm Co and HomeCo as property covered by both companies are different. Vulnerability module is also expected to be different for both companies as risk-protection features for commercial property & residential property are quite different. Commercial property usually have more risk control and mitigation initiatives.
a) (i) Manual - rate is determined by using base rate and rating factors available in rating manual.

(ii) Schedule rating is used to adjust manual rates by applying credit or debit based on specific characteristic of insured.

(iii) Under prospective experience rating, the premium of an insured is determined using actual insured's prior experience.

(iv) Under retrospective experience rating, insured pays an initial premium, after policy term expires, an audit will be done, and premium will be adjusted accordingly based on insured's experience during the policy term.

b) Retrospective experience rating is not appropriate for insureds with small premium size because the claim actual experience of small insured can be very volatile. Under retrospective experience rating, insured with poor claims experience will be charged significantly higher premium.
C) experience modification = \( \frac{\text{Population claim factor}}{\text{Population exposure}} \times Z + (1 - Z) \)

where \( Z \) is credibility factor

<table>
<thead>
<tr>
<th>Participant</th>
<th>Population</th>
<th>% Population</th>
<th>U+ Claims</th>
<th>% Claim</th>
<th>Credibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>435,600</td>
<td>63.54%</td>
<td>550,000</td>
<td>44%</td>
<td>( \frac{\sqrt{435,600}}{1,000,000} = 0.66 )</td>
</tr>
<tr>
<td>Exurb</td>
<td>250,000</td>
<td>36.46%</td>
<td>700,000</td>
<td>56%</td>
<td>( \frac{\sqrt{250,000}}{1,000,000} = 0.5 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>experience modification</th>
<th>allocation percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>( \frac{0.44 \times 0.66}{0.6354} ) + ( 1 - 0.66 ) = 0.797</td>
<td>( \frac{0.797 \times 0.354}{0.9687} = 52% )</td>
</tr>
<tr>
<td>Exurb</td>
<td>( \frac{0.56 \times 0.5}{0.3646} ) + ( 1 - 0.5 ) = 1.268</td>
<td>( \frac{1.268 \times 0.3646}{0.9687} = 48% )</td>
</tr>
</tbody>
</table>

Total experience modification factor = \( \sum (\text{Population}_i \times \text{Experience modification}_i) \)

= 0.6354(0.797) + 0.3646(1.268)

= 0.9687

Allocation percentage \( i \) = \( \frac{\text{Population} \times \text{Experience modification}_i}{\sum (\text{Population} \times \text{Experience modification}_i)} \)

Allocation percentage (Centre) = 52% 
Allocation percentage (Exurb) = 48%
d) It's important to understand the distribution of ALAE in allocation of retained claims and expenses to participants in self-insurance pool to strike a balance between allocation by exposure & allocation by claim. The goal is to achieve stability in contribution and at the same time contribution are equitable.
a) Appropriate split between fixed & variable expenses in ratemaking is important so that the rate charged is sufficient to cover all expense and at the same time maintaining competitiveness of the insurance premium.

b) Indicated rate = \( \frac{PP + F}{1 - V - Q} \)

\[
\begin{align*}
&= \frac{350 + 100}{1 - 0.06 - 0.16 - 0.05} \\
&= \frac{450}{0.75} \\
&= 600
\end{align*}
\]

c) revised fixed expense
a) Change in policy deductibles may influence the tendency to claim, hence resulting in change in claim frequency. For instance, writing have having a low deductible makes a claim more worthwhile as insured ultimately gets more money.

Impact of change in deductible on severity is best illustrate using an example. Assuming there are 2 claims, one cost $1000 and the other one cost $1500. With a deductible of $500, the severity is $750. However, increasing the deductible to $1000 would result in severity of $1000 since insurer is only responsible for $1000, which is $1500 to decrease to $500.

b) Points to consider when experience is not fully credible for trending:
- use the trend of a larger group (in which the group being trend belongs)
- credibility weight the trend from computed from experience with industry trend rate.
C) Average accident date for six-month policies written between June 1, 2014 & May 31, 2015 is 9 months after effective date, which is March 1, 2015.

<table>
<thead>
<tr>
<th>AY</th>
<th>Average Accident Date</th>
<th>Trend to Period</th>
<th>Trend Period (months)</th>
<th>Trend Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>July 1, 2012</td>
<td>March 1, 2015</td>
<td>32</td>
<td>((1 - 0.012)^{\frac{32}{12}} (1 + 0.058)^{\frac{32}{12}} = 1.125)</td>
</tr>
<tr>
<td>2013</td>
<td>July 1, 2013</td>
<td>March 1, 2015</td>
<td>20</td>
<td>((1 - 0.012)^{\frac{20}{12}} (1 + 0.058)^{\frac{20}{12}} = 1.077)</td>
</tr>
</tbody>
</table>

a) Average accident date = June 1, 2015

<table>
<thead>
<tr>
<th>AY</th>
<th>Trend Period</th>
<th>Trend Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>32 + 3 = 35</td>
<td>((1 - 0.012)^{\frac{35}{12}} (1 + 0.058)^{\frac{35}{12}} = 1.138)</td>
</tr>
<tr>
<td>2013</td>
<td>20 + 3 = 23</td>
<td>((1 - 0.012)^{\frac{23}{12}} (1 + 0.058)^{\frac{23}{12}} = 1.089)</td>
</tr>
</tbody>
</table>
Complete paper for candidate 52485.

Failing paper that scored a high “5” on the Spring 2014 sitting for SOA GI IRR Exam.
<table>
<thead>
<tr>
<th>(a)</th>
<th>EFF DATE</th>
<th>TERM</th>
<th>PREM</th>
<th>CY12 WP</th>
<th>CY12 EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2012</td>
<td>A</td>
<td>5000</td>
<td>5000</td>
<td>5000 x 1</td>
<td></td>
</tr>
<tr>
<td>1/1/2012</td>
<td>A</td>
<td>1000</td>
<td>1000</td>
<td>1000 x 0.75</td>
<td></td>
</tr>
<tr>
<td>1/1/2012</td>
<td>S</td>
<td>500</td>
<td>500</td>
<td>500 x 1</td>
<td></td>
</tr>
<tr>
<td>10/1/2012</td>
<td>2</td>
<td>5000</td>
<td>5000</td>
<td>5000 x 3 / 24</td>
<td></td>
</tr>
<tr>
<td>1/1/2013</td>
<td>A</td>
<td>2000</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1/1/2013</td>
<td>A</td>
<td>1500</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

11,500 6875

(b) The calculation is based on earned and written evenly distributed over policy term.

Written more winter motorcycle policies WP increases but EP decreases.
(f) \[ \text{ACTUAL} = AY_{302.24} \]
\[ = 242 \]
\[ \text{EXPECTED} = EP_{302} \times ELR \times \frac{1}{\text{PDF}_{1.299}} \]
\[ = 240.185 \]
\[ \text{ACTUAL} - \text{EXPECTED} = 242 - 240.185 = 1.815 \]
\[ \frac{A}{E} = 1.008 \]

\[ \text{Actual} > \text{Expected} \Rightarrow \text{MORE CLAIMS DEVELOP THAN EXPECTED} \]

\[ \text{However, } \frac{A}{E} = 1.008 \text{ 0.8% difference} \]

\[ \text{IT IS NOT SIGNIFICANT DIFFERENCE} \]

\[ \text{Therefore, BF METHOD PROJECT WL IS VERY REASONABLE, WHICH ELR = 60%} \]

\[ \text{IS APPROPRIATE} \]

\[ (g) \]
\[ X_{0.37} = \frac{X - 0.37}{0.37 - 0} = \frac{0.25 - 0}{0.37 - 0.37} = 1 \]
\[ 30\% \]
\[ \text{Departure} = 0.37 \times 0.37 = 0.47 \]
\[ \text{320} \quad 100\% \]
\[ y_{130} = 0.47 \times 0.37 = 0.17 \]
\[ y_{130} = 130 + (320 - 130) \times \frac{0.47 - 0.37}{1 - 0.37} = 160.159 \]

\[ \text{EXPECTED} = 160.159 \text{ BASED ON LINEAR INTERPOLATION} \]
\[ \text{Actual} = 178 \text{ DIFFERENCE } = A - E = 178 - 160.159 = 17.841 \]
h) 1) Does the case reserve estimate change?
2) Is there a large claim reported?
3) Does claim settlement process change?
(9) \[ ILF(2M) = \frac{LAS(2M)}{LASC(1M)} = \frac{38,865}{27,7900} = 1.374 \]

\[ LASC(1M) = \frac{858 + 62 + 62 + (303 + 330 + 32) 	imes 1M}{8333 + 2900 + 305 + 3100 + 330 + 32} = \frac{27,7900}{18,000} = 1.551,724 \]

\[ LASC(2M-1M) = \frac{470 + 533 + 32 	imes 1M}{805 + 330 + 32} = \frac{1,035,000,000}{665} = 1,551,724 \]

\[ PROBC(LOSS > 1M) = \frac{665}{10,000} = 0.067 \]

\[ LASC(2M) = LASC(1M) + LASC(2M-1M) \times PROBC(LOSS > 1M) \]

\[ = 27,7900 + 0.067 \times 1,551,724 \]

\[ = 28,1865 \]

\[ LASC(3M-2M) = \frac{971}{32} = 241,625 \]

\[ PROBC(E > 2M) = \frac{32}{10,000} \]

\[ LASC(3M) = LASC(2M) + PROBC(E > 2M) \times LASC(3M-2M) \]

\[ = 38,1865 + \frac{32}{10,000} \times 240,625 \]

\[ = 389,565 \]

\[ ILF(3M) = \frac{LASC(3M)}{LASC(1M)} = \frac{389,565}{27,7900} = 1.402 \]
(c) \[ \text{ILF}(2M) = 1.374 \]
\[ \text{ILF}(3M) = 1.402 \]

**CONDITION 1:** \( \text{ILF}(4M) > \text{ILF}(3M) = 1.402 \)

**CONDITION 2:** MARGINAL DECREASE RETURN (CONDITION)

\[ \text{ILF}(4M) \leq \frac{\text{ILF}(6M) + \text{ILF}(3M)}{2} \]
\[ \leq \frac{\text{ILF}(3M) + \frac{\text{ILF}(6M) + \text{ILF}(3M)}{2}}{2} \]
\[ \leq 1.395 \]

(c) NEED TO FOLLOW THE MARGINAL DECREASE RETURN THEORY

\[ \forall x, y, f\left(\frac{x+y}{2}\right) \leq \frac{f(x) + f(y)}{2} \]

(d) FROM (c) RESULT

\[ \text{ILF}(4M) \geq 1.402 \text{ CONDITION 1} \]

BUT \( \text{ILF}(4M) \leq 1.395 \text{ CONDITION 2} \)

THERE IS NO SUCH THING

THUS, WE KNOW CLAIM NOT APPLIED

IN DETERMINING INCREASE LIMIT FACTORS
Candidate No. 52485

INCREMENTAL CLOSED COUNT

(a) 

11  120

12  660  308 \[
\begin{align*}
132 &= 1100 - 308 - 660 \\
360 &= 1200 - 720 - 120
\end{align*}
\]

INCREMENTAL PAID

11  1839000

12  1258000 \[
\begin{align*}
1903365 &= 1391 \times 1.035 \\
1268000 \times 1.035 &= 1969982 = 1391 \times 1.0352
\end{align*}
\]

= 1302030

TOTAL UNPAID = 

120 \times 1302030

132 \times 1903365

360 \times 1969982

= 1.1168 \times 10^9

(b) (i) NEW LEGISLATION LENGTHENS THE STATUTE OF LIMITATIONS

(ii) AFFECT SEVERITY TENDENCY

(iii) AFFECT THE PROPORTION OF CLOSE COUNTS

(c) THERE IS NO IBMR COUNT. THEN, FREQUENCY AND SEVERITY METHOD IS PREFERRED TO OTHER METHODS
Question No. 5

(a) Insurance savings due to subject to maximum charge, due to minimum.

(b) 

\[ \text{Empty Ratio} \]

\[ \psi(r) \]

\[ \phi(r) \]

\[ \text{CDF} \]
### METHOD 1: USE REPORTED SALVAGE A2A TO PROJECT ULTIMATE ULAE

<table>
<thead>
<tr>
<th>A2A</th>
<th>24-12</th>
<th>26-24</th>
<th>48 - 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1.6984</td>
<td>1.2991</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.6970</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SELECTED</td>
<td>3</td>
<td>1.6976</td>
<td>1.2991</td>
</tr>
</tbody>
</table>

1. CDF (12, 24, 36, 48)  
   7.6084 2.5361 1.4939 1.15 \(\in\) ASSUMPTION

2. REPORTED SALVAGE 2013 2012 2011 2010
   35 69 112 139

3. \( x(2) \times 3 \) 266.3962 174.9946 167.3240 159.86
   2013 ULTIMATE SALVAGE = 266.3962

### METHOD 2: ULTIMATE REPORTED NET OF SALVAGE

- ULTIMATE REPORTED GROSS OF SALVAGE = ULTIMATE ULAE

<table>
<thead>
<tr>
<th>A2A</th>
<th>SAMPLE AVERAGE</th>
<th>CDF REPORTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-12</td>
<td>( \frac{900 + 900 + 1500}{3} )</td>
<td>12 2.138 2013 579 1234.388</td>
</tr>
<tr>
<td>26-24</td>
<td>1.103</td>
<td>26 1.1218 -- (CA)</td>
</tr>
<tr>
<td>48-36</td>
<td>1.0104</td>
<td>48 1.0104</td>
</tr>
</tbody>
</table>

ULT-48 \(\in\) ASSUMPTION 48 1
Candidate No. S2485

<table>
<thead>
<tr>
<th>PAGE 2</th>
<th>REPORTED NET OF SALVAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>$4 \quad 36 \quad 48$</td>
</tr>
<tr>
<td>10</td>
<td>$479 \quad 887 \quad 948 \quad 927$</td>
</tr>
<tr>
<td>11</td>
<td>$503 \quad 932 \quad 996$</td>
</tr>
<tr>
<td>12</td>
<td>$588 \quad 978$</td>
</tr>
<tr>
<td>13</td>
<td>$544$</td>
</tr>
</tbody>
</table>

$$A_{2A} = \frac{(887 + 932 + 996)}{3} = 922.67$$

$$12 \quad 2.2259 \quad 813 \quad 549$$

$$36 \quad 24 \quad 1.0680$$

$$68 - 34 \quad 0.9774$$

$$UST - 48 \quad 1.15 \leq USE \ SALVAGE \ TAX \ FACTOR 48 \quad 1.15$$

$$(12 \times 2) = 1210.9156$$(B)

$$(A) - (B) = 1234.388 - 1210.9156 = 23.4232$$
Candidate No. 52485

(a) CHANGE IN CASE RESERVE ESTIMATE => BS RESTATE CASE

O/S METHOD

RESTATED AVG CASE

\[
\begin{align*}
2011 & : 6531 - 8048 = 8740 \\
2012 & : 6857 - 8450 = 1593 \\
2013 & : 7200
\end{align*}
\]

RESTATED REPORTED \( \Delta \) = RESTATED AVG CASE \( \Delta \) X OPEN COUNTS + PAID \( \Delta \)

\[
\begin{array}{ccc}
12 & 24 & 36 \\
1 & 1981510 & 3,708,400 & 3,375,500 \\
12 & 2106590 & 3,245,500 \\
13 & 2376000
\end{array}
\]

\[
\text{A2A} = 6857 \times 240 + 530,000
\]

SELECTED SAMPLE AVG

\[
\begin{array}{ccc}
24-12 & 36-24 & \text{ULT-36} \\
1.639 & 1.193 & 1.193
\end{array}
\]

TAIL FACTOR = LAST A2A FACT

(1) CDF

\[
\begin{array}{ccc}
12 & 24 & 36 \\
2.229 & 1.423 & 1.193
\end{array}
\]

(2) REPORTED

\[
\begin{array}{ccc}
2370000 & 3245500 & 3865800 \\
5582374 & 4619154 & 4623829
\end{array}
\]

(1) x(2) = UL
(a) ULAE = GENERAL EXPENSE, ADMINISTRATION COST
ALAE = LEGAL FEE, COURT FEE

(b) IT IS NOT IN THE STEADY STATE
   "PAID CLAIM \( \times \) BUT PAID ULAE CONSTANT

(c) ULAE RATIO = \( \frac{\text{PAID ULAE}}{\text{EXPENSE+PAID}} \)

\[
\begin{array}{cc}
11 & 0.088 \\
12 & 0.100 \\
13 & 0.116 \\
\end{array}
\]

SELECT 0.116 TO REFLECT CURRENT ENVIRONMENT

ULAE UNPAID = (ULAE FACTOR \( \times \) IBNR) + (ULAE FACTOR \( \times \) MULTIPLIER \( \times \) CASE O/S)

\[
= 0.116 \times 1000 + 0.116 \times 0.5 \times 900
\]

\[
= 168.20 \quad \text{FUTURE}
\]

(d) STEP 1: DETERMINE HOW MANY COUNTS IN CY's
STEP 2: CALCULATE COST PER COUNT WITH TREND ADJUSTMENT
STEP 3: UNPAID ULAE COUNTS IN STEP 1 \( \times \)

COST PER COUNT WITH TREND ADJUSTMENT
RETRIBUTIVE DATE IS THAT

(b) DEFINE THE CLAIM CAN BE REPORTED DATE

(b) MALPRACTICE COVERAGE SINCE THERE ARE LONG REPORTED LAG.

PHYSICIAN LIABILITY

(c)

(i) COST = CM < OCCURRENCE
(ii) DECISION = CM IS MORE PRECISION IN PRICE OCCURRENCE LESS DUE TO LONG LAG.

(iii) CM SHORT LAG => LESS OPPORTUNITY TO OCCURRENCE (LONG LAG =) MORE OPPORTUNITY TO EARN INV INC

(d) GAP

- CM CONVERT TO OCCURRENCE POLICY
- PHYSICIAN RETIRED

(c)

\[
\begin{array}{c}
1000 \\
\frac{500}{300} \\
300 \div 330 \\
200 \div 220 \div 242 \\
200 \div 20 \div 242 \div 266,2 \\
\end{array}
\]

\[
= 1.520.2
\]

TAIL FACTOR = \[\frac{1520.2}{1000} = 1.520.2\]
(b) \[ \text{RESTATED REPORTED } \Delta = \text{RESTATED PAID } \Delta + \text{RESTATED CASE O/S } \Delta \]

\[ \text{ADJUST SETTLEMENT RATE CHANGE ADJUST CASE O/S ESTIMATE} \]

RESTATED CASE O/S \( \Delta \) IS BASED ON (O) RESULTS.

RESTATED PAID \( \Delta \)

**STEP 1.** PROJECTED ULTIMATE COUNT FROM CLOSE COUNT \( \Delta \)

**STEP 2.** CALCULATE THE DISPOSAL RATE

\[ = \frac{\text{CLOSED COUNT IN THE MATURITY AGES}}{\text{PROJECTED ULTIMATE COUNT}} \]

**STEP 3.** RESTATE CLOSE COUNT \( \Delta \) BASED ON

SELECTED DISPOSAL RATE

**STEP 4.** RESTATE PAID \( \Delta \)

\[ = \text{AVG CLOSED } \Delta \times \text{RESTATED CLOSED COUNT } \Delta \]

WHERE \( \text{AVG CLOSED } \Delta = \frac{\text{PAID } \Delta}{\text{CLOSED COUNT}} \)
### Candidate No. 2485

<table>
<thead>
<tr>
<th>(a)</th>
<th>AY</th>
<th>REPORTED CLAIM</th>
<th>(2)</th>
<th>SEVERITY</th>
<th>(1) x (2)</th>
<th>TRENDED REPORTED CLAIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>702000</td>
<td>1.045²</td>
<td>966601</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>645000</td>
<td>1.045¹</td>
<td>679525</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>515000</td>
<td>1.045⁰</td>
<td>515000</td>
<td>(\frac{185126}{185126} = (A))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(a)</th>
<th>AY</th>
<th>EP</th>
<th>USE-UP FACTOR</th>
<th>FREQUENCY TRENDED USE-UP EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>5680</td>
<td>6.834</td>
<td>1.022²</td>
<td>4860</td>
</tr>
<tr>
<td>12</td>
<td>5690</td>
<td>0.652</td>
<td>1.022¹</td>
<td>3798</td>
</tr>
<tr>
<td>13</td>
<td>5460</td>
<td>0.434</td>
<td>1.022⁰</td>
<td>2369</td>
</tr>
</tbody>
</table>

\[
\text{A2A} = \frac{\text{CDF}}{\text{CDF}} = \text{USED-UP FACTOR}
\]

<table>
<thead>
<tr>
<th>Group</th>
<th>EP</th>
<th>SELECTED PP</th>
<th>ULTIMATE CLAIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-12</td>
<td>1.5</td>
<td>2.362</td>
<td>0.434</td>
</tr>
<tr>
<td>36-24</td>
<td>1.28</td>
<td>1.634</td>
<td>0.652</td>
</tr>
<tr>
<td>08-26</td>
<td>1.13</td>
<td>1.197</td>
<td>0.834</td>
</tr>
<tr>
<td>60-68</td>
<td>1.04</td>
<td>1.061</td>
<td>0.943</td>
</tr>
<tr>
<td>U1-68</td>
<td>1.02</td>
<td>1.02</td>
<td>0.980</td>
</tr>
</tbody>
</table>
3 KEY COMPONENTS OF THE ACTUARIAL CYCLE

(b) DEFINE THE PROBLEM

SOLVE THE PROBLEM

MONITOR RESULTS

DEFINE THE PROBLEM - ESTIMATE THE ULTIMATE CLAIMS OR RATE CHANGE

SOLVE THE PROBLEM - USE DIFFERENT METHODS WITH SELECTION AND USE TREND RATE TO ADJUST DATA SUCH THAT REFLECT THE CHANGE IN THE FUTURE PERIOD

MONITOR RESULT - SELECT SOLUTIONS AND TRACE THE CLAIM OR RATE CHANGES
### Question

**Candidate No. 52485**

<table>
<thead>
<tr>
<th>Year</th>
<th>A2A</th>
<th>CDF</th>
<th>AY</th>
<th>Reported</th>
<th>UL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-13</td>
<td>2.05</td>
<td>12</td>
<td>2,192</td>
<td>2013</td>
<td>130</td>
</tr>
<tr>
<td>2013-14</td>
<td>1.19</td>
<td>24</td>
<td>1,299</td>
<td>2014</td>
<td>1070</td>
</tr>
<tr>
<td>2014-15</td>
<td>1.02</td>
<td>48</td>
<td>1,02</td>
<td>2015</td>
<td>60</td>
</tr>
</tbody>
</table>

**UNPAID = UL - REPORTED**

\[ \text{UNPAID} = 346.06 - 130 = 216.06 \]

### (b)

\[ AY_{2012,24} = 24.2 \]

\[ AY_{2012,36} = AY_{2012,24} \times LDF_{36-24} = 24.2 \times 1.19 = 28.798 \]

\[ \text{DEVELOP TO 2014} \]

### (c)

1. NO CHANGE IN CLAIM SETTLEMENT PROCESS
2. NO CHANGE IN DEDUCTIBLES, POLICY LIMITS

### (d)

\[ \text{UL}_{BT, 2012} = AY_{2012,24} + EP_{2012} \times ELR \times (1 - \frac{1}{CDF_{24}}) \]

\[ = 24.2 + 520 \times 0.6 \times (1 - \frac{1}{1.299}) \]

\[ = 313.815 \]

**GIVEN ASSUMPTION**

### (e)

1. FOR THE IMMATURE DEVELOPMENT AGE, IS A2A12 IS LARGE
2. ENTER A NEW BUSINESS OR TERRITORY

**LARGER EFFECT**
(a)  BOOK 1  DETERIORATE CL
     BOOK 2  STRENGTHEN CASE RESERVE

     FOR BOOK 1, (i) EXPECTED METHOD => UNDERESTIMATE
                    UL
     (ii) DEVELOPMENT METHOD ON REPORTED
          CHANGES => NO EFFECT
     (iii) BE ON REPORTED => UNDERESTIMATE
                    UL
          ' ' UNPAID PORTION
          USE ELR

(b)  FOR BOOK 2
     (i) EXPECTED METHOD => NO EFFECT
     (ii) DEVELOPMENT ON REPORTED
          => OVERSTATE : LARGE CDF IN
                        IMMATURE AGES
     (iii) BE ON REPORTED => OVERESTIMATE
          :: CDF ↑ => 1/CDF ↓ => 1 - 1/CDF ↑
          ' ' BE ULTIMATE ↑
(a) The exposure are evenly distributed over the policy term.

(b)\[
\begin{array}{c}
\text{NEW DISCOUNT 10%}
\end{array}
\]

\[
\begin{array}{cccc}
\%/11 & \%/6/2012 & 4/1/2013 & 14 \\
11 & 12 & 13 & \text{NEW DISCOUNT 10%}
\end{array}
\]

Apply 50% of all policies for discount
80% without discount

\[
\text{LEVEL FACTOR 2011} = \frac{0.2 \times (1 \times 1.07 \times 0.94 \times 0.90)}{\frac{1}{2} \times 1} + \frac{1}{2} \times 1.07
\]

\[
= \frac{1.017}{1.035} = 0.983
\]

(c) First, quantify the effect of a state-mandated change in the minimum policy limit.

When state post minimum policy limit,
claims increase.

When the actuary do the rate review,
the indicated rate increase, thus, we know the effect of a state-mandated minimum policy limit.

In (b) diagram, it is a vertical line with 0% of rate change.
<table>
<thead>
<tr>
<th>Claim ID 1, 1/30/2010</th>
<th>AY = 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN 5/1/2010, CASE = +150</td>
<td>REPORTED CLAIM COUNT = 1</td>
</tr>
<tr>
<td>PAY 6/16/2010, PAID = 50</td>
<td>REPORT = +500</td>
</tr>
<tr>
<td>9/22/2011, CHANGE CASE = -90 AND PAID = 100</td>
<td></td>
</tr>
<tr>
<td>5/31/2012, CLOSED REPORTED CASE = -60, PAID = 60</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Claim ID 2, 5/1/2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>AY = 2010</td>
</tr>
<tr>
<td>5/30/2011, OPEN AND CLOSED NEW CLAIM FILE</td>
</tr>
<tr>
<td>REPORTED = 90</td>
</tr>
<tr>
<td>REPORTED COUNT = 1</td>
</tr>
<tr>
<td>CLOSED COUNT = 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Claim ID 3, 10/16/2011</th>
<th>AY = 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/30/2012, OPEN NEW CLAIM</td>
<td>CASE = 250</td>
</tr>
<tr>
<td>REPORTED = 250</td>
<td></td>
</tr>
<tr>
<td>PAID = 0</td>
<td></td>
</tr>
<tr>
<td>REPORTED COUNT = 1</td>
<td></td>
</tr>
<tr>
<td>CLOSED COUNT = 0</td>
<td></td>
</tr>
<tr>
<td>8/18/2012, PAID AND CHANGE CASE</td>
<td>CASE AS OF 8/18/2012 = 250 - 100 = 150</td>
</tr>
<tr>
<td>REPORTED = 1</td>
<td></td>
</tr>
<tr>
<td>CLOSED COUNT = 0</td>
<td></td>
</tr>
</tbody>
</table>
**Candidate No. 52485**

**Revised As**

### Cumulative Paid Claims

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2,150 + 50 = 2,200</td>
<td>4,510 + 150 = 4,660</td>
<td>6,680 + 210 = 6,890</td>
<td>7,650 + 210 = 7,860</td>
</tr>
<tr>
<td>11</td>
<td>2,460 + 140 = 2,600</td>
<td>5,190 + 140 = 5,330</td>
<td>7,450 + 140 = 7,590</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2,390</td>
<td>4,890</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3,260</td>
<td></td>
<td></td>
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</tbody>
</table>

### Cumulative Reported Claims

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7,010 + 200 = 7,210</td>
<td>8,510 + 210 = 8,720</td>
<td>9,560 + 210 = 9,770</td>
<td>9,890 + 210 = 10,100</td>
</tr>
<tr>
<td>11</td>
<td>8,320 + 290 = 8,610</td>
<td>10,840 + 290 = 11,130</td>
<td>11,130 + 290 = 11,420</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>9,610</td>
<td>11,620</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>9,620</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### Cumulative Closed Count

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>22 + 10 = 22</td>
<td>3940 + 1 = 40</td>
<td>54 + 1 = 55</td>
<td>64 + 1 = 66</td>
</tr>
<tr>
<td>11</td>
<td>70 + 0 = 70</td>
<td>44 + 0 = 44</td>
<td>62 + 0 = 62</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>25</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
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</table>

### Cumulative Report Count

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>76 + 1 = 77</td>
<td>594 + 1 = 595</td>
<td>824 + 1 = 825</td>
<td>834 + 1 = 835</td>
</tr>
<tr>
<td>11</td>
<td>824 + 1 = 825</td>
<td>934 + 1 = 935</td>
<td>944 + 1 = 945</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>98</td>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question No. 15

Candidate No. 52485

ADJUST PREMIUM FOR

(a) THE CHANGE OF POLICY LIMIT DISTRIBUTION.

2011

0.24 × 0.9 + 1 × 0.52 + 1.15 × 0.24 = 1.112

→ 1.00494

2012

0.22 × 0.9 + 1 × 0.52 + 1.15 × 0.26 = 1.1017

→ 1.00491

2013

0.2 × 0.9 + 0.52 × 1 + 1.15 × 0.28 = 1.1022

SELECT ANNUAL TREND = 0.49%

(b) 6.70% ANNUAL 3.30% 2014

AWD 12 / 2 = 12 → 9/1/2015

2014

AWD 12 + 6 / 2 = 9 → 6/1/2015

AWD FOR 2012 1/1/2012

AWD FOR 2012 1/1/2012

TREND PERIOD = 36 + 8 / 2 = 44 / 2 = 22

TREND PERIOD = 36 + 5 / 2 = 41 / 2

TREND FACTOR = 0.67 × 1.004912 + 0.33 × 1.004912

= 1.0176
Question No. (6)

Candidate No. 52485

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXISTING RELIABILITY</td>
<td>WEP</td>
<td>BALANCED</td>
<td>Replay REL</td>
<td>UTL</td>
<td>UTL + INDICATED</td>
<td>SPP</td>
</tr>
<tr>
<td>A</td>
<td>1.00</td>
<td>15200</td>
<td>6.986</td>
<td>1200</td>
<td>1.00</td>
<td>4.32</td>
<td>0.949</td>
</tr>
<tr>
<td>B</td>
<td>0.95</td>
<td>12400</td>
<td>0.736</td>
<td>739</td>
<td>0.90</td>
<td>4.15</td>
<td>1.002</td>
</tr>
<tr>
<td>C</td>
<td>1.11</td>
<td>10700</td>
<td>1.094</td>
<td>635</td>
<td>0.84</td>
<td>5.07</td>
<td>1.069</td>
</tr>
<tr>
<td>TOTAL</td>
<td>38,857</td>
<td>38,300</td>
<td>1</td>
<td>18136.9</td>
<td>383</td>
<td>4174</td>
<td></td>
</tr>
</tbody>
</table>

(9) WTD REL

A \(6.949 \times 1 + 0 \times 0.986 = 6.949\)

B \(1.00 \times 0.9 + 0.1 \times 0.936 = 0.995\)

C \(1.069 \times 0.84 + 0.16 \times 1.094 = 1.073\)

(6) AGE OF HOME FACTOR

\[ \begin{align*}
0 & \quad 15 \quad 16^4 \\
390 \times 7600 + 400 \times 4960 + 461 \times 6420 & \quad 510 \times 7600 + 475 \times 7080 \\
1890 & \quad 4280 \times 506 \\
= & \quad 19320 \\
= & \quad 416629 \\
= & \quad 530397
\end{align*} \]

(8) THERE IS A DISTRIBUTION BIAS

(9) THERE IS A CORRELATION BETWEEN AGE OF HOME FACTORS.

Thus, it is different between one-way procedure and minimum bias procedure.
(a) 1. There is a seasonality up and down in 6 mos.
   2. There is a case reserve strengthen, such that paid/report ↓ report ↑ in last diagonal.

(b) For 0, may sell more policies in the first half year, e.g. boat coverage. For 0, change the case reserve estimate assuming claim settlement process constant.

(c) For 0, to see the wef or wtp in the first year, higher than 2nd half year. For 0, see the trend of average open vs. trend of average close. If avg. open trend > avg. close trend, then there is a case reserve strengthen.
   0. Claim adjust process change; more conservative.
   0. Change policy limits or deductible.
(a) **UNPAID CLAIMS WITH ULAB**

\[ \text{UEP} \times \text{ELR} \times (1 + \text{ULAB RATIO}) \]

\[ = 32600 \times 0.72 \times (1 + 0.08) = 25,349 \]

\[ \text{ULT CLAIM/EP.} \]

\[ 11 \quad 32470 / 4400 = 0.719 \]

\[ 12 \quad 0.73 \]

\[ 13 \quad 0.709 \]

SELECT AVG = 0.72

(b) ① **REINSURANCE COST**

② **MAINTENANCE COST**

(c) **PREMIUM LIABILITY = UNPAID CLAIM FROM (a)**

\[ \text{UEP} \times \text{ELR} \times (1 + \text{ULAB RATIO}) + \text{GZ} = 25,349 + 8150 \]

\[ = 33499 \]

\[ \text{GZ} = 32600 \times 0.25 = 8150 \]

(d) **PREMIUM LIABILITY > UEP**

\[ \frac{33499}{32600} \]

\[ \text{PREMIUM DEFICIENCY} = 32600 - 33499 = -899 \]
01. HAZARD MODULE - FREQUENCY, LOCATION, SEVERITY
OF OCCURRENCE OF THE FUTURE CAT EVENT

INVENTORY MODULE - DETAIL DATABASE
FOR PROPERTY VALUE AND
STRUCTURE, BROKEN DOWN
BY LOB, OCCUPANCY,
CONSTRUCT TYPES.

VULNERABILITY MODULE - DAMAGE FUNCTION
THAT INTERACTION BETWEEN
INTENSITY OF EVENT AND STRUCTURE
OF PROPERTY

(10) SIMILARITY - COVER PROPERTY FOR
EQ COVERAGE IN HAZARD MODULE
DIFFERENT - COMMCO EXPOSES IN COMMERCIAL
PROPERTY AND HOMECO EXPOSES
IN PERSONAL PROPERTY.

IN INVENTORY MODULE

(3) HURRICANE LOAD - USING CAT MODEL TO
DETERMINE LOADING
NON-HURRICANE LOAD - USING LONG HISTORICAL
DATA TO DETERMINE LOADINGS
(a) (i) Manual Rate - for average population rate

(ii) Schedule Rate - based on insured characteristics to adjust manual rate (credits/ debit)

(iii) Prospective Rate - based on insured experience to create experience modification such that rate = manual rate * experience modification factor

(iv) Retrospective Rate - initial deposit premium and then based on insured's experience to return or charge more premium.

(b) The cost to maintain retrospective experience rate is very high for small premium size the poor claim experience will let insurer loss profit

(c) Different pool with different ACAS.
(a) If not, it will excess for large and good insureds and inadequate for small insureds.

(b) Indicated rate = \( \frac{PF \times (1000 \times F)}{1 - V \cdot G} \)

\[ = \frac{(1.09)350 + 100}{1 - 0.22 - 0.05} = 65.9 \%
\]

\[ = DP \times \% \times 65.9 \%
\]

(c) \( 100 = 350 \times \frac{2}{3} \times 0.06 \) fixed

\[ = \frac{1}{3} \times 0.06 \text{ variable} \]

variable = 0.20

fixed = 700+114 = 114

(d) \( \frac{1.09 \times 350 + 114}{1 - 0.2 - 0.05} = 660.66 \)
(d) **Policy deductible ↓** ⇒ Increased low-value claims ⇒ Frequency ↑
Also, increase claim amount ⇒ severity ↑

(5) Credible
- Weighted with industry benchmark
- Combined more data to produce trend

(c)

<table>
<thead>
<tr>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

\[9(\text{Q1}) + 6(\text{Q2})\]

(1) ALD for exposed: \[\frac{12+6}{2} = 9\text{Q1}; \quad 3/1/2015\]

(2) ALD for 2012 = 4/1/2012

(3) ALD for 2013 = 4/1/2013

(1) - (2) \[9+12+12+2 = 35\text{ MOS}\]

(1) - (3) \[9+12+2 = 23\text{ MOS}\]

For 2012 \([(0.998 \times 1.058)^{35/2}] = 1.17/18

2013 \([(0.998 \times 1.058)^{33/2}] = 1.1098

(4) **Exclude large single policy and then do the trend factors**