1. **Learning Objectives:**

2. The candidate will demonstrate the ability to prepare claims and exposure data for general insurance actuarial work.

3. The candidate will know how to calculate and evaluate projected ultimate values.

4. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**

(2d) Adjust historical earned premiums to current rate levels.

(3g) Estimate ultimate values using the methods cited in (3e).

(4f) Calculate claim liabilities.

**Sources:**

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 2, 12, 16, and 23.

**Commentary on Question:**

*This question tests the candidate’s understanding of adjusting earned premiums to current rate levels as well as estimating ultimate claims and unpaid claims using the expected method.*

**Solution:**

(a) Provide an advantage and a disadvantage of the extension of exposures approach.

*Advantage:* this is the most precise method, with every policy re-rated at current values using the current rating factors.

*Limitation:* this method is not viable if new rating variables have been introduced for which historical data are not available.

(b) Provide an advantage and a disadvantage of the parallelogram approach.

*Advantage:* this method is simple to apply.

*Disadvantage:* this method assumes exposures are uniformly distributed over time.
1. Continued

(c) Calculate premium on-level factors for accident years 2016-2018 to use for projecting ultimate claim ratios as of December 31, 2018.

<table>
<thead>
<tr>
<th>Rate Level</th>
<th>Rate Level Relative Value</th>
<th>Area in Calendar Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>A</td>
<td>1.0000</td>
<td>87.5%</td>
</tr>
<tr>
<td>B</td>
<td>1.0500</td>
<td>12.5%</td>
</tr>
<tr>
<td>C</td>
<td>1.0815</td>
<td></td>
</tr>
</tbody>
</table>

Average Rate Level: 1.0063, 1.0438, 1.0539

Premium On-Level Factor: 1.0473, 1.0097, 1.0000

e.g., \(1.0063 = (1 \times 0.875) + (1.05 \times 0.125)\)
\(1.0473 = \frac{1.0539}{1.0063}\)
1. Continued

(d) Calculate the 2018 level expected claim ratio, using a simple average of all accident years.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned Premiums</th>
<th>Paid Claims as of Dec. 31, 2018</th>
<th>Cumulative Development Factors</th>
<th>Projected Ultimate Claims</th>
<th>Premium On-level Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>76,000</td>
<td>54,000</td>
<td>1.20</td>
<td>64,800</td>
<td>1.0473</td>
</tr>
<tr>
<td>2017</td>
<td>75,000</td>
<td>45,000</td>
<td>1.40</td>
<td>63,000</td>
<td>1.0097</td>
</tr>
<tr>
<td>2018</td>
<td>80,000</td>
<td>38,000</td>
<td>1.70</td>
<td>64,600</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

\[ (6) = \frac{(4)(6)(7)}{(1)(5)} \]

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Claim Trend @3%</th>
<th>Tort Reform</th>
<th>Claim Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>1.0609</td>
<td>0.90</td>
<td>0.7773</td>
</tr>
<tr>
<td>2017</td>
<td>1.0300</td>
<td>0.95</td>
<td>0.8140</td>
</tr>
<tr>
<td>2018</td>
<td>1.0000</td>
<td>1.00</td>
<td>0.8075</td>
</tr>
</tbody>
</table>

Average 0.7996

(e) Calculate the unpaid claims for accident year 2017 as of December 31, 2018 using the expected method.

Accident Year (AY) 2017:

Selected expected claim ratio at 2018 level (from part (d)) 0.7996

Expected claim ratio for AY 2017 = 0.7996×1.0097/(1.030×0.95) = 0.8251

Ultimate claims = 75,000×0.8251 = 61,883

Unpaid claims = 61,883 – 45,000 = 16,883
2. **Learning Objectives:**
   1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.
   3. The candidate will know how to calculate and evaluate projected ultimate values.
   7. The candidate will understand the need for monitoring results.

**Learning Outcomes:**
(1d) Understand the components of ultimate values.
(3g) Estimate ultimate values using the methods cited in (3e).
(7b) Analyze actual claims experience relative to expectations.
(7c) Develop plans for future actuarial work based on the results of monitoring.

**Sources:**

**Commentary on Question:**
This question tests the candidate’s understanding of estimating claims development using the development method, including adjustments for large claims. In addition, this question tests the candidate’s understanding of expected paid claims for an interim period between actuarial analyses.

**Solution:**
(a) “Complete the square” for the paid claim triangle above.

**Commentary on Question:**
*Accident year 2016 development factors need to be adjusted for the large claim.*

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Age-to-Age Development Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12-24</td>
</tr>
<tr>
<td>2014</td>
<td>1.500</td>
</tr>
<tr>
<td>2015</td>
<td>1.571</td>
</tr>
<tr>
<td>2016</td>
<td>1.571</td>
</tr>
<tr>
<td>2017</td>
<td>1.538</td>
</tr>
</tbody>
</table>

Selected Development Factors (average):

<table>
<thead>
<tr>
<th></th>
<th>1.545</th>
<th>1.177</th>
<th>1.074</th>
<th>1.000</th>
</tr>
</thead>
</table>

e.g., AY2016, 12-24: \(\frac{6,500 - 1,000}{4,500 - 1,000} = 1.571\)
2. Continued

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Paid Claims (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2014</td>
<td>4,000</td>
</tr>
<tr>
<td>2015</td>
<td>3,500</td>
</tr>
<tr>
<td>2016</td>
<td>4,500</td>
</tr>
<tr>
<td>2017</td>
<td>3,250</td>
</tr>
<tr>
<td>2018</td>
<td>3,500</td>
</tr>
</tbody>
</table>

e.g., AY2016, 48 months = (7,500 – 1,000)×1.074 + 1,000 = 7,981

(b) Calculate the following reserves as of December 31, 2018:

(i) Total case reserves

\[
\text{Case reserves} = \text{Reported claims} - \text{Paid claims} \\
= 33,500 - (3,500 + 5,000 + 7,500 + 7,000 + 7,500) \\
= 33,500 - 30,500 \\
= 3,000
\]

(ii) Total IBNR reserves

\[
\text{IBNR reserves} = \text{Ultimate claims} - \text{Reported claims} \\
= (6,836 + 6,320 + 7,981 + 7,000 + 7,500) - 33,500 \\
= 35,637 - 33,500 \\
= 2,137
\]

(c) Calculate total incurred claims for calendar year 2018.

Calendar Year (CY) 2018 Incurred Claims

\[
= \text{CY 2018 Paid Claims} + \text{Change in Unpaid Claims}
\]

CY 2018 Paid Claims = (3,500 + 5,000 + 7,500 + 7,000 + 7,500) – (3,250 + 6,500 + 6,500 + 7,500)

\[
= 30,500 - 23,750 \\
= 6,750
\]

Unpaid as of Dec. 31, 2018 = Case + IBNR from part (b) = 5,137
Unpaid as of Dec. 31, 2017 = 5,350 (given)

CY 2018 Incurred Claims = 6,750 + (5,137 – 5,350) = 6,537.
2. Continued

(d) Calculate the expected calendar year 2019 total paid claims on accident years 2015 through 2018.

\[ \text{CY 2019 expected paid claims} = (5,408 + 5,885 + 7,981 + 7,000) - (3,500 + 5,000 + 7,500 + 7,000) = 3,274. \]

(e) Identify two possible next steps you would take to further investigate the potential adverse claims experience.

**Commentary on Question:**
*Other answers are possible.*

Any two of the following are acceptable:
- Calculate actual versus expected at the AY level to see if the difference is coming from only one AY or multiple AY’s
- Discuss the increase in paid development with the claim department
- Perform diagnostics (e.g., paid to reported ratios)
- Test reported data to see if it is showing similar deterioration
- Confirm data is accurate

(f) Provide one other potential reason for this material difference.

**Commentary on Question:**
*Other answers are possible.*

Any one of the following is acceptable:
- Large claim
- Data error
- Change in settlement pattern only (rather than adverse experience)
- Law change impacting all open claims
3. **Learning Objectives:**
3. The candidate will know how to calculate and evaluate projected ultimate values.
6. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(3d) Analyze development triangles for investigative testing.
(6j) Calculate indicated rates and indicated rate changes using the claim ratio and pure premium methods.

**Sources:**

**Commentary on Question:**
This question tests the candidate’s understanding of ratemaking and expected profit.

**Solution:**
(a) Provide one reason why a regulator would impose a cap on rate increases.

**Commentary on Question:**
Other answers are possible.

Any of the following is acceptable:
- Protect insurance consumers
- Ensure availability of coverage

(b) Demonstrate why you expect this line of business will become unprofitable in the future.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Average Reported Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2016</td>
<td>1,199</td>
</tr>
<tr>
<td>2017</td>
<td>1,337</td>
</tr>
<tr>
<td>2018</td>
<td>1,500</td>
</tr>
</tbody>
</table>

e.g., 1,199 = 800,000 / 667

Change in average reported claims down columns:
2016-2017 11.5% 11.6%
2017-2018 12.2%
3. Continued

Changes in average reported claims are significantly more than the mandated maximum rate increase of 3%. As a result, this book will eventually become unprofitable because the company will not be able to increase rates at the same rate that claims are growing.

(c) Recommend two actions that MTB Insurance could consider in response to the expected deterioration in profit.

Commentary on Question:
Other answers are possible.

Any two of the following are acceptable:
- Withdraw from the market
- Lobby the regulator to consider removing the rate change cap or increase the cap
- Lobby the regulator to reform the line of business to address the increasing severity
- Accept a lower profit in the short term
4. Learning Objectives:
3. The candidate will know how to calculate and evaluate projected ultimate values.

Learning Outcomes:
(3e) Describe the key assumptions underlying the following projection methods: development method, frequency-severity methods, expected method, Bornhuetter Ferguson method, Benktander method, Cape Cod method, Generalized Cape Cod, and Berquist-Sherman adjustments to the development method.
(3g) Estimate ultimate values using the methods cited in (3e).

Sources:

Commentary on Question:
This question tests the candidate’s understanding of the Cape Cod method of estimating ultimate claims.

Solution:
(a) Describe why the Cape Cod method is considered a variation of the Bornhuetter Ferguson method.

Commentary on Question:
Other answers are possible.

Both methods use the same formula (i.e., weighted average of development method and expected method). The expected claim ratio for the Cape Cod is prescribed by the method itself, and not an independent a priori estimate.

(b) Describe the key assumption that differentiates the Cape Cod method from the Generalized Cape Cod method.

A key assumption for Cape Cod method is that the cost per exposure unit is constant for all years in the experience period. The Generalized Cape Cod method does not assume this.

(c) Explain why the Generalized Cape Cod method produces the same result as the development method when a decay factor of zero is used.

The expected claims for each accident year would depend on actual experience from that accident year only. The formula for expected claims simplifies to (Actual Claims)/(Percent Reported), which equals (Actual Claims)×(Cumulative Development Factor).
4. Continued

(d) Identify four other inputs that are needed for the Generalized Cape Cod method.

- Expected percent developed (i.e., development patterns)
- Actual claims experience
- Trend
- Decay factor

(e) Describe your approach in applying the Cape Cod method to this seasonal book of business.

- Split the data into two independent data sets
- Derive two different development patterns
- Then apply the Cape Cod method to each data set separately and sum the final results
5. **Learning Objectives:**
4. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(4g) Describe the components of premium liabilities in the context of financial reporting.
(4h) Evaluate premium liabilities.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of premium liabilities.*

**Solution:**
(a) Calculate the premium liabilities, both gross and net of reinsurance.

<table>
<thead>
<tr>
<th></th>
<th>Gross</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unearned Premium</td>
<td>900</td>
<td>750</td>
</tr>
<tr>
<td>Expected Claims (unearned premium × expected claims ratio):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property</td>
<td>280</td>
<td>210</td>
</tr>
<tr>
<td>Liability</td>
<td>300</td>
<td>288</td>
</tr>
<tr>
<td>Total expected claims</td>
<td>580</td>
<td>498</td>
</tr>
<tr>
<td>ULAE = 580 × 10%</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>General expenses = 900 × 15% × 25%</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Incentive commissions = 900 × 3%</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Reinsurance cost = 400 × 12% (net only)</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Premium Liabilities</td>
<td>699</td>
<td>665</td>
</tr>
</tbody>
</table>

(b) Determine the equity in unearned premiums, both gross and net of reinsurance.

<table>
<thead>
<tr>
<th></th>
<th>Gross</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unearned Premium</td>
<td>900</td>
<td>750</td>
</tr>
<tr>
<td>Premium Liabilities</td>
<td>699</td>
<td>665</td>
</tr>
<tr>
<td>Equity / (Deficiency)</td>
<td>201</td>
<td>85</td>
</tr>
</tbody>
</table>
5. Continued

(c) Calculate the maximum deferred policy acquisition expense (DPAE) that your company could record as an asset.

Minimum of (gross equity in unearned premiums), and (net equity in unearned premiums + unearned ceded commissions) = minimum (201, 85 + 60) = 145

Unearned Commission = 900 × 20% = 180

Maximum DPAE = lesser of 145 and 180 = 145.

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

A premium deficiency reserve is a liability to account for any excess of net premium liabilities over the unearned premium reserve.
6. **Learning Objectives:**
   6. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
- (6d) Quantify different types of expenses required for ratemaking including expense trending procedures.
- (6m) Describe key considerations in the analysis of deductible factors and increased limits factors.
- (6q) Distinguish occurrence-based and claims-made based coverage.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 29, 33, and 34.

**Commentary on Question:**
*This question tests the candidate’s understanding of claims-made ratemaking.*

**Solution:**
(a) Recommend the type of insurance policy that Mitrax Insurance should offer to JC Smith. Justify your recommendation.

  Insurer can offer either an occurrence policy or a claims-made policy:
  - Occurrence has a higher premium and less potential for coverage gap
  - Claims made has an initial lower premium and greater certainty in pricing

(b) Calculate the variable expense provision underlying the premium.

  Premium = \( \frac{(\text{Expected Claim Cost} + \text{Cost of reinsurance})}{1.0 - \text{Variable expense provision}} \)

  Therefore, the variable expense provision = 45% for all limits
  (e.g., \( 1 - \frac{(1,000 + 100)}{2,000} = 0.45 \))

(c) Describe two inconsistencies in the expected claims costs shown in the table above.

  The difference in expected claim cost from 500k to 1M is less than the difference between 1M and 1.5M.
  The difference in expected claim cost from 500k to 1M is less than the difference between 1.5M and 2M.
6. Continued

(d) Describe an adjustment to an expected claims cost figure that will remove the inconsistencies.

Can either adjust the 1M expected claim cost from 1,200 to 1,250, or adjust the 500K expected claim cost from 1,000 to an amount ≤ 900.

(e) Describe two considerations for JC Smith in selecting an appropriate policy limit.

Any two of the following are acceptable:
- Cost
- Tort Limitations
- Client requirements
- Local business customs

(f) Describe two considerations for Mitrax in determining whether to require a deductible for JC Smith’s policy.

Any two of the following are acceptable:
- Cost versus benefit of eliminating small claims payments
- Potential reduction in reported but not incurred or frivolous claims
- Creditworthiness of customer
- Potential for reduction in claims frequency
7. **Learning Objectives:**
   3. The candidate will know how to calculate and evaluate projected ultimate values.
   4. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3k) Estimate ultimate claims by layer using common methods.
(3l) Understand the differences in development patterns and trends for various claim layers.
(4f) Calculate claim liabilities.

**Sources:**


**Commentary on Question:**
*This question tests estimating ultimate claims and IBNR for various claim layers.*

**Solution:**
(a) Explain why the theoretical approach might be preferred to the development method.

There is more volatility in the excess layer. As a result, the excess layer has significantly more uncertainty.

(b) Calculate the theoretically-derived cumulative development factor (CDF) at each development month for:

(i) claims limited to 200,000, and
(ii) claims excess of 200,000.

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age-to-age development factors</td>
<td>1.733</td>
<td>1.084</td>
<td>1.020</td>
<td>1.000</td>
</tr>
<tr>
<td>2. CDF Unlimited</td>
<td>1.917</td>
<td>1.106</td>
<td>1.020</td>
<td>1.000</td>
</tr>
<tr>
<td>3. ( R_t )</td>
<td>0.835</td>
<td>0.825</td>
<td>0.810</td>
<td>0.800</td>
</tr>
<tr>
<td>4. CDF 200,000</td>
<td>1.837</td>
<td>1.072</td>
<td>1.007</td>
<td>1.000</td>
</tr>
<tr>
<td>5. CDF xs 200,000</td>
<td>2.324</td>
<td>1.264</td>
<td>1.074</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Notes: 1. for 12 months: \( 1.733 = (4,460 + 4,560 + 5,020) / (2,480 + 2,780 + 2,840) \)
2. for 12 months: \( 1.917 = 1.733 \times 1.084 \times 1.020 \times 1.000 \)
4. for 12 months: \( 1.837 = 1.917 \times 0.800 / 0.835 \)
5. for 12 months: \( 2.324 = 1.917 \times (1 - 0.800) / (1 - 0.835) \)
7. Continued

(c) Calculate the accident year 2017 IBNR using the CDFs from part (b) for:

(i) claims limited to 200,000, and

(ii) claims excess of 200,000.

Reported claims at 200,000 limits = 4,750
IBNR at 200,000 Limit = 4,750 \times (1.072 - 1) = 342
Reported claims at xs 200,000 limits = 5,020 - 4,750 = 270
IBNR at xs 200,000 Limit = 270 \times (1.264 - 1) = 71
8. **Learning Objectives:**

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

**Learning Outcomes:**

(9a) Describe the structure and modules of catastrophe models.
(9b) Apply catastrophe modeling results in ratemaking, loss mitigation, risk selection, and reinsurance.
(9d) Understand and apply common risk metrics associated with catastrophe modeling results.

**Sources:**
Uses of Catastrophe Model Output, American Academy of Actuaries, July 2018.

**Commentary on Question:**
This question tests the candidate’s understanding of catastrophe models.

**Solution:**

(a) Identify the topics covered by these two ASOPs.

ASOP No. 38, Using Models Outside the Actuary's Area of Expertise (Property and Casualty), provides guidance to an actuary in using models that incorporate specialized knowledge outside of the actuary's own area of expertise.

ASOP No. 39, Treatment of Catastrophe Losses in Property/Casualty Insurance Ratemaking, indicates that an actuary should consider models based on noninsurance data when available historical insurance data does not sufficiently represent the exposure to catastrophe losses. In addition, this ASOP provides guidance for acceptable use of such models.

(b) Identify the four missing catastrophe model components, labelled as I, II, III, and IV in the above flowchart.
8. Continued

(c) Calculate the premium for each of account X and account Y.

Average Annual Loss (AAL) for X and Y is 4,420 (442,000 × 0.01)

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAL</td>
<td>4,420</td>
<td>4,420</td>
</tr>
<tr>
<td>Variance of modeled losses</td>
<td>309,903,600</td>
<td>395,083,600</td>
</tr>
<tr>
<td>Standard deviation of modeled losses (STD)</td>
<td>17,604.08</td>
<td>19,876.71</td>
</tr>
<tr>
<td>Premium *</td>
<td>8,466</td>
<td>8,778</td>
</tr>
</tbody>
</table>

* Premium = (AAL + 0.10 × STD)/(1 – 0.27)

(d) Describe the purpose of each risk metric.

AAL/TIV ratio: The ratio of the AAL to the Total Insured Value (TIV) provides a metric that shows the long-term risk at a location. This can be useful in evaluating how properties that are close geographically can have significantly different expected losses AAL.

PML/TIV ratio: The ratio of a PML at a specified return period, to the TIV gives an indication of the possible severity at a location.

(e) Calculate each risk metric for each of account X and account Y.

AAL/TIV for X and Y = 4,420/10,000 = 0.44

PML/TIV for X = 125,000/10,000 = 12.5
PML/TIV for Y = 150,000/10,000 = 15

(f) Interpret the results from part (e).

X and Y has similar loss potential on average. However, Y will contribute more tail risk and volatility.
9. **Learning Objectives:**

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

**Learning Outcomes:**

(6n) Calculate deductible factors and increased limits factors.

**Sources:**

**Commentary on Question:**
This question tests the candidate’s understanding of increased limit factors when using censored data.

**Solution:**

(a) Calculate the limited average severity for the 250,000 to 500,000 layer.

**Limited Average Severity (LAS) in the layer 250,000 to 500,000:**

<table>
<thead>
<tr>
<th>Claim Range</th>
<th>Counts</th>
<th>Capped Claims</th>
<th>250,000 to 500,000 Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>500,000 Limit Policies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 250,000</td>
<td>600</td>
<td>84,000,000</td>
<td>0</td>
</tr>
<tr>
<td>250,000 – 500,000</td>
<td>1,100</td>
<td>363,000,000</td>
<td>88,000,000</td>
</tr>
<tr>
<td>1,000,000 Limit Policies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 250,000</td>
<td>700</td>
<td>94,500,000</td>
<td>0</td>
</tr>
<tr>
<td>250,000 – 500,000</td>
<td>1,300</td>
<td>442,000,000</td>
<td>117,000,000</td>
</tr>
<tr>
<td>500,000 – 1,000,000</td>
<td>400</td>
<td>288,000,000</td>
<td>100,000,000</td>
</tr>
<tr>
<td>Total (in layer)</td>
<td>2,800</td>
<td>305,000,000</td>
<td></td>
</tr>
</tbody>
</table>

LAS for the layer, given a claim in the layer = \( \frac{2,800}{4,100} = 0.68293 \)

Probability of a claim in the layer = \( \frac{2,800}{4,100} = 0.68293 \)

LAS for the 250,000 to 500,000 layer = 74,391

Notes: 
- \( 88,000,000 = 363,000,000 – 250,000 \times 1,100 \)
- \( 117,000,000 = 442,000,000 – 250,000 \times 1,300 \)
- \( 100,000,000 = 250,000 \times 400 \)
- \( 108,929 = \text{Total Amount in Layer} / \text{Counts in Layer} \)
- \( 74,391 = \text{LAS, given claim in layer} \times \text{Probability in layer} \)
9. Continued

Alternatively, \(74,390 = \frac{305,000,000}{4,100}\) \{the difference is due to rounding\}

(b) Calculate the increased limit factor for a 1,000,000 limit, assuming the basic limit of liability is 250,000.

\(\text{LAS(250,000)}:\)

<table>
<thead>
<tr>
<th>Claim Range</th>
<th>Counts</th>
<th>Capped Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 250,000</td>
<td>2,800</td>
<td>373,500,000</td>
</tr>
<tr>
<td>250,000+</td>
<td>2,800</td>
<td>700,000,000</td>
</tr>
<tr>
<td></td>
<td>5,600</td>
<td>1,073,500,000</td>
</tr>
</tbody>
</table>

\(\text{LAS(250,000)} = 191,696\)

\(\text{LAS in the layer 500,000 to 1,000,000):}\)

<table>
<thead>
<tr>
<th>Claim Range</th>
<th>Counts</th>
<th>Capped Claims</th>
<th>500,000 to 1,000,000 Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000,000 Limit Policies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 250,000</td>
<td>700</td>
<td>94,500,000</td>
<td>0</td>
</tr>
<tr>
<td>250,000 – 500,000</td>
<td>1,300</td>
<td>442,000,000</td>
<td>0</td>
</tr>
<tr>
<td>500,000 – 1,000,000</td>
<td>400</td>
<td>288,000,000</td>
<td>88,000,000</td>
</tr>
<tr>
<td></td>
<td>2,400</td>
<td></td>
<td>88,000,000</td>
</tr>
</tbody>
</table>

\(\text{LAS for the layer:} = \frac{88,000,000}{2,400} = 36,667\)

\(\text{LAS(1,000,000)} = \text{LAS(250,000)} + \text{LAS for the 250,000-500,000 Layer} + \text{LAS for the 500,000-1,000,000 layer}\
\quad = 191,696 + 74,391 + 36,667 = 302,754\)

\(\text{ILF(1,000,000)} = \frac{\text{LAS(1,000,000)}}{\text{LAS(250,000)}} = \frac{302,754}{191,696} = 1.579.\)
10. **Learning Objectives:**
1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.

5. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

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

**Learning Outcomes:**
(1l) Understand credibility as used for actuarial work.
(5b) Identify the time periods associated with trending procedures.
(5e) Calculate trend factors for claims and exposures.
(6f) Explain the requirements for loadings for catastrophes and large claims in ratemaking.
(6g) Calculate loadings for catastrophes and large claims.

**Sources:**


**Commentary on Question:**
*This question tests the candidate’s understanding of determining a credibility weighted wildfire loading used for ratemaking.*

**Solution:**
(a) Describe two differences between large claims and catastrophe claims.

Any two of the following are acceptable:
- Catastrophes are infrequent with very high aggregate severity
- Catastrophes affect multiple insurers in affected area, large claims typically affect just one insurer
- Catastrophes result in large number of claims, whereas large losses result in just a few claims for one insurer
10. Continued

(b) Calculate the Region X wildfire loading as a claim ratio.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned House Years (EHY)</th>
<th>Wildfire Ultimate</th>
<th>Trending Period (months) *</th>
<th>Severity Trend @ 6%</th>
<th>Trended Wildfire Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>15,000</td>
<td>3</td>
<td>650,000</td>
<td>81</td>
<td>1.4819</td>
</tr>
<tr>
<td>2015</td>
<td>14,000</td>
<td>6</td>
<td>900,000</td>
<td>45</td>
<td>1.2442</td>
</tr>
<tr>
<td>2016</td>
<td>14,500</td>
<td>5</td>
<td>57</td>
<td>1.3189</td>
<td>0</td>
</tr>
<tr>
<td>2017</td>
<td>15,500</td>
<td>4</td>
<td>45</td>
<td>1.3980</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>16,000</td>
<td>4</td>
<td>900,000</td>
<td>33</td>
<td>1.1738</td>
</tr>
<tr>
<td>Total</td>
<td>75,000</td>
<td>7</td>
<td>1,550,000</td>
<td>33</td>
<td>2,019,655</td>
</tr>
</tbody>
</table>

* Trending period: average accident date in each accident year (i.e., July 1), to the average accident date in the future rating period (i.e., April 1, 2021).

\[
\text{Trended pure premium for wildfire claims} = \frac{2,019,655}{75,000} = 26.929
\]

\[
\text{Calendar Year (CY) 2018 EHY} 16,000
\]

\[
\text{Wildfire expected claims} = 26.929 \times 16,000 = 430,864
\]

\[
\text{2018 trended earned premium at current level} 15,500,000
\]

\[
\text{Wildfire loading as a claim ratio} = \frac{430,864}{15,500,000} = \frac{2.78\%}{0}
\]

(c) Provide two considerations for assessing the appropriateness of using Region Y’s experience as a complement of credibility.

Any two of the following are acceptable:

- The homogeneity of the sets of experience
- It should have frequency, severity, or other determinable characteristics that may reasonably be expected to be similar to the insurer’s experience.
- The applicability and reliability of Region Y’s experience
- The quality of Region Y’s data
- The variability observed in the Region Y’s experience

(d) Calculate the credibility weighted wildfire loading for Region X.

\[
\text{Credibility for State X} \quad 30\%
\]

\[
\text{Credibility for Region Y} \quad 70\%
\]

\[
\text{Windstorm loading for X} \quad 2.78\%
\]

\[
\text{Windstorm loading for Y} \quad 2\%
\]

\[
\text{Credibility weighted wildfire loading} = \frac{2.78\% \times 0.30 + 2\% \times 0.70}{0} = 2.23\%
\]
11. **Learning Objectives:**
3. The candidate will know how to calculate and evaluate projected ultimate values.

**Learning Outcomes:**
(3e) Describe the key assumptions underlying the following projection methods: development method, frequency-severity methods, expected method, Bornhuetter Ferguson method, Benktander method, Cape Cod method, Generalized Cape Cod, and Berquist-Sherman adjustments to the development method.
(3g) Estimate ultimate values using the methods cited in (3e).

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of the Bornhuetter Ferguson method of estimating ultimate claims.*

**Solution:**
(a) Explain this view.

The Bornhuetter Ferguson method is a credibility weighting of the claim development and expected methods. The insurer’s observed experience is weighted with the expected unobserved experience to produce a credibility-weighted projection of ultimate claims.

Assume that $Z$ is equal to $1/\text{CDF}$, Bornhuetter Ferguson formula can be restated as: $Z(\text{development method ultimate value}) + (1 – Z)(\text{expected value})$

(b) Explain why this view is criticized for lines of business with significant salvage or subrogation recoveries.

The description of the Bornhuetter Ferguson method as a credibility weighted method has been criticized as there are conceptual problems when the cumulative development factor is less than 1, which is the case with salvage or subrogation.
11. Continued

(c) Calculate the report year 2018 ultimate claims using the Bornhuetter Ferguson method.

<table>
<thead>
<tr>
<th>Report Year</th>
<th>Age-to-age Development Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12-24</td>
</tr>
<tr>
<td>2015</td>
<td>4.161</td>
</tr>
<tr>
<td>2016</td>
<td>3.965</td>
</tr>
<tr>
<td>2017</td>
<td>4.095</td>
</tr>
<tr>
<td>Average:</td>
<td>4.074</td>
</tr>
<tr>
<td>Age-to-ultimate:</td>
<td>4.828</td>
</tr>
</tbody>
</table>

e.g., 4.161 = 8,030 / 1,930

Expected claims for the first year of business: $2,065 \times 65\% \times 1,000 = 1,342,250$

Projected ultimate claims using Bornhuetter Ferguson method:

\[
= 315,000 + (1 - 1/4.828) \times 1,342,250 \approx 1,379,236
\]

(d) Assess the reasonableness of the inputs for the Bornhuetter Ferguson method using this data.

Percent paid at 12 months = 1/4.828 = 20.71%

Expected paid at 12 months = 0.2071 \times 1,342,250 = 277,980

Comparison to actual paid = (315,000 – 277,980) / 315,000 = 11.8%

There appears to be a significant difference implying the inputs are not reasonable.

(e) Calculate the report year 2018 ultimate claims using one iteration of the Benktander method.

Projected ultimate claims using Benktander method:

\[
= 315,000 + (1 - 1/4.828) \times 1,379,236 \approx 1,408,562
\]

(f) Provide an estimate of report year 2018 ultimate claims after 100 iterations of the Benktander method.

This iterative process can continue until the projected ultimate values from the Benktander method eventually converge to those of the development method.

Therefore, an estimate of the ultimate claims is the development method value of:

\[
315 \times 1,000 \times 4.828 = 1,520,820
\]
11. Continued

(g) Provide one weakness of the Benktander method.

Either of the following is acceptable:

- One of the weaknesses of the Benktander method is that there is no clear guidance with respect to the appropriate number of iterations to perform.
- Furthermore, there is not a clear sense as to the improvement in the estimation of ultimate claims from additional iterations.
12. **Learning Objectives:**
   5. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

**Learning Outcomes:**

(5b) Identify the time periods associated with trending procedures.
(5c) Analyze and evaluate trend for claims (including frequency, severity, and pure premium) and exposures (including inflation-sensitive exposures and premiums).
(5d) Choose trend rates for claims (frequency, severity, and pure premium) and exposures.
(5e) Calculate trend factors for claims and exposures.

**Sources:**

**Commentary on Question:**
*This question tests premium trending due to vehicle rate group drift.*

**Solution:**
(a) Explain why vehicle rate group drift should be reflected in the ratemaking for an automobile book of business.

Premiums in a portfolio of insureds tend to increase over time as insureds trade in old vehicles, with low model year factors, for new vehicles, with higher model year factors.

(b) Calculate the annual change in premium for each year.

<table>
<thead>
<tr>
<th>Group</th>
<th>Current Differentials</th>
<th>% Earned Exposures by Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.90</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>30%</td>
</tr>
<tr>
<td>3</td>
<td>1.10</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Weighted average differential: 0.970\(^{(1)}\)  
Change in average differential: 0.82%\(^{(2)}\)

Notes: 
(1): \((0.50\times0.90 + 0.30\times1.00 + 0.20\times1.10) = 0.970\)  
(2): \(0.978 / 0.970 - 1 = 0.82\%\)
12. Continued

(c) Recommend the annual premium trend rate to use in adjusting from calendar year 2018 to the future rating period. Justify your recommendation.

2016 needs to be excluded due to the one-time initiative to target customers in different groups. This is not expected in the future and should not be considered in the recommended annual premium trend rate.

Recommend the average of 2015, 2017, 2018 = 0.80%

(d) Calculate the calendar year 2014 earned premium to use for ratemaking.

Need to separate out the two periods - experience period in 2014 to forecast period 2018, then from 2018 to future rating period.

From average earned date in 2014 to average earned date in 2018:

(1) Weighted average differential in 2014: 0.970
(2) Weighted average differential in 2018: 1.028
(3) Trend factor 2014 to 2018 = (2) / (1) 1.060

From average earned date in 2018 to future rating period:

(4) Average earned date in 2018: Jul 1, 2018
(5) Average earned date in future rating period: May 1, 2021
(6) Trending period in months: 34
(7) Trend factor = (1 + 0.008)^(34/12) 1.0228
(8) 2014 earned premium at current rate level 300,000
(9) Total 2014 trended on level EP = (8)×(3)×(7)
    = 300,000×1.060×1.0228 = 325,250
13. **Learning Objectives:**
   1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.

**Learning Outcomes:**

(1q) Understand the types of reinsurance and key reinsurance terms.
(1r) Explain the principal functions of reinsurance.
(1s) Analyze and describe the types of reinsurance.
(1t) Understand important reinsurance contract provisions that potentially affect actuarial work.

**Sources:**

**Commentary on Question:**
This question tests the candidate’s understanding of reinsurance.

**Solution:**

(a) Identify a function of reinsurance that is best addressed by proportional reinsurance.

Either one of the following is acceptable:
- Increased capacity
- Enhance financial strength

(b) Identify a function of reinsurance that is best addressed by excess of loss reinsurance.

Any one of the following is acceptable:
- Increased capacity
- Catastrophe protection
- Stabilize loss experience

(c) Determine the net amount paid by each company.

(i) Insurer A
(ii) Reinsurer B
13.  Continued

The insurer is obligated to make the full claim payment to the policyholder. The reinsurance contract does not alter the underlying policy.

Insurer A:  
\[ 1,000,000 + 500,000 = 1,500,000 \]

Reinsurer B:  
\[ 4,000,000 - 1,500,000 = 2,500,000 \]

(d) Calculate the total net amount paid by each company with pro-rata treatment of ALAE.

(i) Insurer A

(ii) Reinsurer B

Insurer A:  
Indemnity:  
\[ 1,000,000 + 0.5 \times 1,000,000 = 1,500,000 \]
ALAE:  
\[ 1.5/4 \times 500,000 = 187,500 \]
\[ 1,687,500 \]

Reinsurer B:  
Indemnity:  
\[ 0.5 \times 1,000,000 + 2,000,000 = 2,500,000 \]
ALAE:  
\[ 2.5/4 \times 500,000 = 312,500 \]
\[ 2,812,500 \]

(e) Calculate the total net amount paid by each company when ALAE is considered within the retention.

(i) Insurer A

(ii) Reinsurer B

Insurer A:  
Indemnity:  
\[ 1,000,000 + 0.5 \times 1,000,000 = 1,500,000 \]
ALAE:  
\[ 0 \]
\[ 1,500,000 \]

Reinsurer B:  
Indemnity:  
\[ 0.5 \times 1,000,000 + 2,000,000 = 2,500,000 \]
ALAE:  
\[ 500,000 \]
\[ 3,000,000 \]
13. Continued

(f) Explain how net claims paid by Insurer A under the alternative coverage could differ from the current reinsurance coverage despite having the same maximum net retention.

If the claim amount is between 1,000,000 and 2,000,000 then the net amount retained will be more under the new policy.

For example, a loss of 1,500,000:
- original: Insurer A share = 50%×500,000 + 1,000,000 = 1,250,000
- alternative: Insurer A share = 1,500,000
14. **Learning Objectives:**

   2. The candidate will demonstrate the ability to prepare claims and exposure data for general insurance actuarial work.

**Learning Outcomes:**

   (2b) Describe the different types of exposures used for conducting actuarial work.

   (2c) Calculate written, earned, in-force and unearned premiums for portfolios of policies with various policy terms and earnings patterns.

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of earned and unearned exposures.*

**Solution:**

(a) Calculate the exposures earned in 2019.

One-quarter of the premium is earned in each of the four calendar years starting one year after each policy is written.

<table>
<thead>
<tr>
<th>Calendar Year (CY)</th>
<th>Annual Exposures</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>348</td>
<td>174</td>
<td>348</td>
<td>348</td>
<td>348</td>
<td>174</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>570</td>
<td>0</td>
<td>285</td>
<td>570</td>
<td>570</td>
<td>570</td>
<td>285</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>780</td>
<td>0</td>
<td>390</td>
<td>780</td>
<td>780</td>
<td>780</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>912</td>
<td>0</td>
<td>456</td>
<td>912</td>
<td>912</td>
<td>912</td>
<td>456</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,308</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Earned exposures in 2019 by written calendar year:

- 2016: $1,392 / 4 = 348$
- 2017: $2,280 / 4 = 570$
- 2018: $(1/2)(3,120 / 4) = 390$
- 2019: 0 (will only start being earned in 2020)

Total = $348 + 570 + 390 = 1,308$.

(b) State two assumptions underlying in the part (a) calculation.

- Policies are written uniformly over the year
- Premiums are earned evenly over the 4 years of the policy duration
14. Continued

(c) Calculate the expected unearned exposures as of December 31, 2019.

From the chart in part (a), sum all earned exposures after 2019:

- CY 2016: \(248 + 174 = 522\)
- CY 2017: \(570 + 570 + 285 = 1,425\)
- CY 2018: \(780 + 780 + 780 + 390 = 2,730\)
- CY 2019: 3,648

Total unearned exposures as of December 31, 2019:

\[= 522 + 1,425 + 2,730 + 3,648 = 8,325.\]
15. **Learning Objectives:**

5. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

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

**Learning Outcomes:**

(5b) Identify the time periods associated with trending procedures.

(6l) Calculate risk classification changes.

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of risk classification ratemaking.*

**Solution:**

(a) Calculate the Territory 1 trended ultimate pure premium for each accident year.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Development Factors</th>
<th>Written Exposures</th>
<th>Earned Exposures</th>
<th>Ultimate Counts</th>
<th>Reported Claims as of Dec. 31, 2018 (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>From Development Method</td>
<td>Implied Factors</td>
<td>Exposures</td>
<td>Earned Exposures</td>
<td>Ultimate Counts</td>
</tr>
<tr>
<td>2016</td>
<td>1.06</td>
<td>1.07</td>
<td>15,600</td>
<td>15,300</td>
<td>1,575</td>
</tr>
<tr>
<td>2017</td>
<td>1.12</td>
<td>1.11</td>
<td>16,200</td>
<td>16,000</td>
<td>1,570</td>
</tr>
<tr>
<td>2018</td>
<td>1.24</td>
<td>1.22</td>
<td>17,600</td>
<td>17,200</td>
<td>1,720</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>49,400</td>
<td>48,500</td>
<td></td>
</tr>
</tbody>
</table>

Average accident date in AY 2018: July 1, 2018
Average accident date in future rating period: April 1, 2021
Trending period: 33 months

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Trending Period (months)</th>
<th>Pure Premium Trend @3%</th>
<th>Trended Ultimate Claims (000)</th>
<th>Trended Ultimate Pure Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>57</td>
<td>1.151</td>
<td>4,889.33</td>
<td>319.56</td>
</tr>
<tr>
<td>2017</td>
<td>45</td>
<td>1.117</td>
<td>5,021.47</td>
<td>313.84</td>
</tr>
<tr>
<td>2018</td>
<td>33</td>
<td>1.085</td>
<td>5,665.44</td>
<td>329.39</td>
</tr>
</tbody>
</table>
15. Continued

(b) Recommend a Territory 1 trended ultimate pure premium to use in the risk classification analysis. Justify your recommendation.

**Commentary on Question:**
*Other weights are acceptable with appropriate justification.*

Recommended weights: 25% for 2016, 35% for 2017, and 40% for 2018

Justification: use all years but more weight to most recent years.

Weighted average trended ultimate pure premium = 321.49

(c) Calculate the credibility weighted pure premium relativities for each territory.

<table>
<thead>
<tr>
<th>Territory</th>
<th>CY2018 Written Exposures</th>
<th>Pure Premium Relativity</th>
<th>Ultimate Counts</th>
<th>Industry Relativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17,600</td>
<td>0.989</td>
<td>4,865</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>10,500</td>
<td>0.919</td>
<td>2,780</td>
<td>0.90</td>
</tr>
<tr>
<td>3</td>
<td>8,200</td>
<td>1.014</td>
<td>2,360</td>
<td>1.05</td>
</tr>
<tr>
<td>4</td>
<td>6,700</td>
<td>1.140</td>
<td>2,130</td>
<td>1.20</td>
</tr>
<tr>
<td>Total</td>
<td>43,000</td>
<td>1.000</td>
<td>12,135</td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{(16)} = (16)/1.0163 \quad \text{(18)} = \sqrt{(15)/4,329} \\
\text{(19)} = (14)(18) + (17)[1 – (18)]
\]

<table>
<thead>
<tr>
<th>Territory</th>
<th>Industry Relativity</th>
<th>Industry Relativity Rebalanced</th>
<th>Credibility</th>
<th>Credibility Weighted Pure Premium Relativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>0.9840</td>
<td>1.000</td>
<td>0.989</td>
</tr>
<tr>
<td>2</td>
<td>0.90</td>
<td>0.8856</td>
<td>0.801</td>
<td>0.912</td>
</tr>
<tr>
<td>3</td>
<td>1.05</td>
<td>1.0332</td>
<td>0.738</td>
<td>1.019</td>
</tr>
<tr>
<td>4</td>
<td>1.20</td>
<td>1.1808</td>
<td>0.701</td>
<td>1.152</td>
</tr>
<tr>
<td>Total</td>
<td>1.0163</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GI RR Fall 2019 Solutions Page 34
16. Learning Objectives:
3. The candidate will know how to calculate and evaluate projected ultimate values.
4. The candidate will understand financial reporting of claim liabilities and premium liabilities.

Learning Outcomes:
(3j) Evaluate and justify selections of ultimate values based on the methods cited in (3e).
(4a) Describe the key assumptions underlying ratio and count-based methods for estimating unpaid unallocated loss adjustment expenses.
(4b) Estimate unpaid unallocated loss adjustment expenses using ratio and count-based methods.

Sources:

Commentary on Question:
This question tests the candidate’s ability to evaluate and justify selections of ultimate values based on various methods. In addition, this question tests the candidate’s understanding of estimating unpaid unallocated loss adjustment expenses.

Solution:
(a) Recommend which of the six estimates, (A) through (F), is most appropriate for all three AYs 2016-2018. Justify your recommendation.

Commentary on Question:
There are two approaches that can be used. The development method should be avoided due to changing conditions, and any method using paid data for 2016 will not account for the missing large claim.

(E) Cape Cod method applied to reported data:
- This method recognizes the accident year 2016 large claim to date in actual experience with using it in the projection of unpaid claims.
- This method explicitly reflects the effect of tort reform.
- The expected claim ratio used in this method will reflect actual historical experience which reflects deteriorating experience.
16. Continued

(F) Frequency Severity method applied to reported data:
- This method allows the deterioration to be reflected in the frequency and/or severity selections as appropriate.
- A special adjustment could be made for the large claim (e.g., exclude from analysis, then add back at the end).
- A special adjustment could be made for tort reform.

(b) Recommend a method to estimate unpaid ULAE. Justify your recommendation.

The Mango Allen approach is preferred due to increasing exposures or the volatility in actual experience from the large claim.

(c) Estimate unpaid ULAE as of December 31, 2018 using the method from part (b) and a simple three-year average of historical experience.

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Paid ULAE</th>
<th>Expected Paid Claims</th>
<th>Expected Reported Claims</th>
<th>Paid ULAE/ Average of Expected Paid and Expected Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>1,100</td>
<td>8,400</td>
<td>8,500</td>
<td>13.0%</td>
</tr>
<tr>
<td>2017</td>
<td>1,150</td>
<td>8,900</td>
<td>9,000</td>
<td>12.8%</td>
</tr>
<tr>
<td>2018</td>
<td>1,200</td>
<td>9,400</td>
<td>9,500</td>
<td>12.7%</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td>12.9%</td>
</tr>
</tbody>
</table>

Unpaid ULAE
= (ULAE ratio × IBNR) + (ULAE ratio × multiplier × case estimates)
= (12.9% × 6,000) + (12.9% × 75% × (16,000 + 7,000)) = 2,999.
17. Learning Objectives:
6. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

Learning Outcomes:
(6s) Explain the premise of experience rating.
(6t) Describe the types of experience rating used with general insurance.

Sources:

Commentary on Question:
This question tests the candidate’s understanding of individual risk rating.

Solution:
(a) Identify two ways to promote equity among insureds in determining experience rating premiums.

Any two of the following are acceptable:
• Use credibility
• A cap that is used to limit less common large claims
• The number of years in the experience period

(b) Explain how prospective experience rating differs from schedule rating in reflecting risk control activities.

Commentary on Question:
This question is about describing how risk control activities are reflected in prospective experience rating compared to schedule rating as opposed to defining prospective experience rating and schedule rating.

With schedule rating, the insured receives a credit for the presence of a risk control measure. With experience rating, the expected cost savings from risk control activities must actually materialize through lower claims than expected before a credit is given.

(c) Explain whether or not prospective experience rating should be used to reflect each of the changes I and II. Justify your explanation.

I. Only two years of experience would reflect the new sprinkler so prospective experience rating would only reflect part of the actual experience.
17. Continued

II. Prospective experience rating should be used as the expansion would be reflected in the past experience assuming that the new extension is expected to have similar experience to the existing risk.

(d) Explain whether or not schedule rating should be used to reflect each of the changes I and II. Justify your explanation.

I. Schedule rating could still be used as only two years of experience would reflect the new sprinkler. It will depend on how many years of experience is used for experience rating.

II. Schedule rating would not be used, assuming that the new extension is expected to have similar experience to the existing risk.
18. **Learning Objectives:**
3. The candidate will know how to calculate and evaluate projected ultimate values.

**Learning Outcomes:**
(3h) Explain the effect of changing conditions on the projection methods cited in (3e).
(3i) Assess the appropriateness of the projection methods cited in (3e) in varying circumstances.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of the appropriateness of various methods of estimating ultimate claims under changing conditions.*

**Solution:**
(a) Recommend a different estimation method for each of the following independent books of business. Justify your recommendations.

(i) A long-tailed book where the policy limit was increased from 1 million to 1.5 million effective January 1, 2014.

Recommend expected method because both the pattern and experience will change at mature (tail) periods which will take many years to figure out.

(ii) A medium-tailed book where the third-party claim administrator was changed on January 1, 2016.

This scenario is equivalent to a change in case adequacy (using reported data because of long-tail). Therefore, recommend using Berquist-Sherman data adjustment to restate historical triangle, and then apply development method.

(iii) A book with unstable development patterns and deteriorating experience.

Recommend using the frequency-severity method which would separately analyze claim counts and average severity. This might give better insights as to what patterns are changing and where the deterioration is coming from (i.e., frequency or severity or both).
18. Continued

Alternatively, recommend using the Generalized Cape Code method which would directly reflect actual experience (i.e., deterioration) in the expected claims ratio. This method will also help with stability (similar to Bornhuetter Ferguson) since development is applied to unreported claims only, not the actual experience to date.

(iv) A book net of excess of loss reinsurance, where the attachment point increased from 250,000 per occurrence to 500,000 per occurrence effective January 1, 2017.

Recommend estimating gross and ceded reserves separately. Recommend using Bornhuetter Ferguson for gross reserves since nothing unusual is cited in this scenario but accident year 2018 is immature. Get a priori from pricing actuaries.

Recommend using Bornhuetter Ferguson method for ceded reserves. Get a priori from pricing actuaries (or use loss elimination ratios to adjust historical claim ratios to current attachment point). Recommend decelerating the development pattern based on industry data (or create a restated historical triangle based on 500,000 attachment point to derive development factors for Bornhuetter Ferguson method).
19. **Learning Objectives:**

3. The candidate will know how to calculate and evaluate projected ultimate values.

**Learning Outcomes:**

(3e) Describe the key assumptions underlying the following projection methods: development method, frequency-severity methods, expected method, Bornhuetter Ferguson method, Benktander method, Cape Cod method, Generalized Cape Cod, and Berquist-Sherman adjustments to the development method.

(3g) Estimate ultimate values using the methods cited in (3e).

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of Berquist-Sherman adjustments when there has been a change in claim settlement patterns.*

**Solution:**

(a) Describe the patterns you would expect in the following development triangles in a stable environment:

(i) **Average Case Estimates**

   Expect changes down each column to be consistent with expected claim trend.

(ii) **Disposal Rates**

   Rates down each column should be stable.

(b) Calculate the disposal ratio triangle.

Calculate Disposal Ratio = Closed Counts / Ultimate Reported Counts

Select reported ultimate counts, since paid ultimate counts are distorted by settlement pattern changes.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Disposal Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>2016</td>
<td>36%</td>
</tr>
<tr>
<td>2017</td>
<td>36%</td>
</tr>
<tr>
<td>2018</td>
<td>45%</td>
</tr>
</tbody>
</table>

E.g., Accident year 2016 at 24 months: 64% = 374 / 585
19. Continued

(c) Calculate the adjusted closed count triangle.

Selected disposal ratios (last diagonal):

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>45%</td>
<td>75%</td>
<td>90%</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Closed Count Triangle = Selected Disposal Ratios × Reported Ultimate Counts

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Adjusted Closed Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>264 439 527</td>
</tr>
<tr>
<td>2017</td>
<td>272 452</td>
</tr>
<tr>
<td>2018</td>
<td>326</td>
</tr>
</tbody>
</table>

e.g., Accident year 2016 at 24 months: 439 = 75% × 585

(d) Calculate adjusted paid claims for accident year 2016 evaluated as of December 31, 2017 using the data above and the adjusted closed count triangle.

Adjusted closed counts = 439

Adjusted paid claims = 15,000 × e^{(439 × 0.0007)} = 20,396
20. **Learning Objectives:**
3. The candidate will know how to calculate and evaluate projected ultimate values.

**Learning Outcomes:**
(3e) Describe the key assumptions underlying the following projection methods: development method, frequency-severity methods, expected method, Bornhuetter Ferguson method, Benktander method, Cape Cod method, Generalized Cape Cod, and Berquist-Sherman adjustments to the development method.
(3g) Estimate ultimate values using the methods cited in (3e).

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of the frequency-severity claim closure method for estimating unpaid claims.*

**Solution:**
(a) Provide two situations where the frequency-severity method is more appropriate to use than the development method.

Any two of the following 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

(b) Calculate the accident year 2017 incremental closed counts at 36, 48 and 60 months.

\[
\begin{align*}
AY2017 \ @ \ 36 \ months &= 44\% \times (4,473 - (1,260 + 1,340)) = 824 \\
AY2017 \ @ \ 48 \ months &= 59\% \times (4,473 - (1,260 + 1,340 + 824)) = 619 \\
AY2017 \ @ \ 60 \ months &= 100\% \times (4,473 - (1,260 + 1,340 + 824 + 619)) = 430
\end{align*}
\]
20. Continued

(c) Calculate accident year 2017 unpaid claims using the frequency-severity closure method.

Only 36, 48 and 60 months are needed to calculate unpaid for accident year 2017.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Incremental Paid Severity at AY2018 Cost Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2014</td>
<td>22,169</td>
</tr>
<tr>
<td>2015</td>
<td>21,710</td>
</tr>
<tr>
<td>2016</td>
<td>22,000</td>
</tr>
<tr>
<td>2017</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>21,960</td>
</tr>
<tr>
<td>Selected</td>
<td>21,960</td>
</tr>
<tr>
<td>(no outliers so average is acceptable)</td>
<td></td>
</tr>
<tr>
<td>e.g., AY2016 at 36 months = 20,340 \times (1 + 0.04)^2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AY2017 Incremental Severity</th>
<th>36</th>
<th>48</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>(adjusted one year with 4% trend)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AY2017 Unpaid Claims</th>
<th>36</th>
<th>48</th>
<th>60</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g., at 36 months: 17,398,760 = 824 \times 21,115</td>
<td>17,398,760</td>
<td>37,070,672</td>
<td>32,262,470</td>
<td>86,731,902</td>
</tr>
</tbody>
</table>