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.

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

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of certain details of individual insurance policies and ability to make correct calculations of earned premium, unearned premium and written premium for various policies. The candidate also needs to understand earned premiums adjusted to current rate level.*

**Solution:**

(a) Calculate the total earned premium for calendar year 2017.

<table>
<thead>
<tr>
<th>Policy</th>
<th>Policy Term (months)</th>
<th>Months Earned in 2017</th>
<th>Written Premium</th>
<th>Earned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquired book</td>
<td>12</td>
<td>5</td>
<td>150,000</td>
<td>62,500</td>
</tr>
<tr>
<td>Acquired book (1st renewal)</td>
<td>12</td>
<td>7</td>
<td>132,000</td>
<td>77,000</td>
</tr>
<tr>
<td>101</td>
<td>12</td>
<td>8</td>
<td>1,600</td>
<td>1,067</td>
</tr>
<tr>
<td>102</td>
<td>18</td>
<td>6</td>
<td>2,100</td>
<td>700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>141,267</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: Written premium for acquired book 1st renewal = 100×1,500×1.1×0.8
1. Continued

(b) Calculate the total unearned premium as of June 30, 2018.

<table>
<thead>
<tr>
<th>Policy number</th>
<th>Term (months)</th>
<th>Months Unearned as of June 30, 2018</th>
<th>Written Premium</th>
<th>Unearned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquired book (2nd renewal)</td>
<td>12</td>
<td>11</td>
<td>116,160</td>
<td>106,480</td>
</tr>
<tr>
<td>101</td>
<td>12</td>
<td>10</td>
<td>1,800</td>
<td>1,500</td>
</tr>
<tr>
<td>201</td>
<td>6</td>
<td>2</td>
<td>800</td>
<td>267</td>
</tr>
<tr>
<td>202</td>
<td>24</td>
<td>23</td>
<td>2,500</td>
<td>2,396</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>110,643</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Written premium for acquired book 1st renewal = 100×1,500×1.12×0.82

(c) Calculate the calendar year 2017 earned premium at current rate levels using the extension of exposures method.

The acquired book will need to be adjusted for the two 10% rate increases at each renewal and the 5% increase on October 1, 2018. Policies 101 and 102 need to be adjusted for the 5% rate increase on October 1, 2018.

<table>
<thead>
<tr>
<th>Policy number</th>
<th>Months Earned in 2017</th>
<th>Earned Premium at Current Rate Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquired book</td>
<td>5</td>
<td>100×1,500×(5/12)×1.12×1.05 = 79,406.25</td>
</tr>
<tr>
<td>Acquired book (1st renewal)</td>
<td>7</td>
<td>100×1,500×0.80×(7/12)×1.12×1.05 = 88,935.00</td>
</tr>
<tr>
<td>101</td>
<td>8</td>
<td>(8/12)×1,600×1.05 = 1,120.00</td>
</tr>
<tr>
<td>102</td>
<td>6</td>
<td>(6/18)×2,100×1.05 = 735.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>170,196.25</strong></td>
</tr>
</tbody>
</table>

(d) State why the parallelogram approach is not appropriate to use in part (c).

The parallelogram approach is not appropriate to use for determining the earned premium at current rate levels because the exposures are not evenly distributed over time.
2. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

Learning Outcomes:
(4a) Identify the time periods associated with trending procedures.
(4b) Describe the influences on frequency and severity of changes in deductibles, changes in policy limits, and changes in mix of business.
(4c) Choose trend rates and calculate trend factors for claims.

Sources:

Commentary on Question:
*This question tests the candidate’s understanding of calculating claim trend and considerations when using industry data for claim trend analysis.*

Solution:
(a) State two other reasons why actuaries may need to adjust historical data when analyzing claim trend.

Any two of the following are acceptable:
- Catastrophe claims
- Seasonality
- Changes due to tort and product reform
- Legislated benefit level changes
- Changes in claims settlement

(b) Calculate the pure premium trend factor for accident year 2016.

- The average accident date for accident year 2016 is July 1, 2016.
- The average accident date for the forecast period for 6-month policies is July 1, 2020 (i.e., 9 months after effective date).
- The average accident date for the forecast period for 12-month policies is October 1, 2020 (i.e., 12 months after effective date).
- The average accident date for the forecast period (33.3% 6-month, 66.6% 12-month) is September 1, 2020.
- Trending period = July 1, 2016 to September 1, 2020 = 50 months, or 50/6 = 8.333 half-years.
- Therefore, pure premium trend = \( e^{(0.0101 \times 8.333)} \times e^{(0.0292 \times 8.333)} = 1.3875 \).
2. Continued

(c) Provide two potential supplementary sources of data for the trend analysis.

Any two of the following are acceptable:
- External industry data
- The company’s regional data
- The company’s countrywide data
- Combine with other insurers in a group under common ownership

(d) Describe two considerations when evaluating supplementary sources of data.

Any two of the following are acceptable:
- Carefully review the applicability of external data and review the obligations and guidance set out in the standards
- Review the economic, legal, and regulatory environments that influence frequency and severity
- Ensure there are similar operational policies, particularly with respect to underwriting, claims management, and reinsurance
- Ensure there are similarities in the types of exposures and products
3. **Learning Objectives:**
3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3b) Estimate unpaid unallocated loss adjustment expenses using ratio and count-based methods.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of estimating unpaid ULAE.*

**Solution:**
(a) Explain why the classical paid-to-paid method may not be appropriate for estimating unpaid ULAE in this case.

During times of growing exposures, the classical paid-to-paid method may not be appropriate. The numerator of the ratio (i.e., the calendar year paid ULAE) reacts fairly quickly to growing exposures; the denominator of the ratio (i.e., the calendar year paid claims) is not as responsive because a significant proportion of the paid claims are from earlier years. Therefore, ULAE tends to be overstated.

(b) Calculate the ULAE ratio for each year using the Mango and Allen smoothing adjustment based on paid and reported claim data.

<table>
<thead>
<tr>
<th>Maturity Age in months</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported age-to-ult. development factors (CDF)</td>
<td>3.480</td>
<td>1.860</td>
<td>1.310</td>
</tr>
<tr>
<td>% Cumulative Reported (1/CDF)</td>
<td>28.7%</td>
<td>53.8%</td>
<td>76.3%</td>
</tr>
<tr>
<td>% Incremental Reported</td>
<td>28.7%</td>
<td>25.1%</td>
<td>22.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Report Year</th>
<th>Selected Ultimate Claims</th>
<th>Expected Reported in Calendar Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>2016</td>
<td>1,025,000</td>
<td>294,175</td>
</tr>
<tr>
<td>2017</td>
<td>1,290,000</td>
<td>370,230</td>
</tr>
<tr>
<td>2018</td>
<td>1,516,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>294,175</td>
</tr>
</tbody>
</table>

e.g., Report year 2017 expected reported in calendar year 2018
\[= 0.251 \times 1,290,000\]
### 3. Continued

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Paid ULAE</th>
<th>Expected Claims</th>
<th>Ratio of Paid ULAE to Average of Paid and Reported Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paid</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>19,100</td>
<td>132,200</td>
<td>9.0%</td>
</tr>
<tr>
<td>2017</td>
<td>44,500</td>
<td>317,100</td>
<td>9.4%</td>
</tr>
<tr>
<td>2018</td>
<td>86,500</td>
<td>678,300</td>
<td>10.4%</td>
</tr>
</tbody>
</table>

(c) **Recommend the ULAE ratio to use for this line of business. Justify your recommendation.**

Recommendation is to use the average of all years of 9.6%. The justification is to use the average as this is a new line of business and there probably isn’t yet the stability in the numbers.

(d) **Calculate unpaid ULAE using the recommended ratio from part (c).**

Unpaid ULAE = 9.6%×(2,665,000 – 1,290,000) + 9.6%×(1 – 25%)×1,290,000  
= 224,880.
4. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

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

Learning Outcomes:
(4a) Identify the time periods associated with trending procedures.
(4c) Choose trend rates and calculate trend factors for claims.
(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

Sources:

Commentary on Question:
This question tests the candidate’s understanding of basic ratemaking.

Solution:
(a) Calculate the trended pure premiums for each accident year.

- Average accident date in accident year 2018 = July 1, 2018
- Average accident date in future rating period = July 1, 2020 (average accident date between October 1, 2019 to six months after October 1, 2020)
- Therefore, trending period for accident year 2018 = 24 months

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned Exposures</th>
<th>Ultimate Claims</th>
<th>Trending Period (months)</th>
<th>Pure Premium Trend Factor</th>
<th>Trended Ultimate Claims</th>
<th>Trended Pure Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>12,000</td>
<td>7,100,000</td>
<td>60</td>
<td>1.276</td>
<td>9,059,600</td>
<td>754.97</td>
</tr>
<tr>
<td>2016</td>
<td>13,400</td>
<td>8,700,000</td>
<td>48</td>
<td>1.216</td>
<td>10,579,200</td>
<td>789.49</td>
</tr>
<tr>
<td>2017</td>
<td>14,200</td>
<td>9,400,000</td>
<td>36</td>
<td>1.158</td>
<td>10,885,200</td>
<td>766.56</td>
</tr>
<tr>
<td>2018</td>
<td>14,800</td>
<td>10,400,000</td>
<td>24</td>
<td>1.103</td>
<td>11,471,200</td>
<td>775.08</td>
</tr>
</tbody>
</table>

(b) Recommend a pure premium to use for ratemaking. Justify your recommendation.

Commentary on Question:
Other answers are possible.

Recommend straight average = 771.53
Justification: The straight average is reasonable as there is no significant trend and no outliers.
4. Continued

(c) Calculate the indicated rate change.

Weighted average trended pure premium  
$771.53$

Indicated rate  
\[
\frac{(771.53 \times 1.08 + 60)}{(1 - 0.14 - 0.04)} = 1,089.33
\]

Average trended earned premium at current rate levels  
$980$

Indicated rate change  
\[
\frac{1,089.33}{980} - 1 = 11.2\%
\]

(d) Demonstrate that the new base rate needed to achieve this increase is $1,039.50$.

Total premium using current rating factors:
\[
1,000 \times (7,500 \times 1.00 + 5,000 \times 1.10 + 3,000 \times 0.95) = 15,850,000
\]

Total premium using proposed rating factors:
\[
1,039.50 \times (7,500 \times 1.00 + 5,000 \times 1.15 + 3,000 \times 0.92) = 16,642,395
\]

This gives an increase in overall premium of $16,642,395/15,850,000 - 1 = 5.0\%$, which is equal to the implemented rate change.
5. 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.
(7b) Apply catastrophe models to insurance ratemaking, portfolio management, and risk financing.

Sources:

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

Solution:
(a) Explain how each module of the catastrophe models could contribute to the difference in the modeling results from each vendor for the same book of business, for each the following modules.

(i) Hazard
(ii) Inventory
(iii) Vulnerability
(iv) Loss

(i) The hazard module simulates the events to be applied to the risks. The stochastic model used may differ. When simulated events are different, modeled results will be different.

(ii) The inventory module contains the individual policy and risk information of the underlying portfolio. It should be same for all models and should not contribute to difference among modeling results.

(iii) The vulnerability module estimates the level of building damage expected for different levels of severity of the oncoming external forces imposed. When damage ratios/damage curves (part of the model) are different, modeled results will be different.
5. Continued

(iv) The loss module converts the building damage, either direct or indirect, to a monetary loss amount. Candidates could either argue for contributing (because it is using information from vulnerability module that are different) or does not contributing (because all it is doing is applying damage ratios to the insured value and this logic is the same across all models).

(b) Determine the 1-in-25 year probable maximum loss (PML) for Model X2.

\[
\frac{1}{25} = 0.04 \\
\text{On the graph for X2, 0.04 is at 50 million.}
\]

(c) Recommend an approach for selecting or deriving an appropriate AAL from the three estimates. Justify your recommendation.

- The three modeling results are not materially different (i.e., there are no outlier results), therefore, all three should be under consideration.
- The actuary should use a weighted average of the three modeling results.
- The actuary should have an understanding of the differences in the models.
- For the line of business and perils being modeled for NAN insurance, identify which model is more robust, then it will be given more weight. Identify which model is less robust and give that model less weight.

(d) Explain one implication of replacing the original model runs with the re-runs.

**Commentary on Question:**

*Other implications are possible.*

It presents a moral hazard. Presenting a lower AAL can result in lower (cheaper) reinsurance premium from the reinsurer. However, this is essentially understating the exposure that the reinsurer is covering.
6. 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.
(5k) Calculate rates for claims-made coverage.

Sources:
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 28, 33, and 34.

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

Solution:
(a) Provide two reasons why MSB might decide to purchase coverage.

Commentary on Question:
Other answers are possible.

- Offers protection against the possibility of a claim, even though experience has been very good
- Purchasing coverage also provides the opportunity to obtain tail coverage

(b) Recommend two options for an exposure base for XYZ to use in providing insurance coverage. Justify your recommendations.

- Number of full-time equivalent professionals is a typical measure
- Revenue could be used also because of declining revenue

(c) Provide one advantage and one disadvantage for MSB to purchase a claims-made policy.

- An advantage is that it is lower cost than an occurrence policy
- A disadvantage is that nose or tail coverage may be required

(d) Provide one advantage and one disadvantage for MSB to purchase an occurrence policy.

- An advantage is that it covers claims if occurrence coincides with policy period
- A disadvantage is that it is more expensive than a claims-made policy, unless there is a charge for an old retroactive date
7. **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 including expense trending procedures.
(5c) Incorporate underwriting profit and contingency margins into ratemaking.
(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of incorporating expenses and underwriting profit in ratemaking as well as basic ratemaking.*

**Solution:**

(a) Calculate the indicated rate change using the claim ratio approach.

Expected claim ratio (ECR) = $\frac{325/500}{500} = 0.65$
Indicated rate change = $\frac{(0.65 + 0.0500)}{(1 - 0.22 - 0.04)} - 1 = 1.35\%$.

(b) Provide one reason why the regulator would impose such a maximum expense provision.

Any of the following are acceptable (other answers are possible):
- Not pass along a company’s expense inefficiencies to the customer
- Prevent rates from being too high
- Cap company profits

(c) Verify that the calculations with the expense capping produces a negative rate indication.

This can be done by either reducing $V$ or reducing $F/R_C$ (in formula 31.8):

**Reducing $V$:**
Revised variable expense as a percent of premium: 18%
Indicated rate change = $\frac{(325/500 + 0.0500)}{(1 - 0.18 - 0.04)} - 1 = -3.85\%$.

**Reducing $R_C$:**
Revised fixed expense as a percent of premium: $\frac{50/500}{4\%} = 6\%$
Indicated rate change = $\frac{(325/500 + 0.06)}{(1 - 0.22 - 0.04)} - 1 = -4.05\%$. 
7. Continued

(d) Calculate the underwriting profit resulting from charging the indicated rate from part (c).

Assuming $V$ was reduced in part (c):
From formula 31.8: \[
\frac{325/500 + 50/500}{(1 - 0.22 - Q)} - 1 = -3.85%,
\]
Which solves for $Q = 0.0%$. 

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

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

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.
(2e) Assess the appropriateness of the projection methods cited in (2b) in varying circumstances.
(2f) Evaluate and justify selections of ultimate values based on the methods cited in (2b).
(3c) Describe the components of claim liabilities in the context of financial reporting.

Sources:

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

Solution:
(a) Explain the benefit of using the Bornhuetter Ferguson method over the development method.

The Bornhuetter Ferguson method is better for immature periods where the cumulative development factors are highly leveraged.

(b) Explain the benefit of using the Bornhuetter Ferguson method over the expected method.

The benefit of Bornhuetter Ferguson method over expected method is the expected method’s lack of responsiveness to actual claims as they emerge.
8. Continued

(c) Compare the effects of using the Bornhuetter Ferguson method applied to paid and reported claims when claim experience is improving.

If the claim experience is improving, the projected ultimate claims from the Bornhuetter Ferguson method will be overstated (more than the actual ultimate claims) without a decrease in the expected pure premiums. This is the case if the Bornhuetter Ferguson method is applied to either paid or reported claims. However, because the proportion of expected unobserved claims is greater for paid claims than reported claims, the overstatement is even more pronounced when applying Bornhuetter Ferguson method to paid claims compared to reported claims.

(d) Calculate the a priori expected claims for State B for accident years 2017 and 2018, based on all years’ experience of State A.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned Vehicles</th>
<th>Projected Ultimate Claims (000)</th>
<th>Trend at 2.5%</th>
<th>Trended Pure Premiums</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>72,900</td>
<td>17,100</td>
<td>1.077</td>
<td>252.63</td>
</tr>
<tr>
<td>2016</td>
<td>75,000</td>
<td>17,900</td>
<td>1.051</td>
<td>250.84</td>
</tr>
<tr>
<td>2017</td>
<td>80,100</td>
<td>20,100</td>
<td>1.025</td>
<td>257.21</td>
</tr>
<tr>
<td>2018</td>
<td>78,000</td>
<td>19,700</td>
<td>1.000</td>
<td>252.56</td>
</tr>
<tr>
<td><strong>All Years Average</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>253.31</strong></td>
</tr>
</tbody>
</table>

State B a priori expected claims for State B:
Accident Year 2017: \( 11,700 \times \frac{253.31}{1.025}/1,000 = 2,891 \)
Accident Year 2018: \( 19,100 \times \frac{253.31}{1.000}/1,000 = 4,838 \)

(e) Calculate the implied reported age-to-ultimate development factors for State B using the a priori expected claims from part (d).

Accident Year 2017 age-to-ultimate factor: \( 2,891/1,400 = 2.065 \)
Accident Year 2018 age-to-ultimate factor: \( 4,838/920 = 5.259 \)
8. Continued

(f) Recommend a set of development factors to use for estimating ultimate claims for State B. Justify your recommendation.

Commentary on Question: 
Other answers are possible.

Recommend State A factors as there is not enough history for State B factors to be reliable/credible.

(g) Calculate the ultimate claims for State B using the Bornhuetter Ferguson method and the a priori expected claims from part (d).

Projected Ultimate Claims using Bornhuetter Ferguson method:
Accident Year 2017: \(1,400 + 2,891 \times (1 - 1/2.900) = 3,294\)
Accident Year 2018: \(920 + 4,838 \times (1 - 1/5.700) = 4,909\)

(h) Calculate the State B total unpaid claims, showing the case estimate and indicated IBNR separately.

Total ultimate claims from part (g) = 3,294 + 4,909 = 8,203

Total paid as of Dec. 31, 2018 = 1,700
Total unpaid claims as of Dec. 31, 2018 = 8,203 – 1,700 = 6,503

IBNR Accident Year 2017: \(3,294 – 1,400 = 1,894\)
IBNR Accident Year 2018: \(4,909 – 920 = 3,989\)
Total IBNR = 1,894 + 3,989 = 5,883.
9. **Learning Objectives:**

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

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

**Learning Outcomes:**

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

(3e) Describe the components of premium liabilities in the context of financial reporting.

(3f) Evaluate premium liabilities.

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of premium liabilities.*

**Solution:**

(a) Calculate the claims expected to arise after December 31, 2018 from policies in force at that date, excluding claims handling costs.

<table>
<thead>
<tr>
<th>Calendar Year Written</th>
<th>% Claims Expected in Calendar Year</th>
<th>1) Post 2018 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>0.0% 12.5% 50.0% 37.5%</td>
<td>37.5%</td>
</tr>
<tr>
<td>2017</td>
<td>0.0% 12.5% 50.0% 37.5%</td>
<td>87.5%</td>
</tr>
<tr>
<td>2018</td>
<td>0.0% 12.5% 50.0% 37.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E.g., for written policies in calendar year (CY) 2016:

- % claims expected in CY 2017 = ½ × 25%
- % claims expected in CY 2018 = (½ × 25%) + (½ × 75%)
- % claims expected in CY 2019 = ½ × 75%

<table>
<thead>
<tr>
<th>Calendar Year Written</th>
<th>Premium Written</th>
<th>Total Claims Expected</th>
<th>Post 2018 Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>2,400</td>
<td>1,440</td>
<td>540</td>
</tr>
<tr>
<td>2017</td>
<td>2,000</td>
<td>1,200</td>
<td>1,050</td>
</tr>
<tr>
<td>2018</td>
<td>2,200</td>
<td>1,320</td>
<td>1,320</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,910</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. Continued

(b) Calculate the unearned premium reserve as of December 31, 2018.

<table>
<thead>
<tr>
<th>Calendar Year Written</th>
<th>% Claims Expected Post 2018</th>
<th>Premium Written</th>
<th>Unearned Premium Reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>37.5%</td>
<td>2,400</td>
<td>900</td>
</tr>
<tr>
<td>2017</td>
<td>87.5%</td>
<td>2,000</td>
<td>1,750</td>
</tr>
<tr>
<td>2018</td>
<td>100.0%</td>
<td>2,200</td>
<td>2,200</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>4,850</td>
</tr>
</tbody>
</table>

(c) 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.

(d) Calculate the equity or deficiency in the unearned premium reserve as of December 31, 2018.

Unearned Premium 4,850

Expected Claims = 4,850×0.60 = 2,910
ULAE = 2,910×0.10 = 291
Maintenance = 4,850×0.05 = 243

Premium Liabilities 3,444

Equity / (Premium Deficiency) = 4,850 – 3,444 = 1,406

(e) Calculate the maximum reported deferred policy acquisition expense (DPAE) as of December 31, 2018.

DPAE = 0.20×4,850 = 970
Reported DPAE = max (DPAE, equity) = 970
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 candidate’s understanding of the development-based frequency-severity method for estimating ultimate claims.

Solution:
(a) Calculate the trended frequency at the 2018 cost level for each accident year.

<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>2016</td>
<td>0.982</td>
</tr>
<tr>
<td>2017</td>
<td>0.980</td>
</tr>
<tr>
<td>2018</td>
<td>0.975</td>
</tr>
<tr>
<td>Geometric Average</td>
<td>0.979</td>
</tr>
<tr>
<td>Age-to-Ultimate</td>
<td>0.991</td>
</tr>
</tbody>
</table>

\[ e.g., 0.979 = (0.982 \times 0.980 \times 0.975)^{1/3} \]

(b) Recommend the 2018 cost level frequency. Justify your recommendation.

Recommended 2018 cost level frequency: 0.050
Justification: Use the average of 2015-2017 per the method. No trend and no outliers so the average is reasonable.
10. Continued

(c) Calculate the accident year 2018 projected ultimate claims.

2018 ultimate counts: $0.050 \times 24,480 = 1,224$
2018 projected ultimate claims: $18,500 \times 1,224 = 22,644,000$.

(d) Provide a possible explanation why the development method would produce a lower value than the development-based frequency-severity method.

Either of the following are acceptable (other answers are possible):
- 2018 is immature
- The counts appear to be low in AY 2018 at 12 months which could be driving a lower development method value
11. **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:**


**Commentary on Question:**

*This question tests the candidate’s understanding of reserving for reinsurance as well as estimating ultimate claims for an excess claims layer using the development method.*

**Solution:**

(a) Describe one reason why the development method may not be suitable for reserving excess of loss reinsurance.

The development method is better suited for more mature years.

(b) Describe one reason why the expected method may be more suitable for estimating reserves for reinsurers than the development method.

Given the lengthy lags in reporting experienced by reinsurers, the reported and paid claims may be too sparse to be relevant for use in the development method for many years in the experience period.

(c) Describe one challenge when using the claim ratio approach with the expected method for reinsurance reserving.

Actuaries working with reinsurers do not always have detailed information about applicable rate level changes.
11. Continued

(d) Provide a possible reason why the case estimates for the reinsurer are different than the case estimates from the primary insurer.

For reinsurers, case estimates often consist of the case estimate submitted by the primary insurer as well as additional amounts set by the reinsurer based on the reinsurer’s independent assessment of ceded claims, known as additional case reserves.

(e) Calculate the accident year 2018 ultimate claims for the layer 200,000 to total limits using the development method.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Reported Claims (000) at 200,000 Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2015</td>
<td>2,460</td>
</tr>
<tr>
<td>2016</td>
<td>2,600</td>
</tr>
<tr>
<td>2017</td>
<td>2,720</td>
</tr>
<tr>
<td>2018</td>
<td>2,680</td>
</tr>
</tbody>
</table>

Age-to-age Development factors:

<table>
<thead>
<tr>
<th>Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>1.699</td>
<td>1.067</td>
<td>1.009</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>1.615</td>
<td>1.052</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>1.746</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average 1.687 1.060 1.009
Age-Ultimate 1.805 1.070 1.009

Ultimate claims at 200,000 Limit = 2,680×1.805 = 4,837
AY 2018 ultimate claims for the layer 200,000 to total limits = 5,626 – 4,837 = 789.
12. Learning Objectives:

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

Learning Outcomes:

(2d) Explain the effect of changing conditions on the projection methods cited in (2b).

Sources:


Commentary on Question:

This question tests the candidate’s understanding of ultimate claims when conditions are
changing.

Solution:

(a) Describe how this change affected the reported claims development triangle
    evaluated as of December 31, 2018, assuming the following:

   (i) The court decision affected only new claims.

   (ii) The court decision affected new and open claims.

   (i) The change affecting all new claims would occur on a row (accident year)
       basis and would be immediate with the effective date as claim adjusters
       estimate new claims that occurred after the effective date.

   (ii) The change affecting all open claims would occur on a diagonal (or
        calendar year) basis and would have more of a phased-in effect as all
        claim estimates get re-evaluated by the claim department over time.

(b) Describe why the Cape Cod method could be well-suited to estimate claims under
    scenario (a)(i) above.

    The Cape Cod method allows for tort reform adjustments, so the benefit level
    change can be treated as tort reform. This would adjust prior accident years to the
    current benefit level.

(c) Describe why a Berquist-Sherman data adjustment could be well-suited to
    estimate claims under scenario (a)(ii) above.

    The benefit change on a diagonal is similar to the effect of a case adequacy
    change. The Berquist-Sherman adjustment uses the latest diagonal to restate prior
    calendar year data (diagonals) consistent with current benefit level.
12. Continued

(d) Critique the CFO’s suggestion.

Trend and development are two different concepts that do not overlap. It is possible that development is changing as well, but this is a separate analysis and consideration from trend.
13. Learning Objectives:
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

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

Sources:

Commentary on Question:
This question tests the candidate’s understanding of determining a non-hurricane weather excluding hail loading to use for ratemaking.

Solution:
(a) Calculate the trended ultimate non-hurricane weather excluding hail pure premium per 100 EHY for all years.

The trending period is from the average accident date in experience period to average accident date in forecast period. The average accident date in forecast (future rating) period is the average date between August 1, 2019 and July 31, 2021, or July 31, 2020. Therefore, for 2018, the trending period is from July 1, 2018 to July 31, 2020, or 25 months.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Frequency per 100 EHY</th>
<th>Severity</th>
<th>Trending Period (months)</th>
<th>Frequency @1.0%</th>
<th>Severity @6.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td></td>
<td>73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>1.82</td>
<td>7,500</td>
<td>61</td>
<td>1.0519</td>
<td>1.3447</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>2.10</td>
<td>8,900</td>
<td>25</td>
<td>1.0209</td>
<td>1.1291</td>
</tr>
</tbody>
</table>

Trended Ultimate

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Frequency per 100 EHY</th>
<th>Severity</th>
<th>Pure Premium per 100 EHY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>*2.100</td>
<td>*8,600</td>
<td>18,060</td>
</tr>
<tr>
<td>2015</td>
<td>1.914</td>
<td>10,085</td>
<td>19,303</td>
</tr>
<tr>
<td>2016</td>
<td>*1.750</td>
<td>*9,200</td>
<td>16,100</td>
</tr>
<tr>
<td>2017</td>
<td>*2.200</td>
<td>*8,900</td>
<td>19,580</td>
</tr>
<tr>
<td>2018</td>
<td>2.144</td>
<td>10,049</td>
<td>21,545</td>
</tr>
</tbody>
</table>

Note: * = given values
13. Continued

(b) Recommend the trended ultimate non-hurricane weather excluding hail pure premium per 100 EHY to use in determining a weather loading. Justify your recommendation.

Recommend all year’s average of 18,918. Justification: should use more years to smooth out fluctuations and there is no significant trend.

(c) Calculate the non-hurricane weather excluding hail loading percentage to use for ratemaking.

Weather loading as a claim ratio = \( \frac{18,918 \times 8,500}{100} / 13,000,000 = 12.37\% \).

(d) Calculate the hurricane catastrophe loading percentage to use for ratemaking.

There is no exposure trend since hurricane model used in-force exposures as of the same date as the modelled cost level, and the exposure trend rate is 0%.

Trending period is from July 1, 2018 to average accident date in future rating period (see part (a)): Jul 31, 2020 = 25 months.

Trended modeled hurricane claims = 350,000 \times (1 + 0.06)^{25/12} = 395,174
Hurricane loading = 395,174 / 13,000,000 = 3.04\%.
14. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

Learning Outcomes:
(4a) Identify the time periods associated with trending procedures.
(4d) Describe the influences on exposures and premiums of changes in deductibles, changes in policy limits, and changes in mix of business.
(4e) Choose trend rates and calculate trend factors for exposures.

Sources:

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

Solution:
(a) Explain an advantage of using written premiums over earned premiums for premium trend analysis.

Written premiums reflect shifts in the mix of exposures more quickly than earned premiums.

(b) Describe an alternative to using annual written premiums that will improve the responsiveness of the premium trend statistic.

Either of the following are acceptable:
- Quarterly average written premiums
- 12 month moving averages of quarterly written premiums

(c) Calculate the annual trend due to the shift in policy limits for each year.

<table>
<thead>
<tr>
<th>Experience Period</th>
<th>Percent Earned Exposures by Policy Limits</th>
<th>Weighted Avg ILF</th>
<th>Year to Year Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>750,000</td>
<td>1,000,000</td>
<td>1,500,000</td>
</tr>
<tr>
<td>2015</td>
<td>30%</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>2016</td>
<td>27%</td>
<td>40%</td>
<td>33%</td>
</tr>
<tr>
<td>2017</td>
<td>23%</td>
<td>40%</td>
<td>37%</td>
</tr>
</tbody>
</table>

Current Increased Limit Factors (ILF) |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>1.15</td>
</tr>
</tbody>
</table>

e.g., Weighted Average ILF for 2015:
\[= (30\% \times 0.90 + 40\% \times 1.00 + 30\% \times 1.15)/(30\% + 40\% + 30\%) = 1.0150\]
14. Continued

(d) Recommend the annual trend due to the shift in policy limits to use for ratemaking.

Recommend 0.98%. The justification is to use the most recent year as the expectation is that the future will be similar to recent year due to increased interest in higher limit.

(e) Calculate the trend factor to be used for 2016 earned premium using the annual trend selected in part (d).

Average earned date in experience period: Jul 1, 2016
Average earned date in forecast period for annual policies: Jul 1, 2020
Average earned date in forecast period for 6-month policies: Apr 1, 2020
Trending period in months for 12-month policies: 48
Trending period in months for 6-month policies: 45
Average trending period (months): 46.5
Premium trend factor = $1.0098^{(46.5/12)} = 1.0385$
15. **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:**


**Commentary on Question:**

*This question tests the candidate’s understanding of the expected method of estimating ultimate ALAE, as well as calculating calendar year incurred ALAE.*

**Solution:**

(a) Describe two other situations where the expected method may be preferred over the development method when projecting ultimate claims.

Any two of the following are acceptable.

- For new products that have limited or no historical experience
- For new geographical areas that have limited or no historical experience
- Historical relationships and development patterns are not a reliable guide to the future
- Experience observed to date is not relevant for projecting future activity
- For reinsurers who do not have sufficient data from ceding companies
- For reinsurers who have significant reporting lags

(b) Estimate ultimate ALAE for accident year 2018 using the expected method.

<table>
<thead>
<tr>
<th>Accident Year (AY)</th>
<th>Payroll</th>
<th>Payroll Trend Factors at 3%</th>
<th>Trended Payroll</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>155,000</td>
<td>1.1255</td>
<td>174,453</td>
</tr>
<tr>
<td>2015</td>
<td>161,000</td>
<td>1.0927</td>
<td>175,925</td>
</tr>
<tr>
<td>2016</td>
<td>168,000</td>
<td>1.0609</td>
<td>178,231</td>
</tr>
<tr>
<td>2017</td>
<td>172,000</td>
<td>1.0300</td>
<td>177,160</td>
</tr>
</tbody>
</table>
15. Continued

<table>
<thead>
<tr>
<th>AY</th>
<th>Ultimate ALAE from Develop Method</th>
<th>Trend Factors at 3%</th>
<th>ALAE Reduction effective Jan 1, 2016</th>
<th>Trended Ultimate ALAE</th>
<th>ALAE Pure Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>3,900</td>
<td>1.1255</td>
<td>0.950</td>
<td>4,170</td>
<td>0.0239</td>
</tr>
<tr>
<td>2015</td>
<td>8,000</td>
<td>1.0927</td>
<td>0.950</td>
<td>8,305</td>
<td>0.0472</td>
</tr>
<tr>
<td>2016</td>
<td>4,500</td>
<td>1.0609</td>
<td>1.000</td>
<td>4,774</td>
<td>0.0268</td>
</tr>
<tr>
<td>2017</td>
<td>5,000</td>
<td>1.0300</td>
<td>1.000</td>
<td>5,150</td>
<td>0.0291</td>
</tr>
</tbody>
</table>

Average 2014, 2016, 2017 = 0.0266   (Ignore 2015 due to large loss)
Selected (reflects increasing trend in PP) = 0.029
AY 2018 Ultimate ALAE = 2018 Payroll × selected PP = 177,000×0.029 = 5,133.

(c) Calculate the calendar year 2018 incurred ALAE.

Calendar Year (CY) 2018 Paid ALAE
= Paid ALAE as of Dec. 31, 2018 – Paid ALAE as of Dec. 31, 2017
= 8,210 – 3,780 = 4,430

Unpaid ALAE as of Dec. 31, 2018:
= 21,400 – 7,950 = 13,450
AY 2018: Ultimate ALAE from part (b) – Paid ALAE as of Dec. 31, 2018
= 5,133 – 260 = 4,873
Total = 13,450 + 4,873 = 18,323
Unpaid ALAE as of Dec. 31, 2017 = 17,520

CY 2018 Incurred ALAE
= CY 2018 Paid ALAE + Change in Unpaid ALAE
= 4,430 + (18,323 – 17,520) = 5,233.
16. 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 candidate’s ability to create a claims development triangle from claims transaction data as well as reconciling claims data.

Solution:
(a) Reconcile the data to identify any potential issues.

Reported Claims = Cumulative Paid + Case Estimates

<table>
<thead>
<tr>
<th>Accident Year (AY)</th>
<th>Reconciled Reported (000)</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td></td>
<td>2,000</td>
<td>3,450</td>
<td>4,470</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>2,250</td>
<td>3,880</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td>2,580</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are two issues with the given data:
- AY2017 at 12 months is not consistent
- AY2017 at 24 months is not consistent

(b) State two possible causes for data issues.

- There could be data entry errors in one or more of the triangles.
- There could be missing data from one or more of the triangles.
16. Continued

(c) Construct revised paid claims and case estimates triangles incorporating this additional information.

Changes to cumulative paid:
Increase in AY2016 @ 24 months by 9,000 {both indemnity + ALAE}
Increase in AY2016 @ 36 months by 9,000 {both indemnity + ALAE}

Changes in case estimates:
Increase in AY2016 @ 24 months by 20,000 {latest case estimate}
Increase in AY2016 @ 36 months by 20,000 {no adjustments in 2018 so same number}

<table>
<thead>
<tr>
<th>Accident</th>
<th>Revised Cumulative Paid (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>12</td>
</tr>
<tr>
<td>2016</td>
<td>1,020</td>
</tr>
<tr>
<td>2017</td>
<td>1,150</td>
</tr>
<tr>
<td>2018</td>
<td>1,320</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accident</th>
<th>Revised Case Estimates (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>12</td>
</tr>
<tr>
<td>2016</td>
<td>980</td>
</tr>
<tr>
<td>2017</td>
<td>1,100</td>
</tr>
<tr>
<td>2018</td>
<td>1,260</td>
</tr>
</tbody>
</table>

(d) Calculate the calendar year 2018 reported claims using the revised triangles from part (c).

Calendar Year (CY) reported = (Case estimate at end of year) – (Case estimate at beginning of year) + (Paid claims during the year)

Case estimate at the end of 2018 = 1,260 + 1,620 + 1,040 = 3,920
Case estimate at the end of 2017 = 1,100 + 1,460 = 2,560
Paid during 2018 = 1,320 + 2,260 – 1,150 + 3,459 – 2,019 = 3,870
CY 2018 reported claims = 5,230
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.
(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 candidate’s ability to estimate ultimate claims using Berquist-Sherman adjustments when there has been an adjustment in case reserves and a change in settlement rates.*

**Solution:**
(a) Calculate the average case estimate triangle.

\[
\text{Case Reserves} = \text{Reported Claims} - \text{Paid Claims}
\]

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>5,900</td>
<td>8,700</td>
<td>2,900</td>
</tr>
<tr>
<td>2017</td>
<td>6,300</td>
<td>7,800</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>6,500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{Outstanding Counts} = \text{Reported Counts} - \text{Closed Counts}
\]

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>53</td>
<td>46</td>
<td>29</td>
</tr>
<tr>
<td>2017</td>
<td>55</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculate Average Case Estimates = Case Reserves / Outstanding Counts

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>111.30</td>
<td>189.10</td>
<td>100.00</td>
</tr>
<tr>
<td>2017</td>
<td>114.50</td>
<td>104.00</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>84.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
17. Continued

(b) Explain whether the average case estimate triangle indicates reducing, stable or increasing case reserve adequacy.

Average case estimates are decreasing in the last calendar year (diagonal). This suggests a decrease in case reserve adequacy.

(c) Calculate the disposal ratio triangle.

Disposal Ratio = Closed Counts / Ultimate Reported Counts

Note: Need to select reported ultimate counts, since paid ultimate counts are distorted by settlement pattern changes.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>42%</td>
<td>64%</td>
<td>90%</td>
</tr>
<tr>
<td>2017</td>
<td>42%</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(d) Explain whether the disposal ratio triangle indicates reducing, stable or increasing claim settlement rates.

Disposal ratios are lower in last calendar year (diagonal), suggesting decreasing settlement rates.

(e) State the general requirement for meaningful application of Berquist-Sherman adjustments.

A significant volume of credible experience is generally required for meaningful application of the Berquist-Sherman adjustments.
17. Continued

(f) Calculate the adjusted paid claims triangle.

Select Disposal Ratios (last diagonal)

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>35%</td>
<td>55%</td>
<td>90%</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Closed Count Triangle

\[ \text{Adjusted Closed Count Triangle} = \text{Selected Disposal Ratios} \times \text{Ultimate Reported Counts} \]

Accident

<table>
<thead>
<tr>
<th>Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>103</td>
<td>161</td>
<td>264</td>
</tr>
<tr>
<td>2017</td>
<td>106</td>
<td>166</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>109</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Paid Claims Triangle = Adjusted Closed Counts × Cumulative Paid Claims to Cumulative Closed Counts

Accident

<table>
<thead>
<tr>
<th>Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>10,300</td>
<td>16,100</td>
<td>26,400</td>
</tr>
<tr>
<td>2017</td>
<td>10,600</td>
<td>16,600</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>10,900</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(g) Calculate the adjusted reported claims triangle.

Select Average Case (last diagonal)

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.4</td>
<td>104.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Average Case Estimates

Accident

<table>
<thead>
<tr>
<th>Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>78.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2017</td>
<td>81.2</td>
<td>104.0</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>84.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

e.g., 81.2 = 84.4 / 1.04
17. Continued

Adjusted Open Counts = Reported Counts – Adjusted Closed Counts

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>73</td>
<td>73</td>
<td>29</td>
</tr>
<tr>
<td>2017</td>
<td>75</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Case Reserves

= Adjusted Average Case Estimates × Adjusted Open Counts

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>5,694</td>
<td>7,300</td>
<td>2,900</td>
</tr>
<tr>
<td>2017</td>
<td>6,090</td>
<td>7,800</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>6,499</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted Reported Claims = Adjusted Case Reserves + Adjusted Paid Claims

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>12</th>
<th>24</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>15,994</td>
<td>23,400</td>
<td>29,300</td>
</tr>
<tr>
<td>2017</td>
<td>16,690</td>
<td>24,400</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>17,399</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
18. **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 risk classification ratemaking.*

**Solution:**
(a) Describe the purpose of risk classification systems as used by general insurers.

A risk classification system is used to assign risks to risk classes based upon the expected cost for the GI coverage provided.

(b) Describe risk characteristics within a risk classification system.

Risk characteristics are defined as measurable or observable factors or characteristics that are used to assign each risk to one of the risk classes of a risk classification system.

(a) Describe a potential consequence of these pricing inaccuracies from the perspective of each of the following:

(i) The insured

In the absence of risk classification, risks with lower underlying costs will not purchase coverage while risks with higher cost will purchase products. This leads to a mismatch of product pricing and incurred costs. Actual claims will be higher than expected. Additionally, the lower risk insurance customers that do purchase coverage will subsidize the risks exposure of the higher risk insureds.

(ii) The insurer

Ignoring the effect of differences in risk characteristics can lead to inequities among insureds, inaccurate pricing of products and unavailability of coverage, and ultimately the financial distress of insurers.
18. **Continued**

(d) Explain why a risk classification system is not intended to predict costs for an individual risk in the class.

If the timing and magnitude of an event were known in advance, there would be no economic uncertainty and thus no reason for insurance.

(e) Describe a consideration that may be difficult for insurers to demonstrate when using credit scores as a risk characteristic.

While credit score has been shown to be correlated with expected auto insurance costs, it is difficult to show that it is causally related to higher claims.

(f) Describe a potential rate impact to ABC Insurance Company’s high and low risk insureds resulting from this change.

ABC may charge the total expected pure premium to all insureds. The rate charged to the lower risk insureds will increase and the rate charged to the higher risk insureds will decrease.

(g) Explain why the decision for ABC Insurance Company will lead to adverse selection and reduced profits.

Adverse selection occurs when rates do not reflect expected costs. The better than average risks will purchase coverage from an insurer reflecting the risk and will shift the mix of business which will result in a higher total pure premium and will result in lower profit if the rates charged do not reflect the shift in business.
19. **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 tests the candidate’s understanding of deductibles.*

**Solution:**
(a) Provide two other reasons insurers rely on deductibles.

Any two of the following are acceptable:
- Assist in reducing moral and morale hazard
- Encourage risk control measures
- Reduce exposure to catastrophic events

(a) Calculate losses retained by the insured and the claims paid by the insurer under the following deductible options.

(i) A percentage deductible of 10% with coverage of 500,000

- Insured: \(0.10 \times 500,000 = 50,000\)
- Insurer: \(500,000 \times (1 - 0.1) = 450,000\)

(ii) A percentage deductible of 10% with coverage of 400,000

- Insured: \((500,000 - 400,000) + 0.10 \times 400,000 = 140,000\)
- Insurer: \(400,000 \times (1 - 0.1) = 360,000\)

(iii) A franchise deductible of 50,000

- Insured: 0
- Insurer: 500,000; A loss above the deductible, the insured retains nothing.
19. Continued

(iv) A disappearing deductible with a stated value of 10,000, with a provision that losses five times the stated value will be paid in full.
Insured: 10,000 + (50,000 – 10,000)×0.5 = 30,000; Insurer and insured share losses proportionately between the stated value and the multiple of the stated value
Insurer: 450,000 + (50,000 – 10,000)×0.5 = 470,000

(c) Provide a reason why an insured with a policy with a percentage deductible might purchase coverage for less than the full value of a property.

Those who purchase insurance policies with a smaller total insured valued will automatically have a lower deductible.

(d) Provide a reason why an insurer might prefer to offer a percentage deductible rather than a straight deductible for property coverage.

This helps insurers to limit claims following a major catastrophe.

(e) Explain the expected impact on an insurer’s claim frequency and severity from this increase.

An increase in deductible will always reduce an insurer's expected claim frequency because it will eliminate counts below the deductible amount.

An increase in deductible will have an indeterminant effect on severity (increase or decrease) because it will eliminate both counts and claims below the deductible amount.
19. Continued

(f) Propose a reasonable premium rate for this policy with a 1,500 deductible. Justify your answer.

<table>
<thead>
<tr>
<th>Deductible</th>
<th>Premium</th>
<th>Deductible Factor</th>
<th>Marginal Rate per 500 Deductible</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>400</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>300</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>1,500</td>
<td>x</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

E.g., Marginal rate per 500 deductible at 1,000 = (1.00 – 0.75) = 0.25

Marginal rate should decrease with increase in deductible, so R < 0.25. R = 0.75 – x. Therefore, 0.75 – x < 0.25, or x > 0.50

Also, deductible factor for 1,500 deductible should be less than the factor for a 1,000 deductible, or x < 0.75

Therefore, 0.50 < x < 0.75, which implies a premium in the range:

200 < Premium < 300.
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.

(2d) Explain the effect of changing conditions on the projection methods cited in (2b).

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of certain changing conditions and also calculating unpaid claims using the Generalized Cape Cod method.*

**Solution:**

(a) Recommend a separate approach to address each of the following issues. Justify your recommendation.

(i) Change in claim settlement pattern

(ii) Activity observed to-date is not predictive of future activity.

**Commentary on Question:**

*The question asks for a separate approach to address each issue, meaning candidates cannot use the same approach for both (i) and (ii).*

(i) For a change in claim settlement pattern, adjust the reported development triangle data using a Berquist-Sherman approach. The Berquist-Sherman approach restates prior year’s data based on the latest diagonal of information (which reflects the change).

(ii) A method that does not require past data to be predictive of future activity should be used, such as the frequency-severity or expected method.
20. Continued

(b) Recommend the number of accident years you would use for the experience period. Justify your recommendation.

Experience period of 5 years because it would be responsive to the deteriorating claim ratio.

(c) Recommend the decay factor you would use. Justify your recommendation.

Recommend a decay factor of 50%. A lower decay factor gives less weight to each prior accident year which is useful if claims are showing a deteriorating trend and we want to give most weight to recent experience.

(d) Calculate unpaid claim liabilities for all accident years using the Generalized Cape Cod method and a decay factor of 100%.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned Exposure</th>
<th>Expected % Reported</th>
<th>Expected Unreported</th>
<th>Expected Unpaid Claims as of Dec. 31, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>700</td>
<td>100.0%</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>800</td>
<td>90.9%</td>
<td>727</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>900</td>
<td>66.7%</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,400</td>
<td></td>
<td>2,027</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Actual Paid Claims as of Dec. 31, 2018</th>
<th>Actual Reported Claims as of Dec. 31, 2018</th>
<th>Pure Premium Trend @ 2.0%</th>
<th>Tort Reform</th>
<th>Adjusted Reported Claims at Dec. 31, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>70</td>
<td>90</td>
<td>1.040</td>
<td>0.900</td>
<td>84</td>
</tr>
<tr>
<td>2017</td>
<td>50</td>
<td>80</td>
<td>1.020</td>
<td>0.900</td>
<td>73</td>
</tr>
<tr>
<td>2018</td>
<td>30</td>
<td>60</td>
<td>1.000</td>
<td>1.000</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>230</td>
<td></td>
<td></td>
<td>217</td>
</tr>
</tbody>
</table>

(A) Adjusted Expected Claim Ratios = 217/2,027 = 0.107

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Expected Claims</th>
<th>Expected % Unreported</th>
<th>Expected Unreported</th>
<th>Unpaid Claims as of Dec. 31, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>80</td>
<td>0.0%</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>2017</td>
<td>93</td>
<td>9.1%</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>2018</td>
<td>96</td>
<td>33.3%</td>
<td>32</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>269</td>
<td>40</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>
21. **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 results.

**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.

(6b) Analyze actual claims experience relative to expectations.

**Sources:**


**Commentary on Question:**

This question tests the development method for estimating ultimate claims where there is seasonality. In addition, it tests the understanding of expected paid and reported claims for an interim period between actuarial analyses.

**Solution:**

(a) Calculate the ultimate claims for accident year 2018 using the development method. Justify your selections.

<table>
<thead>
<tr>
<th>Accident Half-Year</th>
<th>Age-to-Age Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6-12</td>
</tr>
<tr>
<td>2015-1</td>
<td>0.970</td>
</tr>
<tr>
<td>2015-2</td>
<td>1.030</td>
</tr>
<tr>
<td>2016-1</td>
<td>0.950</td>
</tr>
<tr>
<td>2016-2</td>
<td>1.020</td>
</tr>
<tr>
<td>2017-1</td>
<td>0.980</td>
</tr>
<tr>
<td>2017-2</td>
<td>1.030</td>
</tr>
<tr>
<td>2018-1</td>
<td>0.940</td>
</tr>
</tbody>
</table>

AHY-1 Avg: 0.960 1.170
AHY-2 Avg: 1.027 1.190
All years Avg: 1.180 1.070 1.015 1.000

AHY-1 Selected Factors:
- Age-to-age: 0.960 1.170 1.070 1.015 1.000
- Age-Ultimate: 1.220 1.271 1.086 1.015 1.000

AHY-2 Selected Factors:
- Age-to-age: 1.027 1.190 1.070 1.015 1.000
- Age-Ultimate: 1.327 1.292 1.086 1.015 1.000
21. Continued

Accident Year 2018:

<table>
<thead>
<tr>
<th>Accident Half-Year</th>
<th>Reported Claims</th>
<th>Age-to-Ultimate Factor</th>
<th>Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-1</td>
<td>13,724</td>
<td>1.271</td>
<td>17,443</td>
</tr>
<tr>
<td>2018-2</td>
<td>14,200</td>
<td>1.327</td>
<td>18,843</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>36,286</td>
</tr>
</tbody>
</table>

(b) Calculate the accident year 2018 expected reported claims from December 31, 2018 to March 31, 2019 using your recommendations from part (a) and linear interpolation.

\[
(1) = 1/(1)
\]

\[
(2) = 1/(2)
\]

\[
(3) = 1/(3)
\]

\[
(4) = 1/(4)
\]

\[
\text{Expected Claims as of Mar. 31, 2019} = (17,443 – 13,724) \times (0.854 – 0.787) / (1 – 0.787) = 1,170
\]

\[
\text{Expected Claims as of Mar. 31, 2019} = (18,843 – 14,200) \times (0.764 – 0.754) / (1 – 0.754) = 189
\]

Total Expected Claims as of Mar. 31, 2019 = 1,170 + 189 = 1,359.
21. Continued

(c) Calculate the accident year 2018 expected reported claims from December 31, 2018 to June 30, 2019.

<table>
<thead>
<tr>
<th>Accident Half-Year</th>
<th>(1) Reported Claims</th>
<th>(2) Age-to-Age Dev. Factor</th>
<th>(3) = (2) – 1 Incremental Dev. Factor</th>
<th>(4) = (1)(3) Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-1</td>
<td>13,724</td>
<td>1.170</td>
<td>0.170</td>
<td>2,333</td>
</tr>
<tr>
<td>2018-2</td>
<td>14,200</td>
<td>1.027</td>
<td>0.027</td>
<td>383</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>2,716</td>
</tr>
</tbody>
</table>