GIIRR Model Solutions
Fall 2018

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:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 11.

Commentary on Question:

This question tests the candidate's understanding of written premiums, earned premiums, unearned premiums, and adjusting premiums to current rate levels.

Solution:

(a) Calculate the unearned premium as of December 31, 2016.

Unearned premium as of December 31, 2016:	
Policy 1 = 3/12 × 1,800 =	450
Policy 2 = (24 – 7)/24 × 3,000 =	2,125
Policy 3 = 2/6 × 1,200 =	400
Total	2,975

Note: Policy 2 has 17 months remaining in policy term as of December 31, 2016

(b) Calculate the calendar year 2017 earned premium.

Calendar year 2017 earned premium:	
Policy 1 = (3/12 × 1,800) + (9/12 × 1,800 × 1.1) =	1,935
Policy 2 = 12/24 × 3,000 =	1,500
Policy 3 = (8/6 × 1,200) + (4/6 × 1,200 × 1.1) =	2,480
Total	5,915

Notes: Policy 1 renewal on April 1, 2017 gets the 10% increase
Policy 3 renewal on March 1, 2017 has no increase, but the renewal on September 1, 2017 gets 10% increase

1. Continued

(c) Calculate the unearned premium as of December 31, 2017.

Unearned premium as of December 31, 2016:	
Policy 1 = 3/12 × 1,800 × 1.1 =	495
Policy 2 = 5/24 × 3,000 =	625
Policy 3 = 2/6 × 1,200 × 1.1 =	440
Total	1,560

Notes: Policy 1 gets the 10% rate increase
Policy 2 has 5 months remaining in initial policy term
Policy 3 gets the 10% rate increase

(d) Calculate the premium on-level factor to adjust the 2017 calendar year earned premium to the current rate level.

Calendar year 2017 earned premium at current rates:	
Policy 1 = 1,800 × 1.1 =	1,980
Policy 2 = 12/24 × 3,000 × 1.1 =	1,650
Policy 3 = 2 × 1,200 × 1.1 =	2,640
Total	6,270

On-level factor = 6,270 / 5,915 =	1.060

2. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the application of deductibles, policy limits and coinsurance, including the effect of the order of these insurance policy coverage features.

Solution:

(a) State two advantages for each of the following insurance policy coverage features from an insurer perspective:

(i) Deductible

(ii) Policy Limit

(iii) Coinsurance

(i) Any two of the following are acceptable:

- reduce claims paid by insurers
- assist in reducing moral and morale hazard
- encouragement of loss control
- elimination of small claim processing costs
- reduction of exposure to catastrophic events

(ii) Any two of the following are acceptable:

- restrict insurer obligations
- provide coverage options for insureds
- reflect insurer capacity
- substitute for policy exclusions

(iii) Any two of the following are acceptable:

- limit insurer liability
- motivate insureds to carry appropriate coverage amounts
- penalize insureds that do not carry appropriate coverage amounts

2. Continued

(b) Calculate the amount paid by the insurer for a covered loss of 1,000 under each policy based on the agent's stated position.

Policy A: 1,000 – 800 = 200
(i.e., no coinsurance penalty)

Policy B: Max[0, (1,000×0.5 – 800)] = 0

Policy C: 1,000 – 800 = 200
(i.e., no coinsurance penalty)

(c) Calculate the amount paid by the insurer for a covered loss of 91,000 under each policy based on the policyholder's position.

Policy A: Min[(91,000 – 800), 90,000] = 90,000
(i.e., no coinsurance penalty)

Policy B: (91,000 – 800)×50% = 45,100
(i.e., limit has no effect)

Policy C: Min[(91,000 – 800), 50,000] = 50,000
(i.e., no coinsurance penalty)

(d) State what determines the order of applying coinsurance, deductible, and policy limit.

The terms and conditions of the policy.

3. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the frequency-severity closure method of estimating ultimate claims.

Solution:

(a) Describe two primary assumptions underlying this method.

Any two of the following are acceptable:

- claims emergence can be forecast with reasonable accuracy
- claims files closed at each age are a function of the number to be closed in future
- average closure amounts at each age are a function of averages for preceding periods, adjusted for inflation
- inflation influences costs at the time the case is closed

(b) Calculate the accident year 2014 proportion of closed counts at each maturity age.

12 months: 7,700 / 10,900 = 0.706
24 months: 1,950 / (10,900 – 7,700) = 0.609
36 months: 650 / (10,900 – 7,700 – 1,950) = 0.520
48 months: 600 / (10,900 – 7,700 – 1,950 – 650) = 1.000

(c) Calculate the accident year 2016 incremental closed counts for maturities 36 and 48 months using the proportion of closed counts from part (b).

For 36 months, apply the selected proportion of closed counts to the ultimate minus cumulative closed = 0.520×(6,800 – 5,800) = 520
For 48 months, the remaining selected ultimate counts yet to be closed = 6,800 – (5,800 + 520) = 480

3. Continued

(d) Calculate the accident year 2016 incremental paid severity for maturities 36 and 48 months.

For 36 months: 10,340 / 1.03 = 10,039
For 48 months: 11,200 / 1.03 = 10,874

(e) Calculate the accident year 2016 projected ultimate claims.

Development Month	(1) Counts	(2) Severity	(3) = (1)(2) Projected Ultimate Claims
12	4,600	940	4,324,000
24	1,200	3,360	4,032,000
36	520	10,039	5,220,280
48	480	10,874	5,219,520
AY 2016 Total			18,795,800

4. 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:

(1j) Create a claims development triangle from claims transaction data.
(2a) Use loss development triangles for investigative testing.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 10 and 13.

Commentary on Question:

This question tests the candidate's understanding of creating a development triangle from detailed claims transaction data, identifying potential issues with data triangles, and diagnostic tests that can be used on data triangles.

Solution:

(a) State two benefits of using a development triangle to review reported claims.

Any two of the following are acceptable (other answers are possible):

- Can be used to develop investigative tests to understand the data and predict the future experience
- Analyze the historical relationships to project similar relationships into the future
- Identify the impact of organizational and environmental changes on claims
- Find outliers or other anomalies

(b) Describe two possible data issues with the incremental reported claims.

Accident	Incremental Reported Claims				
Year	12	24	36	48	60
2013	2,000	4,000	4,000	2,000	0
2014	2,500	3,000	3,500	2,000	
2015	1,500	4,500	1,200		
2016	3,000	500			
2017	4,000				

- The increasing pattern in the 12 month reported claims, although accident year 2015 seems low
- The reported claims for accident year 2016 at 24 months seems very low

4. Continued

(c) Describe a diagnostic test you could use to investigate one of the issues identified in part (b).

For the 12 month column pattern: May consider the ratios of paid claims to reported claims to determine if this is potentially a settlement change.

(d) Revise the incremental reported claims triangle to reflect the removal of the three claims.

Accident	Incremental Reported Claims				
Year	12	24	36	48	60
2013	2,000	4,000	4,000	2,000	0
2014	2,500	3,000	*1,500*	*500*	
2015	1,500	*1,500*	1,200		
2016	3,000	500			
2017	4,000				

Accident year 2014 at 36 months: 3,500 – 2,000 (from claim A)
Accident year 2014 at 48 months: 2,000 – 1,500 (from claim C)
Accident year 2015 at 24 months: 4,500 – 3,000 (from claim B)

5. Learning Objectives:

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

Learning Outcomes:

(5b) Calculate expenses used in ratemaking analyses including expense trending procedures.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 29.

Commentary on Question:

This question tests the expense provisions that are used in ratemaking.

Solution:

(a) Recommend the following expense ratios to use for ratemaking. Justify your recommendation.

(i) Fixed expense ratio

(ii) Variable expense ratio

	(1)	(2)	(3)	(4)	(5)
Calendar Year	General and Other Acquisition Expenses	Commission Expenses	Premium Taxes and Licenses	Direct Written Premiums	Direct Earned Premiums
2015	45,600	29,500	11,800	370,000	365,000
2016	46,500	30,500	12,200	381,000	375,000
2017	52,400	30,900	12,300	385,000	380,000

	(6) = (1)/(5)	(7) = (2)/(4)	(8) = (3)/(4)
Calendar Year	General and Other Acquisition Expense Ratio	Commission Expenses	Premium Taxes and Licenses
2015	12.5%	8.0%	3.2%
2016	12.4%	8.0%	3.2%
2017	13.8%	8.0%	3.2%
Budget	14.0%		
Average all years		8.0%	3.2%

Note: Budget General and Other Acquisition Expense Ratio = 56,000 / 400,000 = 14.0%

5. Continued

Recommended general and other acquisition expense ratio = 14.0%.
Justification: 2017 and 2018 budget are similar and much higher than prior years; therefore, the budget is a reasonable ratio.

(i) Fixed expense ratio: 0.25×14.0% = 3.5%

(ii) Variable expense ratio:
Variable expense ratio for general and other acquisition expenses:
0.75×14.0% = 10.5%
Total variable expense ratio = 10.5% + 8.0% + 3.2% = 21.7%.

(b) Identify a potential distortion to a ratemaking analysis when selecting a fixed expense percentage that is applied to a projected average premium.

Any one of the following is acceptable:

1. Recent rate changes can result in differences between the relationship between the fixed expenses and premium during the experience period.
2. Differences between the average premiums of the experience period and the forecast period that arise because of shifts in the mix of business may lead to inadequate or excessive expenses.
3. A premium-based fixed expense ratio analysis may be distorted if countrywide expense ratios are used to project fixed expenses for a specific jurisdiction.

(c) Recommend a solution to the potential distortion identified in part (b).

The solution must match the distortion identified in part (b):

1. Use premiums adjusted to on level.
2. Trend premiums.
3. Track fixed expenses by state (jurisdiction) and calculate fixed expense ratios for each state (jurisdiction).

6. 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:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 20.

Commentary on Question:

This question tests the candidate's understanding of changing conditions on different projection methods.

Solution:

(a) Explain the ability of the following methods to reflect claim deterioration with steady-state volume:

(i) The Cape Cod method

(ii) The Bornhuetter Ferguson method

(i) The Cape Cod method is responsive to deterioration in claim experience because actual reported claims enter the calculation of expected values.

(ii) The Bornhuetter Ferguson expected claims are based on an a priori estimate and do not change unless the actuary deliberately makes such a change.

(b) Describe what effect this benefit level change is likely to have on reported development factors.

A benefit level increase effecting all open and new claims on or after July 1, 2014 will increase development factors along the diagonal (beginning with calendar year 2014).

6. Continued

(c) Explain how this benefit level change would affect the estimate of ultimate claims under each of the following methods:

(i) The development method with a Berquist-Sherman adjustment, applied to reported data

(ii) The Bornhuetter Ferguson method, applied to reported data

(i) Since the benefit level change occurred several years ago, the latest diagonal should have a reasonable effect of change imbedded within it. The latest diagonal can then be used as the basis for squaring the triangle.

(ii) The a priori estimates wouldn't reflect the benefit change (unless an explicit adjustment was made for this). There may be some distortion from the change in development factors.

(d) Describe what effect, if any, the change in claim trend is likely to have on paid claims development factors.

This is a claim cost change, not a development change. In theory, a claim cost change doesn't affect development.

(e) Comment on the appropriateness of each of the following methods when a change in claim trend is occurring:

(i) The development method with a Berquist-Sherman adjustment, applied to paid data

(ii) A development-based frequency severity approach, applied to paid data

(i) This method would not be used for a change in claim cost trend. This method adjusts for development pattern changes, not trend changes.

(ii) A paid-development frequency severity approach would be appropriate for capturing trend changes. It is particularly good in this case because the frequency and severity trend can be separately analyzed.

7. 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.
(4e) Choose trend rates and calculate trend factors for exposures.
(5e) Demonstrate the use of credibility in ratemaking.
(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 15, 16, and 31.

Commentary on Question:

This question tests basic ratemaking using a claim ratio approach.

Solution:

(a) Calculate the trended claim ratios for each accident year.

	(1)	(2)	(3)	(4)	(5) = (1)(3)(4)
			Premium Trend Due to Shifts in		
Accident Year	Earned Premium at Current Rate Level (000)	Trending Period in Months	Deductible at –0.5%	Vehicle Rate Group at 3.0%	Trended EP at Current Rate Level
2015	1,485	57	0.9765	1.1507	1,669
2016	1,620	45	0.9814	1.1172	1,776
2017	1,965	33	0.9863	1.0847	2,102

	(6)	(7)	(8) = (6)(7)	(9) = (8)/(5)
			Trended	
Accident Year	Ultimate Claims (000)	Pure Premium Trend at 5.0%	Ultimate Claims (000)	Trended Claim Ratios
2015	810	1.2608	1,021	61.2%
2016	890	1.2008	1,069	60.2%
2017	1,025	1.1436	1,172	55.8%

7. Continued

Notes: (2) Trending period in months (e.g., 2015):
Trend from average earned date in 2015: July 1, 2015
Trend to average earned date in future rating period: April 1, 2020
Trending period in months = 57
(3) = $(1 - 0.005)^{[(2)/12]}$
(4) = $(1 + 0.03)^{[(2)/12]}$
(7) = $(1 + 0.05)^{[(2)/12]}$

(b) Recommend a trended claim ratio to use for ratemaking. Justify your recommendation.

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

Recommended trended claim ratio to use for ratemaking:
= (0.2×0.612) + (0.3×0.602) + (0.5×0.558) = 58.2%

Justification:
- Recommend using all years to give highest credibility to observation
- More weight given to the more recent experience

(c) Calculate the claim ratio to use for the complement of credibility.

Indicated rate change for policies effective January 1, 2017 through December 31, 2017	8%
Approved rate change for policies effective January 1, 2017 through December 31, 2017	4%
Permissible claim ratio for policies effective January 1, 2017 through December 31, 2017	55%
Pure premium trend	5.0%
Premium trend [(1 – 0.005)(1 + 0.03) – 1]	2.49%
Average accident date of prior filing	Jan. 1, 2018
Average accident date of forecast period	Apr. 1, 2020
Trending period in months	27

Claim ratio used for complement of credibility

$$= \frac{1.08}{1.04} \times 55\% \times \left(\frac{1.05}{1.0249} \right)^{27/12} = 60.31\%$$

7. Continued

(d) Calculate the indicated rate change.

Weighted average trended claim ratio from part (b)	58.2%
Number of ultimate counts in experience period	820
Credibility assigned to XYZ's experience = $\sqrt{820/1,082}$	87.05%
Permissible claim ratio = $\frac{1-0.07-0.04}{1+0.18/0.582}$ =	67.98%
Complement of credibility from part (c)	60.31%
Credibility weighed claim ratio = 58.2%×0.8705 + 60.31%×(1 – 0.8705) =	58.47%
Indicated rate change = 58.47% / 67.98% – 1 =	–14.0%

8. Learning Objectives:

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

Learning Outcomes:

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

Sources:

Catastrophe Modeling: A New Approach to Managing Risk, Grossi, P. and Kunreuther, H., Chapter 6.

Commentary on Question:

This question tests the candidate's understanding of catastrophe modeling relating to portfolio risk.

Solution:

(a) Describe two examples where data quality issues could arise in the inventory module of the catastrophe model.

Type of construction: It can change over time as well as be mis-coded.
Age of building: This relates to building codes at the time.

(b) Provide the reason why inventory is the component of the catastrophe model that requires the most attention with respect to data quality.

In defining as accurately as possible the composition for their portfolio, insurers can reduce the degree of epistemic uncertainty.

(c) Provide an example that illustrates why using the mean damage ratio is insufficient when determining the insurer's expected loss.

The mean damage ratio cannot reflect impact of deductibles. For example, if the mean ratio is 7% and the deductible is 10%, the expected insurer cost would be set at 0%, which makes no sense.

(d) Describe two additional ways that a catastrophe model can reflect correlation.

Correlations are not the same from property to property due to local conditions.
Model errors will propagate across properties. For example, if the vulnerability model is off for a given class of building, all of that class will be simultaneously affected.

9. 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.

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

6. The candidate will understand the need for monitoring results.

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.
(3c) Describe the components of claim liabilities in the context of financial reporting.
(6b) Analyze actual claims experience relative to expectations.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 3, 18, 23, and 36.

Commentary on Question:

This question tests the candidate's understanding of the Cape Cod method for estimating ultimate claims. It also tests the candidate's ability to calculate financial statement incurred claims, as well as the understanding of the process of monitoring actual versus expected claims experience.

Solution:

(a) Cite two situations for which the CC method is well-suited.

Any two of the following are acceptable::

- Immature experience periods
- Intro of new products
- When limited or no historical experience is available
- Entry into a new geographical area
- Internal or external environment changes such that historical patterns are not reliable

(b) Cite a key underlying assumption of the CC method.

The cost per exposure unit is constant for all years in the experience period.

9. Continued

(c) Describe the data you need for your review.

The following data are needed:

- Earned premiums
- Rate change history (or on-level factors)
- Reported claim triangle (or reported development factors and actual claims)
- Trend

(d) Estimate total unpaid claims.

	(1)	(2)	(3)	(4)
Accident Year	Cumulative Paid Claims	Cumulative Reported Claims	Expected % Reported	Expected Claims from CC Method
2015	4,000	8,000	75%	9,000
2016	2,000	6,000	50%	10,000
2017	500	3,000	25%	12,000
	6,500			

	(5) = 1 – (3)	(6) = (2) + (4)(5)	(7) = (6) – (1)
Accident Year	Expected % Unreported	Projected Ultimate	Estimated Unpaid
2015	25%	10,250	6,250
2016	50%	11,000	9,000
2017	75%	12,000	11,500
		33,250	26,750

9. Continued

(e) Derive the calendar year 2017 incurred claims using your results from part (d).

Accident Year	Cumulative Paid Claims	Estimated Unpaid Claims
2015	1,500	8,000
2016	400	10,100
Total @ Dec. 31, 2016	1,900	18,100

Calendar year (CY) 2017 incurred claims
= Unpaid claims as of Dec. 31, 2017 – Unpaid claims as of Dec. 31, 2016
+ 2017 paid claims

2017 CY paid claims = Cumulative paid claims to Dec. 31, 2017 – Cumulative paid claims to Dec. 31, 2016
= 6,500 – 1,900 = 4,600

CY 2017 incurred claims = 26,750 – 18,100 + 4,600 = 13,250.

(f) Provide two questions you might ask management as part of your investigation.

Any two of the following are acceptable (other questions are possible):

- Was there a legal decision that affected claims in all years?
- Were claims found that had not been entered properly in the system?
- Is there an expectation that issues have been resolved or is this adverse experience likely to continue for subsequent quarters?

10. 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.
(4b) Describe the influences on frequency and severity of changes in deductibles, changes in policy limits, and changes in mix of business.
(5d) Calculate loadings for catastrophes and large claims.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 25 and 30.

Commentary on Question:

This question tests the candidate's understanding of loadings for large claims for ratemaking.

Solution:

(a) Explain two reasons for using a large claims loading approach for estimating ultimate claims, rather than using unadjusted total limits claims.

Any two of the following are acceptable:

- The loading factor smooths the influence of large claims over time
- The actuary can introduce a greater volume of experience
- The claims at a limited value are more reliable

(b) Calculate the large claims loadings at a 200,000 limit, adjusted to the cost level for each accident year.

Average earned date in rating period = May 1, 2020

	(1)	(2)	(3)	(4) = (3)/(2)	(5) = 1.34 / (4)
		Severity Trend Factor at:			
Accident Year (AY)	Trending Period (months)	4.0%	5.0%	Trend Factors for Loading for Large Claims	Large Claims Loadings Adjusted to Cost Level of AY
2014	70	1.257	1.329	1.057	1.268
2015	58	1.209	1.266	1.047	1.280
2016	46	1.162	1.206	1.038	1.291
2017	34	1.118	1.148	1.027	1.305

Notes: (1): From July 1, AY to May 1, 2020
(2) & (3): $(1 + \text{trend})^{((1)/12)}$

10. Continued

(c) Calculate the ultimate claims at total limits for each accident year using selected ultimate claims at a 200,000 limit.

Accident Year	(5) Large Claims Loadings Adjusted to Cost Level of AY	(6) Selected Ultimate Claims at 200,000 Limit	(7) = (5)(6) Indicated Ultimate Claims at Total Limits based on Projections at 200,000 Limits
2014	1.268	3,150	3,994
2015	1.280	3,520	4,506
2016	1.291	3,720	4,803
2017	1.305	4,016	5,241

(d) Recommend the ultimate claims at total limits to use for ratemaking. Justify your recommendation.

Recommend using the indicated ultimate claims at total limits based on projections at 200,000 limit (column (7)). The justification is that the selected ultimate claims at total limits are too erratic whereas column (7) smooths out the fluctuations.

11. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the estimation of ultimate claims using the expected method and the Bornhuetter Ferguson method.

Solution:

(a) List two sources of expected claim ratios, other than that implied by prior claims experience.

Any two of the following are acceptable:

- Industry benchmarks
- An insurer's internal business plans
- Analyses conducted for pricing purposes

(b) Calculate the 2017 level expected claim ratio using reported claims and an all-years average.

Accident Year	(1) Earned Exposures (000)	(2) Earned Premiums (000)	(3) Premium On-Level Factors	(4) Reported Claims as of Dec. 31, 2017 (000)	(5) Reported Claims Cumulative Development Factors
2014	200	20,000	1.120	19,500	1.10
2015	210	23,000	1.040	20,000	1.20
2016	230	24,000	1.010	14,000	1.40
2017	260	28,000	1.000	14,000	1.60

11. Continued

Accident Year	(6) = (4)(5) Projected Ultimate Claims	(7) Trend at 3%	(8) Tort Reform	(9) = (6)(7)(8) / [(2)(3)] Trended On-Level Claim Ratio
2014	21,450	1.093	0.75	78.5%
2015	24,000	1.061	0.75	79.8%
2016	19,600	1.030	1.00	83.3%
2017	22,400	1.000	1.00	80.0%
Simple Average (all years)				80.4%

(c) Calculate the 2017 level expected pure premium using reported claims and an all-years average.

Accident Year	(10) = (6)(7)(8) / (1) Trended Pure Premium
2014	87.92
2015	90.94
2016	87.77
2017	86.15
Average	88.20

(d) Calculate the accident year 2016 ultimate claims using the Bornhuetter Ferguson method.

AY 2016 expected claims:

- Expected method = 80.4%×24,000×1.01 / 1.03 = 18,921
- Pure premium method = 88.20×230 / 1.03 = 19,695
- Average = ½(18,921 + 19,695) = 19,308

AY 2016 ultimate claims using the Bornhuetter Ferguson method:
= 14,000 + 19,308×(1 – 1/1.40) = 19,517.

(e) Provide one advantage of the Bornhuetter Ferguson method over the expected method.

The Bornhuetter Ferguson method is more responsive to actual claims as they emerge.

12. Learning Objectives:

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

Learning Outcomes:

(5k) Calculate rates for claims-made coverage.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of claims-made ratemaking.

Solution:

(a) Describe one way that a coverage gap can occur for insureds purchasing claims-made coverage.

Any of the following are acceptable:

- When an insured switches from one coverage form to another
- When an insured switches from claims made with one company to claims made with another, there may be unreported occurrences not covered by either policy
- When an insured with claims-made coverage switches to occurrence, claims reported after the expiration of the claims-made coverage that occurred before the inception of the occurrence coverage are not covered

(b) Construct a numerical example demonstrating this principle.

Commentary on Question:

Any example will suffice as long as the example demonstrates the relationship.

Example demonstrating a total of 300 with equal reporting pattern of 1/3 each year over three years with 10% annual trend:

Accident Year (AY) Lag by Report Year (RY) Matrix

	RY		
AY Lag	1	2	3
0	***100***	110	121
1	**100**	*110*	121
2	**100**	110	*121*

RY1 Claims-made policy = ***100*** + **100** + **100** = 300

RY1 Occurrence policy = ***100*** + *110* + *121* = 331

12. Continued

(c) Construct a numerical example demonstrating this principle.

Commentary on Question:
Any example will suffice as long as the example demonstrates the relationship. It is advantageous to continue the example from part (b) to make the comparison in cost calculation easier.

Use part (b) example with a reporting pattern of 20%/40%/40% over three years with 10% annual trend:

Accident Year (AY) Lag by Report Year (RY) Matrix

	RY		
AY Lag	1	2	3
0	***60***	66	72.6
1	**120**	*132*	145.2
2	**120**	132	*145.2*

RY1 Claims-made policy = ***60*** + **120** + **120** = 300
RY1 Occurrence policy = ***60*** + *132* + *145.2* = 337.2

Change in cost of the policies:

- Change in claims-made policies = 300 / 300 – 1 = 0%
- Change in occurrence policies = 337.2 / 331 – 1 = 1.9%

13. Learning Objectives:

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

Learning Outcomes:

(5g) Calculate risk classification changes and territorial changes.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of classification ratemaking.

Solution:

(a) Describe how insurers can promote fairness and equity with respect to premium rates through the development of a risk classification system.

Fair rates reflect expected costs and promote individual equity.

(b) Describe the financial consequences of adverse selection to an insurer resulting from an absence of a sound risk classification system.

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 losses 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.

(c) Provide two considerations *in support* of using credit score as a rating variable.

Any two of the following are acceptable (others are possible):

- Relationship with risk characteristic and expected outcomes – premium rate should be tied to differences in expected costs.
- Objectivity – based on verifiable, observable facts.
- Practicality – ease of measuring risk characteristics
- Industry practices – it would support use if it is commonly used by others in the industry

13. Continued

(d) Provide two considerations *against* using credit score as a rating variable.

Any two of the following are acceptable (others are possible):

- Causality – it is difficult to demonstrate that low credit causes higher expected claim costs
- Applicable law – credit may not be legal
- Industry practices – it would be hard to justify use if it is not commonly used by others in the industry.
- Business practices – may be practical constraints to using a factor

(e) Calculate one-way relativities for each credit score.

	(1)	(2)	(3) = (2)/(1)	(4) = $(3)_i/(3)_T$
Credit Score	Total Exposures	Total Claims	Total Pure Premium	One-way Relativities to Total
Poor	550	35,500	64.55	1.458
Normal	1,100	49,700	45.18	1.021
Exceptional	550	12,200	22.18	0.501
	2,200	97,400	44.27	

e.g., Total claims for poor credit score:

$= (100\times100) + (300\times50) + (150\times70) = 35{,}500$

(f) Explain whether or not this risk classification plan reflects distributional bias.

It shows no distributional bias because exposures show the same distribution for each risk characteristic.

- Ratios of exposures for credit score: 1:2:1 for every age group
- Ratios of exposures for age group: 1:3:1.5 for every credit group

(g) Describe how this risk classification system may exhibit dependence without having distributional bias.

Same exposures (i.e., no distributional bias), with the cost difference (pure premiums) ratios of poor credit to normal credit could vary by age group (i.e., dependence).

14. Learning Objectives:

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

Learning Outcomes:

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

Sources:

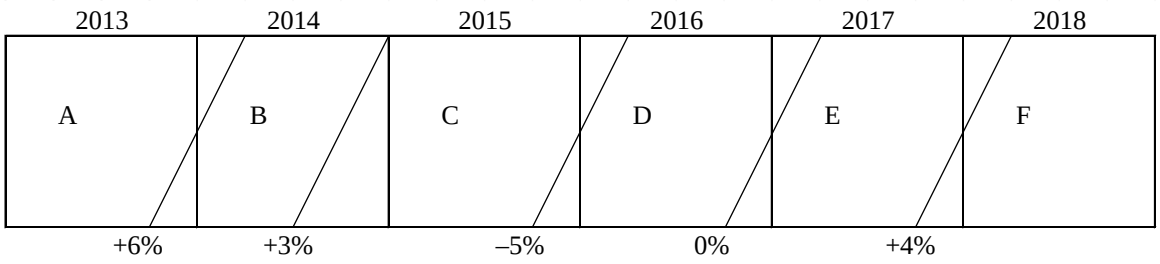
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 12.

Commentary on Question:

This question tests the candidate's understanding of adjusting premium to current rate level for the purposes of reserving and ratemaking.

Solution:

(a) Calculate the premium on-level factor for calendar year 2014 used to project expected claim ratios for reserving purposes as of December 31, 2017.



Rate Level	Rate Level Relative Value	Area in CY: 2014	Area in CY: 2017
A	1.0000	6.25%	
B	1.0600	68.75%	
C	1.0918	25.00%	
D	1.0372		6.25%
E	1.0372		87.50%
F	1.0787		6.25%
Weighted average rate level		1.0642	1.0398

Premium on-level factor for 2014 = 1.0398/1.0642 = 0.977.

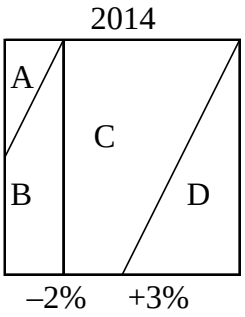
14. Continued

(b) Calculate the premium on-level factor for calendar year 2014 used to project expected claim ratios for ratemaking analysis.

For ratemaking purposes, the premium on-level factor for 2014 must be compared to the rate level relative value after the most recent change.
Premium on-level factor for 2014 = 1.0787/1.0642 = 1.014.

(c) Calculate the weighted average rate level for calendar year 2014 taking into account this new information.

Discount introduced on April 1, 2014 = 10%
Percent of policyholders affected = 20%
This is equivalent to rate decrease of 10%×20% = 2%



Rate Level	Rate Level Relative Value	Area in 2014
A	1.0000	6.25%
B	1.0600	18.75%
C	1.0388	50.00%
D	1.0700	25.00%
Weighted average rate level		1.0482

15. 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.
(2c) Estimate claims-related expenses and recoveries.
(2d) Explain the effect of changing conditions on the projection methods cited in (2b).
(2e) Assess the appropriateness of the projection methods cited in (2b) in varying circumstances.
(3c) Describe the components of claim liabilities in the context of financial reporting.
(3d) Evaluate the estimates of ultimate claims to determine claim liabilities for financial reporting.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 14, 17, 20, 21, 22, and 23.

Commentary on Question:

This question tests the candidate's understanding of estimating ultimate and unpaid allocated loss adjustment expenses (ALAE) using the development method, the Bornhuetter Ferguson method and the Benktander method. It also tests the candidate's understanding of estimating unallocated loss adjustment expenses (ULAE) using the paid-to-paid method.

Solution:

(a) Estimate ultimate ALAE for report year 2017 using the following methods:

(i) Development method

(ii) Bornhuetter Ferguson method

(iii) Benktander method, one iteration

Selected development factors:

12-24	24-36	36-48	48-60	60-Ult
1.832	1.229	1.192	0.993	1.000

Rationale:

- 12-24 months: average of most recent two report years due to the limits change in ALAE
- All other periods using average of all years

15. Continued

12 month to ultimate development factor = 1.832×1.229×1.192×0.993 = 2.665

Ultimate ALAE for report year 2017:

(i) Development method:

Ultimate ALAE to claim ratio = 0.050×2.665 = 0.1333
Ultimate ALAE = 5,080×0.1333 = 677

(ii) Bornhuetter Ferguson method:

Reported ALAE at 12 months = (Reported Claims excluding ALAE)(Reported ALAE to Reported Claim Ratio) = 1,795×0.05 = 90

12 month to ultimate development factor for reported ALAE = (12 month to ultimate development factor for claims excluding ALAE)(12 month to ultimate development factor for reported ALAE to reported claim ratios)

$$= \frac{5,080}{1,795} \times 2.665 = 7.542$$

Ultimate ALAE = 90 + (0.12×5,080)(1 – 1/7.542) = 619

(iii) Benktander method:

Ultimate ALAE = 90 + 619×(1 – 1/7.542) = 627

(b) Describe a limitation that all three methods have in common in this situation.

All three methods rely to some extent on the assumption that historical development patterns are predictive of future patterns. There is not have enough experience in this problem after the ALAE limit change to determine if the pattern has changed, but would expect the pattern to be shorter.

(c) Recommend an estimate of unpaid ALAE for report year 2017. Justify your recommendation.

Recommend the Bornhuetter Ferguson method because it has the least distortion from the limitation explained in part (b) but also reflects actual experience to-date.

Report year 2017 unpaid ALAE = 619 – 18 = 601.

15. Continued

(d) Estimate unpaid ULAE as of December 31, 2017 using a paid-to-paid method.

Calendar Year	(1) Paid Claims excluding ALAE	(2) Reported Claims excluding ALAE	(3) Paid ULAE	(4) = (3)/(1) Ratio of Paid ULAE to Paid Claims	(5) Ratio Excluding One-Time Costs
2015	4,000	4,200	450	0.113	0.113
2016	4,100	4,400	510	0.124	0.117
2017	4,200	4,600	470	0.112	0.112
Total	12,300	13,200	1,430		

Note: (5) for 2016: (510 – 30)/4,100 = 0.117

ULAE ratio = average of column (5) = 0.114

Claim case reserves: 23,038 – 16,010 = 7,028
Claim IBNR reserves: 28,670 – 23,038 = 5,632
Unpaid ULAE: (7,028×75%×0.114) + (5,632×0.114) = 1,243.

16. Learning Objectives:

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

Learning Outcomes:

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

(3f) Evaluate premium liabilities.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of premium liabilities.

Solution:

(a) Recommend expected claim ratios, both for gross and net of reinsurance, that will be used in the determination of premium liabilities. Justify your recommendation.

Commentary on Question:

Other recommendations are acceptable with the proper justification.

The large claim needs to be removed from accident year 2016 as it is not expected to recur.

Gross of Reinsurance	2015	2016	2017
Earned premiums	2,300	2,500	2,400
Accident year ultimate claims	1,100	1,250	1,270
Claim ratio	47.8%	50.0%	52.9%

Recommended expected claims ratio = 53%

Justification: Use the most recent year to recognize the rising trend.

Net of Reinsurance	2015	2016	2017
Earned premiums	1,520	1,680	1,510
Accident year ultimate claims	830	940	950
Claim ratio	54.6%	56.0%	62.9%

Recommended expected claims ratio = 63%

Justification: Use the most recent year to recognize the rising trend.

16. Continued

(b) Calculate the premium liabilities, both gross and net of reinsurance.

		Gross	Net
(1)	Unearned Premium	1,180	880
(2)	Selected claim ratio from part (a)	53%	63%
(3)	Expected claims [(1)(2)]	625	554
(4)	ULAE [625×10%]	63	63
(5)	Maintenance expenses [1,180×5%]	59	59
(6)	Reinsurance cost [1,180×12%]		142
(7)	Premium liabilities [(3)+(4)+(5)+(6)]	747	818

(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 in gross and net unearned premiums.

Gross: 1,180 – 747 = 433
Net: 880 – 818 = 62

(e) Calculate the maximum reported deferred policy acquisition expense (DPAE) as of December 31, 2017.

DPAE = 15%×1,180 = 177
Reported DPAE = Lower of DPAE and Net equity in unearned premium
= lower (177,62) = 62.

17. Learning Objectives:

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

Learning Outcomes:

(5i) Calculate rates for large accounts.
(5j) Perform individual risk rating using standard plans.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of individual risk rating.

Solution:

(a) Define the following terms in the context of individual risk rating:

(i) Modified premiums

(ii) Expense modification plan

(iii) Schedule rating

(i) Modified premiums: The base rates (or manual rates) are adjusted by rating factors (schedule rating factors).

(ii) Expense modification plan: A form of rating plan (or rating procedure) where the variation of the premium for a particular insured is based on the variation in the expenses of the insurer with regard to this insured from those contemplated in the development of the manual rate.

(iii) Schedule rating: A program in which manual rates are adjusted, upward (debits) or downward (credits), to reflect an insured's risk characteristics, such as safety programs in place, financial strength, and overall management capabilities.

(b) Explain why prospective experience rating is frequently used in workers compensation.

In workers compensation, experience rating plans can be used to promote occupational health and safety by providing the insured with incentives for loss prevention and the speedy return-to-work of injured workers.

17. Continued

(c) Critique the use of a prospective experience rating plan for personal automobile coverage.

- An individual's or a family's driving would have limited credibility.
- Personal automobile often surcharges for driving infractions or accidents/claims or has bonus-malus features.
- Experience modification factors could vary widely from policy period to policy period.
- Some personal automobile policy terms are less than one year, exacerbating the volatility.

(d) Critique each characteristic in the new plan.

- Including all experience would create a stable plan and would charge an insured based on its own loss experience, to the extent credible.
- Unlimited claims could increase volatility through large changes in experience modification factors.

(e) Recommend an appropriate exposure base for this pool. Justify your recommendation.

Any one of the following is acceptable:

- Population: Justification is that it differentiates based on size
- Payroll: Justification is that it differentiates based on services provided by municipal employees
- Revenue: Justification is that it differentiates based on income of the municipality, related to services provided

(f) Recommend whether claim counts or claim amounts should determine the experience of a given municipality. Justify your recommendation.

Either one of the following is acceptable:

- Claims: Justification is that it is consistent with an emphasis on stability
- Amounts: Justification is that it is consistent with economic responsiveness

18. 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:

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

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

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 10 and 19.

Commentary on Question:

This question tests the candidate's ability to estimate ultimate claims using Berquist-Sherman adjustments when there has been a change in case reserve adequacy.

Solution:

(a) Demonstrate that there has been case reserve strengthening.

Adjust accident year 2015 case estimates to remove the large claim:

Accident	Adjusted Average Case Estimate (000)			
Year	12	24	36	48
2014	17.8	20.6	21.0	17.6
2015	19.1	***21.7***	***24.3***	
2016	22.0	25.0		
2017	25.1			

Notes: $21.7 = (24.2 \times 135 - 360) / (135 - 1)$
$24.3 = (29.7 \times 55 - 320) / (55 - 1)$

Check the rate of change down each column:

Accident Years	12	24	36
2014 to 2015	7.3%	5.3%	15.7%
2015 to 2016	15.2%	15.2%	
2016 to 2017	14.1%		

Looking down each column of the average case estimate, the annual change for each column is greater than the assumed trend of 5% for most of the entries, especially the most recent diagonal. This suggests a change in case reserve adequacy.

18. Continued

(b) Identify two operational changes in an insurance company that could result in case reserve strengthening.

- Including large claim in the data triangle will lead to higher estimates of development factors and claim projections.
- Using unadjusted data triangle will overestimate age-to-age development factors and thus cumulative development factors. As a result, the projected reported claims will be overstated.

(c) Calculate the triangle of average case estimates with an adjustment for case reserve strengthening.

The latest diagonal comes from the adjusted case reserve triangle in part (a). The entries for other accident years are based on the diagonal value for that development period, trended back using the 5% annual trend.

Accident Year (AY)	Average Case Estimates Adjusted for Case Reserve Strengthening (000)			
	12	24	36	48
2014	21.7	22.7	23.1	***17.6***
2015	22.8	23.8	***24.3***	
2016	23.9	***25.0***		
2017	***25.1***			

i.e., AY 2016 at 12-month development: 23.9 = 25.1/1.05

(d) Explain whether projected ultimate claims are higher with or without an adjustment for case reserve strengthening.

Case estimates without the adjustment are lower, which would yield higher development factors. As a result, the ultimate claims without the adjustment would be higher.

(e) Calculate the ultimate claims for accident year 2015 using adjusted reported claims and assuming no reported development after 48 months.

Reported claims:

- AY 2014, 36 months development = 4,700 + 54×23.1 = 5,947
- AY 2014, 48 months development = 5,700 + 17×17.6 = 5,999
- AY 2015, 36 months development = 5,080 + 54×24.3 = 6,392

36 to 48 months development factor = 5,999 / 5,947 = 1.009

AY 2015 ultimate claims = 6,392×1.009 + 320 = 6,770

19. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of estimating ultimate claims using the development method.

Solution:

(a) Calculate the reported age-to-ultimate factor for the following cases:

(i) Accident month at 3 months

(ii) Accident quarter at 4 months

(iii) Accident half year at 9 months

(iv) Accident year at 12 months

(i)	26/6 =	4.333
(ii)	(26×3)/(8+6+4) =	4.333
(iii)	(26×6)/(18+16+14+12+10+8) =	2.000
(iv)	(26×12)/(2+4+6+8+10+12+14+16+18+20+22+24) =	2.000

(b) Explain the relationship of the results in part (a)(iii) and part (a)(iv) by considering the average accident date.

The results in part (a), subparts (iii) and (iv) are equal. The reasoning is as follows:

The average accident date of an accident semester is three months before the end of the semester. For an accident year, the average accident date is six months before the end of the year. Thus, the percent reported for an accident semester at n months is equal to the percent reported for an accident year at n+3 months.

19. Continued

(c) Identify two potential differences.

Any two of the following are acceptable (other answers are possible):

- All accident months will not be equal in ultimate claims in practice
- There will be variation in the reporting pattern for individual accident months
- The reporting pattern may not be so uniformly increasing

20. Learning Objectives:

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

Learning Outcomes:

(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).

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 21.

Commentary on Question:

This question tests the candidate's understanding of the evaluation and selection of estimated ultimate claims under various circumstances.

Solution:

(a) Evaluate the appropriateness of each of the following methods for estimating ultimate claims for accident year 2013:

(i) Cape Cod method applied to paid claims

(ii) Bornhuetter Ferguson method applied to reported claims

(iii) Frequency-Severity method applied to reported claims

(i) The Cape Cod method applied to paid claims is not appropriate since the data needed is not available (e.g., need rate change history or on-level premium).

(ii) The Bornhuetter Ferguson method applied to reported claims is appropriate because it would incorporate the current estimate of large unpaid claim without distorting the estimate.

(iii) The Frequency-Severity method is appropriate if estimated severity is based on accident years 2012 and prior to exclude the large unpaid claim. An estimate for the large unpaid claim could then be added in as the last step.

20. Continued

(b) Recommend the most appropriate method from part (a) for estimating ultimate claims for accident year 2013. Justify your recommendation.

Recommend the Bornhuetter Ferguson method applied to reported claims because it automatically includes the current case estimate for the large unpaid claim.

(c) Outline the steps for estimating ultimate claims for accident year 2013 using your selection from part (b).

- Use the triangle of reported claims at annual evaluations to calculate development factors
- Select development factors and calculate cumulative development factors (CDF)
- Calculate an IBNR Factor = (1 – 1/CDF)
    - The CDF evaluation age would be 60 months to ultimate
- Derive an a priori accident year 2013 claim ratio from the pricing estimate and the earned premium by calendar year
- Ultimate Claims = Actual Reported Claims + (a priori claims ratios × IBNR factor)

21. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of estimating ultimate claims using the development method.

Solution:

(a) List the two primary assumptions of the development method.

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

(b) State four considerations in selecting age-to-age development factors.

Any four of the following are acceptable:

- Volume of experience in the development triangle and the credibility of the insurer's experience
- Stability (or variability) of individual factors at each maturity interval as well as the similarity (or lack thereof) in the various averages
- Any discernible trends, either increasing or decreasing, in the individual age-to-age factors or in the averages when comparing short-term to long-term averages
- The number of recent age-to-age factors in each maturity interval that are greater than or less than the various average values
- Factors preceding and following the particular maturity age interval
- Effect of known changes in the internal or external environments that could influence future development
- Influence of large claims, both the presence and absence of large claims, recognizing that there can be significant distortions in individual age-to-age factors as a result of large claims
- Relevance of other data such as industry benchmark patterns
- Selected factors from prior actuarial work

21. Continued

(c) Identify one situation where you would recommend a volume-weighted average rather than a simple average for selecting age-to-age development factors.

A volume-weighted average will reduce the standard error of the estimate.

(d) Provide two situations where it might be appropriate to use a triangle that excludes the most recent years in determining age-to-age development factors.

Any two of the following are acceptable:

- where the most recent years are too immature
- where there has been a change (i.e. tort reform)
- there has been volatility in the most recent two years

(e) Calculate the 12-to-24 months age-to-age development factor using a volume-weighted average.

$$\text{Volume weighted average} = \frac{(349+353+393+378)}{(226+249+269+233)} = 1.5077$$

(f) Provide one advantage and one disadvantage for each of the following approaches:

(i) Bondy method,

(ii) Algebraic method, and

(iii) Use of benchmark data.

(i) Bondy method:
Advantage: simplicity since uses the latest observed age to age factor
Disadvantage: potential to greatly underestimate the remaining development for long tail lines

(ii) Algebraic method:
Advantage: based on data entirely on the data contained within the development triangles so no additional data is required
Disadvantage: a reliable estimate of ultimate claims is required for the most mature periods and is not always available

(iii) Use of benchmark data:
Advantage: significant amount of relevant and credible data
Disadvantage: not properly reflecting changes in the environment