GIIRR Model Solutions
Spring 2017

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, Chapters 11 and 12.

Commentary on Question:

This question tests the candidate's understanding of written premiums, earned premiums, unearned premium and inforce premium.

Solution:

(a) Calculate the 2015 calendar year total written premiums.

Calendar year 2015 total written premiums = 750 + 1,040 = 1,790

(b) Calculate the 2015 and 2016 calendar year total earned premiums.

2015 earned premiums:
Policy 1 = 750.00
Policy 2 = 1,000 × 6/12 + 1,040 × 6/12 = 1,020.00
Total = 1,770.00

2016 earned premiums:
Policy 1 = 750 × 3/12 + 780 × 9/12 = 772.50
Policy 2 = 1,040 × 3/12 = 260.00
Total = 1,032.50

1. Continued

(c) Calculate the total unearned premiums as of December 31, 2015.

$750 \times 3/12 + 1{,}040 \times 6/12 = 707.50$

(d) Calculate the 2015 total earned premiums adjusted to the current rate level.

$780 + 1{,}040 = 1{,}820$

(e) Calculate the inforce premium as of December 1, 2015 for each of these two 6-month policies.

With the change, inforce premiums at December 1, 2015 are $0.5 \times 1.04 \times (750 + 1{,}000) = 910.00$

2. 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.

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.
(2e) Assess the appropriateness of the projection methods cited in (2b) in varying circumstances.
(6b) Analyze actual claims experience relative to expectations.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 3, 14, 17, 21, and 36.

Commentary on Question:

This question tests the estimation of ultimate claims using the development method, the Bornhuetter Ferguson method, and the Benktander method. This question also tests the candidate's understanding of IBNR as well as comparing actual vs. expected claims.

Solution:

(a) Calculate projected ultimate claims for accident years 2015 and 2016 using the following methods:

(i) Development method

(ii) Bornhuetter Ferguson method

(iii) Benktander method, one iteration

2. Continued

	Age-to-Age-Development Factors (DF)				
Accident Year	12-24	24-36	36-48	48-60	60-72
2010	1.70	1.20	1.05	1.01	1.00
2011	1.70	1.21	1.05	1.01	1.00
2012	1.80	1.19	1.05	1.01	
2013	1.80	1.20	1.05		
2014	1.80	1.20			
2015	2.00				
Selected DFs:	1.80	1.20	1.05	1.01	1.00
Cumulative DFs:	2.291	1.273	1.061	1.010	1.00

Note: 12-24 selected DF excludes 2015 due to large claim, and relies on 2012 through 2014 to give more consideration to more recent years.

	(1)	(2)	(3)	(4)	(5)	(6)
Accident Year	Earned Premium	Reported Claims as of Dec 31, 2016	A Priori Expected Claims	A Priori Claims Ratio	Unusual Large Loss	Cumulative Reported DFs
2015	4,570	2,600	2,970	65%	260	1.273
2016	4,710	1,400	3,060	65%		2.291

Accident Year	(7) = (6)[(2) − (5)] + (5) Estimate Ultimate Claims: Development Method	(8) = (2) + (3)[1 – 1/(6)] Estimate Ultimate Claims: Bornhuetter-Ferguson Method	(9) = (2) + (8)[1 – 1/(6)] Estimate Ultimate Claims: Benktander Method
2015	3,239	3,237	3,294
2016	3,207	3,124	3,160

2. Continued

(b) Recommend an estimate of ultimate claims for each of accident years 2015 and 2016 and justify your recommendation.

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

Accident Year	Recommended Ultimate Claims
2015	3,257
2016	3,164

Recommendation based on the average of all three methods. The justification is that all methods are sound after adjusting for the large claim.

(c) Calculate accident year 2015 and 2016 IBNR reserves as of December 31, 2016 using your recommendations from part (b).

Accident Year	(1) Reported Claims	(2) Recommended Ultimate Claims	(3) = (2) – (1) IBNR
2015	2,600	3,257	657
2016	1,400	3,164	1,764

(d) Critique management's recommendation.

Management's recommendation should not be taken as all three methods show that recent experience is coming in higher than the a priori expected claims ratio, and accident year 2015 is materially higher due to a large loss.

(e) Calculate the accident year 2016 expected reported claims from December 31, 2016 to March 31, 2017 using your recommendations from part (b) and linear interpolation.

Cumulative DF at 12 months = 2.291, therefore % reported at 12 months = 1/2.291 = 43.6%
Cumulative DF at 24 months = 1.273, therefore % reported at 24 months = 1/1.273 = 78.6%
Interpolated % reported at 15 months = 0.75×43.6% + 0.25×78.6% = 52.4%
Expected reported = $(3{,}164 - 1{,}400)\dfrac{(52.4\% - 43.6\%)}{(1 - 43.6\%)} = 275$

3. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of deductibles and how deductibles can affect severity and the application of policy limits.

Solution:

(a) State two primary approaches used to determine deductible factors for ratemaking.

1. If the data are sufficient and reliable (i.e., credible), then actuaries may group the data by deductible level and determine the deductible factors using the classification techniques.
2. Use the elimination ratio approach.

(b) Provide an example demonstrating how average severity can *increase* when deductibles are increased.

Many examples are possible.

		Amount Paid by Insurer	
		Deductible of	Deductible of
Claim #	Covered Loss	500	1,000
1	750	250	n/a
2	5,000	4,500	4,000
Average (severity)		2,375	4,000

3. Continued

(c) Provide an example demonstrating how average severity can *decrease* when deductibles are increased.

Many examples are possible.

		Amount Paid by Insurer	
		Deductible of	Deductible of
Claim #	Covered Loss	1,000	2,000
1	5,000	4,000	3,000
2	10,000	9,000	8,000
Average (severity)		6,500	5,500

(d) Explain how order of operation in applying deductibles and policy limits could produce different claims for the insurer.

Example:

Deductible = 5,000
Policy limit = 100,000
Covered loss = 120,000

1. Apply deductible and then limit:
   Amount paid by insurer = min[(120,000 – 5,000), 100,000] = 100,000
   i.e., the application of the deductible does not affect the limit

2. Apply limit then deductible:
   Amount paid by insurer = min(120,000, 100,000) – 5,000 = 95,000
   i.e., the application of the deductible does affect the limit

4. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

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

Solution:

(a) Describe two approaches that could be used to deal with high and volatile claims in later maturity ages when analyzing incremental paid severity.

Any 2 of the following are acceptable:

- Use a medial average that excludes the highest and lowest values
- Cap the claims and add back an adjustment to the limited projection
- Select a cutoff age at which the values become volatile and the expected percentage of closed counts is close to 100%
- Other method (such as expected method)
- Credibility weight with other line of business or industry outside source

(b) Identify two decisions that need to be made with respect to the type of counts to be used.

1. Whether to use counts with or without closed no payment
2. Whether to use closed or reported counts for developing the estimate of ultimate counts

4. Continued

(c) Calculate the proportion of closed counts at each maturity for accident year 2012.

Outstanding counts at the end of each year, for accident year 2012:
@ 12 months: 2,870 – 1,640 = 1,230
@ 24 months: 1,230 – 750 = 480
@ 36 months: 480 – 300 = 180
@ 48 months: 180 – 130 = 50

Proportion closed at each duration (i.e., counts closed / counts outstanding):
Year 1 (12 months): 1,640 / 2,870 = 57.1%
Year 2: 750 / 1,230 = 61.0%
Year 3: 300 / 480 = 62.5%
Year 3: 130 / 180 = 72.2%
Year 4: 50 / 50 = 100.0%

(d) Calculate the projected incremental closed counts at each duration for accident year 2016, using the ratios calculated in part (c).

@ 12 months = 1,320 (given)
@ 24 months = 0.61×(2,270 – 1,320) = 580
@ 36 months = 0.625×(2,270 – 1,320 – 580) = 231
@ 48 months = 0.722×(2,270 – 1,320 – 580 – 231) = 100
@ 60 months = 1.0×(2,270 – 1,320 – 580 – 231 – 100) = 39

5. Learning Objectives:

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

Learning Outcomes:

(5e) Demonstrate the use of credibility in ratemaking.
(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.

Solution:

(a) Describe why an actuary might use location as a risk characteristic for ratemaking purposes.

Location can be considered a risk characteristic when risks with similar expected costs can be grouped based on geographical boundaries.

(b) Describe two practical considerations for creating territorial boundaries for establishing insurance rates.

Any two of the following are acceptable:

- Territories with similar expected costs may not be contiguous on a map, and thus hard to explain.
- Territories with similar expected costs may be very small and thus not stable from year to year.
- Use of territory as a rating variable may be limited by law.
- The actuary may want to use existing geographical definitions such as zip code or county in order to establish territory.

(c) Calculate the indicated territory relativity for the Eastern territory relative to the Western territory using the pure premium approach.

Pure premium relativities:
Total weighted average trended ultimate pure premium
$= (150\times5{,}000 + 250\times20{,}000)/25{,}000 = 230$
Ratio of Western to total = 150 / 230 = 0.652
Ratio of Eastern to total = 250 / 230 = 1.087

5. Continued

Comp of credibility rebalanced:
Total compliment of credibility = (0.6×5,000 + 1.2×20,000)/25,000 = 1.08
Rebalanced Western = 0.6 / 1.08 = 0.556
Rebalanced Eastern = 1.2 / 1.08 = 1.111

Credibility weighted pure premium relativities:
Western = 0.652×0.25 + 0.556×0.75 = 0.580
Eastern = 1.087×0.80 + 1.111×0.20 = 1.092

Relativity for the Eastern territory relative to the Western territory: 1.092/0.580 = 1.883.

(d) Describe how social adequacy is different from equity in developing a risk classification system.

An equitable risk classification system charges higher rates to risks with higher expected costs.

Social adequacy considers affordability of the insurance coverage. If social adequacy is a goal, prices may not be set consistent with individual equity.

(e) Explain three alternative procedures to incorporate this new variable into the analysis, including a consideration of how each procedure deals with the dependence.

- One-way analysis: inability to adjust for dependence between risk classes.
- Minimum Bias Procedure: considers two or more risk characteristics simultaneously. It does not adjust for dependence.
- GLM: can make use of comprehensive statistical framework. It does not adjust for dependence unless adjustments are made.

(f) Explain how you would reflect a potential higher frequency in prospective rates.

Analyze claims by peril.
Include a catastrophe model to account for the wildfire claims.

6. Learning Objectives:

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

Learning Outcomes:

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

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 14 and 18.

Commentary on Question:

This question tests the Cape Cod method of estimating ultimate claims.

Solution:

(a) Calculate the projected ultimate claims for all accident years using the Cape Cod method.

	(1)	(2)	(3) = 0.95/(2)	(4) = (1)(3)	(5)	(6) = 1/(5)	(7) = (4)(6)
Accident Year	Earned Premium	Earned Rate Level	Premium On-Level Factor	On-Level Earned Premium	Paid CDF	Expected % Paid	Used-Up On-Level Earned Premium
2014	25,000	1.000	0.950	23,750	2.600	0.3846	9,134
2015	26,000	0.975	0.974	25,324	3.500	0.2857	7,235
2016	27,000	0.950	1.000	27,000	9.000	0.1111	3,000
Total							19,369

Note: (2) Earned rate level for 2015 = 0.5×1.0 + 0.5×0.95 = 0.975

	(8)	(9)	(10)	(11)=(8)(9)(10)	(12)=[(4)×0.721]/[(9)(10)]
Accident Year	Actual Paid Claims	Trend @ 3%	Tort Reform	Adjusted Claims	Expected Claims
2014	6,700	1.061	0.900	6,398	17,933
2015	5,300	1.030	1.000	5,459	17,727
2016	2,100	1.000	1.000	2,100	19,467
				13,957	55,127

Adjusted Expected Claim Ratio = 13,957/19,369 = 0.721

6. Continued

Accident Year	(13) = 1 – (6) Expected % Unpaid	(14) = (12)(13) Expected Unpaid	(15) = (8) + (14) Projected Ultimate Claims
2014	0.6154	11,036	17,736
2015	0.7143	12,662	17,962
2016	0.8889	17,304	19,404
Total		41,002	55,102

(b) Select a decay rate and justify your selection.

Since products liability is a long-tail line of business with significant uncertainty in ultimate claims, a decay factor closer to 1.0 is appropriate.

7. Learning Objectives:

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

Learning Outcomes:

(1b) Identify different types of data used for actuarial analysis.
(1c) Identify professional responsibilities related to data.
(1e) Identify qualitative information required for actuarial analysis.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 3.

Commentary on Question:

This question tests the candidate's understanding of the key concepts underlying the estimation of ultimate claims.

Solution:

(i) The reinsurers should rely on the case estimates provided by EB General Insurance.

Commentary on Question:

Candidates can either provide an argument for or against the statement.

Argument against: Reinsurers will typically add additional case reserves to reflect the difference in view of the case estimates provided by the insurers.

(ii) The case estimates for automobile liability tend to increase over time and case estimates for automobile physical damage tend to decrease over time. Therefore, the modeling of estimates can be simplified by aggregating these coverages and assuming the increases and decreases will offset.

Commentary on Question:

Candidates can either provide an argument for or against the statement.

Argument against: Development on case estimates may be very different, and combining the coverages may mask the difference.

7. Continued

(iii) Large corporate clients are more effective at managing risk, and therefore more likely to self-insure and less likely to purchase insurance from EB General Insurance.

Commentary on Question:
Candidates can either provide an argument for or against the statement.

Argument for: Large corporate clients would tend to know their own business better and have established programs in place to manage risk.

(iv) EB General Insurance should rely on software programs to project ultimate claims based on the appropriate actuarial methodology.

Commentary on Question:
Candidates can either provide an argument for or against the statement.

Argument against: Software can assist with the computations, but professional judgement should be used in selecting the ultimate claims estimates.

8. Learning Objectives:

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

Learning Outcomes:

(3a) Describe the key assumptions underlying ratio and count-based methods for estimating unpaid unallocated loss adjustment expenses.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of estimating unpaid ULAE using the Wendy Johnson count-based method.

Solution:

(a) Calculate the projected open counts for calendar years 2017, 2018, and 2019.

2017: Open from 2016 + 2017 newly reported – 2017 closed = 83 + 16 – 55 = 44
2018: Open from 2017 + 2018 newly reported – 2018 closed = 44 + 5 – 29 = 20
2019: Open from 2018 + 2019 newly reported – 2019 closed = 20 + 0 – 20 = 0

(b) Estimate the unpaid ULAE as of December 31, 2016 using a simple three-year average of historical experience.

	(1)	(2)	(3)	(4)	(5)	(6) = 1,000×(1)/(5)
		Historical ULAE				
	Paid	Counts				
Calendar Year	ULAE (000)	Newly Reported	Open	Closed	Weighted Total	Average ULAE Per Weighted Count
2014	185	116	105	132	113.7	1,627.09
2015	187	108	92	121	102.6	1,822.61
2016	163	111	83	120	98.8	1,649.80
	Weights:	30%	50%	20%	Average:	1,699.83

e.g., (116×0.3) + (105×0.5) + (132×0.2) = 113.7

8. Continued

		(7)		
	Projected ULAE			
	Counts			
Calendar Year	Newly Reported	Open	Closed	Weighted Total
2017	16	44	55	37.8
2018	5	20	29	17.3
2019	0	0	20	4.0

	(8)	(9) = $1.02^{(8)}$	(10) = (9)×1,700.00	(11) = (7)(10)
Calendar Year	Trending Period in Years	Trend to CY 2017	Trended Average ULAE	Estimated Unpaid ULAE (000)
2017	1	1.020	1,734	65,545
2018	2	1.040	1,768	30,586
2019	3	1.061	1,804	7,216
Total				103,347

9. 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 16.

Commentary on Question:

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

Solution:

(a) Evaluate the appropriateness of this new exposure base.

(i) It is based on self-evaluations

It is likely not appropriate since it would be subject to manipulation.

(ii) The evaluations are mailed in by the insureds along with application

It is likely not appropriate since it would not be simple to compile.

(iii) It is not currently used in industry

It is recommended to consider any preexisting exposure base used in the industry, but this does not mean this is a positive or negative toward using as an exposure base.

(iv) It is well correlated with the risk being insured

It is likely appropriate since it would accurately reflect the exposure to loss.

(b) Identify three situations where the expected method is frequently used for projecting ultimate claims.

Any three of the following are acceptable:

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

9. Continued

(c) Calculate the expected claims for 2012 using the expected method with the following approaches:

(i) Claim ratio

(ii) Pure premium

Trend factor is $1.02^4 = 1.0824$
Tort reform factor for 2012 is 0.75

Expected claim ratio approach:
(selected expected claim ratio for 2012)×(premium on-level factor for 2012)×(2012 earned premium) / (trend factor × tort reform factor)
= (0.80 × (1 – 0.2×0.3) × 40,000,000) / (1.0824 × 0.75) = 37,053,461

Pure premium approach:
(selected pure premium for 2012)×(earned vehicles for 2012) / (trend factor × tort reform factor)
= (200 × 150,000) / (1.0824 × 0.75) = 36,954,915

10. **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 the following:

(i) Claims-made policy

(ii) Occurrence policy

(iii) Tail policy

(iv) Nose coverage

(i) Claims-made coverage provides protection for those events that occur during the policy year and are reported during that policy year.

(ii) Occurrence policies provide financial protection for insured events that occur during the policy term, regardless of when the events are reported to the insurer.

(iii) A tail policy covers claims that occur during a period when claims-made coverage is in effect but reported after a claims-made policy has expired.

(iv) A nose policy is often purchased when switching insurers. It covers claims that are reported in the current period but occurred when a previous claims-made policy was in effect.

10. Continued

(b) Explain two scenarios where claims-made policies are preferable over occurrence policies for insurers.

When there is a sudden, unpredictable change in the underlying trend, claims-made policies priced on the basis of the prior trend will be closer to the correct price than occurrence policies priced the same way.

When there is a sudden unexpected shift in reporting pattern, the cost of mature claims-made coverage will be affected very little relative to occurrence coverage.

(c) Describe the risk of reserve inadequacy for claims-made policies relative to occurrence policies.

Claims-made policies incur no liability for IBNR claims so the risk of reserve inadequacy is greatly reduced.

(d) Describe which policy is likely to cost more and under what condition.

The occurrence policy is likely to cost more. This assumes claim costs are increasing.

(e) An incident occurring on November 7, 2017, reported on August 12, 2019.

The claim would not be covered by either policy.

(f) An incident occurring on June 16, 2018, reported on October 28, 2019.

The claim would not be covered by the claims-made policy A but would be covered by occurrence policy B.

11. 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:

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

Commentary on Question:

This question tests the candidate's understanding of the expenses for ratemaking and basic ratemaking.

Solution:

(a) Calculate the total variable expense ratio for each calendar year.

	(1)	(2)	(3)	(4)	(5)
Calendar Year	Earned Exposures	Direct Written Premium	Direct Earned Premiums	Total Commission Expenses and Premium Taxes	General Expenses
2014	20.0	10,400	10,200	1,352	1,530
2015	21.0	10,800	10,600	1,318	1,547
2016	22.8	11,400	11,200	1,312	1,710

	(6) = (5)×70%	(7) = (6) / (3)	(8) = (4) / (2)	(9) = (7)+(8)
	General Expenses		Commission and	
Calendar Year	Variable	As a % of Premiums	Premium Tax Expense Ratio	Total Variable Expense Ratio
2014	1,071	10.50%	13.00%	23.50%
2015	1,083	10.22%	12.20%	22.42%
2016	1,197	10.69%	11.51%	22.20%

11. Continued

(b) Recommend the total variable expense ratio to use in ratemaking. Justify your recommendation.

Calendar Year	Variable General Expense Ratio	Commission and Premium Tax Expense Ratio	Total Variable Expense Ratio
2014	10.50%	13.00%	23.50%
2015	10.22%	12.20%	22.42%
2016	10.69%	11.51%	22.20%
Average	10.47%	12.24%	22.71%
Recommendation:	10.50%	11.50%	22.00%

Justification:

- Recommend variable general expense ratio of 10.5% (reasonably close to average as there is no distinct trend and no outliers)
- Recommend commission and premium tax expense ratio of 11.5% (recognize the decreasing ratios)

(c) Recommend the fixed expense per exposure to use in ratemaking. Justify your recommendation.

	(10) = (5)×30%	(11) = (10)/(1)
Calendar Year	Fixed General Expense (000)	Fixed General Expense Per Exposure
2014	459.0	22.95
2015	464.1	22.10
2016	513.0	22.50
Average		22.52
Recommendation:		22.50

Provision for new system = 960,000/24,000/5 = 8 (amortize over 5 years)

Total = 22.50 + 8 = 30.50

11. Continued

(d) Calculate the indicated rate.

ULAE = 8% (9% historical, less the 1% expected reduction from the new system)

Indicated rate (using formula 31.1):

$$R_I = \frac{PP + F}{1 - V - Q} = \frac{1{,}000 \times 1.08 + 30.50}{1 - 0.22 - 0.05} = 1{,}521$$

(e) Explain why allocating ULAE based on counts may not be appropriate for pricing purposes.

It fails to recognize the relative complexity of different types of claims and may, for example, result in more ULAE being allocated to lines of business with high severities, regardless whether they are easier or more difficult to adjust.

12. Learning Objectives:

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

Learning Outcomes:

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

Sources:

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

Commentary on Question:

This question 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) Calculate the average case estimate triangle.

Accident	Case Reserves = Reported – Paid		
Year	12	24	36
2014	20,000	20,300	20,000
2015	21,700	43,100	
2016	51,900		

Accident	Open Counts = Reported Counts – Closed Count		
Year	12	24	36
2014	200	190	100
2015	210	190	
2016	210		

Accident	Average Case Estimate = Case Reserves / Open Counts		
Year	12	24	36
2014	100.00	106.84	200.00
2015	103.33	226.84	
2016	247.14		

(b) Explain why the triangle in part (a) indicates reducing, increasing or stable case reserve adequacy.

The last diagonal is higher, suggesting increasing case reserve adequacy.

12. Continued

(c) Calculate ultimate claims for all accident years using the reported development method, with a Berquist-Sherman adjustment.

Accident	Adjusted Average Case		
Year	12	24	36
2014	228.49	218.12	200.00
2015	237.63	226.84	
2016	247.14		

The most recent diagonal, trended backwards at 4%; e.g.,
247.14/1.04 = 237.63

Accident	Adjusted Case Estimates = Open Counts × Adjusted Average Case		
Year	12	24	36
2014	45,698	41,443	20,000
2015	49,902	43,100	
2016	51,899		

Accident	Adjusted Reported Claims = Paid Claims + Adjusted Case Estimates		
Year	12	24	36
2014	77,498	93,443	102,500
2015	83,902	98,800	
2016	88,299		

Accident	Development Factors	
Year	12-24	24-36
2014	1.206	1.097
2015	1.178	
Average:	1.192	1.097

Ultimate Claims:
2014 = 102,500 (no development after 36 months)
2015 = 98,800×1.097 = 108,384
2016 = 88,299×1.192×1.097 = 115,462

13. 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:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 25.

Commentary on Question:

This question tests the candidate's understanding of claim trend analysis.

Solution:

(a) Calculate the annual change in average severity from 2015 to 2016.

Claim #	Accident Year	(1) Ground Up Claim Evaluated at December 31, 2016
1	2015	560
2	2015	1,300
3	2015	800
4	2016	950
5	2016	1,500

			(2)	(3) = (1)/(2)	
			Counts	Severity	Annual Change in Severity
	2015	2,660	3	886.67	
	2016	2,450	2	1,225.00	38.2%

13. Continued

(b) Calculate the annual change in average severity following the January 1, 2017 changes.

Claim #	Accident Year	(1) Adjusted Claim Evaluated at December 31, 2015
1	2015	460
2	2015	1,000
3	2015	700
4	2016	850
5	2016	1,000

		(2)	(3) = (1)/(2)	
		Counts	Severity	Annual Change in Severity
2015	2,160	3	720.00	
2016	1,850	2	925.00	28.5%

e.g., Adjustment for claim #2: Minimum[(1,300 – 100),(1,000)] = 1,000

(c) Identify three considerations to use when recommending an annual claim severity trend for this company's business.

Any three of the following are acceptable:

- The company's data is very small and the company only start writing this business in 2014.
- The pure premium trend between industry recommended and your study are very different.
- There is tort reform in 2014 and can have major impact for the trend and the historical industry data may not reflect this, so it may over-state the trend.
- The company is a small regional company so the industry data may not be suitable for the company as the data is driven by a big national account.
- Consider geographic mix of industry data.
- Mix of business (i.e., different limits and deductibles).
- There may be large or catastrophe claims.

13. Continued

(d) Explain the difference between development and trend.

Development adjusts claims that occurred during the experience period to an ultimate value.

Trend adjusts the ultimate value of claims in the experience period to the dollar level in the future rating period.

14. Learning Objectives:

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

Learning Outcomes:

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

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 23 and 24.

Commentary on Question:

This question tests the determination of claim liabilities and premium liabilities.

Solution:

(a) Calculate total unpaid claims as of December 31, 2016, including unpaid ULAE.

Case reserve: Reported claims – paid claims = 112,600 – 91,000 = 21,600
IBNR: Ultimate claims – reported claims = 123,700 – 112,600 = 11,100
ULAE Case: Case reserve × ULAE ratio × ULAE multiplier = 21,600 × 0.06 × 0.50 = 648
ULAE IBNR: IBNR × ULAE Ratio = 11,100 × 0.06 = 666
Total = 34,014

(b) Calculate the on-level claim ratio excluding ULAE for each accident year.

Accident Year	(1) Earned Premium	(2) Earned Rate Level	(3) = 1.25/(2) Premium On-Level Factor	(4) = (1)(3) On-Level Earned Premium	(5) Claims	(6) = (5)/(4) On-Level Claim Ratio
2014	51,900	1.000	1.250	64,875	37,800	58.3%
2015	57,400	1.125	1.111	63,771	41,100	64.4%
2016	63,100	1.250	1.000	63,100	44,800	71.0%

Note: (2) Earned rate level for 2015 = 0.5×1.0 + 0.5×1.25 = 1.125

14. Continued

(c) Recommend a claim ratio excluding ULAE to use for estimating expected claims for the unearned policy period as of December 31, 2016. Justify your recommendation.

Commentary on Question:
Other answers are acceptable, as long as consideration is given toward the increasing trend.

Recommend latest year, 71.0% to give consideration toward the increasing trend.

(d) Calculate premium liabilities as of December 31, 2016.

Unearned premium reserve (UPR) = 64,200/2	32,100
Expected Claims = (UPR)(Claim Ratio) = 32,100×71.0%	22,791
ULAE = (Expected Claims)(ULAE ratio) = 22,791×6%	1,367
Maintenance expenses = 32,100×12%×25%	963
Premium Liabilities (sum of expected claims, ULAE and maintenance expenses)	25,121

(e) Explain how this new information is likely to affect the calculations as of December 31, 2016 for:

(i) Claim liabilities

(ii) Premium liabilities

(i) To the extent that IBNR as of December 31, 2016 relates to unreported claims expected to be reported after February 1, 2017, it will increase by 20%.

(ii) The expected claims ratio would have to be increased to allow for higher amounts on claims reported after February 1, 2017.

15. 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.
(5e) Demonstrate the use of credibility in ratemaking.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 30.

Commentary on Question:

This question tests the candidate's understanding of loadings for large claims by analyzing claims at various limits.

Solution:

(a) Describe two considerations in selecting a credibility factor.

The quality of the underlying data of the insurer as well as that of the other information that is used for the balance of credibility.

The variability observed in the insurer's experience as well as that of the other information.

15. Continued

(b) Calculate the loadings for 100,000 to total limits for each accident year.

Severity trend for 100,000 limit = 5.40%×0.60 + 4.90%×0.40 = 5.20%
Severity trend for total limit = 6.10%×0.50 + 5.70%×0.50 = 5.90%

			(1)	(2) = $1.052^{(1)}$	(3) = $1.059^{(1)}$
	Average Accident Date			Severity Trend at:	
Accident Year	Experience Period	Forecast Period	Trend Period (years)	5.20%	5.90%
2014	July 1, 2014	July 1, 2018	4	1.225	1.258
2015	July 1, 2015	July 1, 2018	3	1.164	1.188
2016	July 1, 2016	July 1, 2018	2	1.107	1.121

	(4)	(5)	(6) = (5) / (4)	(7)	(8) = (6)(7)
	Trended Claims at				
Accident Year	1,000,000 Limit	Total Limit	Loading for 1,000,000 to Total Limit	Loading for 100,000 to 1,000,000 Limit	Loading for 100,000 to Total Limit
2014	4,778	5,032	1.053	1.371	1.444
2015	5,587	5,762	1.031	1.522	1.569
2016	5,646	5,773	1.022	1.514	1.547

Notes: (4) = (2)(Ultimate claims at 1,000,000 Limit)
(5) = (4)(Ultimate claims at Total Limit)

(c) Recommend a loading for 100,000 to total limits for ratemaking purposes. Justify your recommendation.

Recommendation: Average of 2015 & 2016 = 1.558
Justification: Accident year 2014 loading is much lower than 2015 and 2016. Therefore, use the most recent 2 years as it is more stable and it uses the most recent data.

(d) Explain the effect of using a pure premium trend rather than a severity trend in your part (b) calculation.

Limiting claims to remove the effect of large claims does not affect the frequency of claims on a given portfolio; capping only affects the severities. Therefore, using pure premium trend would have overstated the large claim loading.

15. Continued

(e) Describe an alternative approach that accounts for the effect of large claims in a ratemaking analysis.

An alternative approach could be to completely segregate claims greater than the selected threshold from all other claims. Under this approach, actuaries would conduct separate analysis for claims that are less than the selected threshold and for claims that are greater than that value.

16. Learning Objectives:

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

Learning Outcomes:

(4c) Choose trend rates and calculate trend factors for claims.

(4d) Describe the influences on exposures and premiums of changes in deductibles, changes in policy limits, and changes in mix of business.

Sources:

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

Commentary on Question:

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

Solution:

(a) List four changes that premium trend would capture.

- changes in the mix of business
- changes in rating plan and rating rules
- changes in the rating algorithm
- inflationary changes (e.g., amount of ins for property covers)

(b) Evaluate each of the following for use as an exposure base for SuperFun:

(i) Number of hotels
(ii) Revenue

(i) Number of hotels:
Liability risk would vary with the number of hotels so this would be a good exposure base.

(ii) Revenue:
Liability risk would vary with number of hotels which would essentially be reflected in revenue.

16. Continued

(c) Calculate program year 2013 earned exposures trended to the policy period that begins January 1, 2017.

Average earned date in experience period (average from April 1, 2013 to December 31, 2013) = August 15, 2013
Average earned date in forecast period = July 1, 2017
Trending period = 46.5 months, or 3.875 years

Program Period	Revenue (millions)	Annual Change
Apr. 1, 2013 – Dec. 31, 2013	6,450	
Jan. 1, 2014 – Dec. 31, 2014	9,000	Note: 2013 a partial year
Jan. 1, 2015 – Dec. 31, 2015	9,500	5.6%
Jan. 1, 2016 – Dec. 31, 2016	10,010	5.4%
	Selected trend:	5.5%

2013 Trended exposures = $6{,}450 \times (1 + 5.5\%)^{3.875} = 7{,}937$

(d) Recommend an annual premium trend for the new automobile policy, and justify your recommendation.

Experience Period	Written Vehicles	Written Premium	Average Written Premium	Annual Change
2012	2,410	480,000	199	
2013	2,580	542,000	210	5.5%
2014	2,630	563,000	214	1.9%
2015	2,740	598,000	218	2.0%
2016	2,790	612,000	219	0.5%

Recommendation = 1.5%, based on the average of 2014 through 2016 as 2013 appears to be an outlier.

17. 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.

(3c) Describe the components of claim liabilities in the context of financial reporting.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 14 and 23.

Commentary on Question:

This question tests the candidate's understanding of the development method of estimating ultimate claims as well as estimating claim liabilities.

Solution:

(a) Calculate the estimated ultimate claims for all accident years, using the reported development method with the original Bondy method for the tail factor.

	Cumulative Reported Claims			
Accident Year	12	24	36	48
2013	17,800	25,000	31,700	32,800
2014	19,400	28,000	34,700	
2015	22,000	31,500		
2016	24,300			

	Development Factors		
Accident Year	12-24	24-36	36-48
2013	1.404	1.268	1.035
2014	1.443	1.239	
2015	1.432		
Average	1.427	1.254	1.035
Bondy tail factor	1.035		

	12-24	24-36	36-48	48-ultimate
Age-to-age factors	1.427	1.254	1.035	1.035
Age-to-ultimate factors	1.916	1.343	1.071	1.035

17. Continued

Ultimate claims:
Accident year 2014: 34,700 × 1.071 = 37,164
Accident year 2016: 24,300 × 1.916 = 46,559

(b) Calculate the accident year 2014 case estimate, IBNR, and total claim liability.

Estimated ultimate claims from part (a): 37,164
Case estimate = Reported claims – Paid to date = 34,700 – 27,000 = 7,700
IBNR = Ultimate claims – Reported claims = 37,164 – 34,700 = 2,464
Total claim liability = Case estimate + IBNR = 7,700 + 2,464 = 10,164

(c) State two assumptions underlying the algebraic method of estimating a paid tail factor.

Any two of the following are acceptable:
- Paid claim and reported claim development estimates of reported claims are estimating the same quantity
- The reported claim estimate of the ultimate claims for the oldest year is accurate
- The other years will show the same development in the tail as the oldest year

(d) Calculate the indicated paid claims tail factor for accident year 2014 using Boor's algebraic method with the results from part (a).

Estimated ultimate claims from part (a) = 37,164
Estimated claims (using paid) at 48 months = 27,000 × 1.30 = 35,100
Indicated tail factor = 37,164 / 35,100 = 1.06

(e) Calculate the ultimate claims for this accident year using a large claim adjustment.

12-Ult factor = 1.916
With adjustment: (24,300 – 6,000) × 1.916 + 6,000 = 41,063

(f) State an assumption underlying the approach in part (e).

Any one of the following is acceptable:
- Case estimate developed by claims adjuster is the best estimate of the large claim
- An actuarial based estimate is not appropriate for the large claim
- It assumes there is no more development on the large claim

18. Learning Objectives:

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

Learning Outcomes:

(7a) Describe the structure of catastrophe models.

Sources:

Catastrophe Modeling: A New Approach to Managing Risk, Grossi, P. and Kunreuther, H., Chapter 2.

Commentary on Question:

This question tests the candidate's understanding of catastrophe modeling.

Solution:

(a) Explain why the hurricane coverage product line has higher risk than the automobile product line with respect to each of the following risk characteristics:

(i) Availability of data
(ii) Uncertainty of loss
(iii) Correlation between claims
(iv) Insurer capacity

(i) Availability of data – Less data will be available due to lower frequency.
(ii) Uncertainty of loss – Hurricane coverage has more variability (uncertainty) because it is a higher severity coverage.
(iii) Correlation between claims – Auto claims are largely uncorrelated while catastrophe claims are correlated due to concentration.
(iv) Insurer capacity – Due to the correlation between claims, catastrophe coverages are more likely to threaten insurer capacity.

(b) Explain the relationship between insurer capacity and customer demand with respect to catastrophe coverages.

Catastrophe coverages are subject to large correlated losses. These losses can result in reduced capacity if the losses cause insurer insolvencies. The insolvencies, as well as heightened customer awareness following a large industry loss, can increase the demand for insurance further constraining capacity.

18. Continued

(c) Define survival constraint.

The survival constraint states that pricing and selling decisions require that the probability of insolvency be less than a specified amount (the constraint).

(d) Explain how an exceedance probability curve can be used as a tool in assessing an insurer's survival constraint.

The insurer can use an exceedance probability curve to examine the probability that losses exceed a certain amount.

(e) Identify one regulatory constraint that could threaten an insurer's survival constraint.

Any one of the following is acceptable:
- Requirement to offer coverage
- Regulatory cap on rates

(f) State two actions CIC may be able to take to meet the survival constraint when offering hurricane coverage.

Any two of the following are acceptable:
- Sell more policies
- Decrease the coverage (e.g., lower limits, higher deductibles)
- Increase the premium
- Transfer some of the risk to others

19. Learning Objectives:

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

Learning Outcomes:

(2a) Use loss development triangles for investigative testing.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 13.

Commentary on Question:

This question tests the investigation of the paid claims to reported claims triangle as well other data triangles that can be used for investigative testing.

Solution:

(a) Provide three reasons an actuary might use a triangle of ratios of paid claims to reported claims for investigative testing.

Any three of the following are acceptable:

- Evaluate whether or not there is consistency at each maturity
- Ratios are not expected to change materially from one accident year to another (i.e., looking down the values in each column)
- To determine if there is a reasonable progression of ratios from one development age to the next (i.e., looking across the rows)
- Identify patterns of increasing or decreasing ratios and outliers for further investigation

(b) Identify two possible anomalies apparent in this triangle that may need further investigation.

1. Accident year 2011, development 48 months seems to be an outlier.
2. The ratios are increasing down the columns (development periods 12, 24 and 36).

(c) Provide a possible explanation for each anomaly identified in part (b).

Commentary on Question:

The explanation must match the anomalies from part (b).

1. This is due to either a data error or a large claim that was paid, or there was a significant change in a case estimate.
2. There is a possible increasing claim settlement pattern.

19. Continued

(d) Explain a limitation when using a triangle of ratios of paid claims to reported claims.

Changes in the settlement of claims, which could affect the numerator, can be offset by changes in claim processes related to case estimates, which could affect the denominator.

(e) Describe two additional triangles that could be used for investigative testing.

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

- Average reported claims: in a stable environment, expect changes down the column to be consistent with trend
- Ratios of closed to reported counts: used in conjunction with the ratios of paid to reported claims to determine if similar patterns exist between the counts and amounts
- Ratios of counts closed with no payment to closed counts: stable ratios down each column typically indicate stability in claims settlement processes
- Average paid claims: compare to average reported to see whether large increases are due to large claims or by case estimates
- Average case estimates: used to determine whether or not there have been changes in the overall adequacy of case estimates during the experience period