GIRR Model Solutions
Fall 2022

1. Learning Objectives:

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

Learning Outcomes:

(6m) Describe key considerations in the analysis of deductible factors and increased limits factors.
(6n) Calculate deductible factors and increased limits factors.
(6o) Explain coinsurance and coinsurance penalties.
(6p) Analyze coinsurance formulas to calculate the amount retained by the insured and paid by the insurer given various scenarios of coinsurance requirements, amounts insured, and covered losses.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of deductibles and coinsurance used in property insurance.

Solution:

(a) Calculate the losses retained by the garage owner under each of the following deductible scenarios:

(i) Straight deductible of 500 per vehicle

(ii) Deductible of 20% of the garage owner's liability

(iii) Diminishing deductible per event where:

- The garage owner would fully retain any losses less than 50,000,
- The insurer would pay the total value of any covered loss greater than 100,000, and
- Losses with a total value between 50,000 and 100,000 would be proportionately shared between the garage owner and the insurer.

1. Continued

Total amount of loss = 80×1,000 = 80,000

(i) Amount retained = 80×500 = 40,000

(ii) Amount retained = 80×1,000×0.2 = 16,000

(iii) Multiplier = 100,000 / (100,000 – 50,000) = 2
Amount paid by insurer = (80,000 – 50,000)×2 = 60,000
Therefore, retained amount = 80,000 – 60,000 = 20,000

(b) State one advantage of a deductible from an insurer's perspective.

Any one of the following is acceptable:
- Moral and morale hazard
- Risk control
- Processing costs associated with small claims
- Exposure to catastrophic events

(c) Calculate the claims paid by the insurer under each of the following scenarios:

(i) The insured purchased coverage of 200,000 with a 50% coinsurance requirement.

(ii) The insured purchased coverage of 500,000 with an 80% coinsurance requirement.

(iii) The insured purchased coverage of 750,000 with a 90% coinsurance requirement.

	(1)	(2)	(3)	(4)	(5)
Scenario	Amount Purchased	Coinsurance Percentage	Amount of Insurance Required	Coinsurance Penalty Percentage	Amount Paid by Insured
(i)	200,000	50%	400,000	50.000%	200,000
(ii)	500,000	80%	640,000	21.875%	351,563
(iii)	750,000	90%	720,000	0.000%	450,000

Notes: (3) = 800,000×(2)
(4) = max{[1 – (1) / (3)],0}
(5) = min[(1 – (2))×450,000, (1)]

1. Continued

(d) State one reason why insurers favor including a coinsurance requirement in property policies.

Any one of the following is acceptable:

- Coinsurance is a technique used by insurers to limit their liability and assist insureds in managing their costs of coverage (or sharing the risk with the insureds).
- Essentially, coinsurance is used to motivate insureds to purchase the appropriate amount of insurance (close to full coverage) and to penalize those that do not.

2. Learning Objectives:

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

Learning Outcomes:

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

Sources:

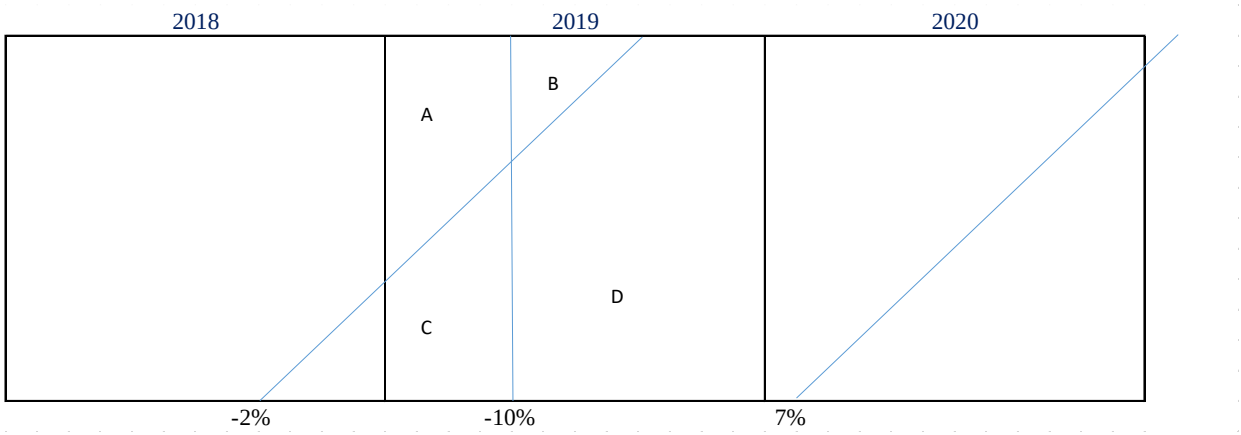
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 12.

Commentary on Question:

This question tests the candidate's ability to adjust premium to current rate levels for ratemaking purposes. Candidates generally did well with the calculations.

Solution:

(a) Calculate the 2019 earned premium adjusted to current rate levels for ratemaking purposes.



Area	Rate Level Index	% Earned in 2019
A	1.05	1/2×4/12 = 16.67%
B	1.05×0.9 = 0.945	1/2×4/12×4/12 = 5.56%
C	1.05×0.98 = 1.029	1/2×4/12 = 16.67%
D	1.05×0.98×0.9 = 0.9261	100% – 16.67% – 5.56% – 16.67% = 61.11%

Weighted average rate level in CY 2019 = 1.05×16.67% + … + 0.9261×61.11%
= 0.9650

Current rate level = 1.05×0.98×1.07×1.03×0.9 = 1.0207

On-level factor = 1.0207 / 0.9650 = 1.0577

CY 2019 earned premium at current rate level for ratemaking purposes:
= 1,400,000×1.0577 = 1,480,819

2. Continued

(b) Explain why the answer to part (a) would be higher if all policies were six-month policies instead of twelve-month policies.

Commentary on Question:
Candidates need to provide the explanation for credit. Candidates struggled to fully explain the impacts from the given changes.

- With all policies being 6-month policies, more of the area of 2019 would be at lower rates (lower % at rate level 1.05, higher % at rate level 0.9261).
- Therefore, the average rate level in 2019 should be lower.
- The current rate level remains unchanged.
- Therefore, the on-level factor would be higher than the value from part (a).

(c) Explain what affect this change would have on the on-level calculation from part (a).

The average premium would increase to reflect such a change but would expect claims would increase as policyholders would receive more coverage. Therefore, expect no change to the on-level calculation.

3. Learning Objectives:

1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.

Learning Outcomes:

(1q) Understand the types of reinsurance and key reinsurance terms.
(1r) Explain the principal functions of reinsurance.
(1s) Analyze and describe the types of reinsurance.

Sources:

Fundamentals of General Insurance Actuarial Analysis 2019 Supplement, J. Friedland, Appendix H.

Commentary on Question:

This question tests the candidate's understanding of reinsurance contracts.

Solution:

(a) be three reasons why an insurer might purchase reinsurance coverage.

Any three of the following are acceptable:

- Increase capacity by passing off risk the insurer is unable or unwilling to retain
- Covers catastrophes that could threaten its earnings and threaten solvency
- Stabilize claims experience by limiting liability due to single claim / multiple claims/ all claims over a period
- Pass on reinsurer technical services and expertise
- Facilitate withdrawal from a market segment by using portfolio insurance

(b) Demonstrate how a reinsurance agreement with a 80% to 90% loss ratio corridor would operate.

Commentary on Question:

Alternative retention assumptions are possible.

Using an example where 100% is retained:

- If the ceded loss ratio is less than 80%, all claims are ceded to the reinsurer.
- If the ceded loss ratio is between 80% and 90%, claims up to 80% would be ceded and claims in the layer excess of 80% would be retained by the primary insurer.
- If the ceded loss ratio is greater than or equal to 90%, claims up to 80% would be ceded, claims in the layer 10% excess of 80% would be retained by the primary insurer, and claims excess 90% would be ceded to the reinsurer.

3. Continued

(c) Calculate the amount paid by I and R for each claim.

Claim Number	(1) Ultimate Claims	(2) I (before AAD)	(3) Amount Paid by I (considering AAD)	(4) = (1) – (3) Amount Paid by R
1	5,500,000	3,000,000	3,000,000	2,500,000
2	2,000,000	2,000,000	2,000,000	0
3	4,500,000	3,000,000	3,000,000	1,500,000
4	7,000,000	3,000,000	2,000,000	5,000,000
5	4,000,000	3,000,000	0	4,000,000

Notes: (2) = Amount of claim less than 3 million plus amount of claim exceeding 5 million

(3) = Cap at 10 million annual aggregate deductible

e.g., Claim #4 capped at 1,500,000 since 3,500,000 + 2,000,000 + 3,000,000 + 1,500,000 = 10,000,000

4. Learning Objectives:

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

Learning Outcomes:

(3k) Estimate ultimate claims by layer using common methods.

(3l) Understand the differences in development patterns and trends for various claim layers.

Sources:

Fundamentals of General Insurance Actuarial Analysis 2019 Supplement, J. Friedland, Appendix I.

Commentary on Question:

This question tests the calculation of claims excess of a limit using various methods.

Solution:

(a) Calculate the ultimate claims for AY 2021 in the layer 500,000 excess of 500,000 using each of the following approaches:

(i) Selected development factors

(ii) Theoretical development factors based upon Siewert's formulas

(iii) Industry ILFs

(i)

	Reported Claims	CDF	Ultimate Claims
1M Limit	4,614,775	2.356	10,870,414
500 Limit	4,520,083	2.298	10,387,785
500 Excess of 500	94,692		482,630

e.g., $2.356 = 1.728 \times 1.153 \times 1.090 \times 1.049 \times 1.034$

$10{,}870{,}414 = 4{,}614{,}775 \times 1.728$

$482{,}630 = 10{,}870{,}414 - 10{,}387{,}785$

4. Continued

(ii)

	Reported Claims	CDF	Ultimate Claims
Unlimited (i.e., 2M)		2.482	
1M Limit	4,614,775	2.216	10,225,743
500 Limit	4,520,083	2.121	9,588,423
500 Excess of 500	94,692		637,320

e.g., $2.216 = 2.482 \times 0.850/0.952$
$10,225,743 = 4,614,775 \times 2.216$
$637,320 = 10,225,743 - 9,588,423$

(iii)

	ILF	Ultimate Claims
1M Limit	1.075	11,166,869
500 Limit	1.000	10,387,785
500 Excess of 500		779,084

e.g., $11,166,869 = 10,387,785 \times 1.075$
$779,084 = 11,166,869 - 10,387,785$

(b) Calculate ILFs for 2,000,000 and 1,000,000, assuming a basic limit of 500,000, using each of the following approaches:

(i) Selected development factors

(ii) Theoretical development factors based upon Siewert's formulas

	Reported Claims	Ultimate Claims (i)	Ultimate Claims (ii)	ILF (i)	ILF (ii)
2M Limit	4,912,320	12,191,272	12,191,272	1.174	1.271
1M Limit	4,614,775	10,870,414	10,225,743	1.046	1.066
500 Limit	4,520,083	10,387,785	9,588,423		

e.g., $1.174 = 12,191,272 / 10,387,785$
$1.271 = 12,191,272 / 9,588,423$

5. Learning Objectives:

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

Learning Outcomes:

(6d) Quantify different types of expenses required for ratemaking including expense trending procedures.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of expenses used in ratemaking.

Solution:

(a) Calculate the historical annual trend in fixed expenses.

Calendar Year	Fixed Expense per On-Level Earned Premium	Change in Fixed Expense per On-Level Earned Premium
2016	3.110%	
2017	3.216%	3.420%
2018	3.320%	3.220%
2019	3.423%	3.120%
2020	3.526%	2.981%
2021	3.632%	3.020%

e.g., for 2019:

- 3.423% = 684,470 / 19,993,320
- 3.120% = 3.423% / 3.320% – 1

(b) Recommend the annual fixed expense trend. Justify your recommendation.

Commentary on Question:

Other recommendations are acceptable with appropriate justification.

Average all years:	3.15%
Average most recent 3 years:	3.04%
Recommendation:	3.04%

Justification: There is a clear decreasing trend rate so give more weight to more recent years and select the average of the latest 3 years.

5. Continued

(c) Calculate the fixed expense ratio to be used in ratemaking, using a simple average from calendar years 2019, 2020 and 2021.

Average incurred date in rating period: June 1, 2024 (i.e., 12 months after effective date)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Average Incurred Date						
Calendar Year	Experience Period	Forecast Period	Trend Period (months)	Expense Trend Factors	Trended Fixed Expenses	Trended On-Level Earned Premiums	Fixed Expense per On-Level Earned Premiums
2019	July 1, 2019	June 1, 2024	59	1.1586	793,049	20,995,763	3.78%
2020	July 1, 2020	June 1, 2024	47	1.1244	825,626	21,654,218	3.81%
2021	July 1, 2021	June 1, 2024	35	1.0913	864,682	22,458,417	3.85%
					Average		3.81%

Notes:

(3) = number of months from (1) to (2)
(4) = $1.0304^{(3)/12}$
(5) = (4)×(Trended Fixed Expenses)
(6) = (Earned Premiums at Current Rate Level)×$1.01^{(3)/12}$
(7) = (5) / (6)

6. Learning Objectives:

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

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

Learning Outcomes:

(3g) Estimate ultimate values using the methods cited in (3e).
(3j) Evaluate and justify selections of ultimate values based on the methods cited in (3e).
(6b) Identify the different types of rate regulatory approaches for general insurance.
(6c) Describe the purpose of base rates and rating factors and explain how they are used to determine an insured's premium.
(6d) Quantify different types of expenses required for ratemaking including expense trending procedures.

Sources:

Fundamentals of General Insurance Actuarial Analysis, Second Edition (2022), J. Friedland, Chapters 16, 17, 18, 20, 22, and 26.

Commentary on Question:

This question tests the candidate's understanding of estimating ultimate claims using the frequency severity method, the expected method and the Bornhuetter Ferguson method. This question also tests the candidate's ability to estimate reported claims with an adjustment for case outstanding strengthening.

Solution:

(a) Calculate ultimate claims using the development-based frequency-severity method.

	(1)	(2)	(3) = (2)/(1)	(4)	(5) = (3)(4)	(6)
Accident Year	Earned Exposures	Ultimate Counts	Reported Frequency	Frequency Trend @ 1%	Trended Frequency	Calculated Ultimate Counts
2015	11,090	1,230	0.11091	1.06152	0.11773	1,234
2016	11,250	1,270	0.11289	1.05101	0.11865	1,264
2017	11,460	1,305	0.11387	1.04060	0.11850	1,300
2018	11,770	1,349	0.11461	1.03030	0.11809	1,349
2019	12,070	1,381	0.11442	1.02010	0.11672	1,397
2020	12,360	1,447	0.11707	1.01000	0.11824	1,445
2021	12,480	1,480	0.11859	1.00000	0.11859	1,474
			Average (all years)		0.11807	

6. Continued

Selected frequency: 0.11807
Rationale: no outliers and no significant trend, so simple average is reasonable.
(6) = 0.11807×(1)/(4)

Accident Year	(7) Ultimate Severity	(8) Severity Trend @ 6.5%	(9) = (7)(8) Trended Severity	(10) Calculated Ultimate Severity	(11) = (6)(10) Projected Ultimate Claims
2015	4,349	1.45914	6,345.81	4,502	5,552,843
2016	4,666	1.37009	6,392.82	4,794	6,059,090
2017	5,002	1.28647	6,434.90	5,106	6,639,119
2018	5,358	1.20795	6,472.19	5,438	7,334,547
2019	5,881	1.13423	6,670.38	5,791	8,090,495
2020	6,314	1.06500	6,724.41	6,167	8,911,632
2021	6,540	1.00000	6,540.00	6,568	9,678,863
	Average (all years)		6,511.50		52,266,590
	Average (latest 5 years)		6,568.38		

Selected severity: 6,568.38
Rationale: there has been an increase in the more recent years, so use average of latest 5 years.

(10) = 6,568.38/(8)

(b) Construct the reported claims triangle adjusted for the change in case adequacy.

Accident Year	Adjusted Average Case Estimates 12	24	36	48	60	72	84
2015	3,019.21	4,711.60	6,331.08	7,611.32	8,629.94	9,217.78	*7,584.81*
2016	3,215.46	5,017.85	6,742.60	8,106.05	9,190.89	*9,816.94*	
2017	3,424.46	5,344.01	7,180.87	8,632.95	*9,788.30*		
2018	3,647.05	5,691.37	7,647.62	*9,194.09*			
2019	3,884.11	6,061.31	*8,144.72*				
2020	4,136.58	*6,455.30*					
2021	*4,405.45*						

e.g., AY2021 at 12 months: 4,405.45 = (3,175,077 – 1,082,487) / (875 – 400)
AY2019 at 24 months: 6,061.31 = 6,455.30 / 1.065

6. Continued

Accident Year	Adjusted Reported Claims 12	24	36	48	60	72	84
2015	1,930,388	2,761,294	3,589,678	4,284,121	4,884,010	5,284,288	*5,274,875*
2016	2,073,457	3,013,099	3,948,018	4,735,629	5,294,541	*5,763,708*	
2017	2,251,286	3,199,812	4,277,015	5,120,705	*5,759,272*		
2018	2,489,201	3,627,479	4,653,380	*5,558,325*			
2019	2,692,962	3,900,733	*5,107,412*				
2020	2,908,798	*4,364,690*					
2021	*3,175,077*						

e.g., AY2019 at 24 months: 3,900,733 = 6,061.31×(975 – 618) + 1,736,844

(c) Recommend the revised annual claim severity trend. Justify your recommendation.

Commentary on Question:
Other selections are acceptable as long as the justification matches the data.

Accident Year	Ultimate Reported Severities	Year-to-Year Change
2015	4,316.59	
2016	4,561.67	5.68%
2017	4,813.61	5.52%
2018	5,066.25	5.25%
2019	5,441.62	7.41%
2020	5,802.31	6.63%
2021	5,990.39	3.24%
Average all years:		5.62%
Average excluding high & low:		5.77%
Average excluding last year:		6.10%
Recommended:		5.77%

Justification: select average excluding high & low to eliminate the variability.

(d) Explain why you might expect the answer to part (c) to be lower than the original annual severity trend of 6.5%.

Due to the increase in the average case in the most recent diagonal, this will tend to overstate the annual severity trend. By adjusting the historical case estimates for the change, this will increase those values, which will tend to decrease the indicated annual reported severity trend.

6. Continued

(e) Calculate ultimate claims using the ultimate counts provided and ultimate reported severities adjusted for the change in case adequacy.

Accident Year	Ultimate Counts	Ultimate Reported Severities	Ultimate Claims
2015	1,230	4,316.59	5,309,406
2016	1,270	4,561.67	5,793,321
2017	1,305	4,813.61	6,281,761
2018	1,349	5,066.25	6,834,371
2019	1,381	5,441.62	7,514,877
2020	1,447	5,802.31	8,395,943
2021	1,480	5,990.39	8,865,777

e.g., AY2019: 7,514,877 = 1,381×5,441.62

(f) Calculate expected claims for all accident years using the expected method and your recommended annual claim severity trend from part (c). Justify any selections.

Annual claim trend = (1 + 0.01)(1 + 0.0577) – 1 = 6.83%

Accident Year	Claim Trend @6.83%	Trended Pure Premiums Based on Reported	Expected Claims
2015	1.48623	711.54	5,311,155
2016	1.39125	716.44	5,755,608
2017	1.30234	713.87	6,263,319
2018	1.21911	707.89	6,871,912
2019	1.14120	710.52	7,528,174
2020	1.06827	725.66	8,235,350
2021	1.00000	710.40	8,882,995
Average all years (excl. 2021)		714.32	48,848,513
Average (excluding 2020)		711.78	
Selected 2021 level pure premium		711.78	

Justification: 2020 appears to be an outlier, so use average of all years excluding 2020.

e.g., AY2019:

710.52 = 7,514,877×1.14120/12,070

7,528,174 = 711.78×12,070/1.14120

6. Continued

(g) Calculate ultimate claims for all accident years using the Bornhuetter Ferguson method.

Accident Year	(12) Reported Claims	(13): part (e) Ultimate Claims	(14) = (13)/(12) Age-to-Ult Factor	(15): part (f) Expected Claims	(16) = (12) + (15)[1 – 1/(14)] BF Estimate Ultimate Claims
2015	5,274,875	5,309,406	1.00655	5,311,155	5,309,417
2016	5,763,708	5,793,321	1.00514	5,755,608	5,793,128
2017	5,759,272	6,281,761	1.09072	6,263,319	6,280,227
2018	5,558,325	6,834,371	1.22957	6,871,912	6,841,381
2019	5,107,412	7,514,877	1.47137	7,528,174	7,519,137
2020	4,364,690	8,395,943	1.92361	8,235,350	8,318,835
2021	3,175,077	8,865,777	2.79230	8,882,995	8,876,829
					48,938,953

(h) Recommend the selected ultimate claims for accident year 2021 for this line of business. Justify your recommendation.

Recommend using average of part (e), part (f) and part (g) estimates = 8,875,200
Justification:

- Development method (9,678,673) and part (a) estimate (9,678,863) do not adjust for the change in case outstanding, so both are inappropriate.
- Parts (e), (f) and (g) estimates all adjust for the change in case outstanding so are all reasonable methods.
- Recommend the average of all 3 since they are all close in value.

7. Learning Objectives:

1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.

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

Learning Outcomes:

(1j) Describe qualitative information required for actuarial work.
(3c) Identify the types of development triangles that can be used for investigative testing.
(3d) Analyze development triangles for investigative testing.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 5 and 13.

Commentary on Question:

This question tests investigative analysis of various development triangles.

Solution:

(a) Describe two operational changes that could have caused this decrease.

- A change in systems or process for reporting counts could cause a decrease in frequency.
- A change in the definition of claim counts could cause a decrease in frequency.

(b) Describe one external environmental change that could have caused this decrease.

Any one of the following is acceptable:

- Legislative change implementing tort reform which reduces claims filed.
- Court interpretation clarifying (confirming) a coverage exclusion.

(c) Identify a change in pattern in this triangle.

There is a significant decrease along the latest diagonal.

7. Continued

(d) Describe two possible operational changes that could have caused the pattern change identified in part (b).

Commentary on Question:
This part of the question incorrectly referenced part (b) instead of part (c). The following solution relates to reference to the pattern change identified in part (c). Candidates who answered based on part (b) were graded on that basis.

- This could be the result of a decrease from slowing down of the payment of claims (claim settlement).
- Alternatively, it could be a result of increasing from a significant change in case estimates.

(e) Describe an additional test to further investigate the change in pattern identified in part (b).

Commentary on Question:
This part of the question incorrectly referenced part (b) instead of part (c). The following solution relates to reference to the pattern identified in part (c). Candidates who answered based on part (b) were graded on that basis.

Candidates can choose to either refer to the change in claim settlement or the change in case adequacy.

Change in claim settlement could be confirmed by evaluating the ratios of closed to reported counts to see if a similar pattern is evident (i.e., significant decrease along the latest diagonal).

Change in case adequacy could be confirmed by evaluating average case estimates to see if there is a significant increase along the most recent diagonal.

8. Learning Objectives:

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

Learning Outcomes:

(6l) Calculate risk classification 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) Critique your colleague's recommendation.

If the company raises the base rate from 100 to 110, it might be able to achieve breakeven provided the distribution of the portfolio does not change.

However, it is very likely that the lower risks (25 and over and/or female) leave the company while the higher risks (under age 25 and/or male) migrate to the portfolio more, which would decrease the profitability again.

(b) Calculate A_2, S_2, and μ with the single variable risk classification analysis, by setting the base class as "25 and over", "male.".

Age Group (i)	Number of the Insureds	Total Claims	Pure Premium	Relativity (A_i)
25 and over (1)	640	60,000	93.75	1.000
Under 25 (2)	360	50,000	138.89	1.481
Total	1000	110,000	110.00	

Sex (j)	Number of the Insureds	Total Claims	Pure Premium	Relativity (S_j)
Male (1)	720	90,000	125.00	1.000
Female (2)	280	20,000	71.43	0.571
	1000	110,000	110.00	

e.g., A_2: 1.481 = 138.89 / 93.75

Need to solve for: 110,000 = $\mu \sum_i \sum_j X_{ij} A_i S_j$,

where X_{ij} = number of insureds for rating combination i,j

8. Continued

$110{,}000 = \mu \times (480 \times 1.000 \times 1.000 + 160 \times 1.000 \times 0.571 + 240 \times 1.481 \times 1.000 + 120 \times 1.481 \times 0.571)$

Solves for: $\mu = 106.94$

(c) Describe two possible issues, in general, with the use of a single variable risk classification analysis.

Distributional bias:
It occurs when there are differences in the distribution of exposures by risk characteristic between risk classes.

Dependence:
It occurs when knowing the risk class of an insured within one risk characteristic changes the true relativities for the risk classes in another risk characteristic from what they would be without that knowledge.

(d) Describe two approaches that address the issues identified in part (c).

Minimum bias procedure/method:
Solve the multiple non-linear equations with the unknown multiplicative factors iteratively.

Generalized Linear Models (GLMs):
Set a relationship between a response variable and several predictor variables using a linear predictor and an appropriate link function.

(e) Describe this conflict.

Increasing homogeneity of a class typically means a smaller class which may have lower credibility due to smaller size.

or

There is an inverse relationship been credibility and homogeneity.

9. Learning Objectives:

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

Learning Outcomes:

(4h) 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) Calculate the premium deficiency reserve or equity in the unearned premium as of December 31, 2021.

	Gross	Net
Unearned Premium	5,000,000	4,000,000
Expected Claims (unearned premium × expected claims ratio):	3,000,000	2,400,000
ULAE = 3,000,000 × 10%	300,000	300,000
Reinsurance cost = 4,000,000 × 5% (net only)		200,000
General expenses = 5,000,000 × 20% × 25%	250,000	250,000
Premium Liabilities	3,550,000	3,150,000

Equity/(deficiency)= 4,000,000 – 3,150,000 = 850,000

Therefore, there is equity in the unearned premium.

9. Continued

(b) Recalculate the premium deficiency reserve or equity in the unearned premium as of December 31, 2021, incorporating this legislative change.

	Net
Unearned Premium	4,000,000
Expected Claims (unearned premium × expected claims ratio × 1.5):	3,600,000
ULAE = 3,000,000 × 10% × 1.5	450,000
Reinsurance cost = 4,000,000 × 5% (net only)	200,000
General expenses = 5,000,000 × 20% × 25%	250,000
Premium Liabilities	4,500,000

Equity/(deficiency)= 4,000,000 – 4,500,000 = (500,000)
Therefore, there is a premium deficiency reserve.

10. Learning Objectives:

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

Learning Outcomes:

(3j) Evaluate and justify selections of ultimate values based on the methods cited in (3e).

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) Describe two weaknesses in selecting each of the following methods to estimate ultimate claims for these accident years.

(i) Development Method using reported data.

(ii) Generalized Cape Cod Method using reported data.

(i)

- For a long-tailed line, applying large development factors to immature years can create volatile (highly leveraged) estimates.
- Development factors will be distorted by the change in case reserve adequacy.

(ii)

- Responsiveness to claim deterioration is reduced by using expected claims. (i.e., the Generalized Cape Cod (GCC) method is not responsive enough)
- The GCC method still relies on development factors for the expected claim ratio (ECR), but development factors are distorted by change in case adequacy.
- The calculation of the ECR in the GCC method gives more weight to years with more exposure, and more weight to years with maturity. This means more weight will be given to older accident years, which may not reflect the recent claim deterioration.

10. Continued

(b) Evaluate the appropriateness of selecting the Expected Method using reported pure premium data to estimate ultimate claims for the two most recent accident years.

Any two of the following statements is acceptable:

- The expected method is good for immature years.
- Pure premium trend (claim deterioration) can be evaluated and explicitly considered.
- The latest year of data can be ignored in selecting expected claims, so case reserve adequacy does not cause a distortion.

11. Learning Objectives:

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

Learning Outcomes:

(2b) Describe the different types of exposures used for conducting actuarial work.
(2c) Calculate written, earned, in-force and unearned premiums for portfolios of policies with various policy terms and earnings patterns.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of earned and unearned exposures. Candidates generally did well on the calculations but struggled to describe how the concepts apply to different types of policies and coverage.

Solution:

(a) Describe the option(s) for recognizing written exposures on each policy.

Policy number 101 should record written exposure at the initial effective date.

Policy number 102 can record written exposure based on:
- (i) at the initial effective date
- (ii) annual basis only, thus, the total written exposure is divided into equivalent annual values and recorded on the anniversary of the effective date.

(b) Calculate the percentage premium *earned* on December 31, 2021 for policy number 101.

2 months earned by end of year, therefore % earned = 2/6 = 33.3%

(c) Calculate the percentage premium *unearned* on December 31, 2021 for policy number 102.

Date written = July 15, 2021, therefore 5.5 months earned by Dec 31, 2021
Therefore, 24-5.5 = 18.5 months unearned as of Dec. 31, 2021. % unearned = 18.5/24 = 77.1%

11. Continued

(d) Explain why a warranty policy is not likely to have exposures earned evenly throughout the policy term.

- A warranty policy is typically a multi-year policy.
- In warranty coverage, the exposure to claims is often significantly greater in the later years of the policy term than in the early years.
- As a result, a pro rata earning of the premium is not appropriate given that the financial reporting objective is to earn revenue (i.e., premium) in accordance with the delivery of service (i.e., protection for the policyholder from loss).

(e) Describe three types of coverages or policies, other than a warranty policy, where it may not be appropriate to assume premiums are earned evenly throughout the policy term.

Any three of the following are acceptable:

(i) property catastrophe coverage for hurricanes or hail coverage are examples of GI where exposure to claims is concentrated over specific months

(ii) aggregate stop loss coverage has much greater exposure near the end of the policy term rather than during the initial months of coverage

(iii) policies covering seasonal risks like snowmobile coverage have loss concentrated in the winter months

(iv) ocean marine insurance may have cessation of shipping operations for three months

(v) new home warranty policies and policies for product warranties that provide protection for mechanical breakdown or manufacturer defects are typically longer than one year and the exposure to claims is often significantly greater in the later years

(vi) financial and performance guarantee

(vii) retrospectively-rated policies have final premiums determined after the policy expiration, which should be written and earned when it enters the insurer's system

(viii) reinstatement premium may be included within the original premium or may require additional premiums to be paid and can have a distorting effect on earned premium

12. Learning Objectives:

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

Learning Outcomes:

(4a) Describe the key assumptions underlying ratio and count-based methods for estimating unpaid unallocated loss adjustment expenses.

(4b) Estimate unpaid unallocated loss adjustment expenses using ratio and count-based methods.

(4c) Evaluate and justify selections of unpaid unallocated loss adjustment expenses based on ratio and count-based methods.

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) Describe one such special study.

The Wendy Johnson method relies on selected weights required for maintaining, opening and closing a claim. In practice the weights would typically come from special studies (e.g., workload studies, time studies) from an insurer's claims department.

(b) Recommend an average ULAE per weighted count. Justify your recommendation.

Commentary on Question:

Newly reported, open, and closed counts can be determined directly or by rearranging the triangles by year end instead of by development.

Directly determining calendar year (CY) counts (e.g., 2018):

CY 2018 newly reported counts = 1,122 + 32 + 26 = 1,180
CY 2018 closed counts = 694 + 263 + 87 = 1,044

Cumulative reported counts to end of 2018 = 1,033 + 1,081 + 1,122 + 28 + 32 + 26 = 3,322
Cumulative closed counts to end of 2018 = 636 + 650 + 694 + 210 + 263 + 87 = 2,540
CY 2018 open counts = 3,322 – 2,540 = 782

12. Continued

Rearranging data triangles:

Reported Counts by Year End

CY	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31
2016	1,033	28	26	1	0	0
2017		1,081	32	16	0	0
2018			1,122	59	8	0
2019				828	41	25
2020					799	34
2021						806
incremental	1,033	1,109	1,180	904	848	865
cumulative	1,033	2,142	3,322	4,226	5,074	5,939

Closed Counts by Year End

CY	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31
2016	636	210	87	21	4	1
2017		650	263	64	10	0
2018			694	274	71	12
2019				521	222	69
2020					511	210
2021						530
incremental	636	860	1,044	880	818	822
cumulative	636	1,496	2,540	3,420	4,238	5,060
Open counts			782	806	836	879

	(1)	(2)	(3)	(4)	(5)
		Counts			
Calendar Year	Paid ULAE	Newly Reported	Open	Closed	Weighted Total
2018	718,960	1,180	782	1,044	933.90
2019	738,400	904	806	880	845.30
2020	746,800	848	836	818	835.40
2021	787,600	865	879	822	864.10

e.g., (5) for 2018: 933.90 = 0.25×1,180 + 0.55×782 + 0.20×1,044

12. Continued

Calendar Year	(6) = (1) / (5) Avg ULAE Per Weighted Count	(7) Trending Period in Years	(8) = $1.02^{(7)}$ Trend to 2022 at 2.0%	(9) = (6)(8) Avg ULAE Trended to 2022
2018	769.85	4	1.0824	833.31
2019	873.54	3	1.0612	927.00
2020	893.94	2	1.0404	930.06
2021	911.47	1	1.0200	929.70

Recommended average ULAE per weighted count = 928.92
Rationale: 2018 appears to be an outlier, so use average of 2019 to 2021

(c) Calculate estimated unpaid ULAE as of December 31, 2021.

	(10)	(11)	(12)	(13)
		Counts		
Calendar Year	Newly Reported	Open	Closed	Weighted Total
2022	208	559	528	465.05
2023	69	278	350	240.15
2024	5	133	150	104.40
2025	0	25	108	35.35
2026	0	0	25	5.00

e.g., for 2018:
(11): 559 = 879 + 208 – 528
(13): 465.05 = 0.25×208 + 0.55×559 + 0.20×528

Calendar Year	(14) Trending Period in Years	(15) = $1.02^{(14)}$ Trend from 2022 at 2.0%	(16) = 928.92×(15) Trended Average ULAE	(17) = (13)(16) Estimated Unpaid ULAE
2022	0	1.0000	928.92	431,994
2023	1	1.0200	947.50	227,542
2024	2	1.0404	966.45	100,897
2025	3	1.0612	985.78	34,847
2026	4	1.0824	1,005.49	5,027
Total				800,308

e.g., for 2018: (16) = 928.92×(15)

13. Learning Objectives:

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

Learning Outcomes:

(3h) Explain the effect of changing conditions on the projection methods cited in (3e).

(3i) Assess the appropriateness of the projection methods cited in (3e) in varying circumstances.

Sources:

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

Commentary on Question:

This question tests the candidate's understanding of effect that changing conditions have on the estimates of ultimate claims.

Solution:

(a) Critique each of the two methods used for the analysis. Your critique should indicate any potential bias in the methods.

- The loss development factors under both methods include both development and currency movement.
- This makes the factors less reliable, and the currency exchange rate does not follow a pattern.
- Because currency B has been losing value since CY 2019, the development factors for the last 3 calendar years will be understated, and so will the ultimate estimates.
- The expected claim ratio for the BF method may not be accurate as the premiums, paid claims and case estimates are converted at different times (and rates).

(b) Propose an alternative approach or method for analyzing this data that should produce more accurate results. Justify your proposal.

- Claims should be analyzed separately by currency without conversion.
- In order to deal with the low volume for claims in currency B, one could credibility weight the currency B development factors with currency A development factors.
- For the BF method, can use 65% for currency A and 60% for currency B.
- For financial reporting, the claim liabilities would be the claim liabilities for currency A plus the exchange rate at the financial reporting date times the claim liabilities for currency B.

13. Continued

(c) Describe how your responses to parts (a) and (b) would be affected if this were a short-tail line rather than a liability line.

- Short tail versus long tail does not change the intermingling of development with currency exchange.
- However, short tail lines have smaller development factors and development factors that reach 1 sooner, therefore the bias should have a smaller effect (i.e., smaller bias on total claim liabilities).

14. Learning Objectives:

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

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

Learning Outcomes:

(5b) Identify the time periods associated with trending procedures.
(5c) Analyze and evaluate trend for claims (including frequency, severity, and pure premium) and exposures (including inflation-sensitive exposures and premiums).
(5d) Choose trend rates for claims (frequency, severity, and pure premium) and exposures.
(5e) Calculate trend factors for claims and exposures.
(6h) Apply loadings for catastrophes and large claims in ratemaking.
(6j) Calculate indicated rates and indicated rate changes using the claim ratio and pure premium methods.
(6k) Demonstrate the use of credibility in ratemaking.

Sources:

Fundamentals of General Insurance Actuarial Analysis, Second Edition (2022), J. Friedland, Chapters 26, 31, and 32.

Commentary on Question:

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

Solution:

(a) Describe one way that large claims are differentiated from catastrophe claims when insurers are estimating loadings for ratemaking purposes.

Any one of the following are acceptable:

- Catastrophes typically result in GI claims for multiple insurers providing coverage in an affected area. Whereas large losses are limited to a few claims for an individual insurer.
- Catastrophes are associated with an event which is infrequent and results in unusually large aggregate losses.
- Catastrophes typically result in a significant number of GI claims for multiple insurers providing coverage in the area affected by the event. Large claims do not typically affect the entire GI industry, or even all GI companies operating in a specific area.

14. Continued

(b) Recommend the annual pure premium trend for weather claims. Justify your recommendation.

Accident Year	Pure Premium per 100 EHY	Year-to-Year Change
2010	5,280	
2011	5,770	9.3%
2012	6,330	9.7%
2013	6,200	-2.1%
2014	6,920	11.6%
2015	7,140	3.2%
2016	7,560	5.9%
2017	8,300	9.8%
2018	8,460	1.9%
2019	8,850	4.6%
2020	9,400	6.2%
2021	9,940	5.7%
Average - all years		6.0%
Average - latest 5 years		5.7%
Average - all years excl. high & low		6.3%
Recommendation		6.3%

Justification: Include more years due to significant volatility. Excluding high & low eliminates outliers.

14. Continued

(c) Recommend the trended ultimate pure premium for weather claims per 100 EHY to use in ratemaking. Justify your recommendation.

Accident Year	Trending Period (months)	Pure Premium Trend Factor	Trended Ultimate Pure Premium for Non-Hurricane Weather excluding Hail per 100 EHY
2010	169	2.3514	12,415
2011	157	2.2129	12,768
2012	145	2.0825	13,183
2013	133	1.9599	12,151
2014	121	1.8444	12,763
2015	109	1.7358	12,393
2016	97	1.6335	12,350
2017	85	1.5373	12,760
2018	73	1.4468	12,240
2019	61	1.3615	12,050
2020	49	1.2813	12,045
2021	37	1.2059	11,986
Average (all years)			12,425
Average (latest 5 years)			12,216
Average (latest 3 years)			12,027
Recommendation			12,027

Justification: Decreasing values in latest years so more weight to more recent data. Therefore, recommend average of latest 3 years.

14. Continued

(d) Calculate the indicated rate level change, including a loading for weather claims.

Accident Year	Trended Earned Premiums at Current Rate Level	Trended Ultimate Claims	Claim Ratio	Accident Year Weights
2019	12,545,160	7,130,200	56.84%	25%
2020	12,777,120	7,449,200	58.30%	30%
2021	12,613,560	6,824,400	54.10%	45%
Weighted average trended claim ratio			56.05%	

(1)	Selected non-hurricane weather excluding hail pure premium per 100 EHY:	12,027
(2)	CY2021 earned house years	16,860
(3)	CY2021trended earned premiums at current rate level	12,613,560
(4)	Loading for non-hurricane weather expressed as a claim ratio = ((1)/100)×(2)/(3)	16.08%
(5)	ULAE to claim ratio	12%
(6)	Total claim ratio including ULAE = (56.05% + (4))(1 + (5))	80.78%
(7)	Credibility of experience period = squareroot(49,500 / 80,000)	78.66%
(8)	Countrywide trended, adjusted ultimate claim, including ULAE, ratio	70%
(9)	Credibility-weighted experience claim, including ULAE, ratio = (6)(7) + [1 – (7)](8)	78.48%
(10)	Selected fixed expenses to premiums ratio	5%
(11)	Selected variable expenses to premiums ratio	15%
(12)	Selected profit and contingencies to premiums ratio	4%
(13)	Indicated rate level change = [(9) + (10)]/[1 – (11) – (12)] – 1	3.06%

15. Learning Objectives:

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

Learning Outcomes:

(3d) Analyze development triangles for investigative testing.

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

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

Sources:

Fundamentals of General Insurance Actuarial Analysis, Second Edition (2022), J. Friedland, Chapters 14 and 15.

Commentary on Question:

This question tests the candidate's understanding of the development method of estimating ultimate claims as well as understanding how a change in the rate of claim settlement can affect development patterns.

Solution:

(a) Estimate ultimate claims using paid claims and your colleague's selected age-to-age factors.

Accident Year	Age-to-Age Factors	Age-to-Ult Factors	Paid Claims	Ultimate Claims
2014	1.0000	1.0000	3,150,859	3,150,859
2015	1.0420	1.0420	3,334,361	3,474,404
2016	1.0730	1.1181	3,340,680	3,735,101
2017	1.1350	1.2690	3,211,463	4,075,362
2018	1.2430	1.5774	3,005,560	4,740,890
2019	1.3530	2.1342	2,385,228	5,090,520
2020	1.8270	3.8992	1,491,676	5,816,280
2021	2.6810	10.4536	766,038	8,007,886
Total			20,685,865	38,091,301

15. Continued

(b) State two concerns with your colleague's selected age-to-age factors.

Commentary on Question:
Other answers are possible. Concerns need to be specific to the colleague's selected factors and not about factors in general. For example, high leverage is influenced by the line of business and not by the colleague's selections.

- There is concern with using straight average.
- There was no tail factor selected.

(c) Explain your rationale for each of the concerns identified in part (b).

- Concern with using straight average: This is clearly a growing line of business, so more weight should be given to more recent years.
- No tail factor: There should be a tail factor as there is still development up to 96 months.

(d) Recommend alternative selected age-to-age factors for the following. Justify your recommendations.

(i) 12-24

(ii) 36-48

Commentary on Question:
Other answers are possible.

(i) 12-24: Latest 3 years will give more weight to the decreasing trend

(ii) 36-48: Remove AY 2016 as it appears to be an anomaly

15. Continued

(e) Estimate ultimate claims using reported claims and your colleague's selected age-to-age factors.

AY	Age-to-Age Factors	Age-to-Ult Factors	Reported Claims	Ultimate Claims
2014	1.01000	1.01000	3,161,268	3,192,881
2015	1.01000	1.02010	3,454,115	3,523,543
2016	1.03100	1.05172	3,684,648	3,875,229
2017	1.06700	1.12219	3,787,476	4,250,262
2018	1.09600	1.22992	3,878,344	4,770,048
2019	1.13100	1.39104	3,997,935	5,561,279
2020	1.35700	1.88764	3,596,409	6,788,720
2021	1.63900	3.09384	3,028,985	9,371,194
Total			28,589,180	41,333,156

(f) Provide two reasons why the ultimate claims from part (e) are higher than the ultimate claims from part (a).

- There is no tail factor for paid claims and there is a tail factor for reported.
- The latest diagonal of age-to-age factors for reported claims is much higher and this will tend to make the reported claims higher.

(g) Evaluate your colleague's conclusion.

- An increase in claim settlement could possibly increase the latest diagonal of the reported triangle.
- This increase would also show up in the paid age-to-age triangle.
- Since the pattern is not in the paid triangle, it is therefore likely that the cause of the increase in the reported triangle was not due to an increase in claim settlement pattern.

16. Learning Objectives:

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

Learning Outcomes:

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

Sources:

Fundamentals of General Insurance Actuarial Analysis, Second Edition (2022), J. Friedland, Chapter 27.

Commentary on Question:

This question tests premium trending for ratemaking purposes.

Solution:

(a) Calculate the quarterly change in average written premiums using:

(i) Change in quarter-to-quarter averages

(ii) Change in rolling 4-quarter volume-weighted averages

16. Continued

Experience Period Calendar Quarter Ending	Average On-Level Written Premiums		Quarterly Change in Average Written Premiums	
	Quarter Average	Rolling 4-Quarter Volume-Weighted Average	Quarter Average	Rolling 4-Quarter Volume-Weighted Average
2018-1	516.48			
2018-2	526.28		1.90%	
2018-3	531.30		0.95%	
2018-4	533.12	527.01	0.34%	
2019-1	545.32	534.25	2.29%	1.37%
2019-2	541.82	538.05	-0.64%	0.71%
2019-3	556.50	544.46	2.71%	1.19%
2019-4	556.54	550.24	0.01%	1.06%
2020-1	558.31	553.50	0.32%	0.59%
2020-2	564.92	559.17	1.18%	1.03%
2020-3	578.59	564.88	2.42%	1.02%
2020-4	576.75	569.88	-0.32%	0.88%
2021-1	589.45	577.69	2.20%	1.37%
2021-2	596.74	585.63	1.24%	1.38%
2021-3	599.16	590.81	0.41%	0.88%
2021-4	605.94	598.01	1.13%	1.22%
2022-1	610.41	603.24	0.74%	0.88%
2022-2	621.06	609.43	1.74%	1.03%

e.g., 2018-4:

533.12 = 3,067,577 / 5,754

527.01 = (2,443,276 + 2,549,138 + 2,676,306 + 2,775,206) / (5,229 + 5,354 + 5,568 + 5,754)

16. Continued

(b) Recommend the annual premium trend. Justify your recommendation.

	Quarter Average	Rolling 4-Quarter Volume-Weighted Average
Average all quarters	1.10%	1.04%
Average all quarters excl. high & low	1.10%	1.05%
Average latest 6 quarters	1.24%	1.13%
Recommended quarterly:		1.05%
Annual:		4.28%

Justification: Use the rolling values as it smooths out the variability. Recommend average excluding high & low.

(c) Calculate the first quarter 2022 on-level earned premiums trended to the future rating period.

Average earned date in 2022-1:	15-Feb-22
Average earned date in future rating period:	01-Apr-24
Trend period (years):	2.125
Trended on-level earned premiums: $5{,}136{,}000 \times (1.0428)^{2.125} =$	5,614,523

17. Learning Objectives:

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

Learning Outcomes:

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

(3f) Demonstrate knowledge of good practice related to projecting ultimate values.

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

(3j) Evaluate and justify selections of ultimate values based on the methods cited in (3e).

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 14, 18, and 21.

Commentary on Question:

This question tests the candidate's understanding of Cape Cod method for estimating ultimate ALAE.

Solution:

(a) Provide two reasons an actuary may want to estimate ultimate ALAE separate from ultimate indemnity.

Any two of the following are acceptable:

- The relationship between ALAE and claims is changing over time
- A change in ALAE handling (e.g., change in legal billing)
- A change in payment/reporting pattern for indemnity
- Trends for indemnity and ALAE are different
- ALAE is material and credible
- The company wants to understand ALAE cost drivers separate from indemnity

17. Continued

(b) Calculate the adjusted expected pure premium for ALAE (i.e., ALAE cost per exposure) by accident year and in total using the Cape Cod method.

Annual pure premium trend = (1 – 0.015)(1 + 0.040) – 1 = 2.44%

Accident Year	(1) Earned Exposures	(2) Reported ALAE as of Dec. 31, 2021	(3) Reported ALAE Cumulative Development Factors	(4) = 1 / (3) Expected % Reported
2014	24,282	3,617	1.000	100.0%
2015	25,414	4,159	1.011	98.9%
2016	26,264	2,256	1.053	95.0%
2017	26,950	2,410	1.114	89.8%
2018	28,044	2,051	1.234	81.0%
2019	29,110	2,672	1.411	70.9%
2020	29,880	4,900	1.922	52.0%
2021	30,606	2,699	3.574	28.0%
Total	220,550	24,764		

Accident Year	(5) = (1)(4) Used-Up Earned Exposures	(6) Adjustment Factors: Pure Premium Trend	(7) Adjustment Factors: Tort Reform	(8) = (2)(6)(7) Adjusted Reported ALAE as of 12/31/21	(9) = (8)/(5) Adjusted Expected Pure Premium
2014	24,282	1.1838	0.90	3,854	0.1587
2015	25,137	1.1556	0.90	4,326	0.1721
2016	24,942	1.1281	0.90	2,290	0.0918
2017	24,192	1.1012	0.90	2,389	0.0987
2018	22,726	1.0750	0.90	1,984	0.0873
2019	20,631	1.0494	0.95	2,664	0.1291
2020	15,546	1.0244	1.00	5,020	0.3229
2021	8,564	1.0000	1.00	2,699	0.3152
Total	166,020			25,225	0.1519

e.g., AY 2019 Pure Premium Trend factor: $1.0494 = 1.0244^2$
AY 2019 Tort reform factor: $0.95 = 0.5 \times 0.90 + 0.5 \times 1.00$

17. Continued

(c) Comment on whether or not the results from part (b) are consistent with the key assumption of the Cape Cod method.

The adjusted expected pure premium shows significant variation by accident year. This is not consistent with the underlying assumption of the Cape Cod method, which assumes relatively constant pure premium for all years in the experience period.

(d) Calculate the projected ultimate ALAE by accident year using the Cape Cod method.

	(10) = [0.1519×(1)] / [(6)(7)]	(11) = 1 – (4)	(12) = (10)(11)	(13) = (2) + (12)
Accident Year	Expected ALAE	Expected Unreported %	Expected Unreported	Projected Ultimate ALAE
2014	3,463	0.0%	0	3,617
2015	3,713	1.1%	40	4,199
2016	3,930	5.0%	198	2,454
2017	4,132	10.2%	423	2,833
2018	4,404	19.0%	835	2,886
2019	4,437	29.1%	1,292	3,964
2020	4,432	48.0%	2,126	7,026
2021	4,650	72.0%	3,349	6,048
Total	33,160		8,264	33,028

17. Continued

(e) Compare actual ALAE as of December 31, 2021 to expected ALAE from the Cape Cod method.

Accident Year	(2) Reported ALAE as of Dec. 31, 2021	(14) = (10) – (12) Expected Reported	(15) = (2) – (14) Test Actual vs. Expected	(16) = (15) / (2) Actual vs. Expected as a % of Actual
2014	3,617	3,463	154	4%
2015	4,159	3,672	487	12%
2016	2,256	3,733	(1,477)	-65%
2017	2,410	3,709	(1,299)	-54%
2018	2,051	3,569	(1,518)	-74%
2019	2,672	3,144	(472)	-18%
2020	4,900	2,306	2,594	53%
2021	2,699	1,301	1,398	52%
Total	24,764	24,897	(133)	-1%

(f) Assess the actual versus expected results from part (e).

- The actual vs. expected appears reasonable overall, however, variation by accident year is significant.
- Need to investigate/research/analyze further (or, need to perform additional diagnostics).

(g) Describe a scenario where an actuary would likely choose to apply the Generalized Cape Cod method over the Cape Cod method.

Any one of the following is acceptable:

- Want to vary the expected claims (or pure premium) by year. The Cape Cod method assumes constant expected claims (or pure premium) for all years in experience period.
- Want to blend development method (experience-based) and Cape Cod method into one method. A decay of 1.0 is the Cape Cod method. A decay of 0 is the development method.

18. Learning Objectives:

1. The candidate will understand the key considerations for and key concepts underlying general insurance actuarial work.

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

Learning Outcomes:

(1d) Understand the components of ultimate values.

(2a) Create development triangles of claims and counts from detailed claim transaction data.

Sources:

Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapters 3 and 10.

Commentary on Question:

This question tests the candidate's understanding of the construction of claims data triangles.

Solution:

(a) Construct a cumulative reported claim development triangle by report year.

Report Year	Cumulative Paid Claims (000)						
	2015	2016	2017	2018	2019	2020	2021
2015	330	1,710	3,025	3,602	3,720	3,741	3,746
2016	0	351	2,206	3,685	4,113	4,204	4,212
2017	0	0	436	1,925	3,177	4,110	4,278
2018	0	0	0	423	2,015	3,197	3,867
2019	0	0	0	0	449	2,124	3,664
2020	0	0	0	0	0	354	2,063
2021	0	0	0	0	0	0	584

Report Year	Reported Claims (000) = Cumulative Paid Claims + Case Estimates						
	2015	2016	2017	2018	2019	2020	2021
2015	1,499	3,078	3,387	3,718	3,741	3,746	3,746
2016	0	1,672	3,554	3,907	4,207	4,227	4,228
2017	0	0	1,892	3,303	3,866	4,287	4,296
2018	0	0	0	1,827	3,364	3,717	4,070
2019	0	0	0	0	1,696	3,825	4,217
2020	0	0	0	0	0	1,897	3,774
2021	0	0	0	0	0	0	1,934

18. Continued

Left justify the reported claims triangle by evaluation age:

Report Year	Reported Claims (000)						
	12	24	36	48	60	72	84
2015	1,499	3,078	3,387	3,718	3,741	3,746	3,746
2016	1,672	3,554	3,907	4,207	4,227	4,228	
2017	1,892	3,303	3,866	4,287	4,296		
2018	1,827	3,364	3,717	4,070			
2019	1,696	3,825	4,217				
2020	1,897	3,774					
2021	1,934						

(b) Calculate the calendar year 2020 reported claims for the coverage above.

CY 2020 Reported Claims = CY 2020 (Paid Claims + Change in Case Reserves)
= 4,256 + 569 = 4,825

(c) Update the reported claim development triangle from part (a) to include the missing claim transactions.

Triangle of missing information:

Report Year	Reported Claims (000)							Transaction
	12	24	36	48	60	72	84	
2015								
2016					–5	–5		4
2017								2*
2018		–15	–15	–15				1
2019	10	10	10					3
2020		5						6
2021	30							5

18. Continued

Corrected reported claims triangle:

Report Year	Reported Claims (000) 12	24	36	48	60	72	84	Transaction
2015	1,499	3,078	3,387	3,718	3,741	3,746	3,746	
2016	1,672	3,554	3,907	4,207	4,222	4,223		4
2017	1,892	3,303	3,866	4,287	4,296			2*
2018	1,827	3,349	3,702	4,055				1
2019	1,706	3,835	4,227					3
2020	1,897	3,779						6
2021	1,964							5

Note: * Transaction 2 does not change reported triangle

(d) Calculate the calendar year 2021 incurred claims.

CY 2021 incurred claims = CY 2021 (reported claims + change in IBNR)
= 4,821 + 200 = 5,021

19. Learning Objectives:

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

Learning Outcomes:

(6u) Determine experience rating modification factors and experience rating adjustments.

Sources:

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

Commentary on Question:

This question tests the calculation of an experience rating modification.

Solution:

Calculate the experience rating modification.

Policy Year	Claim ID	Claims at July 1, 2022			MSL	Reported Indemnity & ALAE at July 1, 2022 Limited by Basic Limits and MSL
		Indemnity				
		Total Limits	Basic Limits	ALAE		
July 1, 2019 – June 30, 2020	1	14,000	14,000	35,000	45,000	45,000
	2	32,000	20,000	20,000	45,000	40,000
July 1, 2020 – June 30, 2021	3	22,000	20,000	16,000	45,000	36,000
	4	10,000	10,000	3,000	45,000	13,000
Total						134,000

Expected unreported claims at July 1, 2022
= 88,600×0.16×0.67 + 92,200×0.38×0.67 = 32,972

Projected ultimate losses & ALAE Limited by Basic Limits & MSL:
= Reported Losses & ALAE (134,000) + Expected unreported (32,972) = 166,972

Basic Limits Premiums Subject to Experience Rating 180,800

AER =
Projected ultimate losses & ALAE Limited by basic limits & MSL / CSLC = 0.9235

AELR 0.67

$Z = \sqrt{180,800 / 2,000,000} =$ 30%

Experience (credit)/debit = Z × (AER – AELR)/AELR = 11.38%

20. Learning Objectives:

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

Learning Outcomes:

(9b) Apply catastrophe modeling results in ratemaking, loss mitigation, risk selection, and reinsurance.

(9d) Understand and apply common risk metrics associated with catastrophe modeling results.

Sources:

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

Commentary on Question:

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

Solution:

(a) Calculate the expected Average Annual Loss (AAL) per $1,000 of building coverage.

AAL = Sumproduct of the Annual Probability of Hurricane (p) and the Expected Loss (L) Per $1,000 of Building Coverage

$= (1.00\% \times 50 + \ldots + 1.20\% \times 100) = 8.785$

(b) Calculate Hurricane Wind Premium for the average building in the zip code using the method described in the American Academy of Actuaries monograph, Uses of Catastrophe Model Output.

Event #	$p \times L^2$	$p \times L^2 - AAL^2$
1	25.00	-52.18
2	20.00	-57.18
3	62.50	-14.68
4	135.00	57.82
5	0.56	-76.61
6	200.00	122.82
7	227.81	150.64
8	312.50	235.32
9	440.00	362.82
10	120.00	42.82
Total		771.61

Risk load = $771.61^{0.5} = 27.78$

20. Continued

$$\text{Expense Load} = \frac{(8.785+27.78)}{(1-0.25)} - (8.785+27.78) = 12.19$$

Hurricane Wind Premium per Coverage A = 8.785 + 27.78 + 12.19 = 48.75
Hurricane Wind Cover in Zip-code per $1,000 of building coverage
= 48.75×200,000/1,000 = 9,750.11

(c) Describe why hurricane deductibles tend to be larger in inland areas compared to coastal regions.

Coastal regions experience higher wind speeds and losses are more likely to be severe, so deductibles tend to be a smaller portion of the overall loss. Because inland counties' hurricane wind losses are likely to be lower, deductibles tend to be a higher percentage of overall loss.

(d) Identify which zip code has the highest potential for loss from hurricane events. Justify your selection.

Zip Code	PML/AAL
A	106.13
B	77.43

106.13 / 77.43 = 1.37

While zip code B has the higher AAL, the ratio of PML/AAL is 37% higher for zip code A indicating there is higher loss potential in zip code A.