SOCIETY OF ACTUARIES
Advanced Topics in General Insurance

Exam GIADV

Date: Friday, April 27, 2018
Time: 2:00 p.m. – 4:15 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 40 points.

   This exam consists of 8 questions, numbered 1 through 8.

   The points for each question are indicated at the beginning of the question.
2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.
3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.
2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.
3. The answer should be confined to the question as set.
4. When you are asked to calculate, show all your work including any applicable formulas.
5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate Exam GIADV.
6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.

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Exam GIADV-Front Cover

****BEGINNING OF EXAMINATION****

1. (*4 points*) For many years, Risky Business, Inc. (RBI) has written an insurance contract against a rare event. The probability of this event is 0.001. The insurance pays 1,000,000 should this event occur. The risk load is based on multiplying the standard deviation of this loss by 0.025.

(a) (*0.5 points*) Calculate the risk load for this existing contract.

RBI has the opportunity to write a second contract against this same event. The payment is 500,000 should this event occur. RBI uses the build-up approach to calculate risk loads.

(b) (*1 point*) Calculate the risk load for this second contract using the Marginal Surplus method.

RBI is considering using the Marginal Variance method instead.

(c) (*0.5 points*) Determine the variance risk load multiplier, λ, that produces the same risk load for the combined portfolio as that obtained using the Marginal Surplus method.

(d) (*1 point*) Calculate the risk load for each contract using the Marginal Variance method.

(e) (*1 point*) Calculate the renewal risk load for each contract using the Marginal Variance method.

2. (*6 points*) SafePort Insurance Company is a small company that provides property coverage to hotels in a specific region.

SafePort's reinsurance arrangements for windstorm losses are applied in the following order:

Reinsurance Treaty	**Description**
Surplus Share	5 lines with 2,000 retained line
Per Risk Excess of Loss	4,000 excess of 1,000
Catastrophe	8,000 excess of 6,000

During 2017, a severe windstorm caused the following covered losses:

Property	**Insured Value**	**Loss**
A	2,000	400
B	20,000	16,000
C	8,000	3,200
D	12,500	12,500
E	4,000	1,200

(a) (*2 points*) Calculate the total losses recoverable under each treaty.

You are provided with the following information on the catastrophe treaty:

- The annual premium is 600.
- There is a reinstatement provision that is 125% pro-rata as to amount.

(b) (*0.5 points*) Calculate the reinstatement premium for the catastrophe treaty.

(c) (*0.5 points*) Discuss whether a reinstatement pro-rata as to time would be appropriate for this type of cover.

(d) (*1 point*) Explain with an example why a catastrophe cover is usually written on a losses occurring basis rather than on a risks attaching basis.

2. Continued

The per risk excess of loss treaty was underwritten by Windy Reinsurance, Inc. Windy priced the treaty using the following exposure factors:

Percent of Insured Value	Exposure Factor
0%	0%
10%	37%
20%	49%
30%	57%
40%	64%
50%	70%
60%	76%
70%	81%
80%	85%
90%	89%
100%	93%
110%	97%
120%	100%

Expected gross losses for each property were assumed to be 5% of insured value.

(e) (*2 points*) Calculate the expected losses in the excess layer underwritten by Windy for each of the following properties:

(i) Property A

(ii) Property B

3. (*5 points*) You are calculating a risk margin for claim liabilities using the methodology set out in "A Framework for Assessing Risk Margins." The following information is provided:

		External Systemic Risk - Coefficients of Variation		
Line of Business	**Claim Liabilities**	**Claim Process Change Risk**	**Event Risk**	**Recovery Risk**
Motor	3,000	2.0%	1.0%	3.0%
Home	7,000	2.0%	1.0%	1.0%
Total	**10,000**			

- The independent risk coefficient of variation for both lines combined is 8.0%.
- The internal systemic risk coefficient of variation for the motor line of business is 3.0%.
- The correlation between lines for internal systemic risk is 75%.
- The correlation between lines for each external systemic risk category is 0%.
- The aggregate coefficient of variation for both lines combined is 9.6%.

(a) (*3 points*) Calculate the internal systemic risk coefficient of variation for the home line of business.

(b) (*0.5 points*) Propose an approach that can be used if external systemic risk categories are partially correlated within or between valuation classes.

You are conducting a hindsight analysis to provide further comfort regarding the outcomes from the deployment of this framework.

(c) (*0.5 points*) Define hindsight analysis.

(d) (*1 point*) Contrast the usefulness of hindsight analysis for short-tail and long-tail portfolios.

4. (*4 points*) You are using the following assumptions to set the premium for a one-year policy:

- Expenses are 25.
- Owners' equity is 100.
- Investable assets are equal to premium minus expenses plus owners' equity.
- Taxes are ignored.
- The investment return is the risk-free rate of 2%.
- The funds generating coefficient is 1.
- The market risk premium is 4%.
- The underwriting beta is 1.5.

(a) (*0.5 points*) Explain why owners' equity is difficult to determine.

You are calculating the premium using the Target Total Rate of Return Model with a target total rate of return of 7.0% and Fairley's CAPM model to determine the underwriting profit margin.

(b) (*2 points*) Calculate the premium.

Your company is considering purchasing quota share reinsurance. A reinsurer has offered the following terms:

- 40% of premium ceded with commission rate of 35%.

Your company's equity is reduced to maintain the ratio of premium to owners' equity at its value prior to purchasing the reinsurance.

(c) (*1.5 points*) Calculate the Total Rate of Return under this reinsurance offer.

5. (*8 points*) You are interested in determining the variability of unpaid claim estimates. The triangle of paid claims data you are working with, by accident year (AY) and development year, is presented below. The shaded cells have been completed using the standard chain ladder method. It is assumed that all claims are fully developed after seven years.

Mack's method of estimating reserve variability has been applied to this triangle. The key results are provided in the table.

	Development Year							
AY	1	2	3	4	5	6	7	Standard error
1	9,146	12,176	17,670	18,546	18,128	18,517	18,888	0
2	10,834	15,902	20,884	23,304	22,887	23,371	23,839	0.04
3	11,946	15,697	20,478	22,854	20,718	21,159	21,583	5.64
4	12,414	19,333	38,991	42,905	40,935	41,806	42,644	1,761
5	14,284	20,888	25,210	27,675	26,405	26,967	27,507	1,514
6	15,648	17,240	25,293	27,767	26,492	27,056	27,598	7,217
7	17,221	23,473	34,438	37,806	36,070	36,838	37,576	9,765
	Age-to-Age Factors							
1	1.3313	1.4512	1.0496	0.9775	1.0215	1.0200		
2	1.4678	1.3133	1.1159	0.9821	1.0211			
3	1.3140	1.3046	1.1160	0.9065				
4	1.5574	2.0168	1.1004					
5	1.4623	1.2069						
6	1.1017							
f_k	1.36304	1.46713	1.09779	0.95408	1.02128	1.02004		
α_k^2	366.962	2012.50	18.3273	40.0504	0.00098	2.4×10^{-8}		

(a) (*1.5 points*) Demonstrate that the value of α_4^2 was correctly calculated. (Your calculation need not match to all four decimal places.)

(b) (*2 points*) Calculate the standard error of the reserve estimator for accident years 4 and 5 combined.

The sample correlation between the first two columns of age-to-age factors is 0.574.

(c) (*1 point*) Calculate the test statistic suggested by Venter to test the significance of this correlation.

(d) (*0.5 points*) Determine whether this correlation is significant.

5. Continued

(e) (*2 points*) Demonstrate that the test statistic suggested by Mack to test for a calendar year effect is equal to 1.

Under the null hypothesis that there is no calendar year effect, the expected value of the test statistic suggested by Mack is 4.875 and the standard deviation of the test statistic is 1.196.

(f) (*1 point*) Determine whether there is a significant calendar year effect and what this indicates about the use of the chain ladder method in this case.

6. (*5 points*) You are given the following triangle of cumulative paid losses:

		Months of Development		
Accident Year	**Onlevel Premium**	**12**	**24**	**36**
2015	10,000	5,000	7,000	8,000
2016	8,500	4,000	5,500	
2017	12,000	6,000		

You apply Clark's stochastic reserving model using the Cape Cod method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$.

One of the assumptions of Clark's model is that incremental losses are independent and identically distributed.

(a) (*1 point*) Provide two examples of situations where this assumption might not hold.

Clark's variance estimates are based on the Rao-Cramér lower bound.

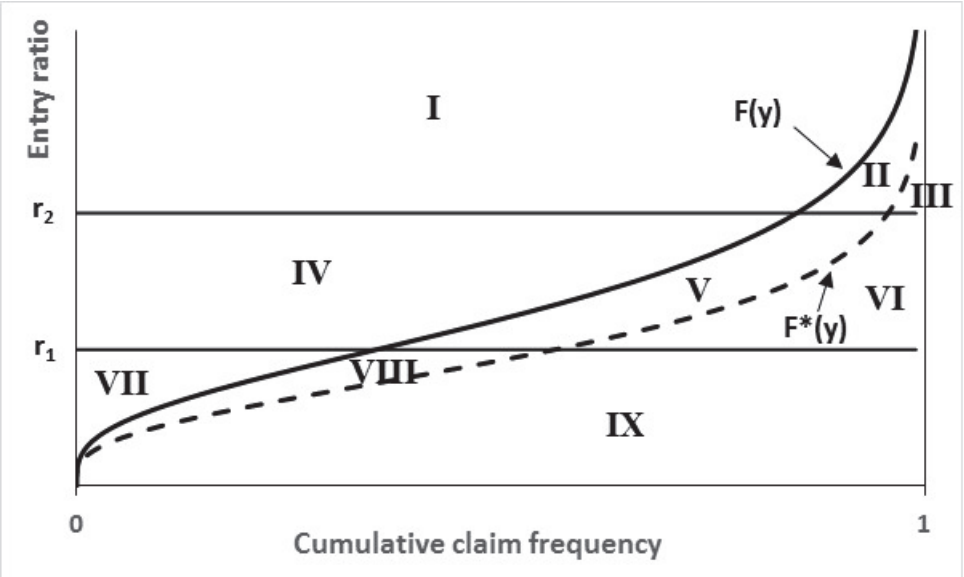
(b) (*1 point*) Explain why the variance estimates are an approximation.

The maximum likelihood estimate of θ is 6.689. The maximum likelihood estimate of the total reserve is 4,369.

(c) (*2 points*) Calculate the maximum likelihood estimate of *ELR*.

(d) (*1 point*) Estimate the expected payments in 2018 for accident year 2017.

7. (*4 points*) For a retrospective rating plan with a per accident limitation, you are given the following graph of $F(y)$, the cumulative distribution function of the actual unlimited loss divided by the expected loss, and $F^*(y)$, the cumulative distribution function of the actual limited loss divided by the expected loss.



(a) (*3 points*) Identify the areas on the graph that correspond to each of the following:

(i) k, the loss elimination ratio

(ii) $1-k$

(iii) $\psi(r_1)$, the Table M savings at entry ratio r_1

(iv) $\psi^*(r_1)$, the Table L savings at entry ratio r_1

(v) $\varphi(r_2)$, the Table M charge at entry ratio r_2

(vi) $\varphi^*(r_2)$, the Table L charge at entry ratio r_2

(b) (*1 point*) Determine each of the following:

(i) The limit of the Table M charge as the entry ratio goes to infinity

(ii) The limit of the Table L charge as the entry ratio goes to infinity

8. (*4 points*) You project that the number of flood losses in the upcoming year will have a binomial distribution with $M = 2$ and $p = 0.5$. Hence, there will be 0 losses with 25% probability, 1 with 50% probability, and 2 with 25% probability.

You also project that each loss size will have the following probability function:

Loss size (billions)	Probability
1	0.25
2	0.25
3	0.25
4	0.25

Loss sizes are assumed to be independent of one another and independent of the number of losses.

The aggregate distribution of flood losses has the following probability function:

Aggregate Losses (billions)	Probability
0	0.250000
1	0.125000
2	0.140625
3	0.156250
4	
5	0.062500
6	0.046875
7	0.031250
8	

(a) (*1.5 points*) Calculate the probability that aggregate flood losses will be:

(i) 4 billion

(ii) 8 billion

Calculation of the full set of aggregate probabilities can be done by either using a recursive formula or employing basic probability rules.

(b) (*1 point*) Explain the advantages of using a recursive formula.

(c) (*1.5 points*) Calculate the mean and coefficient of variation of aggregate flood losses.

****END OF EXAMINATION****

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