SOCIETY OF ACTUARIES
Advanced Topics in General Insurance

Exam GIADV

Date: Friday, May 6, 2016
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. (*5 points*) Beta Reinsurance Company writes property per risk excess reinsurance and uses an exposure curve to price its treaties that is defined by, where x is the proportion of insured value,

$$\text{Exposure Factor} = 1 - \left(1 - \frac{x}{1.2}\right)^2, \; 0 < x < 1.2 .$$

Beta has been presented with an opportunity to write a property per risk excess treaty covering the layer 400,000 excess of 100,000 on a portfolio with insured values and subject premium as follows:

Insured Value	Subject Premium
100,000	1,000,000
200,000	1,000,000
500,000	1,000,000
1,000,000	1,000,000

Surplus share reinsurance with a retained line of 500,000 will inure to the benefit of the treaty.

(a) (*3 points*) Calculate the expected loss in the layer assuming an expected loss ratio of 60%.

(b) (*1 point*) Explain why you might elect not to use an experience rating approach to price this treaty because of the issue of "free cover."

The ceding company has also purchased a property catastrophe cover.

(c) (*0.5 points*) State whether the property catastrophe cover will typically inure to the benefit of the surplus share reinsurance.

(d) (*0.5 points*) State whether the property catastrophe cover will typically inure to the benefit of the property per risk excess treaty.

2. (*5 points*) CRU insurance company has two subsidiaries, ERU and HRU. ERU has only earthquake exposure. The exposure is in three regions. The catastrophe model for these risks indicates that in each region there is an annual loss probability of p and if there is a loss, the amount is L. Losses in the three regions are mutually independent. Values from the model are:

ERU Model Results		
Region	***p***	***L* (in millions)**
1	0.01	100
2	0.02	200
3	0.03	400

HRU has only hurricane exposure. The exposure is in four regions. The catastrophe model for these risks produces the same type of results as for earthquakes. Losses in the four regions are mutually independent. Values from the model are:

HRU Model Results		
Region	***p***	***L* (in millions)**
1	0.02	500
2	0.04	400
3	0.06	200
4	0.07	100

The correlation coefficient of total losses in one year for ERU and HRU is 0.2.

The risk load multiplier is 0.000025×10^{-6}.

(a) (*2 points*) Calculate the variance risk load for the combined portfolio.

(b) (*1 point*) Calculate the risk loads for each of ERU and HRU using the Shapley method.

To use the Marginal Variance method, a decision must be made to use either renewal risk loads or build-up risk loads.

(c) (*0.5 points*) Identify which approach will ensure that the separate risk loads will add up to the combined portfolio risk load calculated in part (a).

(d) (*1.5 points*) Calculate the two possible sets of risk loads for ERU and HRU using the Marginal Variance method and the approach identified in part (c).

3. (*5 points*) You are given the following triangle of cumulative paid losses:

	Months of Development		
Accident Year	12	24	36
2013	4,000	6,500	7,250
2014	5,000	8,000	
2015	6,000		

You are using Clark's LDF method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-\frac{x}{\theta}}$.

(a) (*1.5 points*) State two advantages and one disadvantage of using a parametric cumulative distribution function to model loss development.

The maximum likelihood estimate of θ is 7.804.

The fitted triangle of cumulative paid losses is:

	Months of Development		
Accident Year	12	24	36
2013	*X*	*Y*	7,250
2014	4,766	8,000	
2015	6,000		

(b) (*1 point*) Calculate the maximum likelihood estimate of accident year 2013 ultimate losses, ULT_{2013}.

(c) (*1 point*) Calculate the values of *X* and *Y*.

(d) (*0.5 points*) Identify the number of degrees of freedom associated with the estimate of σ^2.

The estimate of σ^2 is 47.

(e) (*1 point*) Estimate the process standard deviation of the accident year 2013 reserve.

4. (*6 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	9,791	12,431	13,033	14,212	14,486	14,867	15,155	0
2	11,314	19,266	23,518	27,910	28,117	28,697	29,253	15
3	12,654	14,924	18,489	22,433	24,281	24,829	25,310	111
4	13,305	14,234	15,293	15,900	16,474	16,845	17,172	903
5	14,693	26,298	37,108	42,448	43,980	44,972	45,843	3,208
6	16,037	18,544	22,861	26,151	27,094	27,705	28,242	4,399
7	17,360	23,587	29,077	33,262	34,462	35,239	35,922	9,393
f_k	1.35868	1.23279	1.14392	1.03608	1.02256	1.01937		
α_k^2	1,264.53	404.682	111.855	37.514	0.308	0.00252		

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

(b) (*1.5 points*) Demonstrate that the standard error for accident year 3 was correctly calculated.

For a given accident year, it is possible that the value for a given development year will be less than the value for the previous development year.

(c) (*1.5 points*) For each of Mack's three assumptions:

(i) State the assumption; and

(ii) Explain why that assumption does or does not prevent the value from decreasing from one development year to the next.

4. Continued

Venter proposes comparing various models by calculating the sum of squared errors (SSE). For the standard chain ladder method applied to these observations, SSE = 126,347,521. Venter then proposes three methods by which the SSE can be adjusted to account for the number of observations and the number of estimated parameters.

(d) (*0.5 points*) State the number of observations and the number of estimated parameters for this situation.

(e) (*0.5 points*) Calculate the adjusted SSE using one of the three methods suggested by Venter.

Venter proposes investigating models other than the standard chain ladder (where each value is multiplied by a factor that depends only on the development year).

(f) (*0.5 points*) Describe one such alternative model, using words, not formulas.

5. (*5 points*) You are setting the premium for a one-year policy using the Risk Adjusted Discount Technique and the following assumptions:

- The premium, *P*, will be collected at policy inception.
- Expenses of 20 will be paid at policy inception.
- Losses are expected to be 70, 50% of which will be paid at policy expiration and 50% of which will be paid one year following policy expiration.
- Equity allocated to this policy is 100 at policy inception; 50 will be released at policy expiration and the remaining 50 will be released one year following policy expiration.
- The tax rate on all income is 40% and taxes will be paid at policy expiration.
- Reserves are not discounted for tax purposes.
- The risk-free rate is 1%.
- The risk-adjusted rate for losses is –6%.

(a) (*2.5 points*) Calculate *P*.

You are also considering using the Target Total Rate of Return Model. You need to decide whether to use statutory surplus or the company's actual equity to derive the required underwriting profit margin.

(b) (*1.5 points*) Recommend which of the two should be used. Justify your recommendation.

(c) (*1 point*) Explain the adjustment to the Capital Asset Pricing Model (CAPM) needed to reflect increased risk.

6. (*5 points*)

(a) (*1.5 points*) Define the following terms associated with Table M in a retrospective rating plan:

(i) The entry ratio, r

(ii) The Table M charge, $\phi(r)$

(iii) The Table M savings, $\psi(r)$

A risk may have loss ratio 30%, 40%, 50%, 60%, or 70%, each with equal probability.

(b) (*3 points*) Complete the following Table M for this risk:

r	$\phi(r)$	$\psi(r)$
0.00		
0.20		
0.40		
0.60		
0.80		
1.00		
1.20		
1.40		
1.60		
1.80		
2.00		

(c) (*0.5 points*) Explain how Table L differs from Table M.

7. (*5 points*) You are calculating a risk margin for claim liabilities using the methodology set out in "A Framework for Assessing Risk Margins."

The risk margin is to be calculated at the 75% adequacy level and is to be based on the following sources of uncertainty, which are assumed to be mutually independent:

	Source of Uncertainty		
	Independent Risk	**Internal Systemic Risk**	**External Systemic Risk**
Coefficient of Variation	6%	8%	16%

- The central estimate of claim liabilities is 216,000,000.
- Claims are assumed to be normally distributed.
- The *z*-value of the 75th percentile of the normal distribution is 0.674.

(a) (*0.5 points*) Calculate the combined coefficient of variation for all sources of uncertainty.

(b) (*0.5 points*) Calculate the amount of the risk margin.

(c) (*1 point*) Describe two areas of additional analysis that you may conduct to provide further comfort regarding the outcomes from the deployment of this framework.

(d) (*1 point*) Identify four approaches that can be used to analyze independent sources of risk.

One of the attractions of this framework is that each of the sources of uncertainty being analyzed can be aligned with the central estimate analysis and appropriate decisions around volatility made in the context of that analysis.

Your actuarial student proposes analyzing risk margins at the same granular level as used for central estimate valuation purposes.

(e) (*2 points*) Evaluate your student's proposal.

8. (*4 points*) With a proportional reinsurance treaty, there will often be disagreement between the ceding company and the reinsurer about the expected loss ratio and the appropriate ceding commission. To resolve these differences, an adjustable feature is often built into the treaty.

(a) (*1.5 points*) Provide an example of each of the following adjustable features:

(i) Sliding scale commission

(ii) Profit commission

(iii) Loss corridor

The impact of an adjustable feature is best evaluated using an aggregate loss distribution model.

(b) (*1.5 points*) Identify one disadvantage specific to each of the following approaches:

(i) Empirical distribution

(ii) Single distribution model

(iii) Recursive formula

Carryforward provisions complicate evaluation of the impact of adjustable features.

(c) (*1 point*) Describe one approach to pricing the impact of a carryforward provision and identify one problem with that approach.

****END OF EXAMINATION****

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