SOCIETY OF ACTUARIES
Advanced Topics in General Insurance

Exam GIADV

Date: Tuesday, October 27, 2015
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*) Casualty R Us Reinsurance Company has been presented with an opportunity to write a casualty per occurrence excess treaty covering the layer 1,000,000 excess of 1,000,000 on a portfolio of umbrella policies. The following limits profile has been provided:

Subject Premium	Underlying Limit	Policy Limit
5,000,000	1,000,000	1,000,000
4,000,000	1,000,000	2,000,000
2,250,000	1,000,000	3,000,000
2,000,000	2,000,000	1,000,000
1,500,000	2,000,000	2,000,000

An analysis of historical data indicates that losses excess of 1,000,000 in this portfolio will follow a distribution with cumulative distribution function

$$F(x) = 1 - \left(\frac{x}{1{,}000{,}000} \right)^{-2}, \; x > 1{,}000{,}000 .$$

(a) (*3 points*) Calculate the expected losses in the layer using an exposure rating approach with an expected loss ratio of 60%, ignoring "drop down" exposure.

(b) (*0.5 points*) Define "drop down" exposure.

(c) (*0.5 points*) Explain how your analysis would have to be modified to take into account "drop down" exposure.

An experience rating analysis may require the use of excess loss development factors from industry sources such as the Reinsurance Association of America.

(d) (*1 point*) Describe two cautions that should be considered when using such factors.

2. (*4 points*) You are advising a reinsurer specializing in hurricane coverage. You have been asked to evaluate the addition of earthquake coverage to the portfolio. The following information is provided:

Hurricane		Earthquake	
Probability	**Loss Ratio**	**Probability**	**Loss Ratio**
60%	0%	70%	0%
30%	50%	20%	50%
10%	500%	10%	500%

Coverage	Premium
Hurricane	900
Earthquake	100
Total	**1,000**

- Hurricane and earthquake losses have a correlation coefficient of –0.1.
- The risk load multiplier, λ, is 0.00025.
- Premiums are prior to the application of the risk load.

(a) (*2 points*) Calculate the variance risk load for the portfolio, before and after the addition of the earthquake coverage.

(b) (*1 point*) Calculate the renewal risk loads for both hurricane and earthquake coverages using the Marginal Variance method.

(c) (*1 point*) Calculate the renewal risk loads for both hurricane and earthquake coverages using the Shapley method.

3. (*6 points*) You are given the following triangle of cumulative paid losses:

	Months of Development		
Accident Year	12	24	36
2012	4,000	7,000	8,000
2013	5,000	7,000	
2014	6,000		

Each accident year is assumed to be fully developed as of 36 months.

You model development using Clark's truncated LDF method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-\frac{x}{\theta}}$.
The maximum likelihood estimate of θ is 7.94.

(a) (*1.5 points*) Calculate the expected amount to be paid in calendar year 2015.

(b) (*1 point*) Calculate the expected amount to be paid in calendar year 2016.

The estimate of the scaling factor σ^2 is 318.

(c) (*0.5 points*) Explain the purpose of the scaling factor.

(d) (*0.5 points*) Estimate the process standard deviation of losses paid in calendar year 2015.

(e) (*0.5 points*) Estimate the process standard deviation of losses paid in calendar year 2016.

(f) (*1 point*) Calculate the discounted loss reserve for all accident years combined using an annual discount rate of 5%.

(g) (*1 point*) Estimate the process standard deviation of the discounted loss reserve for all accident years combined.

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	12,652	20,548	26,243	30,915	31,365	32,082	32,784	0
2	9,532	12,208	16,229	16,824	16,909	17,223	17,600	6
3	15,074	18,423	25,004	28,617	30,524	31,176	31,858	103
4	27,655	43,895	54,236	58,131	59,990	61,271	62,612	1,775
5	25,451	33,237	35,821	39,581	40,847	41,719	42,632	2,736
6	19,778	22,434	27,543	30,434	31,407	32,078	32,780	4,117
7	16,758	22,936	28,159	31,115	32,110	32,796	33,513	6,939
f_k	1.36864	1.22774	1.10496	1.03198	1.02136	1.02188		
α_k^2	746.086	308.903	104.826	27.980	0.202	0.00146		

(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.

One of Mack's assumptions is $E(C_{i,k+1} \mid C_{i1}, \ldots, C_{ik}) = C_{ik} f_k, \quad 1 \le i \le I, 1 \le k \le I-1$.

(c) (*0.5 points*) Explain why f_k has only the subscript *k* and not both *i* and *k*.

Mack shows that under his assumptions, $C_{ik} / C_{i,k-1}$ and $C_{i,k+1} / C_{ik}$ are uncorrelated.

(d) (*0.5 points*) Describe a situation where these ratios may be correlated.

(e) (*1 point*) Explain why the formula used to estimate α_1^2 through α_5^2 cannot be used to estimate α_6^2.

4. Continued

In the paper "Testing the Assumptions of Age-to-Age Factors," Venter closes with the following statement: "An actuary might advise: 'If the chain ladder doesn't work, try Bornhuetter-Ferguson.'"

(f) (*1 point*) Explain what Venter means when using the terms "doesn't work" and "try."

5. (*4 points*) BCD Corporation has ten years of experience data on each of thirty groups. It plans to use the model and methods in "Credibility with Shifting Risk Parameters" to estimate expected costs two years from now. From the paper, the formula for the credibility weights (making the simplifying assumptions set forth in the paper) for the *j*th group is:

$$\begin{bmatrix} Z_{j,1} \\ Z_{j,2} \\ \vdots \\ Z_{j,10} \end{bmatrix} = \begin{bmatrix} \sigma^2 / w_{j,1} + \delta_0 + \tau^2 & \delta_1 + \tau^2 & \cdots & \delta_9 + \tau^2 \\ \delta_1 + \tau^2 & \sigma^2 / w_{j,2} + \delta_0 + \tau^2 & \cdots & \delta_8 + \tau^2 \\ \vdots & \vdots & \ddots & \vdots \\ \delta_9 + \tau^2 & \delta_8 + \tau^2 & \cdots & \sigma^2 / w_{j,10} + \delta_0 + \tau^2 \end{bmatrix}^{-1} \begin{bmatrix} \delta_{11} + \tau^2 \\ \delta_{10} + \tau^2 \\ \vdots \\ \delta_2 + \tau^2 \end{bmatrix}$$

(a) (*1 point*) Identify the simplifying assumptions reflected in this formula.

(b) (*1 point*) Explain why it is not possible to estimate δ_{10} and δ_{11} without further assumptions.

BCD is considering using an MA(2) model to describe the time dependency of the observations.

(c) (*1 point*) Explain why assuming an MA(2) model overcomes the issue identified in part (b).

BCD plans to use restricted maximum likelihood estimation (REML) to estimate the model parameters. Alternatives that were considered are maximum likelihood estimation (MLE) and method of moments estimation (MM).

(d) (*1 point*) State an advantage of REML with respect to MLE and a different advantage with respect to MM.

6. (*5 points*) You are using the following assumptions to set the premium for a one-year policy:

- The premium will be collected at policy inception.
- Expenses of 30 will be paid at policy inception.
- Losses are expected to be 65 and will be paid at policy expiration.
- The target total rate of return is 13%.
- Investable assets are equal to premium minus expenses plus owners' equity.
- The ratio of premium to owners' equity is 2 to 1.
- The investment return is the risk-free rate of 1.25%.
- The market risk premium is 11.75%.
- The underwriting beta is 0.5.
- The risk-adjusted rate for losses is −7.143%.

(a) (*4 points*) Demonstrate that the Target Total Rate of Return Model, the Capital Asset Pricing Model, and the Risk Adjusted Discount Technique all produce a premium of 100, if taxes are ignored.

(b) (*1 point*) Identify one drawback of each of the three methods.

7. (*4 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:

	Proportion of Insurance Liabilities (Weights)	
Line of Business	**Outstanding Claim Liabilities**	**Premium Liabilities**
Motor	10%	20%
Home	10%	20%
Liability	30%	10%
Total	**50%**	**50%**

Line of Business	**Outstanding Claim Liabilities Internal Systemic Risk Coefficients of Variation**
Motor	6.5%
Home	4.5%
Liability	7.5%

Outstanding Claim Liabilities Internal Systemic Risk Correlation Matrix			
	Motor	Home	Liability
Motor	100%	50%	25%
Home	50%	100%	25%
Liability	25%	25%	100%

(a) (*2 points*) Calculate the internal systemic risk coefficient of variation for outstanding claim liabilities for all lines combined.

(b) (*0.5 points*) Define external systemic risk.

(c) (*1 point*) Describe two sources of external systemic risk.

(d) (*0.5 points*) Explain why traditional quantitative modeling techniques alone are inadequate to capture external systemic risk.

8. (*6 points*) Property R Us Reinsurance Company has been presented with an opportunity to write a property catastrophe cover with an occurrence limit of 20,000,000 and an unlimited number of reinstatements.

(a) (*0.5 points*) Identify two types of information that would be needed to price the cover using a catastrophe model.

The catastrophe model being used for the analysis indicates that the annual number of losses will follow a Poisson distribution with mean 0.1 and that 50% of the losses that occur will exhaust half the limit (i.e., 10,000,000) and 50% of the losses will exhaust the entire limit (i.e., 20,000,000).

(b) (*2 points*) Calculate the probability that annual losses will exceed 20,000,000.

The ceding company has requested a quotation of terms on both a traditional basis and a finite basis.

(c) (*1.5 points*) Propose terms on a traditional basis. Justify your proposal.

(d) (*2 points*) Propose terms on a finite basis. Justify your proposal.

****END OF EXAMINATION****

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