SOCIETY OF ACTUARIES
Advanced Topics in General Insurance

Exam GIADV

Date: Friday, April 28, 2017
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. (*6 points*) Casualty R Us Reinsurance Company has been presented with an opportunity to write a casualty per occurrence excess treaty for accident year 2018 covering the layer 200,000 excess of 400,000.

You are given the following information:

- The following loss experience has been provided, evaluated as of 12/31/2016:

Accident Date	Untrended Loss	Untrended ALAE
7/1/2014	200,000	100,000
7/1/2014	400,000	200,000
7/1/2015	550,000	0
7/1/2015	1,000,000	500,000
7/1/2016	600,000	300,000
7/1/2016	450,000	0

- All losses of at least 200,000 are shown.
- All policy limits throughout the experience period are 1,000,000 and are expected to remain at this level through 2018.
- On level subject premium is 10,000,000 for each year from 2014-2016.
- ALAE is allocated to layer in proportion to losses.
- Loss and ALAE trend are each 6% per year.
- The following accident year development factors are applicable to both loss and ALAE in the layer 200,000 excess of 400,000:

12-Ultimate	2.00
24-Ultimate	1.50
36-Ultimate	1.10

(a) (*4 points*) Estimate the experience rating loss and ALAE cost as a percentage of the subject premium.

The ceding company requests alternative quotes on the following two layers:

(i) 200,000 excess of 300,000

(ii) 200,000 excess of 200,000

(b) (*2 points*) Explain what additional information you would need, if any, to experience rate each layer.

2. (*4 points*) You are calculating a risk margin for claim liabilities using a balanced scorecard approach as set out in "A Framework for Assessing Risk Margins." The following information is provided:

Potential Risk Indicators	Motor Score – Outstanding Claims	Home Score – Outstanding Claims
1. Ability to model using more granular data	3	5
2. Best predictors are stable over time	5	3
3. Checks on reasonableness of results	2	3
4. Data subject to appropriate reconciliations and quality control	4	4
5. Knowledge of past processes affecting predictors	7	6
6. Value of predictors used	3	4

Score from Balanced Scorecard	Motor CoV	Home CoV
1.0 to 2.0	15.0%	15.0%
2.0 to 3.0	11.0%	11.0%
3.0 to 4.0	8.5%	8.5%
4.0 to 5.0	6.0%	6.0%

	Proportion of Insurance Liabilities	
Line of Business	Outstanding Claim Liabilities	Premium Liabilities
Motor	20%	10%
Home	30%	40%
Total	**50%**	**50%**

- The correlation between motor and home outstanding claim liabilities is 50%.
- Risk indicator weights are equal within each source of internal systemic risk.
- Risk indicator weights for each source of internal systemic risk are:
  - 30% for specification error;
  - 50% for parameter selection error; and
  - 20% for data error.

(a) (*3 points*) Calculate the internal systemic risk coefficient of variation for outstanding claim liabilities for both lines combined.

A reasonable a priori assumption is that similar balanced scorecard scales can be used for both outstanding claim and premium liabilities.

(b) (*1 point*) Provide a situation where this a priori assumption may not hold.

3. (*4 points*)

(a) (*1 point*) State four assumptions of the Capital Asset Pricing Model.

You are using the Capital Asset Pricing Model to determine the underwriting profit margin to factor into the upcoming year's premiums for homeowners insurance. The following information is provided:

- The risk-free rate is 2%.
- The slope of the Security Market Line is 3%.
- The covariance between the underwriting return and the market return is half the variance of the market return.
- The funds generating coefficient is 0.75.
- The equity to premium ratio is 2.0.
- The corporate tax rate is 35%.
- The insurer's pre-tax investment income is distributed as follows:
    - 20% from tax-exempt bonds;
    - 20% from dividends taxed at 30% of the corporate tax rate; and
    - 60% from investments taxed as ordinary income.

(b) (*3 points*) Calculate the underwriting profit margin.

4. (*7 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	20,587	29,243	33,208	35,957	36,328	37,131	37,871	0
2	21,399	23,109	30,971	36,752	38,103	38,877	39,652	2
3	22,259	31,780	42,282	45,157	48,759	49,792	50,784	71
4	23,191	33,060	46,113	48,668	50,866	51,944	52,979	1,936
5	25,065	29,536	38,140	41,630	43,510	44,432	45,317	3,157
6	25,024	40,688	52,885	57,724	60,332	61,610	62,838	6,018
7	25,387	34,597	44,968	49,083	51,300	52,387	53,431	9,745
f_k	1.36278	1.29978	1.09150	1.04517	1.02119	1.01993		
α_k^2	910.323	289.210	122.133	50.162	0.0596	0.000071		

(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 5 was correctly calculated.

Each of the estimated development factors ($f_1,\ldots, f_6$) is greater than one.

(c) (*1 point*) Indicate whether or not this observation provides support for the underlying assumptions of Mack's model. Justify your response.

In addition to the estimated development factors being greater than one, the observed paid claims in each row in the table above are increasing.

(d) (*1 point*) Indicate whether or not this observation provides support for the underlying assumptions of Mack's model. Justify your response.

4. Continued

Mack and Venter provide a variety of diagnostics that can be used to verify whether or not the assumptions underlying a loss development model are valid. Suppose that for a given model all of the diagnostics provide support.

(e) (*1 point*) Indicate whether or not this result confirms that the model's assumptions hold. Justify your response.

Now suppose that most of the diagnostics support the given model but one or two do not.

(f) (*1 point*) Indicate whether or not this result confirms that the model's assumptions do not hold. Justify your response.

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

	Months of Development		
Accident Year	12	24	36
2014	4,000	6,000	8,000
2015	5,000	7,000	
2016	6,000		

On level premium for each year is 12,000.

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

(a) (*0.5 points*) State one advantage and one disadvantage of using a parametric distribution function to model loss development.

The maximum likelihood estimates of *ELR* and θ are 75.20% and 8.858, respectively.

(b) (*1 point*) Estimate the expected payments in 2017 for accident year 2015.

(c) (*1 point*) Estimate ultimate losses for accident year 2016.

The estimate of σ^2 is 813.

(d) (*1 point*) Estimate the process standard deviation of the accident year 2016 reserve.

You are considering using the LDF method with the same cumulative distribution function.

(e) (*0.5 points*) Calculate the number of degrees of freedom in the estimate of σ^2 if the LDF method were used.

(f) (*1 point*) Indicate which of the LDF and Cape Cod methods is likely to have a smaller standard deviation of the total reserve. Justify your response.

6. (*4 points*) ABC Reinsurance Company has two accounts, X and Y. The following information is provided:

Account	**X**	**Y**
Expected Losses	2,000	450
Coefficient of Variation	30%	40%

- ABC uses the Marginal Surplus method to calculate risk loads.
- The required return on marginal surplus is 10%.
- The z-score multiplier is 2.33.
- The correlation between the losses for X and the losses for Y is 0.2.

(a) (*1 point*) Calculate the risk load for the combined portfolio of X and Y.

(b) (*1 point*) Calculate the renewal risk loads for accounts X and Y.

(c) (*0.5 points*) State a problem with using the Marginal Surplus method to calculate renewal risk loads.

ABC is considering using the Shapley method to allocate risk loads. The risk load for the combined portfolio of X and Y is the same as in part (a).

(d) (*1.5 points*) Calculate the renewal risk loads for accounts X and Y using the Shapley method.

7. (*4 points*) You are given the following quantities with respect to a retrospective rating plan:

- *b*, the basic premium
- *E*, the expected loss
- *e*, the total expenses
- *C*, the loss conversion factor
- *I*, the net insurance charge of Table M

(a) (*2 points*) Provide an equation that demonstrates the relationship among all five of the quantities above.

(b) (*0.5 points*) Provide an expression for the minimum premium *H* in terms of *b*, *E*, *C* and r_H, the entry ratio corresponding to the minimum premium.

(c) (*0.5 points*) Provide an expression for the maximum premium *G* in terms of *b*, *E*, *C* and r_G, the entry ratio corresponding to the maximum premium.

(d) (*1 point*) Provide an expression for *I* in terms of *E*, the Table M savings $\psi(r_H)$, and the Table M charge $\phi(r_G)$.

8. (*6 points*) You project that the number of catastrophe losses next year for your company will follow a Poisson distribution with mean 2 and that each loss size will have the following probability function:

Loss Size	Probability
1 billion	0.4
2 billion	0.3
3 billion	0.2
4 billion	0.1

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

The aggregate distribution of catastrophe losses has the following probability function for aggregate losses below 10 billion:

Aggregate Losses	Probability
0 billion	0.1353
1 billion	0.1083
2 billion	0.1245
3 billion	0.1306
4 billion	0.1230
5 billion	0.0982
6 billion	0.0804
7 billion	0.0621
8 billion	0.0453
9 billion	0.0318

(a) (*3 points*) Calculate the probability that aggregate catastrophe losses will be 10 billion.

(b) (*1.5 points*) Calculate the mean and coefficient of variation of aggregate catastrophe losses.

You decide to approximate aggregate catastrophe losses with a lognormal distribution.

(c) (*1.5 points*) Calculate the parameters of the lognormal distribution using your answer to part (b).

****END OF EXAMINATION****

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