
SOCIETY OF ACTUARIES
Enterprise Risk Management – General Insurance Extension

Exam ERM-GI

Date: Tuesday, November 1, 2016

Time: 8:30 a.m. – 12:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 80 points.

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

The points for each question are indicated at the beginning of the question. Questions 7 and 8 pertain to the extension readings and/or the Case Study, which is enclosed inside the front cover of this exam booklet.

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 ERM-GI.
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.

CASE STUDY INSTRUCTIONS

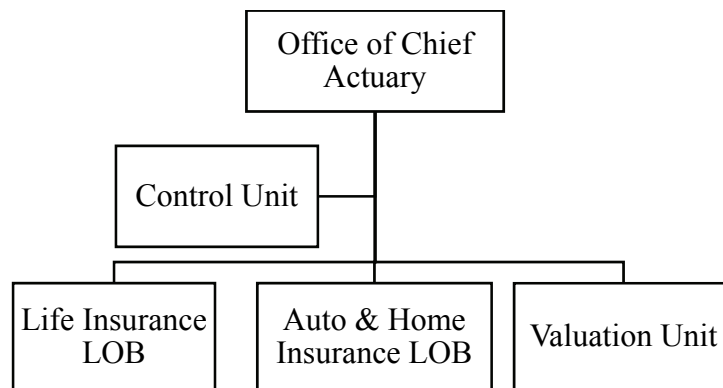
The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

****BEGINNING OF EXAMINATION****

1. (7 points) You are a Risk Management actuary for ABC, a multi-line life insurance company with both life and annuity business. ABC is acquiring XYZ which has two lines of business (LOB):

- Life insurance
- Auto and homeowner's insurance

You have gathered the following information about XYZ's risk management structure before the acquisition:



- Each LOB is responsible for its own product pricing, assumptions setting and profit projections.
- Valuation Unit calculates reserves using pricing assumptions provided by LOBs.
- Control Unit calculates Economic Capital based on the pricing model and assumptions.
- Control Unit also conducts periodic reviews of LOBs and Valuation Unit which are provided to Chief Actuary.

(a) (3 points) ABC considers adoption of the three lines of defense approach as the risk governance and internal controls system.

- (i) Compare XYZ's risk management structure to the three lines of defense framework.
- (ii) Recommend improvements to enhance risk governance.

1. Continued

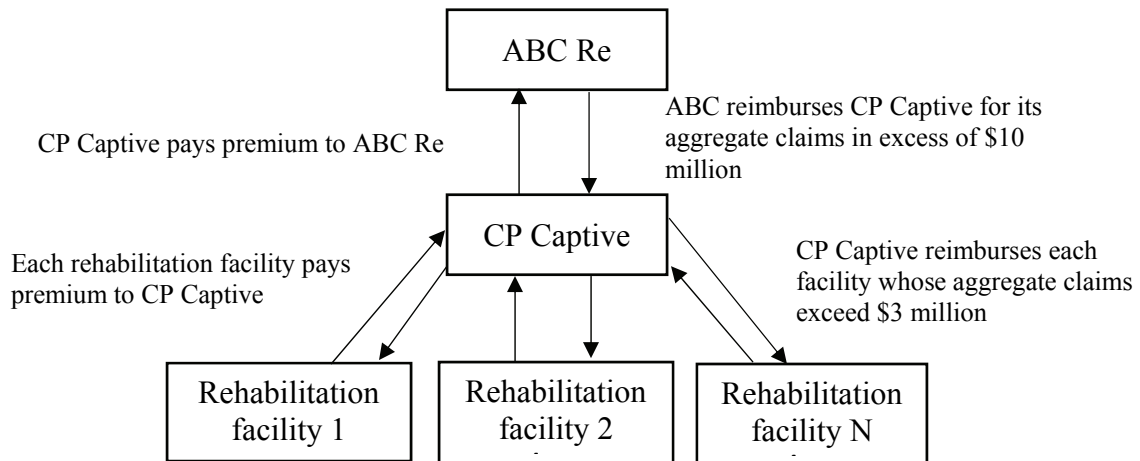
- (b) (2 points) Assess XYZ's existing Economic Capital modeling considerations in light of the acquisition.
- (c) (2 points) You prepared the Own Risk and Solvency Assessment (ORSA) for ABC before the acquisition.

Describe the potential issues, excluding XYZ's Economic Capital modeling considerations from part (b), to address when preparing the ORSA for the combined company after the acquisition.

2. (13 points) You are the CRO of ABC Re, a U.S. group benefits reinsurance company that assumes medical stop-loss business.

A group of rehabilitation facilities has formed a captive insurance company, CP Captive. CP Captive enables each facility to participate in the collective experience. CP Captive is a large enough group to apply for stop-loss coverage.

The chart below illustrates the reinsurance arrangement.



- (a) (4 points)
- (i) Describe the essential elements of captive insurance.
 - (ii) Determine whether CP Captive qualifies as a captive insurance company. Justify your response.
 - (iii) Determine what type of captive CP Captive most resembles. Justify your response.

2. Continued

(b) (4 points) You identified the following top four risks for ABC Re in this captive arrangement:

- Reinsurance treaty negotiation
- Insurance
- Legal and regulatory
- Operational

Describe approaches for ABC Re to manage each of these risks.

(c) (5 points) As a means to manage capital efficiently, ABC Re proposes ceding a portion of the assumed risks from CP Captive to an offshore affiliate in the Cayman Islands called Retro Life.

- (i) Describe key advantages and disadvantages of entering into a reinsurance agreement between ABC Re and Retro Life.
- (ii) Recommend a course of action with regard to this proposal. Justify your response.

- 3.** (12 points) DirectComp is an insurer that sells an annuity product with benefits linked to the S&P 500 index. The product has a very long liability-duration profile. Premiums are collected in the first two policy years, and most benefit payments occur after fifteen years.

DirectComp's economic reserve is calculated using the CTE70 measure of the accumulated deficiency via Monte Carlo simulation. The accumulated deficiency is defined as present value of future benefits minus present value of future premiums.

In 2006, DirectComp and Reinsurer entered into a 90% quota share coinsurance agreement whereby the Reinsurer would receive the annuity premiums from DirectComp and pay benefits when they occur. In addition, the Reinsurer was required to hold collateral equal to DirectComp's economic reserve in a trust account.

- (a) (1 point) Describe the steps to compute DirectComp's economic reserve requirement using Monte Carlo simulation.
- (b) (2 points) Explain the advantages and disadvantages of using Monte Carlo simulation to determine DirectComp's economic reserve.
- (c) (1 point) Determine whether a risk-neutral or real world model is more appropriate when performing DirectComp's economic reserve calculation. Justify your response.

3. Continued

- (d) (5 points) In 2016, Reinsurer is performing a retrospective analysis of this reinsurance arrangement as a case study.

At pricing (in 2006), DirectComp conducted the following stress test for Reinsurer and showed that the biggest increase in CTE70 was 25%, which Reinsurer considered to be within its tolerance.

Account Value Shock	CTE70 (Million)	% of Baseline
Baseline	100	
-10%	104	104%
-20%	110	110%
-30%	125	125%

When it received the 2008 annual reinsurance report in early 2009, Reinsurer observed that its collateral asset requirement had increased by 80% during the 2008 financial crisis.

- (i) Analyze the adequacy of the provided stress test.
- (ii) Evaluate whether the collateral asset increase is reasonable.
- (iii) Identify the risks DirectComp is exposed to from the reinsurance arrangement.
- (iv) Recommend actions DirectComp could have taken in advance to mitigate risks from the reinsurance arrangement that you identified in (iii).

Question 3 continued on next page

3. Continued

- (e) (3 points) Following the increase in the collateral requirement in 2009, Reinsurer became skeptical about the reserve amount quoted by DirectComp and requested annual validation of the model DirectComp uses to calculate the reserve.

The following steps were taken by DirectComp to complete the annual model validation:

- DirectComp’s chief actuary assigned the writing of the report for Reinsurer to the department that developed the model.
 - The annual validation report was included in the department’s “critical date” list so that whoever could work it into his/her work load around the time it was due would complete the task.
 - The report writer worked from audit reports, results of tests that were run to check on certain calculations performed in the model, or any other existing documentation that had been created throughout the year.
- (i) Evaluate the adherence of DirectComp’s model validation process to key model validation principles.
- (ii) Recommend any changes or enhancements that DirectComp should make to this process.

4. (8 points) You are a portfolio manager and are responsible for making investment decisions on behalf of one of your company's biggest clients – Mr. Jackson. Mr. Jackson currently has \$5 million invested entirely in Fund A and he wishes to invest an additional \$3 million into either Fund B or Fund C in order to reduce portfolio volatility. Characteristics for each fund are listed in the table below.

Fund	Fund Variance	Correlation Coefficient – Relative to Fund A
A	1.00%	1.0
B	4.00%	-0.3
C	2.25%	-0.2

- (a) (2 points) Demonstrate that investing the \$3 million in Fund C results in a lower 95% VaR for the aggregate portfolio than investing in Fund B. Show your work.

Mr. Jackson's aggregate portfolio now includes \$5 million in Fund A and \$3 million in Fund C.

- (b) (1 point) Calculate the diversification benefit for Mr. Jackson's aggregate portfolio.
- (c) (1 point) Describe two factors, besides the diversification effect, that an investor should consider when adding funds to a portfolio.
- (d) (4 points) At the end of the following month, Mr. Jackson plans on making an additional contribution in the amount of \$100,000 to either Fund A or Fund C.
- Calculate β for each of these two funds before the additional contribution.
 - Estimate, for each of the two funds, the marginal impact to the 95% VaR of investing \$100,000.
 - Discuss the limitations of using the calculated β to estimate marginal VaR.
 - Recommend an alternative method to estimate marginal VaR.

5. (11 points) Bank XYZ is concerned about its vulnerability to losses due to cyberliability risk. Such losses may result from fraud, settlement with account owners, or government fines after a hacking event.

You are developing a model for quantifying cyberliability risk for Bank XYZ. Below is a table of losses for known hacking events at companies of similar size over the past five years. All these cyber loss events were reported in major news media when they occurred.

Company Hacked	Loss Amount from Individual Hacking Event Millions of \$
A	45
A	276
B	102
C	330
C	700
D	19
E	557

- (a) (3 points)

- (i) Describe challenges that you would encounter in developing a cyberliability risk model for Bank XYZ.
- (ii) Explain how you would address these challenges.

You decide to model the cyberliability loss distribution using a two-parameter generalized Pareto distribution as below:

$$F(x) = 1 - \left(1 + \xi \frac{x-u}{\beta} \right)^{-\frac{1}{\xi}}, x \geq u$$

5. Continued

- (b) (1 point) Explain why this distribution may be appropriate for fitting these data.
- (c) (1 point) Explain the considerations in setting the threshold parameter.

Assume:

- The threshold has been set at \$100 million
- The probability of exceeding the threshold is 5%
- Shape parameter equals 1
- The most extreme data point falls between the 98th and 99.5th percentiles of the full loss distribution.

- (d) (5 points)
- (i) Calculate the range for beta under these assumptions. Show your work.
- (ii) Calculate the range for the 99th percentile of the loss distribution under these assumptions. Show your work.
- (e) (1 point) Recommend two methods to validate inputs for the cyberliability model.

6. (9 points) You work as a financial analyst for ABC. During a recent review, one rating agency expressed concern over increased exposure to credit risk due to the prevalence of below investment grade bonds in the company's investment portfolio.

- (a) (1 point) Describe three components of credit risk.
- (b) (1 point) Your manager states that because VaR and CTE are used extensively in ABC's risk management activities, these are appropriate risk measures for credit risk analysis.

Critique your manager's statement.

(c) (2 points) The CFO recommends that ABC establish a special purpose vehicle (SPV) into which many of the below investment grade bonds would be transferred. The CFO claims that this arrangement would move these risks off ABC's balance sheet.

- (i) Explain bankruptcy remoteness and off-balance sheet accounting as they relate to the CFO's proposal.
- (ii) Recommend alternatives for managing ABC's credit risk.

(d) (3 points) The CFO has provided the following details:

- ABC is subject to IFRS rules.
- The SPV would be established as a U.S. limited liability corporation.
- The SPV would only act on behalf of ABC.
- ABC would be the sole investor in the SPV.

The CFO doesn't want the SPV to be considered "controlled" under IFRS.

- (i) Describe the term "controlled" in the context of SPV accounting under IFRS
- (ii) Explain why the SPV is considered "controlled" under IFRS
- (iii) Propose changes to the SPV so that it will not be considered "controlled" under IFRS.
- (e) (2 points) The CFO states that an SPV will address the concerns expressed by the rating agency.

Critique this statement.

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**Questions 7 and 8 pertain to the Case Study and/or extension readings.
Each question should be answered independently.**

7. (9 points) Pryde is considering investing in one of four strategic initiatives. Lyon will provide \$100 million of capital to support the selected initiative.

Pryde’s current risk appetite specifies that the estimated net Probable Maximum Loss (PML) from a 1 in 250-year event is limited to 10% of statutory capital and surplus, and that economic capital is maintained at a 99% VaR level.

The strategic initiatives under consideration are shown in the table below:

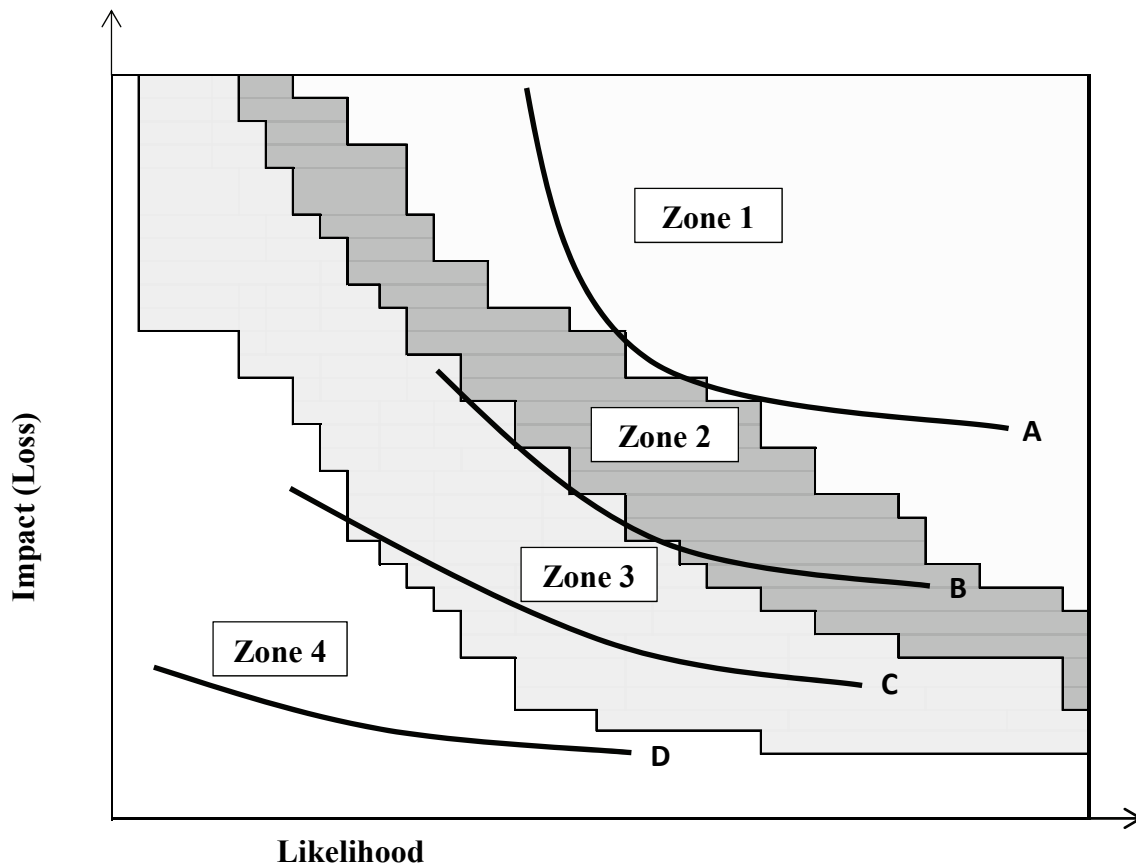
Strategic Initiative 1	Develop new distribution system to target new customer segment
Strategic Initiative 2	Increase market share in Florida
Strategic Initiative 3	Increase Personal Auto portfolio through acquisition
Strategic Initiative 4	Increase retention in reinsurance coverage with Big Re

- (a) (1.5 points) Assess the risk of failure as high, medium, or low for each strategic initiative based on the business innovation risk relative to Pryde’s current business. Justify your answers.
- (b) (2 points) You have assessed the expected payoffs from the strategic initiatives, as follows:

		Expected Return on Capital (ROC)	Standard Deviation
Strategic Initiative 1	Develop new distribution system to target new customer segment	7%	4%
Strategic Initiative 2	Increase market share in Florida	15%	24%
Strategic Initiative 3	Increase Personal Auto portfolio through acquisition	5%	2%
Strategic Initiative 4	Increase retention in reinsurance coverage with Big Re	11%	8%

7. Continued

You next use a risk heat map matrix to assess the initiatives as follows:



- (i) Identify which line (A, B, C, or D) in the graph corresponds to each strategic initiative. Justify your response.
- (ii) Rank the proposed strategic initiatives from a risk appetite perspective, based on their locations on the heat map. Justify your rankings.

Question 7 continued on next page

7. Continued

- (c) (2.5 points) To further analyze the potential strategic initiatives, Pryde has run economic scenarios for its total business assuming each initiative is selected, one at a time. The results for projected year-end 2016 are summarized in the following table.

			Total Company	
		Expected Return on Capital (ROC)	VaR (99%) (millions)	250-year PML (millions)
Strategic Initiative 1	Develop new distribution system to target new customer segment	7%	1,050	48
Strategic Initiative 2	Increase market share in Florida	15%	1,120	100
Strategic Initiative 3	Increase Personal Auto portfolio through acquisition	5%	1,005	44
Strategic Initiative 4	Increase retention in reinsurance coverage with Big Re	11%	1,095	90

Recommend which initiative or initiatives should be considered, given these results and the analysis in previous parts. Justify your answer.

- (d) (2 points)
- (i) Describe the limitations of the analysis you have completed so far.
 - (ii) Describe two other factors that might be taken into consideration in deciding which initiative to pursue.

- (e) (1 point) For any initiative that exceeds either capital at risk limit:

Propose actions that Pryde can consider for reducing exposure with respect to the strategic initiative in order to meet its capital at risk limits.

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- 8.** (11 points) Pryde is reviewing its catastrophe exposure in preparation for the Standard & Poor's (S&P) rating review.

You are given the following information:

- Pryde has a granular view of exposure in areas of high concentration.
- Pryde has some in-house expertise, with reliance on external (i.e., reinsurance company) resources.
- Pryde performs sufficient validation of in-house models and data.

- (a) (1 point) Identify important considerations for Pryde's S&P rating pertaining to the risk controls and risk model sub-factors.
- (b) (1 point) Assess what the appropriate S&P score would be for Pryde based on the risk controls and risk model sub-factors. Justify your response.
- (c) (0.5 points) Pryde is considering expanding its catastrophe business to cover flood events.

Identify the expected impact on the S&P risk control score if Pryde completes this expansion. Justify your response.

- (d) (3 points) The Event Loss Tables (ELTs) for the current Hurricane (HU) and potential Flood (FL) businesses are given in the tables below. Each row involves a set of events of similar severity.

Event Set	Annual Rate	Loss (millions)	EP (Exceedance Probability)
U.S. HU101	0.08%	\$186	0.08%
U.S. HU102	0.12%	\$127	0.20%
U.S. HU103	0.09%	\$123	0.29%

Event Set	Annual Rate	Loss (millions)	EP (Exceedance Probability)
U.S. FL101	0.03%	\$167	0.03%
U.S. FL102	0.19%	\$154	0.22%
U.S. FL103	0.16%	\$103	0.38%

8. Continued

- (i) Group the data into a single table, assuming no interaction in the outcomes for the events in the two tables.
- (ii) Identify issues with combining this data into a single table.
- (iii) Assume all the floods in U.S. FL101 are associated with hurricanes classified as U.S. HU101. Other than those events, hurricanes and floods are assumed to be independent.

Group the data into a single table.

- (e) (1.5 points) Pryde wants to improve its catastrophe models in order to re-evaluate its catastrophe reinsurance program.
 - (i) Describe three potential uses of catastrophe models for Pryde.
 - (ii) Describe additional information that Pryde would need to provide with respect to the Exposure Data module of a model to improve its modelling of earthquake and hurricane risks.

Question 8 continued on next page

8. Continued

- (f) (2.5 points) Pryde is considering developing a stochastic catastrophe model. For Hurricane events, Pryde will fit a stochastic model for each entry in the ELT.

The model for each ELT entry is assumed to be Compound Poisson, conditional on the event happening. The individual events are assumed to arise each year with frequency modelled as a Poisson random variable. The frequency and severity parameters vary for each entry. An excerpt is given below.

	Annual Frequency	Poisson parameter for the loss frequency given the event occurs	Expected Severity of each individual loss given the event occurs (millions)	Standard deviation of severity of individual losses (millions)
U.S. HU101	0.08%	1200	186	200
U.S. HU102	0.12%	1000	127	140
U.S. HU103	0.09%	1000	123	85

- (i) Explain why the severity distribution may differ for the different Hurricane entries.
- (ii) Calculate the 95% VaR for the aggregate losses under HU101, using a normal approximation to the aggregate distribution.
- (g) (1.5 points) Describe two advantages and two disadvantages of the stochastic model compared with the ELT approach.

****END OF EXAMINATION****

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