SOCIETY OF ACTUARIES
Enterprise Risk Management – General Corporate ERM Extension

Exam ERM-GC

Date: Friday, April 28, 2017
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 9 questions, numbered 1 through 9.

   The points for each question are indicated at the beginning of the question. Questions 8 and 9 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-GC.

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 ERM-GC Front Cover

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. (*10 points*) DML is a large life insurance company and is due to report its economic capital (EC) to the regulators. DML currently offers three main products:

- **Single premium immediate annuity (SPIA**)
  - Level payments are guaranteed for life.
  - The current mortality assumption is based on DML's experience, but the experience data are not fully credible.
  - One set of assumptions is used for the entire block.
- **5-year deferred annuity**
  - The credited rate is guaranteed for the term of the contract.
  - The death benefit is equal to the book value of the account.
  - There are no surrender charges after 2 years.
- **Participating whole life insurance**
  - This product provides a level death benefit plus accrued dividend.
  - The dividend is based on the difference between actual rates of mortality and interest versus rates assumed in the contract.
  - There is currently no more room to pass adverse experience to policyholders.
  - This product is sold in three different countries but the mortality assumption is based on the DML's experience in its home country.

The assets supporting the DML liabilities are corporate bonds with an average duration of 10 years. The liability duration is 17 years.

(a) (*2 points*) Describe two important considerations for measuring and modeling each of the following risks for DML:

- Mortality risk
- Interest rate risk.

(b) (*5 points*)

(i) Explain how mortality and interest rate risks interact within each of DML's three main products as well as across products. Use examples to illustrate your response.

(ii) Describe the following approaches to aggregate EC:

- Correlation
- Copulas
- Multivariate methods

(iii) Recommend an appropriate capital aggregation approach for determining the DML's EC. Justify your answer.

1. Continued

(c) (*3 points*) You are reviewing DML's model governance procedures. All you found was evidence of the following three activities:

- Model output should be validated by comparing the projected premiums and benefits from the EC model with those from the cash flow testing model for a set of ten random policies.
- All individual risk factors should be validated independently and in aggregate.
- Comprehensive documentation of model output should exist to support model validation.

(i) Evaluate how each of these activities adhere to core model validation principles.

(ii) Recommend steps that DML should implement to enhance its model governance procedures.

2. (*8 points*) You are an actuarial student at CMP Financial, an insurance company specializing in fire indemnity insurance. CMP Financial has a stop-loss reinsurance agreement with XYZ Re that reimburses aggregate monthly claims in excess of $130,000. CMP Financial receives an experience refund at the end of any calendar year in which no reimbursements are paid by XYZ Re.

Your boss, Stan, asks for your assistance with modeling aggregate monthly claims activity. Stan would like you to analyze claims using a Generalized Pareto Distribution (GPD).

In addition to providing summary statistics for historical aggregate monthly claim amounts for the block, Stan has also calculated estimates for the GPD parameters at various threshold percentiles.

Average Aggregate Monthly Claim = $12,200
Standard Deviation of Aggregate Monthly Claim = $53,000

Percentile	Aggregate Monthly Claim Amount in $ million	ξ	β
90th	0.095	0.12	0.05
91st	0.100	0.13	0.05
92nd	0.104	0.13	0.05
93rd	0.110	0.15	0.04
94th	0.115	0.15	0.04
95th	0.123	0.14	0.04
96th	0.134	0.14	0.04
97th	0.147	0.14	0.04

GPD's cumulative distribution function is

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

(a) (*2 points*)

(i) Explain considerations when selecting a threshold value for parameterizing a GPD.

(ii) Recommend an appropriate threshold level. Justify your response.

2. Continued

(b) (*3 points*) Assume that aggregate monthly claim amounts are independent of prior months' claim activity. Consider the following two claim models.

I. The GPD model using the threshold you recommended in part (a)
II. A normal approximation

Calculate the probabilities, for each claim model, that:

(i) No claim reimbursement will be made in a given month.

(ii) CMP will receive the experience refund at the end of the upcoming calendar year.

(c) (*3 points*) Stan is currently preparing cash flow projections for the upcoming calendar year and would like to incorporate the results of your analysis.

(i) Explain why the GPD model more appropriately reflects the true likelihood of payment of the experience refund.

(ii) Describe two shortcomings of the normal approximation in the context of modeling CMP's aggregate claim distribution.

3. (*12 points*) You are a new CERA hired by the finance department of Protection Partners (PP), a clearinghouse that trades derivatives and other financial instruments. PP has maintained an AA rating ever since its inception. You are analyzing a new credit derivative issued by XEN Bank that PP wishes to offer.

You are given:

- The annual risk free rate is 5%

ABC Bond

- Issued in $100 notional amount increments
- 3 year term
- Pays 15% annual coupons
- If the bond defaults, no coupon is paid, and the bondholder immediately receives whatever principal is recovered, terminating the bond contract.
- The probabilities of default are:
  - 5% in each of years 1 and 2
  - 10% in year 3
- The recovery rates given default are:
  - 0% with probability 50%
  - 50% with probability 30%
  - 75% with probability 20%

ABC Credit Derivative

- The derivative is on ABC bonds
- Each $100 ABC Credit Derivative backs $100 in ABC bonds
- When an ABC bond defaults, the ABC Credit Derivative will
  - Immediately pay the defaulted coupon
  - Pay any future coupons at their normal due date
  - Pay the unrecovered principal (with no adjustment for interest) at the planned ABC bond maturity.

(a) (*2.5 points*) Determine the price of the ABC Credit Derivative at issue assuming no taxes or profit margin. Show your work.

3. Continued

(b) (*3.5 points*)

(i) Describe how each of the following credit enhancers mitigates credit risk.

I. Collateral
II. Netting Agreement
III. Walkaway features

(ii) Explain whether the credit enhancers listed above are appropriate for the purchaser of the ABC Credit Derivative contract to use with PP.

(c) (*3.5 points*)

(i) Define Potential Future Exposure (PFE) and Expected Positive Exposure (EPE).

(ii) Identify which of PFE or EPE is more appropriate for capital purposes.

(iii) From PP's perspective:

Determine the PFE to PP from the ABC Credit Derivative assuming a 100% confidence level and a 0% interest rate. Explain your reasoning.

(iv) From the ABC Credit Derivative owner's perspective:

Determine the PFE from the ABC Credit Derivative assuming a 100% confidence level and a 0% interest rate. Explain your reasoning.

(d) (*1.5 points*) PP is putting together a brochure to help with understanding the ABC Credit Derivative. You have been asked to draft the answer to the following question in the brochure:

"Q: For this product, you list a value for the Potential Future Exposure that is very different from the Expected Positive Exposure. Which value should matter more to an investor?"

Prepare an answer to this question indicating which one is more important.

(e) (*1 point*) Other than minimizing their credit exposure to ABC, explain how ABC bondholders could benefit from owning the ABC Credit Derivative.

4. (*9 points*) You are given the following capital information on company XYZ for its three lines of business.

Line of Business	Stand-Alone Capital ($ million)
Annuities	20
Life	6
Auto	14

A matrix for the risk correlation between lines of business is provided below.

	Annuities	Life	Auto
Annuities	1	0.8	0.4
Life	0.8	1	0.5
Auto	0.4	0.5	1

(a) (*2 points*) Demonstrate that the diversification benefit for XYZ is $6.35 million. Assume that risks within lines of business are normally distributed.

(b) (*4 points*) Calculate the capital allocation using the following two methods:

I. Pro-rata
II. Discrete marginal contribution

(c) (*3 points*)

(i) Compare the following capital allocation approaches:

I. Standalone
II. Pro-rata
III. Discrete marginal contribution

(ii) Recommend a capital allocation method for XYZ. Justify your response.

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5. (*7 points*) You are asked to calculate economical capital (EC) for the Long Term Care (LTC) business of the XYZ Insurance Company. This block of business has the following characteristics:

- Level premium for life
- Policy pays certain qualified expenses incurred to assist with activities of daily living
- Liability duration is approximately 40 years at issue
- Supporting assets are invested in government securities and high-yield corporate bonds
- Interest rate swaps and options are used to manage interest rate risk
- Economic Liability is based on best estimate assumptions.

(a) (*2 points*) You are evaluating the following risk categories as related to the LTC business:

I. Insurance Risk
II. Credit Risk
III. Market Risk

(i) Describe the specific risks in each of above categories.

(ii) Rank the risks. Justify your response.

(b) (*2 points*) XYZ uses the deterministic stress tests to calculate EC.

Describe how you would select shocks for a deterministic stress test.

5. Continued

(c) (*3 points*) XYZ uses the following deterministic shocks:

- +/- 1% parallel shift in interest rates
- +/- 20% in lapse rates in all durations
- 10% increase in claims

XYZ's Chief Risk Officer (CRO) commented that:

I. Interest rate shock may not capture the inherent interest risk in this line of business.
II. The shock design seems overly simplistic to reflect all the material risks.

(i) Explain the CRO's concerns.

(ii) Provide recommendations to address the CRO's concerns.

6. (*8 points*) LMN Insurance Company, a BBB-rated insurer, plans to expand into a new market. The CFO of LMN is exploring the possibility of securing additional capital using Special Purpose Vehicles (SPV) to fund the expansion. The CFO thinks that the current financing rates are too high for what he thinks is a very low risk venture.

Major rating agencies recently changed LMN's credit rating outlook to negative.

LMN holds high-quality commercial real estate investments in a fast-growing city. This accounts for more than half of its asset portfolio.

The CFO suggests using the real estate portfolio to collateralize the bonds issued by an SPV to finance the expansion.

(a) (*0.5 point*) Define an SPV.

(b) (*3 points*) Illustrate how LMN can structure this SPV to obtain financing.

(c) (*2 points*) Identify four of the key risks and four of the key benefits of the SPV transaction for LMN.

(d) (*1 point*) Recommend whether LMN should proceed with the SPV transaction based on your response to (c). Justify your response.

(e) (*1.5 points*) Describe three other strategic considerations that LMN would need to address prior to initiating the SPV transaction.

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7. (*6 points*) XYZ is an insurance company that sells life insurance and hurricane insurance. In order to grow, XYZ is investigating selling a new tornado insurance product. For hurricane and tornado insurance combined, XYZ is willing to absorb a loss of $100 million, which is 10% of expected company-wide profits.

The CFO has asked you to quantify the risk of offering the tornado insurance. An outside consultant provided you with the sales data from several other companies that sell tornado insurance. The data for one company is shown below.

Date	Sales in Millions
Jan. 2010	15.34
Feb. 2011	18.23
Mar. 2012	18.23
Apr. 2013	18.23
May 2014	99.99
Jun. 2015	19.74

(a) (*3 points*) You are reviewing ASOP 23 prior to performing your work.

(i) Describe concerns you have with the data you have been provided.

(ii) Identify two key data-related disclosures that you would include as part of your actuarial report on the profitability of the tornado insurance.

7. Continued

Your colleague has estimated the 90% VaR for hurricane product's losses over 5 years to be $60 million; and the corresponding CTE to be $90 million.

Your calculations for the tornado product's losses show a 90% VaR over 5 years of $75 million, with a corresponding CTE of $120 million.

(b) (*1.5 points*) Explain whether VaR or CTE is the more appropriate risk measure to use in this situation.

(c) (*1.5 points*) The CFO has directed you to use the 90% VaR measure with complete independence between hurricane and the tornado products.

Recommend whether or not XYZ should offer the tornado product. Justify your response.

Questions 8-9 pertain to the Case Study and/or extension readings.
Each question should be answered independently

8. (*10 points*) Lyon hired you as a consultant to assess operational risk management at its insurance subsidiaries. Four recent events have prompted the review.

Event 1 – Pryde Claims personnel have been understating Workers Compensation case reserves in order to improve profits and get higher bonuses.

Event 2 – An audit of claims in Pryde's Personal Auto line revealed a history of fraud.

Event 3 – It was discovered that for certain of SLIC's Saver Supreme policies the account charges were input incorrectly in the administration system, resulting in overstated account values.

Event 4 – Certain agents for SLIC have been adding riders and extra coverages to certain insureds without their knowledge in order to earn credits for the convention in Hawaii.

(a) (*2 points*)

(i) Distinguish between an operational risk and an operations risk.

(ii) Indicate for each of the Events 1 – 4 whether it is an operations risk. Justify your response.

(iii) Determine which of the Events are significant enough that they should be immediately reported to the Board. Justify your response.

8. Continued

(b) (*4 points*)

(i) Identify which of the following risks are typically in the Traditional Operational Risk universe:

- Principal-Agent
- IT systems
- Legal Controls
- Rating Downgrade
- Liquidity
- Employee Turnover
- Lapse
- Issuer Concentration
- Financial Reporting

(ii) Identify for each of the Events 1-4 the type of operational risk illustrated, based on the Modern Operational Risk taxonomy.

(iii) Indicate for each of the Events 1-4 whether it is a controllable or non-controllable risk. Justify your response.

(iv) Explain how using a Modern Operational Risk Management approach may have detected the behavior described in Event 4 while Traditional Operational Risk Management may have missed it.

Question 8 continued on the next page.

8. Continued

(c) (*3 points*) Lyon is considering a possible risk mitigation to Event 2. Lyon's ERM department is evaluating a new fraud prevention system designed to identify fraudulent claims early in the claims paying process.

- From Pryde's historical actuarial analysis the expected loss due to fraudulent claims in a year is $3,000,000 with a 1% chance that losses due to fraudulent claims could be above $12,000,000.
- With the new proposed system, it is anticipated that the expected loss due to fraudulent claims will be reduced by 50% and that the aggregate exposure at the 99% risk threshold will be reduced by 60%.
- Annual cost of the new system: $2,000,000

Recommend to Lyon senior management whether Pryde should adopt this new system based on a cost-benefit analysis performed on an economic capital basis. Show your work.

(d) (*1 point*) Lyon is planning to issue a significant amount of new debt to take advantage of the low-interest rate environment.

Explain how this change could affect the analysis you completed in part (c).

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Questions 8-9 pertain to the Case Study and/or extension readings.
Each question should be answered independently

9. (*10 points*) AHA is considering offering $240 million cash for Eureka but, before doing so, has asked Lyon's risk team to evaluate the offer.

Eureka is a publicly traded company with 40% of the shares being owned by its President, Marvin Beetz, and his family. The company has 8 million shares outstanding and the current trading price is $24.50 per share. Mr. Beetz is seeking a 20% premium over the current price.

AHA believes that it can introduce rate increases and improve Eureka's performance despite its recent losses and has estimated Eureka's after tax profits in thousands as follows:

Year	After Tax Profits (Losses)
2017	$(6,285)
2018	(1,500)
2019	4,700
2020	8,100
2021	11,900

- The present value of after-tax profits for the sixth year and beyond is $175 million as of the valuation date.
- The present value of the release of surplus is $60 million.

(a) (*2 points*)

(i) Calculate the value of this acquisition.

(ii) Evaluate AHA's offer based solely on financial considerations.

(iii) Determine whether Mr. Beetz would accept or reject the offer based solely on financial considerations.

(b) (*2 points*)

(i) Identify four possible synergies that could result from this acquisition.

(ii) Assess whether AHA might realize the synergies.

9. Continued

(c) (*3 points*) Evaluate whether this acquisition fits within the draft of Lyon's Risk Appetite Statement.

(d) (*1.5 points*) Explain the challenges that AHA would face by operating in a jurisdiction with different regulations with respect to setting reserves and introducing new products.

(e) (*1.5 points*) Describe the key risks of the proposed acquisition.

****END OF EXAMINATION****

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