

Exam ERM

Date: Thursday, May 4, 2023

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 7 questions numbered 1 through 7 with a total of 60 points.

The points for each question are indicated at the beginning of the question. Questions 1 through 4 and question 7 pertain to the Case Study.

2. 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 provided in this document.

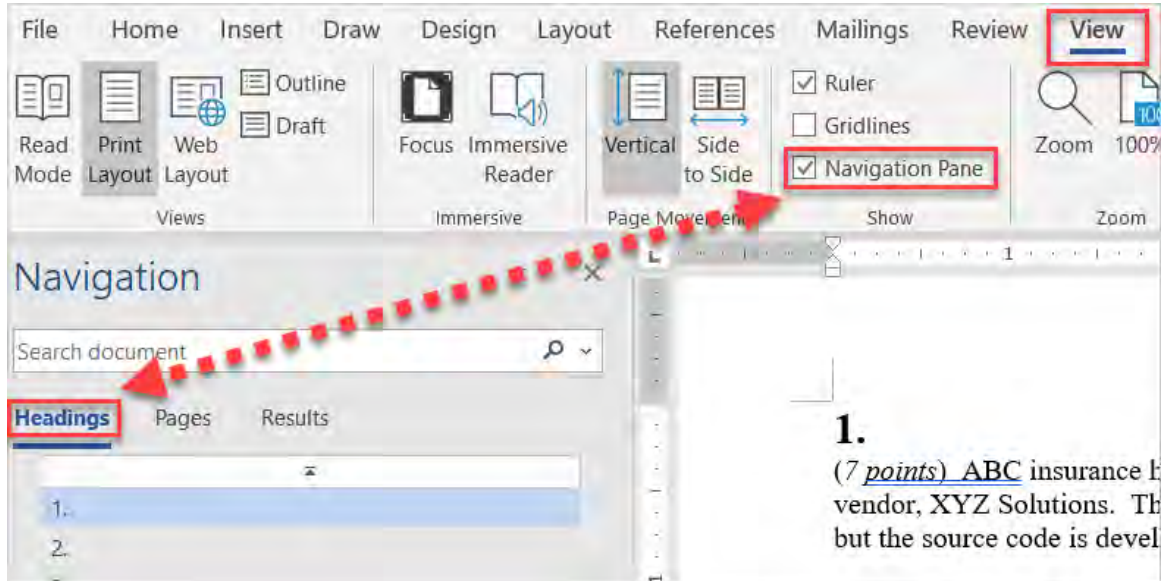
Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.
 - a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 (and ^ used to indicate a superscript).
 - b) In the Excel document formulas should be entered. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.
 - c) For each question part requiring an answer in Excel, (1) clearly identify the inputs to the calculations, (2) show the necessary interim calculations, adding rows and / or columns, if necessary, and (3) enter the final answer in some or all of the cells highlighted in yellow, as applicable in each circumstance. These cells should contain formulas with links to other calculations in the worksheet. Minimize the use of hard-coded figures and maximize the number of interim steps in the calculations that would demonstrate your line of thinking.
2. The answer should be confined to the question as set.
3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.
4. The Word and Excel files that contain your answers must be uploaded before the five-minute upload period expires.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:



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.

**Questions 1 through 4 and question 7 pertain to the Case Study.
Each question should be answered independently**

1.

(11 points) William Xu, SLIC SVP for Term Life operations, is advocating the use of predictive analytics to improve the competitiveness of the term life insurance products. Jamal Robinson, VP and Actuary - Operational Risk Management, raises the following concerns on the readiness of SLIC to support this strategy:

- SLIC does not have an established model risk governance framework.
- SLIC has no experience in predictive modeling.
- This model would have heavier reliance on data quality compared to traditional models. However, SLIC does not have a data governance strategy.
- Bias and privacy issues associated with this type of model are getting regulator attention; risks associated with bias and privacy have not been areas of focus in the past for SLIC.

(a) (2 points) A working group has been established to assess the proposed accelerated underwriting strategy using predictive analytics. Refer to section 3.5 of the Case Study. Working group members are listed in the table below.

| Voting | Name | Department | Title |
|---------------|-----------------|--------------------|--|
| Yes | William Xu | Operations | SVP - Term Life |
| Yes | Mary Smith | Risk Management | VP & Actuary - Financial Risk Management |
| No | Robert Johnson | Risk Management | Director - Capital Management |
| No | Patricia Chen | Risk Management | Director - Risk Reporting |
| No | Paul Miller | Risk Management | Director - Risk Modeling |
| Yes | Jamal Robinson | Risk Management | VP & Actuary - Operational Risk Management |
| Yes | Andrew Lopez | Compliance | Director |
| Yes | Mark Wilson | Internal Audit | VP |
| No | Michelle Taylor | Product Management | Director |

Critique the composition of this working group based on the governance structures recommended by the Committee of Sponsoring Organizations (COSO).

ANSWER:

1. Continued

Below are some features of a proposed accelerated underwriting model:

- Internal data contains both data collected from the applicants during online application and data from affiliate companies.
- External data includes health records, drug-use records, driving records, and credit related information.
- Applicants with probability of 95% or more of passing medical underwriting will be offered a policy using accelerated underwriting; the applicants with a probability of 1% or less of passing medical underwriting will be automatically rejected; and the rest of applicants will be sent through full underwriting.

The working group is performing a risk assessment of the accelerated underwriting proposal. The following risks are identified as relevant.

| Operational Risk | Strategic Risk | Insurance Risk |
|-------------------------|-----------------------|-----------------------|
| People Risk | Competitive Risk | Mortality Risk |
| IT Risk | Reputation Risk | |
| Model Risk | | |
| Laws/Regulation Risk | | |

(b) (7 points)

- (i) Evaluate how Model Risk, Mortality Risk, and IT Risk are impacted by accelerated underwriting.

ANSWER:

1. Continued

The working group identified the following key model risk management roles and responsibilities for SLIC to implement in developing its model risk management framework.

| Roles | Responsibility |
|-----------------------------|--|
| First Line Model Owner | Model development, implementation, and testing |
| | Model documentation |
| | Model risk assessment |
| Second Line Model Validator | Model validation |

(ii) Identify one additional responsibility for each role.

ANSWER:

(iii) Justify why the additional responsibilities you identified in (ii) are important in managing accelerated underwriting model risk for SLIC.

ANSWER:

The working group also proposed quantifying the risk exposure through stress / scenario testing. Risk exposures under each risk category are assessed independently using historical scenarios. Strategic risk is excluded for the following reasons:

- The working group views that applying accelerated underwriting will improve SLIC's competitiveness (i.e., positive risk).
- Reputation risk is assumed to be minimal, considering the customers who are eligible for accelerated underwriting are limited, and history has shown that "the internet has short memory" on reputational events.

(iv) Critique the working group's stress / scenario testing proposal.

ANSWER:

1. Continued

The most recent performance data reflects a diminishing market share of SLIC's term life insurance products. Analyses of root cause indicate that SLIC has higher expenses than its peer companies and is losing clients that do not want to go through the hassle of full underwriting. In addition, the use of predictive analytics in the insurance industry is less regulated and most of SLIC's competitors have received the benefits of being early adopters of accelerated underwriting.

(c) (2 points)

- (i) Evaluate the risk-return trade-off of this accelerated underwriting strategy including your analyses in (b).

ANSWER:

- (ii) Recommend three risk mitigation actions that SLIC could take to limit and control its risk exposure if SLIC decided to go forward with this strategy.

ANSWER:

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2.

(11 points) SLIC's senior management is re-evaluating the investment strategy for SLIC's SPIA product due to the long-duration nature of the SPIA product and a persistently low interest rate environment. A working group has been established to explore alternative investment opportunities while balancing the risk-return tradeoff. You are asked to perform quantitative and qualitative analyses to assist the working group in making risk-informed decisions.

You are given the following information:

- Breakdown of the SPIA Investment Portfolio as of 12/31/2022

| Asset Class | Market Value (\$ million) |
|-------------------------------|----------------------------------|
| Treasury | 7 |
| Corporate Investment Grade | 91 |
| Corporate High Yield | 4 |
| Mortgages | 97 |
| Cash & Short-Term Investments | 31 |
| Private Equity Investments | 10 |
| Total | 240 |

- A correlation matrix between asset classes is used in the Economic Capital Model.
- VaR is calculated using historical annualized volatility of asset classes compiled by SLIC, assuming normal distribution of returns.
- Cash & Short-Term Investments and Private Equity Investments asset classes are independent from other asset classes.

Refer to the tabs corresponding to this question, Q2, in the accompanying Excel workbook for data and assumptions.

2. Continued

(a) (3 points) Refer to the tab 'Q2(a)' in the accompanying Excel workbook for data and assumptions.

(i) Calculate the diversified portfolio VaR(97.5).

The response for this part is to be provided in the Excel spreadsheet.

(ii) Calculate the Marginal VaR(97.5) for each asset class.

The response for this part is to be provided in the Excel spreadsheet.

(iii) Explain how Marginal VaR can be used to reduce portfolio risk for SLIC's SPIA portfolio.

ANSWER:

(b) (1.5 points) The working group is considering moving \$10 million of assets from Mortgages to buy a new asset class – S&P 500 Index fund.

Refer to the tab 'Q2(b)' in the accompanying Excel workbook for data and assumptions.

(i) Calculate the Sharpe Ratio of both the old and the new portfolios.

The response for this part is to be provided in the Excel spreadsheet.

(ii) Describe how the Sharpe Ratio could be used in optimizing asset allocation in SLIC's SPIA portfolio.

ANSWER:

2. Continued

- (c) (2.5 points) As an alternative to the investment in the S&P 500 Index fund, the group is considering moving assets from Mortgages to Private Equity Investments. You are given the following information:

| Portfolio | Sharpe Ratio | Diversified Portfolio VaR |
|--|---------------------|----------------------------------|
| Moving \$10 million of assets from Mortgages to Private Equity Investments | 0.360 | \$15.5 million |
| Moving \$10 million of assets from Mortgages to buy S&P 500 Index fund | Result from (b) | \$14.2 million |

- (i) Determine which approach is preferable based on the information in the table above. Justify your answer.

ANSWER:

- (ii) Describe two other considerations for asset allocation and portfolio optimization that SLIC should consider.

ANSWER:

2. Continued

- (d) (4 points) You perform a holistic review of SLIC's risk and product profile and note that products with high minimum interest rate guarantees are driving spread compressions for SLIC. In addition, you note that inflation is increasing, and the Federal Reserve is considering raising interest rates. As a result, you believe the company should consider ways to respond to this risk.

The following are potential risk responses generated by the working group:

- I. Stop selling interest rate sensitive products.
 - II. Optimize the return of the asset portfolio and temporarily relax constraints on investing in alternative assets such as private equities.
 - III. Implement a hedging program to manage interest rate risk.
 - IV. Take no action while continuing to monitor the macroeconomic and fiscal policy changes.
 - V. Sell or 100% coinsure the block of spread compressed products.
- (i) Categorize the above risk responses into the four risk response categories (i.e., Reduce, Remove, Transfer, Accept).

ANSWER:

- (ii) Rank the proposed risk responses for SLIC. Justify your ranking.

ANSWER:

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3.

(9 points) Refer to section 2 of the Case Study.

Lyon has not considered currency exchange rate risk in the past but now wants to focus on quantifying this risk. Lyon hires you as a consultant to propose ways to quantify currency exchange rate risk.

(a) (2 points)

(i) Describe the three types of currency exchange rate risk.

ANSWER:

(ii) Evaluate whether each risk identified in (i) is high, medium, or low for Lyon as it relates to Helios.

ANSWER:

(b) (4 points) Laila Lynx, Lyon's CFO, has proposed taking a dividend from Helios to help fund a possible acquisition. She plans to obtain an OTC currency forward contract to hedge against fluctuations in the exchange rate. Laila asks Feng Hu, Lyon's treasurer, to prepare an analysis of Euro/USD exchange rate volatility to understand the risk in the timing of any dividend from Helios.

To calculate the exchange risk volatility, Laila considers the following three approaches:

- Implied volatility using the implied standard deviation (ISD) methodology
- Moving average (MA) approach
- Exponentially weighted moving average (EWMA) approach

3. Continued

Refer to the tabs corresponding to this question, Q3, in the accompanying Excel workbook for data and assumptions.

- (i) Describe how to use the ISD method to forecast implied volatility.

ANSWER:

- (ii) Compare and contrast the ISD approach to the MA and EWMA methods.

ANSWER:

- (iii) Calculate the volatility forecast using the MA approach with a 10-day window for each day from February 4, 2022 through February 23, 2022. Show all work.

The response for this part is to be provided in the Excel spreadsheet.

- (iv) Calculate the volatility forecast using the MA approach with a 30-day window. Show all work.

The response for this part is to be provided in the Excel spreadsheet.

- (v) Describe an advantage and a disadvantage of the MA method using the results of (iii) and (iv).

ANSWER:

3. Continued

(c) (3 points) Laila hired a broker to get quotes from several firms for an exchange rate forward contract. Differences in the quotes were greater than she was expecting so she has asked the broker to get more information. One firm said it estimated the volatility by using the EWMA method with a decay factor of 0.935. Laila wants to evaluate the sensitivity of changing the decay factor on the volatility estimate.

- (i) Calculate volatility for January 26, 2022, through February 23, 2022, using the EWMA model with a decay factor of 0.97 and a decay factor of 0.90. Show all work.

The response for this part is to be provided in the Excel spreadsheet.

- (ii) Calculate the weight of the January 26, 2022, data point in the volatility calculation using a decay factor of 0.97 and a decay factor of 0.90. Show all work.

The response for this part is to be provided in the Excel spreadsheet.

- (iii) Explain which decay factor results in more effective observations.

ANSWER:

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4.

(8 points) Refer to sections 2 and 3 of the Case Study.

You are an actuary at Lyon assisting in developing this year's ORSA report.

- (a) (5 points) In preparing this year's ORSA, the sub-unit responsible for AHA has asked you to assist in the risk identification process. The sub-unit team leader has suggested the use of a brainstorming session to identify risks facing AHA.
- (i) Describe two shortcomings of brainstorming as a risk identification technique.

ANSWER:

- (ii) Propose a strategy to address each shortcoming you have identified in (i).

ANSWER:

The proposed brainstorming group is made up of the following AHA employees.

| Name | Department | Job Title |
|-----------------|-----------------------------|---------------------------------|
| Frances Ngarta | New Business Group Sales | Vice President |
| James Buchanan | Claims Operations | Director |
| Helen Stevenson | Claims Operations | Claim Intake Specialist |
| Salim Khalil | Valuation | AVP, Health Insurance Reserving |
| Joan Vickers | Claims Operations | Claim Intake Associate |

- (iii) Critique the makeup of the proposed group including recommending alternatives.

ANSWER:

4. Continued

(b) (3 points) Lyon management has requested that this year's ORSA reflect risk associated with the persistence of COVID-19.

(i) Assess how the persistence of COVID-19 could affect the diversification benefits for Lyon at the enterprise level.

ANSWER:

(ii) Propose a method for reflecting the risk of future pandemic events in assessing prospective solvency. Focus on SLIC in developing your response.

ANSWER:

5.

(7 points) You are an actuarial student on the modeling team at MEK, a life insurance company. You have been given responsibility to maintain MEK's Monte Carlo market loss model which is used to estimate changes in surplus given movement in market parameters. The previous model owner has left the company without providing documentation or reporting the results of the analysis. The following table shows results for 2020-2022 based on a 95% confidence interval and a 1-year time horizon.

| \$ thousand | 2020 | 2021 | 2022 |
|-------------|-------|-------|------|
| VaR | 1,428 | 1,345 | 870 |
| TVaR | 1,458 | 1,450 | 725 |

Refer to the tab corresponding to this question, Q5, in the accompanying Excel workbook for data, assumptions, and the simulation output of market losses.

You have confirmed that the simulation output matches what was used by your predecessor.

- (a) (2 points) Your manager is puzzled by the 2022 results.
- (i) Explain what caused the 2022 results to differ greatly from the previous two years.

ANSWER:

- (ii) Calculate the correct VaR and TVaR for 2022.

The response for this part is to be provided in the Excel spreadsheet.

- (b) (2 points) Critique the use of VaR and TVaR from this Monte Carlo simulation for understanding the market exposure of MEK.

ANSWER:

5. Continued

MEK's CRO proposes to expand the use of the model to estimate operational risk. The CRO believes the model's versatility allows it to minimize the number of software packages used by the company.

The model uses aggregated data from a third party.

The model results were copied and pasted into the Excel workbook and were compared against the prior year's model results as a check of reasonableness.

(c) (3 points)

- (i) Identify three questions you should consider in evaluating the CRO's proposal.

ANSWER:

- (ii) Describe three other review and testing procedures that MEK can use to improve model validation.

ANSWER:

6.

(7 points) ABC, a public Canadian life insurance company, is interested in developing a comprehensive ALM framework. ABC has the following characteristics:

- Its main products are long duration universal life products with death benefits based on a fixed account value with minimum guaranteed crediting interest rate.
- ABC also offers products with adjustable features, namely participating insurance with dividends.
- It follows the Canadian Asset Liability Method (CALM) and is required to include Margins for Adverse Deviations (MfADs) when conducting ALM.
- ABC's main strategy is to focus on its long-term economic results.

You are hired as a consultant to assist with this process.

- (a) (1.5 points) Critique ABC's strategy of focusing on long-term economic results.

ANSWER:

ABC has proposed the following ALM conceptual framework.

- Financial Objectives: Optimize long-term economic results
- Risk Tolerances: Establish specific risk limits for each financial variable that is material to the company's long-term economic results.

- (b) (1 point) Evaluate ABC's proposal.

ANSWER:

The CRO of ABC made the following statement regarding ALM strategy:

“By requiring the book value of assets equal the book value of liabilities and matching the modified duration of the assets and liabilities, our economic surplus will be fully immunized from changes in interest rates.”

- (c) (1.5 points) Critique the CRO's statement.

ANSWER:

6. Continued

To help achieve its financial objectives and a comprehensive ALM framework, ABC implemented a carve-out strategy by investing in a portfolio of equities that is actively managed with a benchmark to the S&P 500 index with a carve-out point 20 years in the future.

Now, five years after its implementation, the CFO is concerned that there will be a significant increase in market volatility and wants to temporarily hedge ABC's exposure by selling 2-year futures contracts on the S&P 500 index.

You are given the following information:

- Market value of the carve-out portfolio is \$150 million.
- The size of each 2-year S&P 500 futures contract is \$12 per S&P 500 point.
- The current S&P 500 index value is 5000.
- The beta of the portfolio relative to the S&P 500 index is 1.5.

(d) (3 points)

- (i) Describe two ways that ABC can measure the risk exposure associated with the carve-out strategy.

ANSWER:

- (ii) Calculate the number of contracts required to hedge this position. Show all work.

ANSWER:

One year after selling the hedge, the CFO wishes to close out the hedge by buying equivalent futures contracts. You are given the following information:

- The size of each 1-year S&P 500 futures contract is \$11 per S&P 500 point.
 - The S&P 500 index value has decreased to 4500.
 - Market value of the carve-out portfolio is \$127.5 million.
- (iii) Calculate the net value of the hedge position and the total gain/loss for the carve-out portfolio. Show all work.

ANSWER:

6. Continued

- (iv) Evaluate the effectiveness of the hedge. Justify your answer.

ANSWER:

**Questions 1 through 4 and 7 pertain to the Case Study.
Each question should be answered independently**

7.

(7 points) Disruptive Energy (DE) is looking to improve its risk management practices with respect to battery design and manufacturing, as batteries are a critical component of growth in all its current businesses.

You have been hired by DE to enhance risk management identification and reporting specifically related to emerging and political risks.

Refer to section 1.8 of the Case Study.

- (a) (2 points) Explain four **key** characteristics of emerging risks that specifically apply to DE's battery design and manufacturing.

ANSWER:

- (b) (2 points) In reviewing management reports, you determine that most of the metrics outlined are Key Performance Indicators (KPIs), which are not particularly effective at being "early warning indicators" for risk events. You work with DE's management to determine potential Key Risk Indicators (KRIs) it can use to augment DE's existing reports. To begin, you plan not only to survey individuals in the battery-manufacturing business but also to consider external sources.

- (i) Describe two benefits of using external data sources to develop KRIs.

ANSWER:

You survey several managers throughout the business to gather potential metrics to track. One manager recommends monitoring delays in shipping manufactured lithium batteries to DE's car factories as a KRI. Another recommends monitoring recently added futures contracts for lithium on the commodities exchange as a KRI.

- (ii) Critique both recommendations.

ANSWER:

7. Continued

- (c) (3 points) DE looks to continue growing its geographic footprint by expanding into new countries. However, the new China plant is not yet capable of providing sufficient supply of cobalt-free batteries. As a result, executives at DE are concerned about the increased dependence on the cobalt mining operations.
- (i) Identify two types of political risk that DE might face specifically related to cobalt mining. Support your response with examples from the Case Study.

ANSWER:

You have also been asked to update the Residual Risk Effort Matrix (RREM) of political risk for the battery design and manufacturing.

- (ii) Describe how the four factors of the RREM change with the expanded development of cobalt-free batteries as a mitigation to the political risks of cobalt mining for DE.

ANSWER:

****END OF EXAMINATION****