ERM Model Solutions
Spring 2023

1. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.

Learning Outcomes:

(1b) Demonstrate an understanding of the perspectives of regulators, rating agencies, stock analysts, auditors and company stakeholders and how they evaluate the risks and the risk management of an organization.

Commentary on Question:

This question was intended to evaluate a candidate's understanding of the fundamental three lines of defense risk management framework, its application in managing unquantifiable risks and the process of embedding risk management principles and techniques in strategic decision making. Candidates were expected to be able to articulate the roles and responsibilities of different lines of defenses, basic model risk management and data governance concepts and the use of risk mitigants. In addition, candidates should have demonstrated an understanding of the concept of risk reward trade-off in supporting a strategic decision and taken initiative to design and evaluate risk mitigations to support management's decision. Candidates should have been able to apply the concepts into practice and have a holistic view of risk management.

Overall candidates were able to demonstrate a basic understanding of the three lines of defense risk management framework as applied to this question. Most candidates were able to receive at least partial credit for each section.

1. Continued

Solution:

(a) 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).

Commentary on Question:
Most candidates received minimal points, with many commenting on one or two aspects. Most candidates were able to identify that additional people were needed, but few candidates identified that the voting rights should be adjusted, and the concerns about audit's role in the group. To get full points candidates needed to provide justifications for their analysis.

This working group structure is not appropriate. Based on COSO expectations, each one of the three lines of defense has different roles and responsibilities. At a high level, the first line of defense (e.g., model user and model owners) owns and manages the risks and controls; the second line of defense (e.g., risk management, compliance) monitors and reports the risks and controls in support of management; and the third line of defense (i.e., internal audit) provides independent assurance to the board and senior management on the effectiveness of risk management and controls.

1. Continued

Based on these expectations, the following are noted:

1. The working group is primarily led by the Second Line function. Considering the working group is to identify risks and design controls, the first line of defense who will be owning the risks and controls should be involved in this discussion. The business in the first line functions have the most information on the design and implementation of the accelerated underwriting tool and how it could impact their business process. They also have extensive knowledge on what type of controls are appropriate and effective in mitigating the risks.
2. Only having two representatives from the first line with only one of them being a voting member, especially when all the other voting members are from the second line and third line functions, will silence the voice from the first line.
3. Assigning a representative from Internal Audit (Third Line) function may jeopardize their independency. Internal audit is typically not permitted to perform management functions to protect their objectivity and organizational independence. Although it may be OK to keep internal audit in the loop of the discussion to increase efficiency of their audit coverage, they should not opine on the design of controls and their opinions should be independently documented. Having internal audit as a voting member in this working group amplifies this issue.

(b)

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

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.

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

1. Continued

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.

Commentary on Question:
Most candidates did well on b(i) but struggled with b(ii), b(iii) and b(iv).

b(i) – Most candidates were able to demonstrate an understanding of the impact of the three risks.

B(ii) and b(iii) – Most candidates did poorly on this section, describing responsibilities that were within the responsibilities provided in the stem, earning them little or no points.

B(iv) – Most candidates didn't earn full points, because they didn't fully critique the proposal, instead focusing on only part of the proposal.

B(i)

Model Risk – The accelerated underwriting model could temporarily increase the overall model risk for SLIC. Model risk has two major aspects: 1) model performance 2) the use and interpretation of model outputs. Considering that an innovative method (i.e., machine learning algorithm with new data/inputs) with a more complex implementation process is going to be used, the risk of inappropriate model design and implementation is higher than with traditional models. In addition, model outputs (e.g., feature importance) in predictive analytics are also harder to interpret, which increases the inherent risk of misinterpretation or misuse.

Mortality Risk – Full underwriting is a control for an insurer to manage its mortality risk. Using this accelerated underwriting model to allow a percentage of people going through underwriting without medical exams could increase mortality risk for the company. As the model gains more insights and performs continuous refinements from data and performance outcomes, the model performance could increase and may provide a more accurate prediction of mortality than traditional underwriting.

1. Continued

IT Risk – The accelerated underwriting model has limited actuarial assumptions and is developed primarily based on data. Therefore, IT Risk associated with data integrity and information technology increases. In addition, data needs to be pulled and fed into the modeling system, which increases the exposure to risks associated with IT infrastructure failure. Using a "big data" based accelerated underwriting model will require large computation power and storage, therefore, the model is probably stored in the cloud. This increases the risk of cyber-attacks, which is one type of IT risk.

b(ii)

For First Line Model Owner: Model performance monitoring. The first line model owner should be responsible for providing assurances of the effectiveness of the model through controls which monitor the performance of the model.

For Second Line Model Validator: Model change validation. The second line validator, should be responsible for validation of the changes made to the model.

b(iii)

Importance of Model Performance Monitoring: Models have life expectancies, especially for machine learning/ predictive analytic models, whose performance could deteriorate due to data or concept drift. Therefore, the model owner(s) should closely monitor the performance of the model and recalibrate or refine the model to ensure the model performs as intended.

Importance of reviewing and validating model changes: Model changes could introduce risks to the existing model and should trigger a new round of validation to ensure changes are appropriate and implemented accurately. Machine learning models require more frequent changes including tuning/calibration, therefore, it is critical to establish a review/validating process for this type of model.

b(iv)

Using stress testing/scenario analysis is an appropriate approach to quantify risk measures for risks that are hard to quantify, such as strategic risks. However, this approach has the following shortcomings:

- Risks are tested in silos, which fails to capture the interrelationship among risks. Some risks are positively correlated, such as law/regulation and reputation risk. Ignoring such interrelationship could underestimate the overall risk.

1. Continued

- The severity of the scenarios is limited to historical scenarios. Historical scenarios are not necessarily representative of future experience, so additional hypothetical scenarios should be included.
- The rationale for excluding reputation risk is not valid: the reputational impact is not solely from the applicants who are eligible for accelerated underwriting. Instead, how the other applicants who are not eligible for accelerated underwriting interpret their eligibility and whether they agree with such classification creates reputational risk for the company. For example, if a group of individuals feels that they are not eligible due to the bias of the model/company, SLIC will face a severe reputational event. In addition, the statement of "the internet has short memory" is to assume that future events have the same impact as historical events, which is not true as previously explained.

(c)

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

(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.

Commentary on Question:
In general candidates did poorly on these questions.

c(i) Several candidates identified risks and returns without providing their evaluation of them, earning minimal points. In order to receive full credit candidates needed to opine on both risks and returns. Many candidates only focused on risks.

c(ii) Alternative answers with a valid explanation could receive full credit. Many candidates gave risk mitigation actions not related to the accelerated underwriting strategy.

1. Continued

c(i)
Risks of implementing this strategy considerations:

- Increased operational risks as the company does not have established risk management frameworks, including model risk management and data governance framework. Model and Data/IT are two material risks associated with this strategy. People Risk associated with human error and talent will also increase as SLIC has no prior experience to predictive analytics. Law / Regulatory risk might be low for now but could also increase soon as regulators implement guidance/expectations on the use of Artificial Intelligence and Machine Learning.

Returns of implementing this strategy considerations:

- Increased underwriting speed because this strategy simplifies the process for qualified individuals with low mortality risks.
- Reverse diminishing market share by attracting clients who do not want the hassle of full underwriting.

Evaluating the risk-return tradeoff, it seems that SLIC primary goals are to increase sales, but that they may not be very prepared to implement accelerated underwriting yet. Additional time and investment will be necessary to control risk exposures. Alternatively, SLIC might go back to the drawing board and brainstorm other ways to increase sales that don't involve such a heavy lift.

c(ii)
Below are some mitigation activities that SLIC should consider to limit and control its risk exposure from this strategy:

- Set aside a certain percentage of applicants to send to underwriters for review as a preventive control. If underwriters have a different opinion on the risk class of the applicant, this will indicate that model adjustments may be necessary. The percentage of reviews could decrease as the model matures.
- Hire external consultants to develop or validate the model. Since some insurers in the industry have already implemented such models, SLIC could leverage the lessons learned from others to avoid similar mistakes/failures.
- Set maximum face amounts and age ranges that are eligible for this model. This initial screening of eligibility helps filter out applicants with large mortality exposure.

2. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.

5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

(2a) Describe different definitions and concepts of risk.

(5a) Demonstrate risk optimization and analyze the risk and return trade-offs that result from changes in the organization's risk profile.

Sources:

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion Ch. 7 Portfolio Risk: Analytical Methods

Financial Enterprise Risk Management, Sweeting, 2017 Ch. 16 Responses to Risk

Risk Appetite: Linkage with Strategic Planning Report

Commentary on Question:

This question intends to evaluate candidate's understanding of the fundamental three lines of defense risk management framework, its application in managing unquantifiable risks and embedding risk management principles and techniques in making strategic decisions. Candidates are expected to be able to articulate the roles and responsibilities of different lines of defenses, basic model risk management and data governance concepts and the use of risk mitigants. In addition, candidates should understand the concept of risk reward trade-off in supporting a strategic decision and take initiative to design and evaluate risk mitigations to support management's decision. Candidates should be able to apply the concepts into practice and have a holistic view of risk management.

Solution:

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

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

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

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

2. Continued

Commentary on Question:
Most candidates are able to obtain at least partial credits for this question. Candidates generally performed well in calculating variance matrix using the provided correlation matrix and were able to explain what is Marginal VaR and how it is used conceptually. However, most candidates failed to calculate Marginal VaR and were not able to explain the use of Marginal VaR in the context of SLIC's SPIA portfolio.

(i) See excel component for details.

(ii) See excel component for details.

(iii) The calculated Marginal VaR in step (a) could be used to minimize portfolio risk without adding new risk classes. From a risk perspective, the company should decrease their holdings of assets with high marginal risks and reallocate them to asset classes that have less marginal risk. Based on the calculation results, Corporate Investment Grade and Private Equity Investments have the highest marginal VaR, i.e., taking an additional dollar of exposure of assets in these two asset classes increases the VAR more significantly than other asset classes. By decreasing its holding of these two assets and increasing its exposure in asset classes such as Cash & Short-Term Investments, SLIC could decrease its portfolio risk.

(b) 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.

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

Commentary on Question:
This question tests candidates' understanding of Sharpe ratio, how it is calculated using portfolio return and portfolio volatility and how to interpret the results of Sharpe ratio. Candidates who didn't do well in the calculation either failed to calculate portfolio volatility or failed to understand that Sharpe ratio is based on the excess return instead of the expect return. Most candidates received partial credits for question (ii) due to not being able to interpret the results in the context of SLIC.

2. Continued

(i) See excel component for details.

(ii) Sharpe Ratio reflects the risk adjusted excess return of the portfolio comparing to its benchmark. When comparing similar portfolios (e.g., investment horizon), a portfolio with higher Sharpe Ratio is better than the portfolio with lower Sharpe Ratio. From an optimization perspective, a company would benefit from shifting its asset allocation to maximize its Sharpe Ratio. In this case, Sharpe Ratio for the old portfolio is 0.30 while the new portfolio is 0.35. Sharpe Ratio increased after allocating $10M from Mortgage to S&P index. Therefore, the new portfolio is better than the old portfolio from a portfolio management perspective.

(c) 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 preferrable based on the information in the table above. Justify your answer.

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

Commentary on Question:
Candidates needed to be able to discuss both Sharpe Ratio and Diversified Portfolio VaR to receive full credit for part (i). Most candidates were able to select the approach with higher Sharpe ratio but failed to explain the considerations based on both matrices. Most candidates were able to get partial credits for part (ii), however, the responses were generic and failed to leverage information in the Case Study.

2. Continued

(i) Based on the calculation results, reallocating $10M assets from Mortgage to Private Equity Investments is more preferrable than to S&P 500 since the prior option creates higher Sharpe Ratio. Although the diversified portfolio VaR is higher when allocating to Private Equity Investments, which indicates higher level of risk, this elevated risk is well compensated as reflected in higher risk adjusted return (i.e., Sharpe Ratio).

(ii) The following should also be considered when allocating assets and/or optimizing portfolio:

a. **Constraints from internal risk policies/limits:** Sharpe Ratio uses portfolio volatility as a risk measurement, which does not differentiate between various risks. However, from a strategic planning perspective, SLIC has risk policies for each risk category (e.g., Credit Risk, Market Risk). SLIC's risk policies specify its risk appetite, limit, target as well as its risk management strategy for each risk category. Compliance with these risk policies ensures a well-diversified risk profile for SLIC. For example, allocating some fixed-income funds to equity funds increases Sharpe Ratio. However, this could also increase equity risk of the portfolio. SLIC has a limit of a "maximum of 20% of the portfolio" for equity and real estate investments in its Corporate Account, which will probably be breached after this allocation.

b. **Asset and liability risk profiles:** Both asset and liability risk profiles should be analyzed during strategic planning. For example, SLIC's limits on duration mismatch will also prevent overallocation of assets to Corporate High Yield whose duration is much lower than Corporate Investment Grade assets. Considering SLIC has long duration liabilities, asset duration / reinvestment risk is critical to its asset strategy.

c. **Capital and regulatory requirements:** Insurance companies are punished from taking extreme risks in their investment portfolio by being required to hold more capital (e.g., capital charge). SLIC should consider its capital impacts when considering investing in alternative investments that are highly risky.

2. Continued

(d) 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).

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

Commentary on Question:
Most candidates did well in part (i) and were able to assign risk responses to the correct category, however, candidates did not do well in ranking risk responses (part (ii) based on criteria for good risk responses. The focus of part (ii) is not the order of the ranking, but the considerations/justifications to support the ranking. Candidates who provided only generic justification (such as "doing nothing is not a proactive risk response") but failed to use information from the question stem did not receive credits or only received minimal credits.

A good risk response should be economical, closely match the risk they are intended to control (i.e., efficiency), as simple as possible, proactive, and allow flexibility to change when situation changes. Based on the above criteria, the following ranking is recommended.

II – Based on the calculations performed in question a) and b), this risk response could improve asset returns and effectively decrease interest rate exposure for SLIC. Although it could be costly when the company has to liquidate certain assets and repurchase others, the cost is low comparing to option III and V. Portfolio reallocation and optimization is also less complex than establishing a hedging program. It is flexible and could be reperformed when economic conditions changes. Therefore, SLIC should prioritize this strategy.

2. Continued

IV – As mentioned in the question stem, Federal Reserve is planning on raising interest rates soon to combat high inflation. If the spread compression is limited, it makes sense for SLIC to accept and monitor this risk, especially when there is a good possibility that the interest rate may increase to cope with high inflation rates. This "do nothing except monitoring" risk response avoids unnecessary expenses in managing a risk that is not significant and/or just transitional. Through continuous monitoring of this risk, SLIC has total flexibility to take other risk responses/actions when risk profile exceeds its tolerance.

V – 100% coinsurance allows SLIC to totally transfer interest rate risks of the spread compressed products to a reinsurer. This approach is highly effective in mitigating the risk and it could be economical especially when there is a positive appraisal value difference between SLIC and the reinsurer. However, the company will also give up the profits when interest rate is higher in the future. This approach has relatively low flexibility to change once executed.

I – This approach won't impact the current interest rate risk exposure of the company, however, it prevents SLIC from taking on additional interest rate risk. This strategy is not as costly as option V) and III). However, SLIC will have to forgo profits generated from selling these products and other products will have to bear more costs to make profits. In addition, SLIC might lose market share, which impacts its product strategy in a long run. In addition, starting and stopping the selling ofa product is not a simple switch, complex processes have to be followed if SLIC wants to revert this decision. Therefore, it is not flexible.

III- Develop and implement a hedging program to manage interest rate risk should be the least plausible risk response as it is costly, prone to basis risk (i.e., fails to precisely match the risk it is trying to manage) and complex to implement. In addition, considering most of SLIC's products are basic and less interest rate sensitive (except for the ones with minimum guarantees), the benefits of having this expense hedging strategy is limited.

3. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.

4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

(2a) Describe different definitions and concepts of risk.

(2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks.

(4a) Determine risk exposures using common risk measures (e.g., VaR and TVaR) and compare the properties and limitations of such measures.

(4b) Analyze quantitative financial and non-financial data using appropriate statistical methods to assist in quantifying risk.

Sources:

ERM-150-22: Exchange Rate Risk Measurement and Management

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion Ch. 9 Forecasting Risk and Correlations

Commentary on Question:

Overall, candidates did reasonably well on the written part of the question. Most candidates struggled with the Excel portion of the question, especially part b (iii) and b (iv).

Solution:

(a)

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

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

Commentary on Question:

Overall candidates did well on part a. Most candidates evaluated currency exchange rate risk for Lyon as it relates to Helios correctly, demonstrating understanding of the risk and the case study.

3. Continued

(i) 1.Transaction risk is a cash flow risk and deals with the effect of exchange rate moves on transactional account exposure related to receivables (export contracts), payables (import contracts) or repatriation of dividends.
2. Translation risk is a balance sheet exchange rate risk and relates exchange rate moves to the valuation of a foreign subsidiary and, in turn, to the consolidation of a foreign subsidiary to the parent company's balance sheet.
3. Economic risk reflects the risk to the firm's present value of future operating cash flows from exchange rate movements. It's the effect of exchange rate changes on revenues (domestic sales and exports) and operating expenses (cost of domestic inputs and imports).

(ii) 1. Transaction risk is low for Lyon. Any receivables or payables involving Helios's normal business should not impact Lyon: these transactions involve only Helios. Repatriation of dividends from Helios to Lyon would be affected by exchange rates so there is exposure there but Lyon has not previously taken dividends from Helios.
2. Translation risk is high for Lyon, as Helios's value in Euros is consolidated on the Lyons financial statements in USD.
3. Economic risk is medium for Lyon as it relates to Helios because of Lyon's exposure to exchange rate risk regarding Helios's revenues and expenses in determining future cash flows.

(b) 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.

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

(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.

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

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

3. Continued

Commentary on Question:
Candidates performed well on parts (i) and (v) of the question and struggled with (ii), (iii) and (iv). For part (ii), some candidates did not compare and contrast different methods, instead provided definitions for those methods, which received no credit. For part (ii), two comparison points were sufficient to receive full credit. For Excel calculation, most candidates received partial credit for attempting the calculation, but majority of candidates didn't calculate the return and missed a square root. Most candidates received at least partial credit for part (v).

(i) Implied volatility can be determined by using an option pricing model. Invert the option pricing formula (such as the Black-Scholes function) and solve for volatility that equates the model price to market observed price.

(ii) - ISD approach is forward looking, while Moving Average and EWMA are calculated based on historical data (they are "backward-looking" measures).
- MA and EWMA are easy to calculate; ISD requires to solve the pricing model for volatility. ISD is more complex calculation approach: Option ISD can include risk premium on top of actual volatility. Additional calculations are required to calculate true volatility under ISD method.
- Moving Average and EWMA can be easily calculated, where ISD requires a wide market to be able to recover the volatility.

(iii) Model Solution is in Excel file attached

(iv) Model Solution is in Excel file attached

(v) Advantages:
1. Easy to calculate. It's a straightforward calculation that can be easily done in excel.
2. Each day, the forecast can be updated by addition of new information. It doesn't require recalculation of any parameters.

Disadvantages:
1. Ghosting effect. The results are sensitive to one outlier. Exchange rate on 2/7/2022 causes immediate increase in volatility and reverts back after 10 days as the datapoint is dropped from the calculation.
2. Results depend on the window size. In the excel calculation MA(10) and MA(30) results are different. Selecting the right window size requires a tradeoff between sensitivity of the results to each data point and validating of the results.

3. Continued

(c) 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.

(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.

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

Commentary on Question:
Most candidates received partial credit for part (i). Candidates did reasonably well on parts (ii) and (iii). Full credit was given for part (iii) for a good justification independent of part (ii) calculation.

(i) Model Solution is in Excel file attached

(ii) Model Solution is in Excel file attached

(iii) EWMA model with decay factor 0.97 has more effective observations than lower factor model. As more weight is given to the prior observation, it takes longer for the observation weight to decrease.

4. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.

Learning Outcomes:

(1d) Assess the overall risk exposure arising from an organization's current and emerging risks.

Sources:

Financial Enterprise Risk Management, Sweeting, 2017, Ch. 8 Risk Identification
ERM-137-20: ORSA and the Regulator by AAA

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) 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.

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

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.

Commentary on Question:

Most candidates received most or all points for sub-parts i) and ii) but few received full credit for sub-part iii) which required considerable depth of response consistent with asking for a "critique". Reasonable responses outside of the text were considered for points for all sub-parts.

4. Continued

(i) Free-riders may be included in the group but fail to provide any input to the discussion, thus limiting the ideas generated.

Openness of the conversation can lead to convergent thinking, where ideas and thoughts are influenced by other participants' prior comments

(ii) Mitigate free riders by using a skilled facilitator to lead discussion and draw out thoughts from all participants

Mitigate convergent thinking by using independent group analysis or surveys, which solicit ideas individually prior to discussing as a group

(iii) – Current group too heavy on claims personnel, leads to repetitive suggestions, convergent thinking

- Lacks representation from other key AHA areas such as IT, pricing, UW, legal, etc.
- Helen's and Joan's roles appear very similar. Having both does not contribute to diversity of expertise or experience.
- Current group includes a good mix of individual contributors and management which will help flush out a wide range of ideas
- Consider adding a facilitator to manage the flow of the session and solicit ideas
- Expand the group and do so by adding participants from other key functional areas

(b) 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.

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

Commentary on Question:
Some candidates performed well on this question while others did not. In general, most candidates did better on part ii than on part i. The question draws from concepts in the text and asks the candidates to think critically and apply these concepts to Lyon specifically. For sub-part i) candidates were required to add additional insight into perceived diversification benefits if correctly identifying that Lyon does not explicitly calculate an enterprise-level diversification benefit. Many different ideas and responses received credit for this question.

4. Continued

(i) Under normal circumstances, Lyon would have diversification benefits between SLIC, Pryde, AHA and Helios as SLIC and Helios are subject primarily to mortality risk, AHA to morbidity risk and Pryde to incidence and severity of property damage.

COVID had a significant adverse impact on both mortality and morbidity risk which would reduce any diversification benefits assumed between AHA and SLIC. Reduced driving during the pandemic could lead to lower Pryde claims which may help to offset the increased Life and Health claims. However, in total, persistence of COVID would reduce the diversification benefits for Lyon.

(ii) Reflecting stress and scenario testing using mortality shocks similar to what were observed during peak COVID surges.

If using stochastic scenarios, give considerable weight to recent COVID-driven experience periods when developing scenarios.

5. Learning Objectives:

3. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.

4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

(3f) Demonstrate an understanding of model and parameter risk.

(4a) Determine risk exposures using common risk measures (e.g., VaR and TVaR) and compare the properties and limitations of such measures.

Sources:

ERM-141-20: Managing Investment Portfolios

SOA Monograph A New Approach to Managing Operational Risk (Ch 8)

ERM-130-18 AAA Model Governance Practice Note

Commentary on Question:

The question was intended to test understanding of the VaR and TVaR metrics, including their limitations, as well as a general understanding of model risk. Parts (a) and (b) were answered very well, with most candidates achieving all or almost all grading points. Most candidates missed the point of part (c) (i.e. model risk), instead focusing on data verification and limitations. Partial credit was granted for these topics, and scores were still generally high.

Solution:

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 internal 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.

5. Continued

(a) Your manager is puzzled by the 2022 results.

(i) Explain what caused the 2022 results to differ greatly from the previous two years.

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

Commentary on Question:

In the Excel, at least 2/3 of the marks were awarded if the candidate demonstrated that they understood the methodology. Because the 95th percentile fell between data points, full marks were awarded for candidates who chose values on either side, as well as those who averaged the bordering values, as long as VaR and TVaR were calculated consistently.

(a)(i) Reviewing the excel file, the predecessor failed to sort the results of the simulation by severity resulting in the VAR and TVAR values being inaccurate as the losses were not ranked and so the numbers are meaningless.

(a)(ii) See Excel.

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

Commentary on Question:

There were many more valid points in response to the question than what was required for full marks, which resulted in most candidates achieving full credit for this part of the question. The answer below is just a small sample of the acceptable responses.

VaR is simple to explain and versatile, but can provide a false sense of security as the tail outcomes are not reflected in VaR (especially using the 95% percentile, which should be a higher figure).

TVaR provides better value in understanding how fat the tail may be, but does not recognize conditional tail dependency, i.e. the tendency of otherwise independent variables to become more correlated given extreme events.

(c) 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.

5. Continued

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.

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

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

Commentary on Question:

Part (c) was the most challenging part for candidates, but was still generally answered well. If candidates repeated the same information in parts (i) and (ii), particularly about approaches to data validation, they did not get the marks twice. Part (i) was intended to elicit responses about appropriateness of the model, effective model governance, potential need for training, and other comments pertinent to decision-making. Most candidates zeroed in on the suitability of the data, yet with a robust enough discussion they were still able to score well.

(i)

Is the model suitable for use to measure operational risk?

Would the team in-charge be familiar in using the model to measure operational and risk and would they be able to interpret and communicate properly the results?

Is the data from the third party appropriate in measuring operation risk of MEK? Should it be scaled for size and complexity?

(ii)

MEK could create an independent calculator verifying if the results used from this other model is close to what is calculated by the Monte Carlo model.

An independent party or audit could review the model for reasonableness check.

MEK could perform stress testing and validate if the model results are as expected.

6. Learning Objectives:

5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

(5d) Demonstrate how derivatives, synthetic securities, and financial contracting may be used to reduce risk within a static or dynamic hedging program.

(5g) Analyze how ALM and other risk management principles can be used to establish investment policy and strategy, including asset allocation.

Sources:

ERM-144-20: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies

Financial Enterprise Risk Management, Sweeting, 2017 Ch. 16 Responses to Risk

Commentary on Question:

The goal of this question was to test the candidate's ability to apply ALM techniques and practices for an insurance company, including hedging market risk through futures.

As with all questions, candidates should ensure they are answering the question that is asked – e.g., providing both pros and cons when asked to "critique", and to tie answers back to the specific parameters about ABC Company (given in the introduction to the question) when appropriate. Many candidates failed to do so.

Candidates that answered a question generally received partial credit. However, more than half the candidates did not even attempt to answer subparts d(i), d(iii) and d(iv). This may be related to not allocating sufficient time to question 6, one of the last questions on the exam.

Solution:

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

Commentary on Question:

Many candidates did not receive full credit for this question because they did not adequately critique the strategy (e.g., provide both pros and cons). Also, to receive full credit, candidates had to consider the appropriateness of the strategy given ABC's major product offerings.

6. Continued

Given the long duration nature of ABC's products, it is productive to analyze long-term economic results and how they can be impacted by changes in market inputs. However, most risks also impact short term results and solvency – these risks include liquidity, credit, interest rate, and equity risk which all affect ABC's product offerings. Additionally, ABC should focus on statutory results instead of just economic. Regulators will want quality analysis of statutory results to evaluate current and prospective solvency. Also, rating agencies consider statutory results in their rating methodologies.

(b) 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.

Evaluate ABC's proposal.

Commentary on Question:
To obtain full credit, candidates had to provide specific examples of how the Risk Tolerance framework could be improved, and to acknowledge that the proposal was missing guidance on risk limits/constraints. Many candidates observed that the framework was vague without providing specific examples of what was missing.

Financial Objectives: should be more specific – for example, specify risk adjusted returns (RAROC) so stockholders can appreciate and monitor their risk-return tradeoffs. Also helps management to assess their strategies.

Risk Tolerances: need to be more specific – for example interest rate risk (long duration liabilities, guaranteed interest rates) seems to be a key risk that might impact financial objectives. So, proposal might want to limit asset/liabilities duration mismatch to a specified amount.

(c) 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."

Critique the CRO's statement.

6. Continued

Commentary on Question:
Many candidates did not receive full credit for this question because they did not thoroughly critique the strategy (e.g., provide specific comments to support their observations). Also, to receive full credit, candidates had to consider the statement against the backdrop of ABC's ALM framework. For full credit, candidates had to unequivocally state that the CRO's statement did not meet ABC's objective of optimizing economic results.

The CRO's statement is not correct nor in alignment with ABC's strategy.

ABC has decided their focus is long term economic results, meaning their ALM strategy should focus on protecting economic surplus, and not accounting surplus, which is what the CRO recommended.

Additionally, matching the values and modified duration of assets and liabilities is effective at protecting changes for small interest rate changes, but is not effective for bigger swings, as modified duration is a linear measure. So, they will not be fully immunized from all interest rate changes.

(d)

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

Commentary on Question:
Several candidates failed to answer the question that was asked, instead providing commentary on how the carve-out point could be determined. In addition, a significant number of candidates did not even attempt to answer the question.

1. Use stress and scenario testing to see find out the impact of extreme but plausible events that CFO is concerned about. For example, analyze the impact of equity return decreased by 50% on the carve-out strategy. How would that affect the carve-out ALM. Would ABC still have enough asset to fund liabilities starting from 20 years in the future?

2. Use stochastic approach to generate 10000 simulations to analyze the impact on carve-out strategy by using metrics such as 99.5% VAR. How would that affect the carve-out ALM. Would ABC still have enough asset to fund liabilities starting from 20 years in the future?

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

6. Continued

Commentary on Question:
This was an easy question – candidates scored the highest on this question on average, even though about one third of the candidates did not attempt to answer the question.

Beta * (Portfolio value) / (Contract value * point notional)
= (1.5*150M)/ (5000*12)
= 3750 contracts needed

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.

Commentary on Question:
This was a difficult question for candidates – they scored the worst on this question. Many candidates did not answer both parts of the question. More than half the candidates did not attempt to answer this question.

Gain from shorting 3750 contracts, gain = 500*11*3750 = 20.625M
Value loss of Carve out = 150M – 127.5 = -22.5M
Overall loss = -1.875M

Candidates would also receive full credit if the size of each 1 year S&P 500 futures contract was replaced by $12 instead of $11.

Gain from shorting 3750 contracts, gain = 500*12*3750 = 22.5M
Value loss of Carve out = 150M – 127.5 = -22.5M
Overall loss = $0M

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

Commentary on Question:
Candidates performed relatively poorly on this question. More than one-third of the candidates did not attempt to answer the question. Of the candidates that did answer, about one-fourth provided no justification for their answer.

6. Continued

This hedge doesn't consider the basis risk by potentially having the futures contract close out earlier. The hedge is fully hedged if the contract gets closed out earlier. Furthermore, this hedge may still have transaction costs.

7. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.

5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

(2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks.

(5c) Demonstrate the use of controls for retained and residual risks.

(5i) Choose appropriate techniques to measure, model and manage various financial and non-financial risks faced by an organization.

Sources:

ERM-133-19: Emerging Risks and Enterprise Risk Management (pp. 2-6)
COSO KRI Paper

ERM-147-21: Working with Inherent and Residual Risk

Commentary on Question:

This question tests a candidate's understanding of emerging risks, political risk and KRIs, specifically as it relates to Disruptive Energy from the Case Study.

Most candidates did well on knowledge retrieval but moderate on analysis and utilization, specifically the KRI vs KPI analysis.

Solution:

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

Commentary on Question:

Most candidates did well on question (a). To receive full points, candidates would need to connect to case study examples in each of the four characteristics.

7. Continued

1. High level of uncertainty - Typically, emerging risks are expected to be characterized by very low frequency ("not likely to happen soon") and relatively high impact.
   Example: Demographic shifts might affect future sales for DE: e.g., fewer millennials buying cars/driving

2. Lack of consensus - There is a general lack of consensus both internally (within an organization) and externally (within the public at large) regarding the drivers, impacts and likelihood of an emerging risk event occurring.
   Example: DE focused on quarterly earnings & production goals ("Having hit its production goals for these affordable sedans and posting positive earnings in September 2019"), ignoring long term management of risks and earnings ("margins may be squeezed as it moves down market")

3. Uncertain relevance - Little guidance is available for determining how emerging risks can be obstacles to (or accelerate) the achievement of objectives.
   Example: Climate change and related initiatives (clean energy, clean air) will greatly impact solar panel and electric vehicle development/adoption, but DE can't easily predict how the risk will help or hurt

4. Difficult to communicate - There is a real possibility of an emerging risk being perceived as so unlikely to occur that it does not warrant attention ("it can't happen here" syndrome), or is relegated to a "watch list" as a type of phantom risk that has little bearing on existing circumstances.
   Example: It can be challenging to communicate the potential risks associated with climate change given that impacts are highly uncertain and progress slowly over time.

(b) 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.

7. Continued

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.

Commentary on Question:
Most candidates did well on question b(i), but moderate to poor on question b(ii). The root differences between KRI and KPI is that KRI is to better monitor potential future shifts in risk conditions or new emerging risks, while KPIs often shed insights about risk events that have already affected the organization. To receive full points on b(ii), candidates would need to correctly differentiate which recommendation is KRI or KPI, then critique whether it is a good/bad indicator.

(b)(i):
1. External sources such as trade publications and loss registries compiled by independent information providers may be helpful in identifying potential risks not yet experienced by the organization.

2. KRI data sourced from external and/or independent parties provides the benefit of objectivity.

(b)(ii):
First recommendation is actually a KPI, tracking events affecting organization.
First recommendation is too specific to DE (not a general/ industry trend).

Second recommendation is a KRI.
Second is more general and tracks industry trends.

(c) 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.

7. Continued

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.

Commentary on Question:
On average, candidates did well on (c)(i) but to receive full points, candidates need to focus on clearly identifying each political risks, not the risk impacts (reputational harm, operational delay) caused by the political risks.
Candidates did moderate on (c)(ii). Some candidates did not recall what the PREM is. Some did not realize no matter what types of batteries DE has, either cobalt-free or cobalt-dependent, DE will be always heavily relying on battery manufacturing and facing associated risks. Therefore, the residual risks always stay.

(c)(i):
1. Social activism against the child labor used in mining operations in only country where cobalt mined.

2. Natural Resource Manipulation or Corruption in the country where DE is solely sourced from. This would affect supply and costs of cobalt.

(c)(ii):
1. How vulnerable are you now to a certain risk? (Factor A) :
Reduced vulnerability, less reliant on cobalt or cobalt mining. Batteries are the most valuable asset for DE though, so still high vulnerability to battery manufacturing.

2. How exposed are you (here and now)? (Factor B) … How often do risk events happen?
No change to exposure, as long as any reliance on cobalt mining still, there is still political risk related to mining in that country, and for any event DE reputation is still exposed.
Since asking about cobalt mining, the potential increase of risk in China from cobalt-free plant isn't as relevant, but might be considered

3. How much effort do you put in mitigation? (Factor C)
Increased effort: Expensive to have new facility and new process.

7. Continued

4. If the risk occurs and mitigation fails, what will be the impact? (Factor D) What will be the worst possible outcome?
Batteries are the most valuable asset for DE though, so no change and still high impact to company should mitigation effort fail.