# CURATED PAST EXAM ITEMS
# - Solutions -

## CFE 101 – Enterprise Risk Management

**Important Information:**

- These curated past exam items are intended to allow candidates to focus on past SOA fellowship assessments. These items are organized by topic and learning objective with relevant learning outcomes, source materials, and candidate commentary identified. We have included items that are relevant in the new course structure, and where feasible we have made updates to questions to make them relevant.
- Where an item applies to multiple learning objectives, it has been placed under each applicable learning objective.
- Candidate solutions other than those presented in this material, if appropriate for the context, could receive full marks. For interpretation items, solutions presented in these documents are not necessarily the only valid solutions.
- Learning Outcome Statements and supporting syllabus materials may have changed since each exam was administered. New assessment items are developed from the current Learning Outcome Statements and syllabus materials. The inclusion in these curated past exam questions of material that is no longer current does not bring such material into scope for current assessments.
- Thus, while we have made our best effort and conducted multiple reviews, alignment with the current system or choice of classification may not be perfect. Candidates with questions or ideas for improvement may reach out to education@soa.org. We expect to make updates annually.

# Course CFE 101

## Curated Past Exam Solutions

**All Learning Objectives**

Learning Objective 1: Enterprise Risk Management Foundations

Learning Objective 2: Risk Analysis and Evaluation

Learning Objective 3: Embedding ERM into Decision-Making

The following solutions are taken from Enterprise Risk Management Exams from 2020 – 2024. They have been mapped to the learning objectives and syllabus materials for the CFE101 2025-2026 course and in some cases modified to fit the 2025-2026 curriculum.

The related questions and Excel spreadsheets are provided in separate files.

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# 2. Fall 2024 ERM Exam (LOs 2.1a, 3.2c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.2c | Demonstrate how derivatives or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2 Risk Taxonomy
    - Ch. 15: Risk Mitigation Using Options and Derivatives
- CFE101-109-25: Managing 21st-Century Political Risk

**Commentary on Question:**

*The goal of this question is to test the candidates' understanding of foreign exchange rate risk as it applies to a particular company. Candidates are also asked to demonstrate understanding of risk management practices and mitigation instruments addressing foreign exchange risk. Lastly, candidates are required to apply their knowledge of political risk to the same company and context.*

*Candidates that were able to apply their risk knowledge around exchange rate risk and political risk into GRD's specific situation performed well. Candidates that gave generic responses could only receive partial credit.*

## 2. Continued

**Solution:**

(a) **(LO 2.1a)**

(i) Describe the three types of exchange rate risk as they apply to GRD.

(ii) Assess whether each type of risk described in (i) is low, medium, or high for GRD. Justify your answer.

**Commentary on Question**:
*While most candidates demonstrated knowledge and understanding of the three types of exchange rate risk, some struggled to articulate their application to GRD.*

a(i):
Transaction Risk: GRD pays for parts manufactured in Country X in their local currency. If the exchange rate between the US dollar (USD) and Country X's currency weakens (depreciates) before GRD pays the factory, they will need to spend more USD to cover the same amount in the local currency. This would lead to higher costs for parts and potentially lower profit margins.

Translation risk: GRD reports its financial statements in USD. If the exchange rate between the USD and Country X's currency weakens (depreciates) after GRD has purchased parts but before they sell the finished toys, the value of their inventory (which is denominated in Country X's currency) will appear lower when translated into USD on their financial statements.

Economic Risk: This is the risk of exchange rate fluctuation to GRD's company value. This risk would be reflected on the changes of GRD's future operating cash flows from exchange rate movement. For example, A sustained weakening of the USD compared to Country X's currency could make GRD's finished toys relatively more expensive in the US market. This could lead to decreased demand and lower sales for GRD.

a(ii):
Transaction Risk: Considering the long-term relationship and frequent transactions with the factory in Country X, the transaction risk is ranked as High for GRD.

Translation risk: Low Risk. Considering GRD's sales have been surging in recent years, the inventory delinquency time is not material.

Economic Risk: This risk is High considering Country X 's economy has been volatile, and the foreign exchange rate is likely to be impacted.

## 2. Continued

(b) **(LO 3.2c)** Jon Doe, the CFO of GRD, states the following:

> "*While we lack a formal exchange rate risk management program, we've been actively monitoring the fluctuations of the ELI against the US Dollar (USD). Historically, we've mitigated potential risk by using currency forwards when anticipating a stronger ELI. This approach has been successful in the past and we expect it to continue working in the future. Considering the ELI has been consistently weakening since the pandemic, the exchange rate risk is a positive risk for us. We've got this under our control and don't need to spend any more time on this risk.*"

Critique Jon Doe's statements on exchange rate risk management.

**Commentary on Question**:
*The question sought to have candidates critique each part of the statement specifically, rather than giving generic feedback or comments. Successful candidates connected their critiques directly back to GRD's situation and context.*

Jon Doe is correct in stating that using a forward contract is a useful way to mitigate exchange rate risk, as it allows the company to transfer the entire exchange rate exposure to a third party.

However, the mitigation strategy Jon Doe described is only a tactical approach that addresses short-term transaction exposures. This strategy does not cover other types of foreign exchange risks, such as economic risk and translation risk.

Jon is relying on past risk management experiences to predict that the same process will work in the future. Without a formal exchange rate risk management framework, the company lacks clarity on the extent of its risk exposure and which risk management strategy is the most effective and efficient.

Although the current transaction risk exposure is favorable for the company, the currency of Country X has experienced high volatility due to its weakened economy. Consequently, GRD's US earnings could be volatile. Considering the company is contemplating an IPO, this volatility could negatively impact the company's valuation, as investors may perceive the risk-adjusted return for GRD to be low.

The statement that there is no need to spend more time on this risk fails to consider the exchange rate risk comprehensively and evaluate the hedging strategy holistically. When determining the hedging strategy, GRD should also consider the impact of risk exposure on other risks. Specifically, forward contracts from OTC markets could have higher counterparty credit risk and liquidity risk compared to instruments from an exchange.

## 2. Continued

Although forward contracts can be effective, they might not be the most efficient mitigation strategy for the company, as they forgo potential gains when exchange rates move favorably. The company should establish a formal program to measure risk exposure and explore various hedging strategies.

A comprehensive risk assessment should consider how exchange rate movements impact other risk categories, shaping GRD's overall risk profile. For instance, mitigating exchange rate risk through currency forwards could increase credit risk exposure.

(c) **(LO 3.2c)** GRD does not have expertise in investing and hedging. You have been helping the company design its hedging strategies and explore hedging instruments in both OTC and exchange-traded markets. GRD is considering the following alternatives for its hedging strategy.

- Currency (call) options
- Currency futures

(i) Assess the suitability of each alternative for mitigating exchange rate transaction risk including any risk implications. Justify your response.

GRD has decided to further consider currency (call) options as an alternative to forwards (as noted by Jon Doe) and would now like to examine cash flows and potential benefits. There is an upcoming payment of 1 million ELI in three months.

As of today, the prevailing spot exchange rate stands at $1.26 per ELI.

You have two choices for hedging:

- An over-the-counter three-month currency forward contract with a predetermined forward rate of $1.30 per ELI. There are no transaction costs.
- An exchange-traded three-month currency call option on ELI with a strike price of $1.28 per ELI. The premium for the call option is $0.012 per ELI.

You are given:

- The interest rate in the U.S. is 2.5% per annum.
- The interest rate in Country X is 1.75% per annum.
- It is forecasted that the exchange rate will increase to at least $1.30 per ELI in three months.

## 2. Continued

This information is shown in tab "Q2.c.ii" of the Excel spreadsheet.

(ii) Calculate the dollar costs in three months for each of the two hedge choices assuming the forecast is correct. Show your work.

(iii) Recommend which hedging choice best meets the needs of the company. Justify your answer.

You are asked to perform a sensitivity analysis on the exchange rate which would impact the choice of hedging instrument.

(iv) Calculate the breakeven exchange rate in three months such that the dollar costs in three months of the currency forward and currency option are equal. Refer to tab "Q2.c.iv" of the Excel spreadsheet. Show your work.

**Commentary on Question**:
*Most candidates demonstrated a basic understanding of hedging instruments and their respective pros and cons. Generally, candidates either performed the calculations correctly or produced nonsensical answers that could have been avoided by checking their answers for reasonableness.*

c(i)
A currency option has an initial cost but provides the flexibility to capitalize on favorable currency movements, allowing GRD to benefit from the upside. As an exchange-traded currency hedging instrument, it carries lower credit risk compared to OTC instruments.

Currency futures are also exchange-traded contracts with specified volume and settlement dates. Unlike options, there is no upfront cost; however, GRD will forgo any potential upside profits. Using currency futures as a hedging instrument could increase GRD's liquidity risk due to potential margin calls. In addition, similar to currency options, currency futures have lower credit risk compared to OTC instruments.

## 2. Continued

c(ii)

| Inputs/Assumptions | |
|---|---|
| Annual interest rate in US | 2.50% |
| Quarterly interest rate in US | 0.625% |
| Predetermined forward rate ($/ELI) | $1.30 |
| Call option strike price ($/ELI) | $1.28 |
| Spot Rate ($/ELI) | $1.26 |
| Premium for call option ($/ELI) | $0.012 |
| Upcoming payment (ELI) | 1,000,000 |
| | |
| **The dollar cost in three months using a forward contract** | |
| | |
| **$1,300,000** | |
| | |
| **The future dollar cost using a call option contract** | |
| | |
| Total option premium | 12,000 |
| 3 months simple interest | $75 |
| Cost to exercise the options at strike price | 1,280,000 |
| **Total expected cost of buying 1000000 ELI** | **1,292,075** |

c(iii)

*Candidates could have used an incorrect calculation from c(ii) combined with additional qualitative justification to recommend futures and still receive full credit for c(iii).*

A call option is the best hedging instrument for the company. As demonstrated in the calculations in question c-(ii), the cost of a forward contract is higher when the future spot rate for ELI exceeds the strike price of $1.28. Unlike futures or swaps, a currency option provides the right, but not the obligation, to transact, allowing the company to benefit from favorable exchange rate movements. Additionally, although there is an upfront "sunk" cost for the call option, this cost is known and fixed at the outset.

c(iv)

*Some candidates correctly noted that there are no meaningful exchange rates that can make the cost of a currency option equal to the cost of a currency forward. Candidates who received full credit correctly set up the calculation, attempted to derive a number using Goal Seek or algebraic methods and/or correctly concluded that there are no exchange rates that will equate the cost of both instruments.*

## 2. Continued

| | |
|---|---|
| **Currency Option** | |
| Exchange rate in 3 months | **N/A** |
| | 1.287925 |
| The future dollar cost using a call option contract | |
| Total option premium | 12,000 |
| 3-months simple interest | $75 |
| Cost to excerise the options at strike price or simply buy the curren | $1,280,000 |
| **Total expected cost of buying 1000000 ELI** | **1,292,075** |
| | |
| | |
| **Currency Forward** | |
| The future dollar cost using a forward contract | 1,300,000 |
| | |
| **Cost Difference between Currency Forward and Currency Option** | $7,925.000 |

(d) **(LO 2.1a)** As you continue your review, you note that there have been more instances where political issues have caused disruptions than you were originally led to believe. You recommended to GRD management that it add political risk to its risk taxonomy. Katie, a director of Risk Management at GRD, disagrees with your recommendation. In her email, she states:

"*We believe the company's exposure to political risk in Country X is minimal and doesn't necessitate active management. Here's our reasoning:*

- *Limited Ownership: We don't directly own the factory, minimizing direct risk from disruptions.*
- *Non-Sensitive Goods: The imported components are not subject to heightened regulatory scrutiny due to their nature.*
- *Past Performance: The factory has maintained deliveries despite previous political events in Country X.*"

Critique Katie's statement on political risk.

**Commentary on Question**:
*Candidates generally performed well in critiquing the three points Katie outlined. Those who received full credit also identified areas where they agreed with Katie's statements and provided justifications for their agreement.*

## 2. Continued

Katie is correct that, compared to companies that directly own subsidiaries in Country X, GRD's exposure to political risks in Country X is lower. Additionally, since GRD is not importing sensitive goods, the probability of regulatory changes impacting these imports is also lower. However, Katie's statement that the company's exposure to policy risk in Country X is minimal fails to consider the potential impact of disruptions due to political events. In other words, even if the likelihood of political events in Country X affecting GRD's supplier is low, the impact on GRD could still be significant if the cost of switching to an alternative supplier is high. Specifically, Katie's reasoning has the following issues:

1. **Limited Ownership**: Although GRD does not directly own the factory, Katie's assessment fails to consider other types of political risks, such as internal conflict, social activism, and geopolitics, especially given that the factory has experienced shutdowns in the past few years.
2. **Past Performance**: While the foreign factory managed to deliver during prior shutdowns, GRD should still learn from these "near miss" events, develop contingency plans, and test the effectiveness of these plans.
3. **Non-Sensitive Goods**: Identifying this as a risk and including it in the company's risk taxonomy helps reduce blind spots, such as the potential for these goods to become sensitive in the future. When assessing whether the company is exposed to this risk, the decision should not only be based on the current materiality of the risk but also on its potential to become material.

# 3. Fall 2024 ERM Exam (LOs 2.2g, 3.3c, 3.3d, 3.3e)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |
| 3.3d | Demonstrate the use of techniques to allocate risk once aggregated. |
| 3.3e | Propose techniques of attributing the "cost" of risk/capital strategies to business units in order to gauge performance (e.g. returns on marginal capital). |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 18: Quantitative Enterprise Risk Management by Mary Hardy and David Saunders, Chapter 18: Risk-Adjusted Measures of Profit and Capital Allocation* (Except Section 18.6)

**Commentary on Question:**

*The goal of this question is to test the candidate's understanding of various ways to allocate capital by lines of business and the pros and cons of different approaches. In addition, the candidate is asked to consider the use of RAROC in setting compensation targets.*

**Solution:**

(a) **(LOs 2.2g, 3.3c, 3.3d, 3.3e)**

(i) Compute the capital allocated to each business unit using Pryde's current approach and the projected 2024 data provided in the tab "Q3 - 30k CapitalSim Scenarios" of the Excel spreadsheet. Refer to tab "Q3.a.i" of the Excel spreadsheet. Show your work.

You decide to evaluate alternative capital allocation methods.

(ii) Calculate the allocated capital following the Proportional and the Co-VaR allocation methods based on the VaR(99.6) and using the projected 2024 data provided in the tab "Q3 - 30k CapitalSim Scenarios" of the Excel spreadsheet. Refer to tab "Q3.a.ii" in the Excel spreadsheet. Show your work.

## 3. Continued

(iii) Recommend a change to Pryde's current methodology. Justify your answer.

**Commentary on Question**:
*See excel for solution to a (i) and (ii) and additional commentary around responses and partial credit. Some comments:*

*Key information is found in Case Study section 4.5. This section includes an explanation of Pryde's approach to required capital and capital allocation as follows:*
*"Pryde defines required capital as the capital necessary to protect Pryde's policyholders in order to meet all of their claims on a VaR basis with a confidence level of 99.6 percentile over a one-year time horizon. Pryde uses 30,000 simulation results to estimate the amount of required capital.*
*Pryde allocates capital to lines and products using a Co-CTE approach on modeled GAAP equity at the 99.0 percentile using the outputs from the economic capital model over a one-year horizon.Risk adjusted return on capital (RAROC) is calculated for each line and product using expected net income after tax divided by the required economic capital allocated for each segment."*

*Most candidates did well on parts (i) and (ii). If candidates used different excel functions other than Percentile to arrive at the correct results (e.g., use Vlookup or Index function to look up the correct scenario(s) to calculate VaR99.6 and CTE99), they will earn full credits as well. In addition, candidates were not penalized if they left the VaR99.6 and CTE99 values as negative ones.*

*If candidates make a mistake in any calculation, but they carry the mistake through with the correct methodology, they would only lose points for the item where the mistake was made.*

*For (iii), candidates must recommend a change with justification to receive full credits.*

(iii) Recommend a change to Pryde's current methodology. Justify your answer.

## 3. Continued

Answer:
I think Pryde should rethink their current capital approach. For one thing, they are mixing approaches which likely does not lead to satisfying all four fair allocation criteria. I recommend that they change their capital to equal a 99% CTE measure and then use a Co-CTE approach. The 99CTE would result in a total capital measure that is very similar to the 99.6% VaR measure used today. But adding consistency between the approaches used to determine required capital and then those used to allocate capital means that we can satisfy all four fair allocation criteria.

(b) **(LO 3.3e)** Pryde uses RAROC to reward appropriate risk-taking behaviors in its compensation structure for business unit leaders.

Pryde's net income by line of business was as follows (000's):

| | **2022** | **2023** |
|---|---:|---:|
| Commercial Multiple Peril | 77,184 | 20,696 |
| Workers Compensation | 6,179 | 6,716 |
| Total Net Income | 83,363 | 27,412 |

(i) Compute the retrospective RAROC for Pryde's two lines of business for 2022 and 2023. Use Pryde's current approach for calculating economic capital (EC) and assume the EC is constant throughout each year. Refer to tab "Q3.b.i of the Excel spreadsheet. Show your work.

The Commercial Multiple Peril business unit leader asserts that the RAROC-based compensation structure is unfair, but the Workers Compensation business unit leader disagrees.

(ii) Explain each business unit leader's reasoning.

(iii) Recommend a change to address fairness for both business unit leaders. Justify your recommendation.

**Commentary on Question**:
*See excel for solution to b(i). Some comments:*

*In order to calculate the retrospective RAROC, the candidate needs to essentially repeat the calculation in part A for 2022 and 2023. They are given additional work space in the template, but they need to understand what should go in there and complete accordingly. (They won't be penalized for doing this incorrectly if they were already penalized in part A.) Once they have the allocated capital for the denominator, the numerator is the net income provided in the question stem.*

## 3. Continued

*Note that retrospective RAROC in the text is calculated with average EC in the denominator. Candidates don't have to calculate an average here since the EC assumed to be constant throughout each year.*

(ii) Explain each business unit leader's reasoning.

**Commentary on Question**:

*Each business leaders' thinking should be tied together to make a logical conclusion of fairness to receive full credit.*

*RAROC can be a useful indicator for performance-based compensation. However, for salary-based incentives to be effective, the measures used must be perceived by the employees to be fair, and should reward performance that is within the control of the individuals, not for factors from outside their domain. For Pryde, the realized net income of the commercial multiple peril business unit in particular is highly dependent on natural catastrophes. Using retrospective RAROC in 2022 and 2023 would have provided an outsize reward in 2022 and would have penalized the commercial multiple peril team in 2023, neither of which were due to conditions the team members had control over.*

Answer:
Risk adjusted returns are fairly volatile for the Commercial Multiple Peril business unit, due to exposure to catastrophic events. The risks that threaten risk adjusted returns are largely out of the business' control since they are natural disasters. Since the CMP business can't control the risk and results are volatile, the CMP business leader would see volatile performance-based compensation under the current structure. They could argue however, it's not really due to their performance, and conclude it is unfair.

Risk adjusted returns are relatively stable for the Worker's Comp line. The risks that threaten risk adjusted returns are largely in the business' control. Since WC is doing a fairly good job of controlling the risk, resulting in stable results, the WC business leader can count on steady performance based compensation under the current structure, which they'd likely consider fair.

(iii) Recommend a change to address fairness for both business unit leaders. Justify your recommendation.

**Commentary on Question**:
*For (iii), Only one "fix" needs to be recommended for full credit with good justification. However, it should tie directly to the observations provided in part (b) - ii, even if the response to (b) - ii is incorrect.*

## 3. Continued

Answer:
Given the huge volatility of net income shown for CMP for 2022 and 2023, we may consider removing or smoothing cat losses before calculating RAROC to balance YOY volatility, as the volatility is most likely due to natural disasters which is out of business leaders' control.

# 4. Fall 2024 ERM Exam (LOs 1.2a, 2.1a, 2.2h, 3.2f)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2f | Demonstrate possible techniques for managing non-financial risks. |

**Relevant Sources:**

- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

**Commentary on Question:**

*This question was testing candidates' understanding of the value KRIs bring to an organization by enabling early identification of emerging risks, including ESG risks, and assist in providing actionable insights that drive risk management. Full credit answers required candidates to have a sufficiently thorough understanding of these concepts that they could argue persuasively for implementing new risk identification & management measures that would benefit an organization (SLIC) based on the specific risks that organization was exposed to. This included both emerging ESG risks & recent risk events that a better risk management culture would have helped prevent.*

## 4. Continued

**Solution:**

(a) **(LOs 1.2a, 2.2h)**

(i) Identify one element of good KRIs that is present in the quarterly dashboard's metrics. Justify your response.

(ii) Identify one element of good KRIs that is missing from the quarterly dashboard's metrics. Justify your response.

(iii) Recommend three specific ways that SLIC could benefit from including more effective KRIs. Justify your recommendation.

**Commentary on Question**:
*The metrics presented were not KRIs, but were actually KPIs. While KPIs like these have some elements that aid in risk management they are lacking critical components like the ability to reduce risk before the company experiences the identified risk event. For SLIC this may include the many risks that do not have a currently defined trigger or limit. E.g. Interest rate risk, legal, strategic, environmental, political or cybersecurity risks. Effective KRIs may have identified the asset administrative system's age before it became outdated and smoothed the transition to the new system (e.g. could have started gradual, organic downsizing instead of implied immediate layoffs). Could also help with smoother transitions when we need to react to existing thresholds like the asset/liability duration mismatch.*

The metrics on the quarterly dashboard are more like KPIs, not KRIs, but like KRIs they are based on **established benchmarks** (like loss ratios) that are easily understood by the senior management. This helps to improve communication and understanding of any emerging risk exposures.

The metrics are **lagging indicators, not leading indicators**. Those metrics above reflect past events that have already affected the firm. KRIs, however, should be able to reflect increasing risk exposure and serve as early warning signals. Having a better understanding of SLIC's emerging risk exposure through better KRIs will allow it to make better strategic decisions that protect and grow the value of the firm. For example, SLIC could identify VA Hedging opportunities for the opportunistic hedging they're interested in.

Having better KRIs related to its operational risks could alert SLIC to the increased risk of any operational failures like those associated with the asset administrative system aging out. This would reduce the possibility of business disruption or customer dissatisfaction. This would therefore lead to improved operational processes and maintain SLIC's reputation.

## 4. Continued

Having better KRIs related to its insurance risk exposure will ensure that SLIC is able to modify and adjust its risk mitigation measures to deal with any increasing risk exposures. By having this "proactive" feedback loop, this may reduce the perceived risk of SLIC's business, thereby improving its credit rating and also reducing the cost of capital. These are all top of mind considerations for SLIC and Lyon, e.g. the work done around Kelly's rating and Lyon's strategic objective to be able to raise capital.

(b) **(LOs 2.1a, 2.2h)** The new CRO is particularly concerned about the impact of Environmental, Social, and Governance ("ESG") risks on the organization's key risks. Refer to tab "Q4.b" in the Excel spreadsheet.

(i) Identify three ESG risks that could be significant to the financial results of SLIC's life and annuity blocks.

(ii) Evaluate the anticipated risk impact and likelihood of each identified risk with regard to SLIC's life and annuity blocks by placing it on the likelihood/severity table in the Excel spreadsheet.

(iii) Justify each identified risk's placement on the likelihood/severity table.

**Commentary on Question**:
*Full credit answers would demonstrate an understanding of the effects of various ESG risks on annuity & life insurance blocks. To be a significant ESG risk the identified risk must be expected to change in frequency or severity over time based on environmental, social or governance drivers. For example, a change in capital requirements is a risk, but unless the candidate was able to justify that this event is expected to increase in frequency or severity over time it would not be an ESG risk. Similarly, if a candidate later placed the risk in a low-impact/low-frequency box then it would not have fulfilled the requirement in (i) to identify significant risks. Commonly identified significant ESG risks included Pandemics, Extreme Weather Events, and Healthcare improvements. Candidates were not required to identify a risk in each ESG category, merely to identify three in total.*

*For Part (iii) candidates receiving full credit had to justify all elements of the risk's placement – not just to re-state their placement. That is – they had to provide rationale for why the likelihood would be where they placed it, why the severity would be where they placed it, and why the frequency would be where they placed it with an explanation that considered the specific situation at SLIC with a large exposure to mortality risk and a much smaller offset from longevity risk.*

## 4. Continued

*Question parts were graded based on what each part was asking. For example, if a candidate identified three risks that were NOT ESG risks, they would not receive full credit for (i) but may receive full credit for (ii) & (iii) depending on their justification & risk placement on the grid.*

Model solution provided in attached spreadsheet.

(c) **(LO 3.2f)** Recommend a KRI to monitor for each ESG risk from part (b). Justify your recommendation using the characteristics of good KRIs.

**Commentary on Question**:
*This question had two parts and was graded on candidates ability to identify a KRI that conformed to multiple characteristics of good KRIs and to identify those characteristics. Many examples were provided in the source text and candidates were expected to apply their learning to this new context. There was no set list of acceptable answers but generally the recommended KRIs needed to identify a risk before it affected SLIC (vs looking at SLIC's historical results or experience) and be easily obtainable, allow for comparisons across time etc.*

Environmental: key profitability metrics like Earnings Per Share for listed companies grouped by their environmental ESG rating

- Profitability metrics are based on established benchmarks, so are easily understood
- Profitability metrics allow comparisons over time
- Addresses a root cause event – poor environmental performance (root cause) leading to poor investment performance (risk event)
- Consistent with SLIC because SLIC is part of Lyon which is a listed company
- Information is readily available and doesn't consume a lot of resources to obtain
- While these metrics may only be obtained on a quarterly or semiannual basis, the identified risk has a more long-term horizon so the current reporting frequency is appropriate.

Social: proportion of rejected applications by each underwriting method, classified by reason for rejection

- The data is internal data so it is the most relevant for SLIC. It is easy to obtain and the frequency of monitoring can be performed regularly.
- The data addresses to the root cause event. Because of bias reflected in the underwriting method, then social risk about discrimination will arise.
- Comparisons of the data can be monitored over time and across different UW methods, such as between existing and the proposed accelerated underwriting method.

## 4. Continued

Governance: total number of governance violations published by the insurance regulator, arranged by type of governance violation (e.g. poor risk management).

- Increases in this KRI over time can indicate that regulatory scrutiny is increasing – the KRI is easily understandable
- Severe governance violations are published by the regulator regularly and can be obtained easily. The information also comes from a trustworthy source
- While the KRI may not include all governance violations from insurers, it reflects the most severe ones which should be the priority for SLIC to address. So this is acceptable.
- The violations published also contained a lot of qualitative information which may be useful in assessing the emerging risk exposure too.

# 1. Spring 2024 ERM Exam (LOs 2.1a, 2.1b)

**Learning Objectives:**
2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.1b | Detect emerging risks. |

**Relevant Sources:**

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-113-25: Identifying and Evaluating Emerging Risks

**Commentary on Question:**
*Overall, candidates did well on this question. Most candidates struggled with the part c(ii).*

**Solution:**
(a) **(LOs 2.1a, 2.1b)** Describe two key opportunities and two key threats to include in a SWOT analysis of SeaLux.

**Commentary on Question**:
*Most candidate did well on this question. Only **key** opportunities and threats specific to SeaLux received full credit. Reasonable opportunities and threats specific to SeaLux received partial credit. Strengths and weaknesses didn't receive credit.*

## 1. Continued

Opportunities:
1. Large markets with low penetration rates in numerous countries where SeaLux already an established presence.
2. Asian market, where economic growth has raised discretionary income levels, fueling an increasing demand for travel.

Threats:
1. Increases in fuel prices.
2. COVID impact travel trends..

(b) **(LOs 2.1a, 2.1b)** As part of your analysis you meet with senior officers of SeaLux to get their thoughts on emerging risks facing the company. The CFO expresses concern about exchange rate risk because SeaLux wants to expand in markets such as China and Southeast Asia where it currently has low penetration. Meanwhile, the Chief Technology Officer (CTO) is concerned with cyber attacks if SeaLux expands in these markets.

(i) Critique whether interviewing senior officers is an effective technique to identify the emerging risks facing SeaLux.

(ii) Assess whether the risks identified by the CFO and CTO are emerging risks for SeaLux.

**Commentary on Question**:
*Most candidate did well on this question. At least two distinct statements were required to receive full credit and the alternative answers were accepted. In order to receive full credit for part (ii) candidates needed to provide justification to whether the risk is emerging risk for SeaLux specifically.*

(i) This is an effective supplemental technique. All the interviews were carried out by the same person, which ensured consistent treatment.
It can be a time-consuming approach, however meeting only with senior officers ensure reasonable time spent on this exercise.
Framing of the questions is important part of the interviews, however, concentrating only on the emerging risk made the interview focused and made it easier to frame the questions.

(ii) Exchange Rate Risk is not an emerging risk for SeaLux. As the company operates in Australia, Europe and Asia, SeaLux already and has significant exposure to exchange rate risk. Additionally, Exchange Rate Risk doesn't have the characteristics of the emerging risk:
- It is not hard to communication as SeaLux management is familiar with the risk.

## 1. Continued

- It is not hard to assign ownership as CFO owns that risk.
- There is no lack of consensus around the exchange risk.

Cyber risk is an emerging risk for SeaLux. Even though it's one of the main industry risks, it has a high level of uncertainty, where both frequency and potential impact are hard to assess. Cyber risk has the secondary impact on the company reputation that can have a large impact, but it's hard to quantify.

(c) **(LO 2.1b)** You are preparing a presentation to the Board on the most important emerging risks for SeaLux. They have asked you to present one risk from the five Industry Key Risks listed in Section 1.8 of the Case Study, and one risk not on that list. The CRO has asked you to choose risks that are both highly material to SeaLux and good examples of emerging risks.

(i) Recommend which of the five Industry Key Risks you will present to the Board. Justify why your recommendation fits both criteria.

(ii) Recommend one risk not listed in the five Industry Key Risks to present to the Board. Justify why your recommendation fits both criteria.

**Commentary on Question**:
*Most candidates did reasonably well on part (i), but struggled with part (ii). Responses discussing world events, weather/natural disasters and ability to recruit, with the strong justification, received full credit, while other two risks received partial credit if a good argument was provided. Some candidates recommended a risk from the five Industry Key Risks as a response to part (ii), which resulted in no credit.*

(i) I recommend presenting "World events impacting the ability to travel" to the Board. This is a key risk for SeaLux. The risk covers the pandemic-related events as well as political instability, new laws and regulations (for example gambling laws) and natural disasters. This is a good example of an emerging risk since there is a high level of uncertainty around these events and it's difficult to assess the potential impacts on the company. It's difficult to assign the ownership for the risk, as there is no one person or workgroup that "owns" each risk as they cover multiple events and can significantly impact all stakeholders. The events are also wildly unpredictable, for example COVID's impact resulting in a global travel ban.

**1. Continued**

(ii) Shifting demographic patterns and its impact on cruise lines. For example - the younger generation's preference for other modes of travel. While it is known that demographic patterns, such as age and ethnicity are evolving, the impact on the cruise line business is highly uncertain.

# 2. Spring 2024 ERM Exam (LOs 1.2a, 2.1a, 3.2a, 3.2d, 3.2f)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |
| 3.2f | Demonstrate possible techniques for managing non-financial risks. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- CFE101-120-25: IAA Risk Book Reinsurance
- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis

**Commentary on Question:**

*This question is testing candidates' knowledge of Operational, Social, and Underwriting risk, as well as regulations governing the use of consumer personal data.*

## 2. Continued

**Solution:**

(a) **(LOs 2.1a, 3.2a, 3.2d)**

(i) Describe one operational risk associated with designing the TAU product that SLIC should now consider when evaluating the overall risk of its Term product portfolio.

(ii) Explain one approach to mitigate the risk described in part (i). Justify your response using details from the Case Study.

William Xu's November 15th, 2022, memorandum discusses whether death benefit limits and reinsurance arrangements are needed for TAU. Refer to Section 4.5 of the Case Study.

(iii) Critique the recommendations in Xu's memorandum, considering SLIC's existing Term products and reinsurance.

**Commentary on Question**:
*Most candidates received at least partial credit for this part. Technology Risk, People Risk, and Model Risk were all acceptable answers, as were other risks that could be considered as Operational. Candidates needed to describe the risk, including tying to SLIC, for full credit.*

(i) Model risk – a new product needs new models, how established is SLIC's model governance? Can we use an existing model or would a new one need to be built? Accuracy in model output and avoiding model bias are both key.

**Commentary on Question:**
*Most candidates received at least partial credit. Full credit was given to an answer that addressed the risk in part a)i) and was a plausible response.*

(ii) SLIC could outsource the modeling to a consultant or reinsurer, building confidence at SLIC to where this work would move in-house at some point. This would also create a smoother roll-out, where risk of model errors is reduced.

**Commentary on Question**:
*Most candidates received partial credit. Candidates were expected to address and explain at least two valid points that closely relate to the case study.*

## 2. Continued

(iii) From Xu's email: "I expect our underwriting system to be robust, and as such, do not expect to have to limit the death benefit requested. However, to be safe, we may want to find a reinsurance partner to cover the excess of our desired retention level." This is not appropriate because in reality there are different levels of underwriting depending upon the size of the policy – SLIC should cap the death benefit given the limited UW information being gathered… higher face needs more UW up front.

Considering the Reinsurance / risk transfer: Simplified issue has quota share, multiple reinsurers who may each react to AUW differently. Full UW has one reinsurer above retention, likely has a say in pricing / rates and the UW done. For AUW, might want reinsurer input on UW / pricing given its new venture for SLIC, Or could argue the proportional reinsurance will allow selling more to help diversify the risk of any one policy if simplified issue reinsurers would be amenable to any additional UW being done depending upon reinsurance allowance for the additional acquisition expense.

(b) **(LOs 1.2a ,3.2f)** A state where SLIC is licensed has proposed a new ECDIS regulation as part of Environmental, Social and Governance issues, designed to protect consumers from potential bias and misinformation in underwriting algorithms used by insurance companies.

The following is an excerpt from the regulation:

*"External Consumer Data and Information Source" or "ECDIS" means any data or information source used by a life insurer to supplement or supplant traditional underwriting factors or to establish lifestyle indicators that are used in insurance practices. This term includes credit scores, social media habits, purchasing habits, home ownership, educational attainment, licensures, civil judgments, court records or occupation that does not have a direct relationship to mortality, morbidity or longevity risk, and any insurance risk scores derived by the insurer or third-party from the above list or similar data and/or information source.*

*Life insurers that use ECDIS as well as any algorithms and/or predictive models incorporating ECDIS must establish a governance framework that facilitates and supports policies, procedures, and systems designed to determine whether the ECDIS are credible in all material respects and that their use in any insurance practice does not result in unfair discrimination."*

## 2. Continued

(i) Evaluate how SLIC can address this underwriting regulation in its existing risk policies. Justify your response using details from the Case Study.

(ii) Propose how SLIC can stay aware of similar regulations going forward.

**Commentary on Question**:
*Most candidates did not receive full credit for this part. Candidates needed to show an understanding of SLIC's current ERM framework, as well as where changes needed to be made.*

(i) Policies for Credit, Market, Liquidity and Operational but seem to be focused only on investments. No Insurance policy or Reinsurance policy? SLIC doesn't model any Insurance or Ops risks. Could develop new policies.

Might wish to develop a unique ESG governance policy framework or similar structure which details roles, responsibilities and processes. This can allow a well-defined approach (e.g. using the Responsibility Assignment Metric – RACI methodology), but there might be a greater effort needed to develop guidance and subsequent internal implementation

Integrating ESG risks into the existing risk framework of organizations is common, sometimes within reputation and investment risk policies.

**Commentary on Question**:
*Most candidates did well on this part. Full credit was awarded to candidates who proposed and explained at least two options.*

(ii) SLIC could either set up an in-house regulatory / compliance department or build out Legal or Risk departments to cover.

SLIC could continue using CAERUS consulting who is already focused on the industryregulations and responses of other insurers.

# 3. Spring 2024 ERM Exam (LO 2.2c)

**Learning Objectives:**

2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |

**Relevant Sources:**

- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)

**Commentary on Question:**

*The goal of question was for candidates to demonstrate knowledge and application of copulas as a diversification methodology, compare to variance-covariance approach, and consider how to incorporate copula insights in practice.*

**Solution:**

(a) **(LO 2.2c)**

(i) Explain two key challenges MOK would face implementing a copula model for aggregating risks.

(ii) Recommend which two risk types should be selected to test the new copula aggregation method based on the provided standalone CDFs. Justify your selection.

**Commentary on Question**:

*(i) Candidates were able to identify two challenges, but most couldn't explain the challenges earning them limited points. To get full points, candidates had to provide challenges with implementing a copula, not just choosing a copula.*

## 3. Continued

*(ii) Many candidates incorrectly mentioned Mortality or Operational Risk which cannot be modeled in a way that a copula can be used. Candidates needed to justify their selection, reflecting an understanding of the risk that could be brought into the copula to receive full points.*

(i) One challenge is that copulas are computationally intensive, especially with the number and types of risks ABC includes in the model.

A second challenge is that copulas are less transparent and intuitive to executives when compared to other aggregation methods (variance-covariance). This may result in more difficult communication and additional hurdles prior to enterprise-wide acceptance.

(ii) Interest Rate and Lapse Risk would be appropriate to model using copula since their CDFs demonstrate that the two risks exhibit tail dependence. When interest rates are high, lapses are more likely to be high as policyholders will want to put their money in current yields. When rates are low, lapses will tend be lower.

(b) **NO LONGER RELEVANT**

~~Management has decided that you should focus on Interest Rate Risk and Lapse Risk, regardless of what was chosen in a(ii). You have decided to use the following Gaussian copula function to aggregate the selected risks.~~

$$~~Z(p,q) = a \times \Phi_{-1}(p) + \sqrt{1 - a^2} \times \Phi_{-1}(q)~~$$

~~Assume that $a$ = 0.75. Refer to the tab "Q3.b" of the Excel spreadsheet.~~

~~(i) Calculate diversified Interest Rate and Lapse Risk at the 99.5$^{th}$ percentile by applying the Gaussian copula for provided independent uniform draws $p$ and $q$.~~

~~(ii) Calculate the correlation parameter $\rho$ that would lead to an equivalent diversified Interest Rate and Lapse Risk at the 99.5$^{th}$ percentile using the variance-covariance aggregation method.~~

~~(iii) Compare your results from part (ii) with the implied overall distribution correlation using the copula.~~

~~**Commentary on Question**:~~

~~*(i) Most candidates were able to do most if not all of this part earning a significant number of points.*~~

~~*(ii) Few candidates were able to provide the correct formula. Full points were given if the correct formula was provided even if part (i) was not done correctly.*~~

## 3. Continued

*(iii) Although many candidates were able to provide the correct formula for this part, few earned full points on the discussion of the comparison. Many candidates based their discussion solely on the results when the results were incorrect, instead of reflecting on what the results mean.*

(i) Column E Inverted Normal Dist Values
Column F Inverted Normal Dist Values
Column G Joint Distribution using Copula
Column H revised q'
Column I simulated IR Risk Value
Column J simulated Lapse Risk Value

99.5th Percentile Interest Rate = 399 (Cell N17)
99.5th Percentile Lapse Rate = 141 (Cell N18)
99.5th Percentile of Aggregate Risk = 486 (Cell N19)

(ii) Per Jorion Chapter 7: VaR(Port) = sqrt(VaR(A)^2 + VaR(B)^2 - 2*VaR(A)*VaR(B)*rho)
486 = sqrt (399^2 + 141^2 + 2*399*141*rho)
rho = 0.5076 (note actual solution is 0.50 due to individual VaRs not being rounded)

(iii) Implied correlation across distribution using copula is 0.39, lower, but close to, the solved-for correlation of 0.5. The solved-for correlation being close to the implied distribution is due to the fact that the copula used is Gaussian, which does not assume tail correlation.

There is also a very low probability of truly extreme events occurring for both Lapse Risk and Interest Rate Risk. It's possible that running only 1000 scenarios is not sufficient for capturing the potential tail dynamics of the two risks.

# 4. Spring 2024 ERM Exam (LOs 2.1a, 2.2h, 3.2f)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2f | Demonstrate possible techniques for managing non-financial risks. |

**Relevant Sources:**

- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**
You are an actuary reporting to the CRO at DEF Life Insurance Company. During the last year two significant changes have taken place:

- DEF has started a new policyholder wellness program. Policyholders can connect their fitness trackers to DEF's mobile wellness app and are rewarded when they meet exercise targets.
- DEF has adopted a new HR policy allowing all employees to work remotely from wherever they choose, including internationally.

Prior to the past year the company experienced on average fewer than one cyber security incident per year. However, in the last year DEF has experienced at least one cyber security incident per month. Recent cyber security incidents have had various causes, including employees clicking on links in phishing emails and hacker attacks through the wellness app used by policyholders.

## 4. Continued

(a) **(LO 2.1a)** The CRO is concerned about the growing risks from cyber security threats and asked you to review three proposed Key Risk Indicators (KRI):

I. Number of attempted phishing attacks at DEF

II. Average amount of time for DEF's cyber security team to identify a cyber security incident

III. Number of insurance industry data breaches

Critique each of the three proposed KRIs.

**Commentary on Question**:
*Candidates should consider both strengths and weaknesses when forming a critique.*

*Some candidates addressed the proposed KRI's by listing aspects of a good KRI from the source. The best critiques explained how these aspects made the proposed KRI's better (or worse) at predicting changes in the risk environment.*

KRI 1 will have reliable & consistent data to track, is easy to understand, and can serve as early warning of increased cyber threat. It is also related to a root cause of recent cyber incidents. However, KRI 1 doesn't capture risk from the wellness app. It also does not capture the success rate of those attacks so it provides no information about DEF cyber risk preparedness.

KRI 2 is specific to DEF, will have reliable and consistent data to track, is easy to understand, and captures all types of cyber risk. However, even though KRI 2 captures all types of cyber risk, it lacks relevant historical perspective because of recent significant changes in cyber risk exposure from the new wellness program and the new HR policy allowing remote employees.

KRI 3 will capture general industry exposure to cyber risk which could serve as an early warning signal. KRI 3 would also capture wellness app risk if other companies in industry also have a product. However, KRI 3 relies on industry data which might not be a good indicator for DEF's cyber risk, possible lag in reporting, and monitoring frequency might not be high enough to be useful.

(b) **(LO 2.2h)** You would like to better understand how the KRIs relate to actual losses from cyber incidents at DEF.

The loss amount due to cyber incidents is based on total expenses incurred per month for investigation and resolution of cyber incidents.

## 4. Continued

| Month | Loss amount due to cyber incidents (dollars) | KRI 1: Number of attempted phishing attacks | KRI 2: Average time to log a cybersecurity incident (mins) | KRI 3: Number of insurance industry data breaches |
|---|---|---|---|---|
| January | 33,000 | 7 | 80 | 11 |
| February | 18,000 | 5 | 35 | 1 |
| March | 51,000 | 18 | 8 | 5 |
| April | 100,000 | 22 | 29 | 7 |
| May | 27,000 | 8 | 18 | 0 |

(i) Calculate Kendall's Tau for each of the three KRIs compared to loss amounts. Show your work.

(ii) Analyze the reasonableness of the results from part (i).

**Commentary on Question**:
*Most candidates calculated Kendall's Tau correctly. Using a mathematically equivalent formula could earn full credit.*

Please see the excel workbook for the model solution to b(i).

KRI 1 is the most positively correlated with losses. This is reasonable because KRI 1 is an internal measure of security incidents. Phishing attacks could have directly led to losses, so its high correlation is not surprising.

KRI 2 is loosely negatively correlated with losses. This is reasonable because KRI 2 is more of a measure of internal team efficiency. Discovering a cyber security incident quickly might not lead to lower losses. Alternatively, there might be a delay in logging an incident if it is deemed immaterial/not urgent.

KRI 3 is somewhat positively correlated with losses. A positive correlation is reasonable because an industry environment that has more attacks could reasonably be expected to impact DEF as well. The weaker positive correlation for KRI 3 compared to KRI 1 is also reasonable due to KRI 3 being an external measure.

(c) **(LO 3.2f)** The CRO has asked you to recommend a KRI to be included in the monthly "Key Risk Dashboard" shared with executives throughout the company.

(i) Recommend one of the three proposed KRIs to be included in the "Key Risk Dashboard". Justify why you would include your chosen metric over the other two.

## 4. Continued

(ii) Propose a new KRI to supplement your recommendation in part (i) by covering its weaknesses. Justify your proposal.

**Commentary on Question**:
*Part c(i): Any of the 3 KRI's could have been recommended with proper justification. Candidates were not able to gain full credit without also addressing why they did not recommend each of the other two.*

*Part c(ii): Candidates that used DEF's specific circumstances described in the question stem generally performed better than candidates that did not.*

(i)
I recommend KRI 3. It provides early warning indication by using an external measure that includes companies that would likely be targeted in the same way because they are in the same industry. This early warning indication allows DEF to raise awareness potentially address deficiencies before DEF has been targeted specifically.

KRI 1 only deals with phishing attacks and doesn't address DEF's concerns regarding the wellness app.

KRI 2 is not well correlated with losses according to Kendall's Tau calculation, and is also impacted by the quality and quantity of the employees logging cybersecurity incidents.

(ii)
KRI 3 is a good measure in that it is looking at the overall insurance industry, but it could be difficult to get the data to analyze, there could be a lag reporting due to the time needed to aggregate the data, and may be too narrow focused if other companies have more conservate work from home policies.

I recommend tracking the number of DEF cyber security incidents, split by region. This data is much easier and faster to obtain because it is internal data, it covers multiple types of cyber security incidents, and evaluating by region allows DEF insight into the cyber risk impact of their HR policy.

# 5. Spring 2024 ERM Exam (LOs 2.1a, 3.1b, 3.2a, 3.3c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 3: Risk Measures
- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk

**Commentary on Question:**

*This question was testing candidates' understanding of asset-related risks and potential risk management techniques. The question also tests the candidates' ability to calculate VaR on risk-return metrics. Candidates did generally better on the calculations in part (b) than the explanations in part (a) and struggled in particular with demonstrating understanding of disintermediation risk.*

## 5. Continued

**Solution:**

(a) **(LOs 2.1a, 3.2a)**

(i) Explain the relevance of each of these key risks for XYZ.

(ii) Recommend an appropriate risk management approach for each of the three key risks. Justify your response.

(iii) Identify which of the three key risks XYZ should monitor more closely in the environment described above. Justify your response.

**Commentary on Question**:

*Responses relative to credit risk were mostly strong, and full credit on part (ii) was given for responses including CDS / credit insurance, diversification or reinsurance. A common response was to invest only in high quality assets / highly-rated counterparties. Partial credit was given for this because it does reduce XYZ's credit risk but would severely limit the achievable return on the asset portfolio.*

*For market risk, candidates needed to identify at least 2 components in part (i). Many candidates responded relative to equity levels/XYZ's stocks only, ignoring interest rates, etc. Similar to credit risk, full credit was given on part (ii) for any plausible method of risk reduction, transfer or acceptance.*

*For disintermediation, many candidates struggled to demonstrate that they understood the definition. For those that were successful on part (i), it was common on part (ii) to recommend product design features to dis-incentivize lapse. Since the stem of the question addresses risk on the asset portfolio, candidates needed to provide risk management techniques relative to the assets for full credit.*

*For part (iii), substantial credit was given for responses recommending any of the 3 options provided the candidate gave appropriate explanation tying it to the economic conditions mentioned and the implication for XYZ's asset portfolio.*

## 5. Continued

(i) Credit risk is the risk that a counterparty could default or a security could be downgraded resulting in a decrease in value. Credit risk applies to the short-term and long-term bonds and mortgages in XYZ's portfolio.

Market risk includes equity, interest rate and foreign currency exchange rate risks which can impact the value of the asset portfolio. For XYZ, equity risk applies to the domestic and foreign stocks, interest rate risk applies to the bonds and mortgages and exchange rate risk applies to the foreign stocks.

Disintermediation risk is the risk that interest rates rise resulting in elevated lapses as policyholders shift to products offering higher crediting rates, potentially driving a need to sell assets which have decreased in value with the risk in rates. This is relevant to XYZ because they sell life and annuity products and hold 70% of assets (bonds + mortgages) in fixed income.

(ii) Credit risk can be managed by purchasing credit insurance and/or by diversifying across sectors and issuers.

Market risk can be managed by hedging if desired, but this could significantly reduce the return of the asset portfolio; alternatively XYZ may choose to accept market risk up to a defined appetite.

Disintermediation risk can be managed by holding assets in the portfolio that are liquid and not exposed to rising interest rates. XYZ has significant allocation to stocks which could be sold to cover higher than expected lapses if rates rise.

(iii) Given rates have risen rapidly, XYZ should monitor disintermediation risk which could cause policyholders to lapse, driving the need to sell assets at lower values. XYZ should also monitor market risk since the rise in rates likely reduced the value of the bonds and mortgages and the equity market volatility is likely impacting the stocks in the portfolio.

(b) **(LOs 3.1b, 3.3c)**

(i) Calculate the expected 1-Year default rate and expected annualized return at time 0 for each of the portfolios shown above.

(ii) Calculate the VaR(95) expected capital charge for each bond portfolio at the end of year 1 using the 100 simulations provided in the "Q5.b.ii" tab of the Excel spreadsheet.

## 5. Continued

(iii) Recommend which portfolio allocation should be adopted. Justify your response.

**Commentary on Question**:
*Most candidates did well on this part. There were a couple of common mistakes with the calculations.*

*On part (i) a common mistake in calculating the expected annualized return at time 0 was attempting to adjust for defaults by multiplying the expected return for each initial rating by (1-probability of default in 1 year). This is incorrect because the expected rate of return already reflects the probability of default. Partial credit was given, and this mistake does not impact the values relative to XYZ's goals in part (iii).*

*On part (ii) a common mistake in calculating the VaR was to use the Percentile.excl function in Excel which produces the VaR exclusive of the first and last values. Full credit was given despite this if the calculation was otherwise correct.*

*On part (iii) substantial credit was given for recommendations consistent with the values that candidates calculated in parts (i) and (ii) relative to XYZ's goals, even if the values were incorrect. To receive full credit, candidates needed to correctly identify that Portfolio #2 comes the closest to meeting XYZ's goals and also acknowledge that the expected return was slightly below the 5% that XYZ desired.*

(i) Refer to Excel template for solution.

(ii) Refer to Excel template for solution.

(iii) Refer to Excel template for solution.

# 6. Spring 2024 ERM Exam (LOs 1.2a, 2.1a, 2.2h)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 13: Liquidity Risk
- CFE101-119-25: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks

## 6. Continued

**Commentary on Question:**
*This question tests candidates understanding of liquidity risk as it relates to different products and investment strategies, as well as understanding of a risk management framework. Several candidates confused liquidity risk with credit risk in parts (a) and (c). In part (b), many candidates only commented on incorrect statements made by William King, and were awarded part marks.*

**Solution:**
(a) **(LOs 2.1a, 2.2h)** Describe how the revised investment strategy might impact SLIC's liquidity risk.

**Commentary on Question**:
*This question asks about liquidity risk within the context of the case study. Most candidates were able to identify and justify that the changes increased liquidity risk. Stronger candidates commented on the suitability of UL and SPIA sharing the same investment strategy.*

The revised SPIA investment strategy includes alternative assets, emerging market equity, and derivatives. Adding these assets to SLIC's portfolio increases the company's liquidity risk. Alternative assets have thin markets and uncertain market values, making them difficult to liquidate quickly, and adds uncertainty to liquidation value. Additionally, derivatives have margin requirements, and margin calls will increase SLIC's liquidity needs.

SLIC may face further liquidity risk by applying the revised SPIA investment strategy to UL. Unlike SPIA, SLIC's UL products include a surrender benefit. As a result, UL is exposed to policyholder behavior, which may cause unexpected liquidity needs.

(b) **(LO 2.2h)** William King, a director in the ERM department, made the following comments on liquidity risk:

"Unlike banks, liquidity risk is minimal for life insurance companies like SLIC. There haven't been any failures of life insurance companies caused by liquidity issues. SLIC has long-duration liabilities and predictable policyholder behavior. We hold sufficient liquid assets and would not need to liquidate these new assets to pay benefits. In fact, liquidity risk is usually a consequence of inappropriate management of other risks. If we manage other risks properly, we shouldn't be worried about liquidity risk."

Critique William King's comments.

## 6. Continued

**Commentary on Question**:
*Many candidates struggled on this part. In a critique question, candidate should consider the entire statement, both accurate and inaccurate parts. Correct answers are not limited to the model solution below.*

William King is correct that liquidity risk is lower for life insurance companies than for banks, but it's incorrect to say that liquidity risk is minimal for life insurers. It's also true that managing other risks can mitigate liquidity risk, but that won't eliminate liquidity risk and it should still be monitored.

It's not correct to say that SLIC has predictable policyholder behavior. Stressed market conditions or rising interest rates may lead to an unexpected increase in lapses, which may stress SLIC's liquidity position. Although SLIC holds sufficient liquid assets in normal market conditions, asset values fall in a stressed market scenario, which may lead to the need to liquidate additional assets to pay for claims.

(c) **(LO 1.2a)** The SLIC Risk Management Committee approved applying the revised investment strategy to both SPIA and UL blocks. However, the Committee wants to enhance SLIC's current liquidity risk management framework. Refer to SLIC's current Liquidity Risk Policy described in Section 3.2 of the Case Study.

Recommend ways to enhance the liquidity risk management framework.

**Commentary on Question**:
*This question assesses candidates understanding of a strong risk management framework. To receive full marks, candidates are expected to provide several different recommendations to improve SLIC's current liquidity risk management framework. Many candidates provided multiple unique scenarios to improve stress testing. This was treated as one recommendation and awarded part marks.*

1. Create a liquidity risk appetite statement. The current liquidity risk policy only requires that SLC holds sufficient assets to meet cash demands in a unique liquidity stress-test scenario. The policy should be enhanced to include a clear risk appetite statement and more formal targets.

2. Create Key Risk Indicators for liquidity risk, such as a liquidity coverage ratio, which are regularly monitored (IE monthly). If pre-specified soft or hard thresholds are breached, senior management and the Risk Management Committees should be notified.

**6.** **Continued**

3. Improve liquidity risk modeling. SLIC's liquidity scenario stress test is limited to an idiosyncratic reputational liquidity crisis. Additional scenarios should be tested which capture other liquidity risk drivers, such as catastrophic events, changes in policyholder behavior, or adverse financial market conditions.

4. Create a liquidity contingency plan which outlines actions to take in stressed scenario. The company should assess all available sources of liquidity, in order of availability. The plan should identify order of execution of liquidity sources, and should be stress tested to account for different scenarios.

# 1. Fall 2023 ERM Exam (LOs 3.1b, 3.3b)

**Learning Objectives:**

3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

## 1. Continued

**Commentary on Question:**
*Overall, candidates did reasonably well on the written part of the question and very well on the calculation part of the question. Most candidates struggled with the part a (ii).*

**Solution:**

(a) **(LOs 3.1b, 3.3b)**

(i) Explain the value each of the existing metrics MCEV and EVA adds to the New Business Budgeting process.

(ii) Describe how RAROC fulfills each of the six core elements of a well-designed KRI.

(iii) Assess whether RAROC provides additional value to CDE's existing New Business Budgeting Process.

**Commentary on Question**:
*Most candidates received partial credit for parts (i) and (iii). For part (ii), most candidate failed to recall the six core elements of the well-designed KRI and apply the list to the RAROC.*

(i) MCEV is a good candidate for measuring economic value. It accounts for the cost of nonhedgeable risks, the cost of options and guarantees offered in the insurance contracts, and the frictional cost of capital. MCVE represents the present value of shareholders' interests in the earnings distributable from assets allocated to the covered business after sufficient allowance for the aggregate risks in the covered business.

EVA is a risk-adjusted measure that focuses on value rather than return. It encourages senior management to take opportunity cost of capital into consideration and maximize shareholder's value given their risk appetite. EVA = earning – opportunity cost * capital allocated.

(ii) 1. RAROC is a standard calculation based on present value of profits & required capital, both of which are established concepts
2. Standardization (i.e. consistency) of the RAROC KRI is possible across the organization
3. The RAROC formula is simple, intuitive, and easy to understand how profits are risk-adjusted
4. RAROC has clear inputs allowing for measurement and comparison across time without ambiguity
5. RAROC can be evaluated at a business line or product level and tracked over time. Product and business line profits can then be compared on a risk-adjusted basis.

## 1. Continued

6. Since the components are common calculations, the development and monitoring of RAROC would be efficient (i.e., consume little extra resources).

(iii) EVA is risk based, but it requires multiple departments and many assumptions from each department. In short, EVA is not simple and may be difficult to explain. It likely would require workshops with senior management to get their buy-in and help them understand the concepts. RAROC adds value in that it is simpler to calculate and understand. MCEV accounts for some risks (cost of nonhedgeable risks, cost of options and guarantees, and frictional cost of capital) explicitly, but RAROC explicitly captures the company's risk profile through the inclusion of required capital.

(b) **(LO 3.3b)** The Company agrees to adopt RAROC as a KRI and adjusts its Risk Appetite to include:

- The aggregate RAROC must exceed 8%.
- The RAROC for each product line must exceed 5%.

(i) Verify the Term Life RAROC of 7.4% using the data provided in the "Q1.b.i" tab of the accompanying Excel spreadsheet.

(ii) Critique the Company's New Business Budgeting plan.

**Commentary on Question**:
*Most candidates did well on the calculation section of the question, part (i). Candidates did reasonably well on part (ii) by recognizing the shortfalls of the New Business Budget plan.*

(i) Model Solution is in Excel file attached.

(ii) VA does not meet the RAROC target. The low RAROC for VA implies the company may want to consider lowering its new business premium projections for this line of business. The Company will need to consider de-risking measures for VA to meet the RAROC target. The SPIA product has the highest RAROC. This implies that the product has a low risk profile. Due to the high RAROC on SPIA, the company could consider increasing the new business premium projections for this line if they are satisfied with the profitability.

# 2. Fall 2023 ERM Exam (LOs 1.2a, 2.1a, 2.2d, 3.1a, 3.2a)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

**Commentary on Question:**

*The question was testing candidates' ability to recognize Social Risk in underwriting and recommend ways to mitigate it. Also, testing ability to construct a Risk Appetite Statement for a new category of risk. Finally, this question tests ability to brainstorm scenarios that could create risk events that are specific to social risk in underwriting.*

**Solution:**

(a) **(LOs 2.1a, 3.2a)**

(i) Describe three examples of potential Social Risks generated by ABC Life's proposed new underwriting program.

(ii) Recommend ways ABC Life can alleviate these Social Risks in the new underwriting program.

## 2. Continued

**Commentary on Question**:
*Candidates generally did well on this part. Most candidates were able to describe at least one example of social risk in underwriting, although three were required for full credit. Any three acceptable examples would receive credit, not just the examples in this model solution. Some candidates described social risk as a reaction on social media, which did not get credit.*

(i) The use of credit scores can introduce bias against lower socioeconomic status customers

Using zip codes can also introduce racial and socioeconomic bias

People in hazardous occupations might be declined unfairly or charged too much or too little

(ii) Consider alternatives to credit scores or removing them from the underwriting process

Zip codes – use more broad geographic info than zip codes to remove unintentional bias

Ensure underwriting and rates are fair for those in hazardous occupations, for new occupations and changes in workplace safety.

(b) **(LOs 1.2a, 3.1a)** The CEO would like to develop a Risk Appetite Statement for ESG risks, incorporating both quantitative and qualitative components, which will make it clear to the Board where ABC Life stands on Social Risk

Construct a Risk Appetite Statement for ABC Life for Social Risk in underwriting that is responsive to the CEO's request.

**Commentary on Question**:
*Most candidates got partial credit, describing quantitative or qualitative risks specific to social underwriting.*

Risk Appetite Statement – This document assesses which risks the company will take on and the value that will be created for the company. This document uses both quantitative and qualitative risks to describe the maximum risk the company is willing to take.

- ABC Life will take on Social Risks because they can bring value to the company by lowering underwriting costs and decreasing time to issue.

## 2. Continued

- ABC Life is not willing to accept any significant losses due to social risk, defined by a decrease in capital of more than 10%.

- ABC Life values its solid reputation, and will not take undue social risks that could result in bad PR.

- ABC Life ensures that its algorithmic underwriting practices are fair, and do not produce results biased by race or socioeconomic status.

- ABC Life will broaden zip code data to ensure no specific areas are declined coverage.

(c) **(LO 2.2d)** One of ABC Life's board members mentions that ESG risks might be prominent in newspaper headlines but are not as important as ABC Life's traditional risks.

Design scenarios, one for each category shown below, where ignoring Social Risks could have a large detrimental impact for ABC Life:

- Reputation
- Financial results

**Commentary on Question**:
*Most candidates did well on this part, creating scenarios that could have an impact on ABC Life. Those that only mentioned social media risk received some credit.*

Reputation Risk

If AI underwriting models are not screened and adjusted for bias, the result could be declining more of a certain class like ethnicity. This could produce bad PR or even a class action lawsuit.

Financial Loss

Prescription drug databases won't screen for recreational drugs, and a new recreational drug becomes available that kills many of its users. This would create high mortality and cause worse financial results.

# 3. Fall 2023 ERM Exam (LOs 2.2c, 2.2f, 3.3b)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2f | Demonstrate an understanding of model risk. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 14: Model Risk and Governance
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)

**Commentary on Question:**

*The question focuses on the topic of model risk. The question is based entirely on the case study. -Big Ben Bank.-*

*Candidates received maximum points for being able to answer specific questions on model risk in the context of Big Bank as described in the case study.*

## 3. Continued

**Solution:**

(a) **(LO 2.2f)** Critique the proposed model governance process presented in the memo.

**Commentary on Question**:

*To receive maximum points, candidates had to provide both positive and negative aspects of the overall model governance process at Big Bank.*

*Examples of possible statements. At least 4 statements were required to obtain maximum points.*

*Many candidates provided relevant comments. However, fewer related those comments to the specific context of the case study.*

Potential Answer:

Objective of the review is too narrow: Focusing on the qualitative review of the model is a positive aspect. However, it could be expanded to include quantitative and other COSO ERM components - ex. intended purpose and consequences.

Risk-based control approach: The actual approach is only focused on a rating of High, Medium, and Low. Although it is a good base, it could be improved with a risk-based control approach - preventive, detective, corrective. - The business owners should participate in the review process to obtain their risk assessment of their models.

Riskiness of the models to be reviewed: There is some level of implied risk analysis done; however, it only focuses on models for financial reporting in order to be cost effective. There could evaluation of the riskiness of other models by exposure, impact, control.

## 3. Continued

Segregation of duties: The proposal is for an independent review from conception. It is OK but is not ideal and we could add more specific delegation authority for model changes.

Time horizon: There is consideration of the requirement of time. However, it is only done every three years. It is limited. An improvement would be to do a review for material changes to the model or business environment more frequently.

Overall governance of the model review features: There is a valid tone from the top as management will review material model changes and a proposed sign-off by management after model changes is required.

Documentation of the review process: There is a summary of controls, which is positive. However, it is focused on a limited set of controls, only those that are sufficient. It could be expanded.

Model Validation: The is no formal testing of the models results. We could add performance monitoring as well.

Use of formal risk identification techniques: The proposed review is qualitative, which is a good start. We could integrate other techniques: risk-based process, gap, brainstorming. etc.

(b) **(LO 2.2f)** As part of your engagement, you are asked to devise a detailed validation plan for Big Ben's Economic Capital model as described in Section 1.5 of the Case Study. Your proposed validation plan includes the following steps:

-Step 1: Planning phase
-Step 2: Review of model inputs
-Step 3: Review of the calculation engine
-Step 4: Review of model outputs

Recommend specific tasks for Big Ben for each of the steps shown above.

**Commentary on Question**:
*To receive maximum points, candidates had to recommend specific tasks relevant to Big Bank for each step. As in the previous question, many candidates provided valid statements that are generic but fewer related to specific aspects of the situation at Big Bank as described in the case study.*

## 3. Continued

Step 1: Planning phase: Some specific actions: set up goal and objectives, have kick-off meetings, plan steps, establish teams and contact persons, owners of models in all business groups.

Case study examples: There should be an explicit identification of the owners of models at the business level and overall. For example, for credit model, how does the EC model relate to the actual credit scoring of customers? Is Corporate treasury the only group that should be involved in the overall EC model as it impacts many areas of the organization?

Step 2: Review of model inputs: Obtain and review documentation, analyze data, verify, and validate assumptions, review product specifications.

Case study examples: Many assumptions are used in the credit and market risk models. There should be explicit validation of these assumptions with the sources of risk within each business unit from which the risk arises.

Step 3: Review of calculation engine: review testing done by owners, review code, replicate results, perform sensitivity testing, compare calculations to standards, if necessary, document findings.

Case study examples: There should be an explicit review of the stress tests used for the evaluation of strategic risks. Compare to previous experience, external cases.

Step 4: Review of model outputs: output, fitness of model results, compare results to actual reports, document findings.

Case study examples: There should be an explicit review of the output results, which is not undertaken. Ex. Allocation of EC to the business units is based on a simple rule of thumb. Big Ben uses frequency tests to validate models. This is somewhat limited. It seems to relate only to the review of the calculation engine, which is just one step in a total validation of models. There should be an explicit effort to document all the previous EC steps.

## 3. Continued

(c) **(LOs 2.2c, 3.3b)** Big Ben has asked you for feedback on the Economic Capital model approach described in Section 1.5 of the Case Study. Management knows there are many improvements they could make, but they want to focus their efforts.

(i) Identify three areas where model risk could have the biggest impact on Big Ben's Economic Capital results. Justify your selections.

**(ii)** Assess the diversification benefit methodology and results in Big Ben's Economic Capital model.

**Commentary on Question**:
*To receive maximum points, candidates had to answer these two questions as they relate to the situation at Big Ben Bank. Again, many candidates failed to relate their answer to the specific situation at Big Bank.*

c(i)

Credit risk component: Credit risk is by far the largest component in the current EC model and given that it is based on a Monte Carlo simulation of systematic risk factors and correlations in a joint normal distribution, there is a lot of space for misestimations or errors in the credit risk model.

Since this risk is already large, a relatively minor change could lead to meaningfully higher losses from credit risk and therefore higher capital requirements.

It is also interesting to see that the credit risk is so stable in the tail. We're only seeing the worst 1.5% of scenarios, so the results could be reasonable, but the stability in the tail could also be a function of the use of a normal distribution when it should be a fat-tailed one. Additional testing and validation of the credit risk model is strongly recommended.

Market risk component: The tail risk of the market risk component has a lot of volatility. This leads to concern that the formulation of the model as a VaR measure instead of CTE or TailVaR is questionable and might significantly understate the tail risk and hence, economic capital. For example, the 99CTE for the market risk component is 364, but the VaR at the 99.5th percentile is only 223. This change is larger than the entirety of the operational or business risk components.

Diversification benefit: Credit and market risk are estimated independently and then aggregated using a variance-covariance matrix. By their own admission, Big Ben finds these correlations difficult to obtain and updates them infrequently.

There are two potential model risk issues embedded here that could impact economic capital. First, the uncertainty around the appropriate correlation assumptions means that the diversification benefit, which reduces overall required capital by more than 15%, could be uncertain, meaning economic capital would be understated or overstated. And secondly, the fact that the market and credit risk components are independent ignores the possibility that a combination market-credit event could cause larger losses than the sum of the VaR for each risk independently (which would be the largest value possible in this model if the correlation were 1 and the diversification benefit was zero). This is another factor potentially contributing to understated economic capital.

Mis-estimation for operational risk: Using a simple add-on model likely underestimates this risk as it doesn't consider operational risk present in the other risk categories.

Given that the credit and market risk appear to be driven by economic and market forces and are not a function of losses experienced by Big Ben in the past, a reasonable conclusion is that operational risk impacts on market and credit losses are being ignored, which is likely resulting in an underestimation of overall risk and insufficient economic capital.
It is difficult with the information given to quantify the impact of missing out on this aspect of operational risk, but past examples of company failures have almost invariably been linked to a negative event combined with an operational failure.

Lack of model validation: In Big Ben's writeup, they admit that the various component models of the EC calculation haven't been validated (validation is scheduled for next year) and the developers haven't completed the model documentation, including implementation and change management testing.

The EC results are incorporated in the financial reporting, but the models aren't documented, and no testing was done when they were implemented. This is a significant failure of model risk management that would raise red flags with auditors and examiners if it were known, and raise questions about appropriate levels of economic capital. Documentation and testing should be prioritized.

Other potential issues:

Liquidity risk is a huge risk for the banking industry and for Big Ben Bank. The economic capital model does not consider liquidity risk which could severely impact the economic capital results by understating economic capital. Liquidity risk should be included in the economic capital for Big Ben Bank.

## 3. Continued

Economic Capital Allocation to the Business. This is only done upon request and not updated regularly. Economic Capital should be allocated to each business line on a yearly basis. This will put a few constraints on management and incentivize them to use the capital available most effectively.

Demographic risk If the underlying mortality is set incorrectly, level risk is exposed and the financials will be skewed because of it. Similarly, trend risk can be exposed if future mortality does play out as projected. This assumption is usually found in the EC for ALM or as part of market risk. It could be determined more explicitly.

c(ii)

The diversification benefit would have to be questioned - ex .use of assumptions - particularly based on the existing model used. It is known that var/cov models are not appropriate for extreme events, a situation recognized by Big Ben themselves, resulting in some level of unknown model risk. Based on the existing numbers, it does represent a large component of the overall net EC values.

Additionally, the diversification methodology needs to be improved. Correlations are updated infrequently due to difficulty in obtaining correlations. This is inappropriate, especially given that the current diversification benefit appears to be rather volatile from year to year (-147 an EOY 2021 vs -114 at EOY 2022), as well as it being relatively large and helps reduce overall required capital sizably. 750M without div benefit vs 636M with div benefit.

A variance-covariance- matrix also only captures any linear dependence between risks and does not include any potential non-linear dependencies which a copula (that they suggest exploring) might successfully do. Increased tail-dependence would result in higher economic capital.

# 4. Fall 2023 ERM Exam (LOs 2.2c, 3.1a, 3.2d, 3.3c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-120-25: IAA Risk Book Reinsurance

**Commentary on Question:**

*Commentary listed underneath question component.*

## 4. Continued

**Solution:**

(a) **(LO 3.3c)**

**(i) For relevance, this question has been modified from the original exam format in this fashion: A note was added defining Relative VaR.**

Calculate the following risk metrics for each segment and in total, gross and net of reinsurance

- Relative VaR (99.6) assuming the data follows a normal distribution
- Relative VaR (99.6) using the distribution implied by the simulation data

**Note: Relative VaR is equal to VaR minus the mean loss.**

(ii) Recommend the VaR risk metric in part (i) that would be most appropriate for these lines. Justify your response.

**(iii) NO LONGER RELEVANT**

~~Determine the following:~~

- ~~The business segment with the highest inherent risk~~
- ~~The business segment with the lowest residual risk~~

~~Justify your responses.~~

**Commentary on Question**:

*Candidates performed generally well on parts (i) and (iii) but struggled with part (ii).*

*A common mistake in part (i) was calculation of total VaR, and not relative VaR including subtraction of the mean loss. There were multiple ways to approach the calculation from an Excel standpoint, including selecting the specific 99.6$^{th}$ percentile simulation as opposed to using a built-in function, for which credit was still given.*

*Those who did well in part (ii) recognized that simulated losses reflected significant tail risk for the Property Catastrophe line, and thus a normal distribution was not appropriate, despite the results being close on other lines.*

## 4. Continued

*In part (iii), some candidates lost points for discussing the highest residual risk, despite the question prompting for the lowest residual risk.*

(i) Refer to Excel template for solution.

(ii) Refer to Excel template for solution.

(iii) Refer to Excel template for solution.

(b) **(LO 2.2c)** CapitalSim models correlation between business segments using a Student's t copula. The CRO ask you to use Spearman's correlation and the simulation outputs to validate the results.

(i) Calculate the Spearman's correlation for all 10,000 simulations of gross losses between each segment of business.

(ii) Determine which segments appear to be correlated with regard to gross loss using Spearman's correlation from part (i). Justify your response.

**Commentary on Question**:
*Many candidates performed well and received credit on the correlation calculations in part (i) but not as many did enough to justify their responses in part (ii).*

*On the calculation, some candidates ran into issues if they sorted the data separately by coverage and then applied rank correlation incorrectly, which would result in non-sensical results such as perfect correlation between products.*

*In part (ii), more credit was given not just to point out which lines had the highest correlation but to note that other lines were uncorrelated. The best responses also justified the results by speaking to the nature of the products and why they might experience correlation, or lack thereof. The minority of candidates justified their responses enough to receive full credit.*

(i) Refer to Excel template for solution.

(ii) Refer to Excel template for solution.

(c) **(LO 3.2a, 3.2b)** Pryde's reinsurance treaties are coming up for renewal in three months and Ebony is concerned about the risks in the Property Catastrophe segment of business given the recent hurricane events and news about climate change.

## 4. Continued

You are given the following information:

- Pryde has Property Catastrophe reinsurance for aggregate losses for a year with retention of $20M and limit of $150M
- Pryde's risk tolerance for property catastrophe risk is to have annual Property Catastrophe modeled net losses at VaR (99.6) to be less than 2% as a percentage of surplus
- Pryde's 2024 projected statutory surplus is $1,052,864,000.

(i) Assess whether the property catastrophe risk exposure is within the risk tolerance.

(ii) Recommend whether Pryde should increase its property catastrophe reinsurance retention. Justify your response.

**Commentary on Question**:
*The large majority of candidates did well enough on the risk tolerance calculation to receive close to full credit. However, responses in the recommendation (part (ii)) were often lacking justification and thus did not receive as much credit. In many instances a recommendation was provided with little to no justification to support it.*

(i) Refer to Excel template for solution.

(ii) Pryde should not increase the reinsurance retention. The current retention ($20M) is close to the maximum retention before the tolerance would be breached ($24M) and thus an increase would put Pryde even closer to the risk tolerance of 2%. Additionally, the recent trend in hurricane activity may suggest that the actual risk may be higher than indicated by the catastrophe models. Given that Ebony James is concerned about the recent activity and exposure, keeping the retention as is protects Pryde from increased activity and within the risk tolerance. Any unexpected reduction in future surplus could also cause a breach of the risk tolerance, even without increasing the current retention level.

# 5. Fall 2023 ERM Exam (LOs 2.2g, 3.1a, 3.1b, 3.2a, 3.2d)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-120-25: IAA Risk Book Reinsurance

**Commentary on Question:**

*This question tested the candidate's understanding of cyber risk and related mitigation strategies to either reduce the risk or transfer it. Candidates were also tested on their ability to quantify counterparty credit risk in the context of risk transfer. Candidates were then asked to make a recommendation to the ERM Committee through the lens of VaR reduction while also incorporating information from parts (a) and (b). Candidates performed reasonably well, but few received full credit.*

## 5. Continued

**Solution:**

(a) **(LOs 3.1b, 3.2a)** Your team's initial review of cyber risk finds that GAK's system security is not up to today's standards, leaving GAK vulnerable to data breaches and network outages. Your team has modeled GAK's potential cyber losses and has assessed annual VaR(99.6) at $100 million dollars. To reduce the potential losses, your team has presented two strategies:

> Strategy A - Educate GAK's workforce on hacking and phishing attempts, while improving its cyber security and controls on sensitive data. The estimated cost of this strategy is $8M-$10M in aggregate over the first two years and $1M annually thereafter for maintenance.
>
> Strategy B - Purchase a cyber insurance policy that covers both data breaches and network outages. Annual premium for these policies ranges from $3M-$4M and depends on GAK's current security standards, the deductible for each incident, and the coverage limit for the policy. The policy could be put in place almost immediately.

Describe two advantages and two disadvantages for each of the strategies.

**Commentary on Question**:
*Candidates performed reasonably well on part (a). Most were able to list two advantages and disadvantages for each strategy, but very few candidates received full credit since the question asked to "describe" two of each. Many candidates listed brief bullets when the Guide to SOA Exams states, "A description is not a list; each item needs supporting information." The syllabus reading, Embedding Cyber Risk in Risk Management: An Insurer's Perspective, included clear advantages and disadvantages of each strategy, but any reasonable answer could receive credit as long as it was properly described and the relevance was made clear.*

Strategy A has the advantage of being a known, established mitigation technique for helping employees understand the sources and formats of cyber attacks, detect the existence of these attacks, follow precautious procedures and be able to take timely actions to mitigate their impact. Another advantage of Strategy A is it is proactive. Like other operational risks, proactive management is important to ensure a company's cyber risk tolerance level is not exceeded and Strategy A is an effective way to permanently reduce cyber risk.

Strategy A has the disadvantage of being slow to implement, so it will take some time to effectively reduce GAK's cyber risk and hence, VaR. Another disadvantage of Strategy A is that it has a high upfront cost, which could be spent on more direct or efficient risk mitigation strategies.

## 5. Continued

Strategy B has the advantage that cyber insurance is an established and effective strategy for transferring severe impact of cyber risk events to a counterparty. Even with heavy investment in technology, training and active risk monitoring, unexpected cyber risk events can still happen, and cyber insurance adds an extra layer of protection to cover unexpected losses. Another advantage of Strategy B is that it is relatively efficient when compared to Strategy A, since the risk mitigation is immediate.

Strategy B has the disadvantage however, of introducing moral hazard. If financial impacts are covered by an insurance policy, GAK has less incentive to improve internal controls. Another disadvantage of Strategy B is the introduction of counterparty credit risk with the transfer of large loss amounts. The insurer's ability to pay the promised benefits needs to be assessed since cyber events can affect many companies and personal users at the same time.

(b) **(LO 2.2g)** You've decided to recommend a blend of Strategies A and B to the ERM committee. You have identified a cost-effective pool of insurers to provide this coverage. The pool of insurers would provide a total of $60M of coverage. Their ratings are listed below.

| Reinsurer | Coverage provided in cyber event | Credit Rating |
|---|---|---|
| Insurer Blue | $10M | Ba |
| Insurer Green | $20M | B |
| Insurer Red | $30M | Caa |

The ERM Committee is concerned that the selected insurers do not meet GAK's internal counterparty credit risk standards.

You have the following table from Kelly Rating Agency:

| Rating | Annual Default Rate | Recovery on Default |
|---|---|---|
| Aaa | 0.01% | 25% |
| Aa | 0.03% | 25% |
| A | 0.06% | 25% |
| Baa | 0.14% | 25% |
| Ba | 0.82% | 20% |
| B | 3.16% | 15% |
| Caa | 11.40% | 10% |

## 5. Continued

(i) Calculate the cumulative default rate over 5 years for each insurer using the annual default rates shown above. Assume no rating transitions for simplicity.

The ERM Committee is also concerned about collectability if a cyber event occurs. They ask you to assess the expected losses in the following scenario:

Assume that a cyber event occurs at the full coverage limit and the three insurers each owe GAK their full coverage amounts.

(ii) Calculate GAK's expected credit loss for this cyber event scenario. Assume a one-year default rate for simplicity

**Commentary on Question**:
*Candidates generally performed very well on part (b) with many candidates receiving full credit. Multiple approaches were possible and full credit was awarded to any method used to arrive at the correct answer. Candidates that provided a single, incorrect calculation with no explanation were awarded little to no credit.*

See Excel Document

(c) **(LOs 3.1a, 3.2d)** GAK has decided to accept your recommendation and move forward with a combination of Strategies A and B.

Your modeling shows that Strategy A would reduce the cyber VaR(99.6) by $25M. GAK would like to use insurance to reduce the VaR by an additional $50M to come down to GAK's enterprise risk tolerance level.

To estimate the reduction in VaR provided by the insurance, assume the VaR decreases by the amount paid by the pool net of defaults and deductibles in a $60M loss event.

GAK is considering three alternative deductible structures that the group of insurers have proposed:

| Deductible | Annual Cost |
|---|---|
| $0 per event | $4.0M |
| $5M per event | $3.5M |
| $10M per event | $3.0M |

You have been given a total budget of $30M over five years to achieve the implementation of both Strategies A and B.

## 5. Continued

Recommend a deductible structure to the ERM Committee using all information provided and your responses from parts a and b. Justify your response.

**Commentary on Question**:
*Candidates generally performed poorly on part (c) and very few received full credit. The directions stated to use all information and responses from parts a and b. Several candidates focused only on the information in part c to form their recommendation. Some candidates failed to mention either the $30M budget or $50M VaR reduction in their recommendation. Many candidates also failed to provide a clear recommendation and instead listed pros and cons of each deductible choice. Although only one deductible satisfied all of the decision-making constraints to be considered, other recommendations could receive partial or close to full credit depending on the support provided for the candidate's recommendation.*

I recommend the $5M per event deductible to the Committee. The Committee has provided a budget of $30M over five years to fund both strategies A and B. Based on the information provided, assume the highest cost of strategy A will be $13 million, $10 million in the first two years, and $1 million per year thereafter. Thus, $17 million remains for strategy B. Since the question states that the VaR decreases by the amount paid by the pool, net of defaults and deductibles, a risk event of $60 million in losses will have $3.7 million of credit losses (answer from part b) netted against it. The resulting payment would be roughly $56.3 million, prior to accounting for the deductible. The $5 million deductible would also be netted, resulting in a total VaR decrease of $51.3 million in a $60M loss event. The goal of reducing the VaR by an additional $50M would therefore be achieved. The annual cost would be $3.5M per year, or $17.5 million over 5 years which puts total cost for both strategies $0.5M over the budget if Strategy A runs at its highest cost. The recommended $5M deductible will thus satisfy both the VaR and budget constraints. The $0 deductible will reduce the VaR even further, but will exceed the budget by $3M or 10% which is likely undesirable. The $10M deductible would keep costs $2M below budget, but will fail to reduce the VaR by the targeted amount.

# 6. Fall 2023 ERM Exam (LOs 1.3a, 2.2c, 2.2g, 3.3b)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.3a | Examine the impact of the external environment on an organization's ability to achieve its objectives. |
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 &7)

## 6. Continued

**Commentary on Question:**
*The question was designed to assess a candidate's understanding of ORSA and RBC capital adequacy requirements. After comparing the two and calculating the diversification benefits, candidates had the opportunity to demonstrate their knowledge by recommending and justifying a method appropriate for DEF.*

**Solution:**

**(a) NO LONGER RELEVANT**

~~You explain that an ORSA starts with a description of the company's risk management framework.~~

~~Describe four characteristics of a risk culture that DEF could adopt, which AM Best would consider strong.~~

~~**Commentary on Question**:~~
~~*Candidates who described each characteristic earned substantially more credit than those candidates who merely listed the characteristics. Candidates received credit for relevant responses that were outlined in the AM Best material. Responses that were not specific to risk culture did not receive credit.*~~

- ~~Senior management has a thorough understanding and is supportive of the risk culture.~~
- ~~There is a separate ERM department with a dedicated Chief Risk Officer.~~
- ~~Management's incentive compensation is tied to goals and objectives that are consistent with the risk culture.~~

(b) **(LOs 1.3a, 3.3b)** You explain that Section 3 of an ORSA includes an assessment of risk capital. The CEO points out that DEF already calculates risk capital under NAIC Risk Based Capital (RBC).

Compare and contrast how capital adequacy is analyzed as part of an ORSA versus RBC.

**Commentary on Question**:
*Most candidates did not identify any similarities between ORSA and RBC. Candidates who noted how they were different performed better than those candidates that simply listed key features.*

- ORSA is calculated at Group Level whereas RBC is calculated at the company level
- ORSA is model based, whereas RBC is factor based
- ORSA is a prospective view, where is RBC is calculated at a point in time
- Both are regulatory requirements for most large companies
- Both attempt to identify how much capital a company should hold to prevent insolvency

## 6. Continued

(c) **(LOs 2.2c, 2.2g)** You are discussing with the CEO possible assumptions for aggregating risks. The CEO would like you to consider both the diversification method used by the RBC formula and the Correlation Matrix method.

DEF has computed risk capital using the RBC method for the following risk components:

| Risk Components | Values in $millions |
|---|---|
| C1o Asset Risk – other | 150 |
| C2 Insurance Risk | 30 |
| C3a Interest Rate Risk | 85 |
| C3c Market Risk | 20 |
| C4a Business Risk | 15 |

A consultant has suggested the risk correlation matrix shown below as appropriate for a company of DEF's size and type.

| | Asset Risk Other | Insurance Risk | Interest Rate Risk | Market Risk | Business Risk |
|---|---|---|---|---|---|
| Asset Risk Other | 1.00 | 0.50 | 0.80 | 0.70 | 0.50 |
| Insurance Risk | 0.50 | 1.00 | 0.50 | 0.50 | 0.20 |
| Interest Rate Risk | 0.80 | 0.50 | 1.00 | 0.50 | 0.90 |
| Market Risk | 0.70 | 0.50 | 0.50 | 1.00 | 0.80 |
| Business Risk | 0.50 | 0.20 | 0.90 | 0.80 | 1.00 |

(i) Compute the diversification benefit for these risks under the RBC method (Authorized Control Level).

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

(ii) Compute the diversification benefit for these risks under the Correlation Matrix method.

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

(iii) Recommend which of these methods should be used to compute the diversification benefit for DEF's ORSA report. Justify your response.

## 6. Continued

**Commentary on Question**:
*Partial credit was given in part (i) where candidates had the formula structure correct but had the incorrect components. Candidates did receive credit for their diversification calculations regardless of their solutions to the Authorized Control Level RBC and Total Risk using Correlation Matrix answers.*

*In part (iii), most candidates recommended the correlation matrix. Given what we know about DEF, the stronger response was to recommend the RBC approach. Either recommendation received credit so long as it was properly justified.*

iii) The recommendation is to use the RBC approach when computing the diversification benefit for DEF's ORSA report.

ORSA suggests that you measure solvency the way you manage your business which would be consistent with the RBC approach.

The RBC approach is already computed, and management is familiar with measurement. Whereas the correlation matrix requires effort to compute and maintain.

# 1. Spring 2023 ERM Exam (LOs 1.2c, 1.2d, 2.1a, 2.2d, 2.2f, 3.1b, 3.2a)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2c | Demonstrate an understanding of governance issues, such as agency, compliance and legal risks and the need for audit and market conduct compliance activities. |
| 1.2d | Evaluate the elements and structure of a successful risk management function. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2f | Demonstrate an understanding of model risk. |
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 14: Model Risk and Governance
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Section 1.5 Section 1.5 and Pages 9–38
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

## 1. Continued

**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.*

**Solution:**
(a) **(LOs 1.2c, 1.2d)** 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).

## 1. Continued

**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.

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.

## 1. Continued

(b) **(LOs 2.1a, 2,2d, 2.2f)**

(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.

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.

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.

## 1. Continued

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.
- 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.

## 1. Continued

(c) **(LOs 3.1b, 3.2a)**

(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.*

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.

## 1. Continued

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.

# 4. Spring 2023 ERM Exam (LOs 2.1a, 2.2d, 3.3b)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

**Commentary on Question:**

*Commentary listed underneath question component.*

## 4. Continued

**Solution:**

(a) **(LO 2.1a)** 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) **(LOs 2.2d, 3.3b)** 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. Spring 2023 ERM Exam (LOs 2.2b, 2.2f, 3.3c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2b | Describe the properties and limitations of common risk measures (e.g., VaR and TVaR). |
| 2.2f | Demonstrate an understanding of model risk. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
    - Ch. 14: Model Risk and Governance

**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) **(LO 3.3c)** 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 95$^{th}$ 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) **(LO 2.2b)** 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) **(LO 2.2f)** 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. Spring 2023 ERM Exam (LOs 3.2c, 3.2e)

**Learning Objectives:**

3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 3.2c | Demonstrate how derivatives or similar methods may be used to manage or reduce risk. |
| 3.2e | Analyze how ALM and similar risk strategies can be used to manage or reduce risk in an organization. |

**Relevant Sources:**

- CFE101-119-25: ERM-144-20: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 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) **(LO 3.2e)** 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) **(LO 3.2e)** 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) **(LO 3.2e)** 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) **(LOs 3.2c, 3.2e)**

(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. Spring 2023 ERM Exam (LOs 1.3a, 2.1a, 2.1b, 2.2h)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 1.3a | Examine the impact of the external environment on an organization's ability to achieve its objectives. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.1b | Detect emerging risks. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |

**Relevant Sources:**

- CFE101-113-25: Identifying and Evaluating Emerging Risks
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk
- CFE101-109-25: Managing 21st-Century Political 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) **(LO 2.1b)**

**For relevance, this question has been modified from the original exam format in this fashion: The question now asks about types of emerging risks instead of characteristics of emerging risks due to a syllabus change.**

Explain the three major types of emerging risks and how they 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 uncertainty/Lack of knowledge – These types of emerging risks are characterized by lack of data or knowledge regarding their possible impacts.
   Example: Demographic shifts might affect future sales for DE: e.g., fewer millennials buying cars/driving

2. Growing complexity – These types of emerging risk come from new interactions and adaptive behaviors.
   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

3. Contextual changes - These types of emerging risks come from known risks where the conditions or processes change.
   Example: DE recently introduced a cobalt-free battery in China. Changing materials used in an existing product can lead to unexpected impacts.

(b) **(LO 2.1b)** 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) **(LOs 1.3a, 2.1a)** 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

**NO LONGER RELEVANT**

~~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.~~

# 1. Fall 2022 Exam ERM (LOs 2.2b, 2.2c, 2.2g, 3.3a, 3.3b, 3.3c, 3.3d)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2b | Describe the properties and limitations of common risk measures (e.g., VaR and TVaR). |
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.3a | Explain how to develop a capital model for a hypothetical organization. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |
| 3.3d | Demonstrate the use of techniques to allocate risk once aggregated. |

## 1. Continued

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 14: Quantifying Particular Risks
  - Ch. 16: Responses to Risk
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, section 1.5 and pp. 9-38
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
  - Ch. 3: Risk Measures
  - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation (excluding section 18.6)
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)

**Commentary on Question:**
*This question tests the candidates' ability to apply knowledge and concepts related derivatives, economic capital, modeling approaches and efficient capital allocation. The candidate is required to use the case study as well as other perspectives introduced in the question stem to evaluate strategic decisions. The final recommendation required candidates to revisit all parts of the question to provide a level of justification similar to what would be required in a real business setting. Candidates generally scored well on parts (b) and (c). Scores on parts (a) and (d) however, were generally low due to failure to apply the case study and additional information provided in the question.*

**Solution:**

(a) **(LO 3.3c)** SLIC has recently engaged more heavily in the use of interest rate swaps to mitigate interest rate risk. SLIC currently uses Lyon's approach of applying a factor to Corporate assets to account for credit risk in the EC framework.

Annabelle, your actuarial student, asserts the exposure to interest rate swap counterparties constitutes additional credit risk and as a result, SLIC's credit risk profile is now materially different than that of Lyon's Corporate assets. She plans to show that continuing with a factor approach may no longer be appropriate for SLIC.

You are given the following information:

- Annabelle suggests that assessing the counterparty credit risk for interest rate swaps will add complexity.
- Annabelle will draft a communication to alert senior management of the emerging counterparty risk, but she admits the risk's relevance is not obvious until she completes a materiality study.
- Annabelle acknowledges that it will be difficult to explain the change in credit risk to internal stakeholders, since swaps are new to both SLIC and Lyon. However, the associated credit risk is well-documented industry-wide and best practices exist for assessing the risk.

## 1. Continued

Assess the appropriateness of continuing with the factor approach to determine credit risk for SLIC based on Annabelle's suggested approach. Justify your answer.

**Commentary on Question**:
*Candidates generally scored low on this question and few received full credit. Reponses that scored low failed to use the information provided in the question to assess the appropriateness of the factor approach. Several candidates also provided brief responses that did not align with the number of points possible for the question. Responses that recommended maintaining the factor approach could receive full credit as long as sufficient justification was provided.*

The credit risk for a derivatives transaction fluctuates over time and to appropriately assess it, one needs to determine both current exposure and potential exposure. Current exposure is straightforward since it simply asks for the current market value of a derivative. Potential exposure is more difficult since it calls for an assessment of what the replacement cost of the derivatives transaction would be in the future, if the underlying variables that determine the value of the contract move adversely. The potential exposure in 1 year is needed to assess economic capital so Annabelle is correct that there is added complexity to SLIC's credit risk profile and it will be difficult to reasonably assess using a factor approach.

Annabelle has categorized this as an emerging risk. An emerging risk is a developing or already known risk which is subject to uncertainty and ambiguity and is therefore difficult to quantify using traditional risk assessment techniques. Although the risk is new and not well understood by SLIC, this is not an emerging risk since it is well understood in the industry and best practices exist for assessing. The existing best practices can be leveraged to re-evaluate SLIC's credit risk and compare to results using the factor approach. This will certainly be helpful in the materiality assessment. Also, best practices can be used to overcome the challenge of explaining the changes in credit risk to internal stakeholders, making stakeholders more comfortable with any new methodology.

Given that the factor approach cannot reasonably capture the complexity of the credit risk related to swaps and the fact that there are existing methods available to assess and explain the changes, it is not appropriate to continue with the factor approach.

## 1. Continued

(b) **(LOs 2.2b, 2.2g)** You and Annabelle decide to recommend that SLIC move to a more sophisticated approach to calculating EC for interest rate swap credit risk. Annabelle proposes the following:

1. Use a Monte Carlo simulation combined with an appropriate interest rate model to generate interest rates in one year.

2. From the resulting distribution of projected interest rates, determine the VaR(85) of the replacement value of each swap transaction. The replacement value for each swap is the credit exposure.

3. For counterparties with multiple swaps, assume netting applies and is enforceable. Then the potential exposure for that counterparty is the gross loss; that is, the sum of all positive exposures only.

4. The maximum potential exposure is then simply the sum of all individual counterparty exposures.

Critique each of Annabelle's proposed steps.

**Commentary on Question**:
*Candidates scored well on this question. A thorough critique of each step was required for full credit. Justification related back to the information provided in the question was required to receive full credit.*

Monte Carlo simulation is a generally accepted approach to interest rate modeling since it is flexible and can generate thousands of scenarios reflecting different interest rate movements. It is therefore a good choice for measuring VaR. It also has the capability to reflect market dynamics and interactions between risks. It will be key, however, to choose an interest rate model that can generate sufficiently adverse movements to determine a meaningful VaR measure. SLIC will require internal experience and expertise on Monte Carlo modeling and interest rate models, which may be a challenge depending on current resources. The costs should be weighed against the benefits before proceeding with this approach.

**1. Continued**

VaR is appropriate for measuring and communicating risk through the lens of economic capital since most people are familiar with it and it provides a straightforward measure of the capital needed to protect to a desired level of confidence. For economic capital, however, a measure that is sufficiently extreme that it is unlikely to be exceeded should be chosen. Calculating the replacement value under various interest rate scenarios is reasonable, but they should consider a confidence level between the $95^{th}$ and $99^{th}$ percentiles to be consistent with subsidiaries. A lot can happen beyond the $85^{th}$ percentile in the tail. Also, other subsidiary economic capital models use confidence levels much further out in the tail, indicating that their risk appetite is lower. As a supplement, Annabelle can look beyond the VaR level to gather additional information about the risk not covered by economic capital and educate everyone on the potential downsides to using an incoherent risk measure such as VaR.

In calculating the current replacement costs for a portfolio of transactions with a counterparty, it is important to know whether netting applies and is enforceable. Netting should not be assumed unless master agreements can be checked, as the risk will be understated for each counterparty where netting is not established. Also, if netting applies, the potential exposure should be the net loss or sum of both positive and negative exposures. The gross loss should be considered where netting does not apply.

The suggested calculation of Maximum Potential Exposure is flawed. For large, diversified derivatives portfolios, worst-case exposure becomes a less useful measure since it is highly unlikely that all worst-case outcomes will occur simultaneously. Correlation should be assessed and some level of diversification should be reflected.

With the corrections stated above, all of the proposed steps will introduce more rigor to SLIC's assessment of credit risk and should make both SLIC and Lyon more confident that they are improving their ability to accurately measure and manage credit risk.

**1. Continued**

(c) **(LOs 2.2c, 3.3b, 3.3d)** Senior management shifts focus to the enterprise assessment of EC, as described in Lyon's recent ORSA report.

Refer to sections 2.11 and 2.12 of the Case Study.

(iii) Discuss an advantage and a disadvantage of Lyon's approach to calculating required EC.

(iv) Annabelle suggests that it is reasonable to assume complete independence between all of Lyon's subsidiaries, including Lyon Corporate, under normal business and economic conditions. She proceeds with the independence assumption and calculates a combined required EC of $2,048,357,000 reflecting the diversification benefit of $1,288,269,000.

Critique Annabelle's assumption.

(v) Marcus, your supervisor, states it is a mistake to use Annabelle's correlation assumption in a stressed business and economic environment.

Explain your supervisor's statement.

(vi) Propose two unique modeling solutions that could address the correlation issue. Justify your answer.

**Commentary on Question**:
*Many candidates were able to provide responses for part (c) that received close to full credit. Only partial credit was awarded for those responses without justification. For sub-parts (i) and (iv), any reasonable response was awarded full credit as long as the candidate could justify the response.*

(i) Lyon's approach to calculating required economic capital is to simply sum the economic capital from each of its subsidiaries. One advantage of this approach is that it provides a conservative view of economic capital since it effectively assumes 100% correlation between each of the subsidiaries. One disadvantage to this conservative measure, however, is that economic capital is overstated. The objective is to set economic capital efficiently so capital can be deployed in a way that maximizes returns for Lyon. Setting EC too conservatively goes against the principal of maximizing returns.

**1. Continued**

(ii) The assumption of complete independence effectively assumes zero correlation between each of Lyon's subsidiaries, but this should be assessed for reasonableness based on the risk sources. Helios, SLIC and AHA, for example, are all life and health companies so assuming complete independence between all three would likely be inappropriate. Also, she should not be assessing correlation during normal business and economic conditions since economic capital is meant to reflect tail risks. Given that complete independence is not reasonable, the calculation of $2,048,357,000 is reflecting too much diversification benefit and understating the economic capital Lyon should be holding.

(iii) Annabelle is assuming zero correlation between the risk sources during normal business and economic conditions. Assuming the same level of correlation is not acceptable during extreme events. Economic capital is calculated to provide protection during extreme events so assessment of correlation in this part of the loss distribution, where risks often exhibit increased correlation, is of greatest interest. For example, systemic risks such as market downturns are likely to impact each subsidiary in some way, even if they were independent during normal business and economic conditions. Failing to reflect some level of increased positive correlation in extreme events will understate required economic capital.

(iv) Lyon should pursue modeling solutions that can reflect increased correlation in the tail.

One suggestion is to use copulas to solve this problem. A copula function can be defined and specified such that the interaction between correlated risks differs at different parts of the combined distribution. A T-copula, for example, could achieve some level of increased tail risk.

Another suggestion for addressing increased tail risk is using multi-variate methods as they allow interaction between risk factors directly in the aggregated risk impact. This can work if Lyon is able to assess the change in correlation from normal to stressed conditions.

Annabelle will need to understand that any method used to reflect increased tail correlation will reduce the diversification benefit she previously calculated.

## 1. Continued

(d) **(LOs 2.2g, 3.3a)** You have completed additional analyses and determine the following:

- The changes for the enterprise EC would result in approximately 50% of the diversification effect shown in (c)(ii).
- The changes to the calculation of credit risk could further reduce Lyon's EC by approximately 5% of the diversification effect shown in (c)(ii).

Recommend if Lyon should move forward with each of the changes, based on your answers to (a) through (c) and the additional analyses above. Justify your response.

**Commentary on Question**:
*Most responses provided for part (d) were not sufficient for full credit. Responses were generally brief and did not reflect the level of detail implied by the maximum number of points available for the question. Also, many responses failed to use answers from previous parts of the question to justify the recommendation. Any recommendation could have received full credit with proper justification.*

Assuming the recent assessments of diversification have addressed all issues stated prior, Lyon should move forward with the proposed changes to both their credit EC and enterprise EC. Lyon is a large company with a complicated structure, making their economic capital calculations and their credit risk profile complex. A more sophisticated approach to calculating EC is therefore warranted and they've also prioritized improving EC calculations this year.

From the enterprise perspective, diversification should be reflected for such a large, sophisticated company. The diversification effect is now approximately $644M (50% of $1.288B). The reduction from $1.288B reflects that Annabelle addressed Marcus' concerns and was able to incorporate increased correlation in the tail. Although there will be costs involved with monitoring and assessing changes in correlation, Lyon can now confidently move forward and assess where the newly accessible capital of $644M can be used to maximize returns such as growing the company organically, or new acquisitions. Also, now that the tail correlation has been appropriately assessed, the change is straightforward to implement since it is purely formulaic. Lastly, there will be no burden on the subsidiaries since they will not need to make changes to their EC calculations.

**1.** **Continued**

From the credit risk perspective, again Lyon is a large, complex company and it has been established that their credit risk profile has changed materially, warranting a more detailed credit risk calculation. The required modeling to assess credit risk under the new methodology is much more complex and will require additional resources compared to the enterprise change. It was also noted that the changes will be difficult to explain to stakeholders. They do benefit however from the release of another $64M (5% of $1.288B) of capital. $64M is small compared to $644M from the enterprise change, but it's unlikely that the additional resources required will cost more than $64M. It is therefore worthwhile to invest the time and resources necessary for explaining the changes and making all stakeholders comfortable. Since the change in methodology is not required, i.e. the decision is internally driven, they can also take time to slowly phase the changes in to lessen the strain on resources.

# 2. Fall 2022 Exam ERM (LOs 2.1a, 2.2g, 3.2c, 3.3b, 3.3c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.2c | Demonstrate how derivatives or similar methods may be used to manage or reduce risk. |
| 3.3a | Explain how to develop a capital model for a hypothetical organization. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
    - Ch. 10: Economic Scenario Generators
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)
- CFE101-118-25: What is Basis Risk? Definition and Types of Basis Risk, Examples (corporatefinanceinstitute.com)
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-103-25: ORSA and the Regulator

## 2. Continued

**Commentary on Question:**
*This question is intended to test Monte Carlo simulation, economic capital calculations, and risk identification for a variable annuity product with guaranteed minimum benefits and an associated dynamic hedging program.*

*Overall, candidates did moderately well on the written answer portions but struggled significantly with the Excel calculations.*

*The stock price model given in the question stem gave the stock price at time T as a function of the stock price at time 0. Some candidates correctly noted in their critique that this is a drawback of the proposed EC model, as a random walk would typically base S(T) on the prior stock price S(T-1). Although candidates were expected to apply the formula in the question stem in the Excel model, it was decided that full credit for the S(T) calculation would also be given to correct application of a revised formula which based S(T) on S(T-1).*

*Most candidates were able to correctly calculate the management fees, but few candidates took the necessary step of reducing the account value by the management fee each year. Most candidates also showed a lack of understanding of how payoffs of GMDB and GMAB benefits are calculated.*

*There was some difficulty amongst candidates in correctly understanding the impact of dynamic hedging, but most performed better with risk assessment and identification.*

**Solution:**
(a) **(LOs 2.2g, 3.3b, 3.3c)** EFG's CRO would like to integrate the VA product into the company Economic Capital (EC) model. You are given the following assumptions:

- The annual mortality rate is assumed to be constant at 0.001
- Renewals, withdrawals, and rollovers are ignored
- The discount rate is 3.00%.

Equity returns are modeled using the distribution described below.

## 2. Continued

- $S(T) = S(0)e^{\left(\mu - \frac{\sigma^2}{2}\right)T + \sigma\epsilon\sqrt{T}}$, where
- S(0) = 1.0
- μ = 3.00%
- σ = 0.3, and
- ε is a random variable from a N(0,1) distribution.

The EC framework will be based on 100 scenarios of equity returns for the next 10 years. The EC requirement is set as CTE(95) - CTE(0) based on the distribution of losses.

95 total simulations have already been run, and the resulting liability calculations are shown on the tab 'Q2(a)(rank)' in the accompanying Excel workbook. Pseudo-random simulated values from the U(0,1) distribution for the final five scenarios are also available on the tab 'Q2(a)(cash flow)'.

(i) Describe the process of simulating stock price paths using Monte Carlo methods.

(ii) Calculate the required EC for the VA risk. Show your work.

(iii) Critique EFG's approach for modeling EC for VA risk.

**Commentary on Question**:
*Subpart (i)*
*Many candidates received close to full credit on this question, with those who received less failing to get into sufficient detail about the Monte Carlo simulation process. However, almost all candidates received at least some credit for their responses.*

*Subpart (ii)*
*Overall, candidates struggled with the Excel calculations, with very few candidates receiving close to full credit. Most candidates correctly executed the simpler calculations, such as the normal inverse, account value, persistency, management charges, and the discounting factor. However, very few candidates correctly understood how to calculate the guarantee cashflows, or recognized that they were outflows from the perspective of EFG. Several candidates also struggled with the application of the stock price path formula given in the question stem. Even with errors in the preceding steps, the majority of candidates correctly calculated the CTE and EC measures.*

## 2. Continued

*Subpart (iii)*
*Candidates generally performed well on this question, with many receiving full credit. Most candidates recognized that there was not a sufficient number of simulations, and that the mortality and policyholder withdrawal assumptions were too simplistic or missing altogether. Though none are listed in the model solution below, credit was also given for valid positive critiques with justification that related to EFG and the EC model in question.*

(i) Assume that stock prices follow a given model, such as the one for S(T) given above, which has a random error term that follows the Normal (0,1) distribution. First, simulate a set of randomly generated values from the uniform (0,1) distribution. Transform the simulated variables using the inverse cumulative N (0,1) probability distribution. Using the selected model and randomly simulated error terms, calculate the stock price into the future. Repeat several times.

(ii) Refer to Excel for calculation solutions.

(iii) EFG's EC model has several shortcomings that are mostly due to oversimplification.

The model does not reflect the potential impact of policyholder behavior such as lapse or withdrawal. Given the reduction in surrender charges after three years, policyholders may exhibit dynamic behavior that is not accounted for.

Additionally, mortality is assumed to be a constant rate that does not consider policyholder age or vary by time. Discount rates are similarly static.

Lastly, 100 simulations are too few to produce a reliable result. EFG should add more simulations to the EC calculation.

(b) **(LOs 3.2c, 3.3c)** To manage risks associated with VA guarantees, EFG is planning to implement a dynamic hedging program.

(i) Describe the risks associated with implementing and maintaining dynamic hedging as it relates to the new VA product.

(ii) Explain how dynamic hedging could be reflected in EFG's EC framework.

## 2. Continued

**Commentary on Question**:
*Subpart (i)*
*Candidates generally performed well on this part of the question, with the majority earning at least half of the points available. Many candidates tended to focus on operational risk, for which credit was given if it was tied back to the scenario in this question, but did not put enough emphasis on the market and financial risks associated with dynamic hedging.*

*Subpart (ii)*
*Candidates tended to struggle with this explanation, with many responses being too vague or simplistic. Those who received more credit were able to correctly explain the impact of hedging on the economic capital calculations that were presented earlier in the question.*

(i) Dynamic hedging programs introduces multiple associated risks.

Basis risk – the potential for mismatches in the hedged position given that the hedge is not perfectly correlated with the underlying fund.

Higher than expected transaction costs, given the potential for frequent rebalancing of the hedge portfolio.

If the hedge requires investment in a position with a thin market, EFG could experience market liquidity risk resulting in increased hedging costs or an inability to purchase the hedge at all.

Given that EFG is new to the VA market and dynamic hedging in general, operational inexperience in these areas could lead to mistakes and further losses.

(ii) To incorporate dynamic hedging, EFG should model the hedge as part of the existing EC framework. To do so, assets representing the hedge need to be modeled. Cashflows resulting from these hedging assets should serve to offset a portion of the expected guarantee cashflows. The model should incorporate appropriate transaction costs reflecting the rebalancing of the hedge assets. Adjusted liability cashflows accounting for these impacts of the hedge should be used to calculate the new capital requirement.

(c) **(LOs 2.1a, 2.2g, 3.2c, 3.3c)**Within two years of the successful product launch, EFG Life grew its assets under management by 500%. Due to this growth, EFG doubled its workforce and implemented a new hedging platform and administrative system to manage the VA business but did not have enough time to properly train the new employees.

## 2. Continued

EFG had previously identified the following key risks arising from the traditional life insurance business:

- Mortality
- Interest rate
- Credit
- Liquidity

(i) Evaluate how the success of the new VA product launch should be reflected in the assessment of each of these risks.

(ii) Recommend two ***key*** additional risks that EFG should consider when assessing the newly launched VA block. Justify your recommendation.

**Commentary on Question**:
*Subpart (i)*
*Candidates performed moderately well here, with those who received credit doing a better job of specifically assessing the impact on each of the risks. Some candidates were too general in that they stated EFG should simply assess/evaluate the risks, but didn't elaborate on potential impacts. There were several different interpretations of exactly what the question was asking, with some candidates seeming thrown off by the word "success" in the question. Credit was given for alternative interpretations of the question as long as they made valid points relating to how the new VA product would interact with the listed risks above.*

*Subpart (ii)*
*Candidates did very well in identifying additional risks. The most common pitfall was recommending a risk but not justifying how it related to EFG or the VA product launch.*

(i) Mortality risk: though annuities typically have offsetting mortality/longevity risk profiles with traditional life insurance, the existence of the GMDB in this VA will serve to increase mortality risk for EFG, as they are liable for 100% of the initial investment upon the death of the policyholder.

Interest rate risk: there is minimal direct impact from interest rates as the VA accounts are invested in various equity mutual funds. Low interest rates will made the GMDB and GMAB benefits more expensive to hedge, however.

**2. Continued**

Credit risk: as the VA block grows and EFG increases its hedge positions as a result, credit risk will likely increase as the number of counterparties and exposures grows.

Liquidity risk: given the reduction in surrender charges in future years, liquidity risk will be a concern for EFG as policyholders are more likely to increase withdrawals under stressed economic conditions.

(ii) Equity risk: poor performance of the equity markets could trigger increased GMDB and GMAB payouts.

Operational risk: due to the inadequate training for employees, operational risk is significantly increased and could result in business disruption or process failures.

# 3. Fall 2022 ERM Exam (LOs 2.1a, 2.1b, 2.1c, 3.2f)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.1b | Detect emerging risks. |
| 2.1c | Determine an appropriate monitoring mechanism for emerging risks. |
| 3.2f | Demonstrate possible techniques for managing non-financial risks. |

**Relevant Sources:**

- CFE101-113-25: Identifying and Evaluating Emerging Risks
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
    - Ch. 16: Responses to Risk
- CFE101-110-25: IAA Paper: Importance of Climate-Related Risks for Actuaries (Pages 2-14)
- CFE101-103-25: ORSA and the Regulator

**Commentary on Question:**

*The question tests candidates' ability to identify, assess, and mitigate emerging risks, and climate risk in particular. The question also tests candidates' ability to discuss emerging risks in the context of an ORSA report.*

**Solution:**

(a) **(LO 2.1a)** Rank the appropriateness of the following risk identification techniques for emerging risks. Justify your ranking.

- Individual risk interviews of Lyon's senior management
- Brainstorming among Lyon's senior management as a group
- Case studies of other companies and how they dealt with emerging risks

## 3. Continued

**Commentary on Question**:
*The grading rubric was looking for a ranking of techniques, along with justification. There was no best way to rank identified in the grading rubric, any order could receive credit. Full credit was given for a ranking, justification, and explaining pros and cons of each method. Most candidates did well on this part, although few received full credit.*

From best to worst:

1) Brainstorming, because collective discussions will fill in individual gaps in knowledge

   Pros – many ideas, should record all of them
   Cons – free riders in the meeting, need to get everyone in one place

2) Interviews, will have good general knowledge with the team.

   Pros – can ask clarifying questions
   Cons – time consuming, Lyon might not have the expertise we need

3) Case studies, because this is relatively new topic, and will not likely find one that covers all products.

   Pros – can suggest specific risks, shows risk in context
   Cons – might not get relevant case studies

(b) **(LOs 2.1a, 2.1b, 2.1c)** Lyon's management has decided to focus on climate change as the key emerging risk.

Describe two ***key*** impacts of climate change on each of Lyon's four subsidiaries.

**Commentary on Question**:
Most candidates were able to list and describe two impacts, however, many of those candidates applied the same key impact to several subsidiaries – for example, property damage could apply to all the subs. Partial credit was given for this approach, and most candidates did well on this part. Full credit was given for identifying separate key risks for each sub.

Simple Life:

Mortality increases from food and water insecurity, disease, and/or social unrest.
Investment losses from climate change exposures

## 3. Continued

AHA Health
- Increased morbidity from air pollution, or food and water supply
- Morbidity increases from diseases

Pryde P&C
- Property damage from wind or storms, claims and liquidity risks
- Legal risk due to insureds' failure to mitigate risk

Helios
- Storms or floods may disrupt operations
- Climate change impacts for different geographies may introduce currency risk, given their use of the Euro

(c) **(LOs 2.1b, 2.1c, 3.2f)** Recommend a risk mitigation strategy, other than reinsurance, for each risk identified in (b). Justify your response.

**Commentary on Question**:
*Almost all candidates received at least partial credit for this part, but most candidates did not have a recommendation for each risk identified in part b). Full credit was given for a logical mitigation recommendation for each risk. Mitigations did not have to come directly from a syllabus reference.*

Simple Life
- Mortality increases - can be mitigated by underwriting methods that take into account geography and climate risk
- Investment losses – Adopt an ESG investment strategy

AHA Health
- Increased morbidity from pollution, air, food, etc. – communications to policy holders about steps they can take to stay healthy
- Diseases – stress test worst-case scenarios and increase risk capital

Pryde
- Diversify by geography to reduce concentration risk
- Put in place stricter requirements for coverage – like hurricane rated construction

Helios
- Storms or floods – have a disaster recovery plan in place, including offsite work areas to maintain operations
- Currency risk – currency hedging may be used

(d) **(LOs 2.1a, 3.2f)** Explain how you would incorporate climate change risk into each of the three sections of the ORSA report.

## 3. Continued

**Commentary on Question**:
*While almost all candidates received some credit on this part, many candidates could not identify the three sections of an ORSA Report. Full credit was given for identifying and describing the three sections, and explaining how climate risk could be incorporated into each part. Partial credit was given for each section identified, and partial credit was given for explaining how to incorporate even if a section was not identified.*

1. Insurer's Risk Management Framework

   Add to governance structure who owns climate change risk
   Create a new committee to oversee, educate the board of directors
   Create risk reporting around climate change

2. Insurer's Assessment of Risk Exposure

   Stress-test scenarios, use qualitative and quantitative assessments
   Measure interrelationship of risks
   Explain any hedging or reinsurance

3. Group Assessment of Risk Capital and Prospective Solvency Assessment

   Determine metrics, VaR for example
   Extend time horizon of model to capture future potential impacts
   Determine additional capital to hold for climate risks

(e) **(LOs 2.1a, 2.1b, 2.1c, 3.2f)** Identify the subsidiary most likely to be impacted by climate change. Justify your answer.

**Commentary on Question**:
*Most candidates did well on this question. Full credit was given for identifying a sub, and having two or more logical justifications. Most candidates identified Pryde, but other subs could also get full credit with justification.*

Pryde would be most likely to be impacted by climate change, given that it insures events directly tied to weather and climate events. It is concentrated in risky areas, with its largest state being CA (wildfire risk made worse by wind and drought), and then TX, GA, FL, MS, all with hurricane risk exposure. This could result in large claims impacting Pryde's ability to meet its obligations.

# 4. Fall 2022 ERM Exam (LOs 1.2a, 1.3a, 2.2c, 2.2d, 3.3b)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 1.3a | Examine the impact of the external environment on an organization's ability to achieve its objectives. |
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- CFE101-103-25: ORSA and the Regulator

**Commentary on Question:**

*The goal of the question is for candidates to understand the uses of stress and scenario testing for ERM-related applications. A candidate should be able to understand the main risks a company faces and be able to explain how to model those risks. They should also be able to recommend and defend aspects of internal models.*

**Solution:**

(a) **(LO 2.2d)** XYZ currently has limited capacity to implement stochastic scenario testing and plans to apply stochastic modeling for a single product at this time.

(i) Assess, for each product, which risk type would be best suited for stochastic modeling.

(ii) Recommend which product should be selected for stochastic modeling. Justify your response.

**Commentary on Question**:
*Candidates did reasonably well on this part. Even though the suggested answers were market risk for UL and Fixed Deferred Annuity, the asset/credit risk answer was also accepted if the candidates provided their explanation for the answer. For part ii), both the UL and the Variable Annuity answers were accepted for full credit if there was sufficient explanation.*

(a)i –

1. Traditional Life Insurance
    - Insurance risk is the most important risk impacting traditional life insurance. It would be best suited for stochastic modelling, given the large impact changes in mortality claims can affect traditional life insurance.
2. Universal Life
    - Credit/Asset risk should be modelled stochastically. For the UL products, they face significant risk due to guaranteed crediting rate. If the assets backing the UL product experience changes in interest rates or experience credit downgrades, this will drastically impact the profitability of UL policies. Modelling this stochastically will allow XYZ to better understand their sensitivity to these factors.

## 4. Continued

3. Fixed Deferred Annuity
    - Credit/Asset risk should be modelled stochastically. Like UL, the fixed deferred annuity has a guaranteed crediting rate and will face similar risks as UL. Understanding interest rate impacts are of key importance to this product line.
4. Variable Annuity
    - Market risk is the risk that should be modelled stochastically. Market variables have a drastic impact on VA products and are highly unknown variables. Given the potential for downside risk for policyholders, they are more likely to lapse their policies in stressed market conditions. Testing this stochastically can help assess the appropriateness of the assumptions for the product.

(a)ii –

UL should be selected for stochastic modelling. UL is highly dependent on economic variables, which are best assessed through stochastic modelling. Additionally, XYZ has the most exposure to the UL product line. It would make the most sense for XYZ to focus their efforts, especially for something as computationally intensive as stochastic modelling, on something that is likely to have a material impact to the company

(b) **(LO 2.2c)** XYZ is considering the following four aggregation approaches for calculating Economic Capital:

- Fixed diversification percentage
- Correlation matrix based on its own experience
- Correlation matrix based on industry experience
- Copulas. The software that XYZ has licensed can model copulas, although XYZ has done limited testing of that capability.

Recommend an aggregation technique appropriate for XYZ. Justify your response.

**Commentary on Question**:
*Candidates did reasonably well on this part. Full credit was given for both the correlation matrix based on industry experience and copulas. Sufficient explanation of the answer was required for full credit. Candidates who chose the correlation matrix based on own experience, received partial credit. No credit was given for selecting the fixed diversification percentage answer.*

## 4. Continued

Recommend a Correlation Matrix based on Industry Experience.

A correlation matrix is more appropriate method to aggregate risk compared to the fixed diversification method. This method is easy to communicate and can be understood by senior management. It allows for interactions between risks. We can easily add risks, subsidiaries, or lines of business. By relying on industry experience, the resultant correlation matrix is more credible and reliable than one developed based purely on the company's limited experience data. A fixed diversification percentage would likely be too simplistic, while the use of copulas may be outside the capabilities of XYZ at this time.

(c) **(LOs 1.2a, 3.3b)** At the quarterly meeting of XYZ senior managers, the topic of scenario and stress testing in the internal models was discussed. The following items were specifically mentioned by the CEO:

- Because our ERM department serves as our company's first line of defense, our CRO and her team should be responsible for developing the scenarios and stresses.
- We will rely on the ERM team to explain the results.
- Our risks are siloed enough that we should not have to worry about dependencies.
- These results should be provided shortly after quarter-end reporting if we are to use them in our planning processes.

Critique each of the CEO's statements.

**Commentary on Question**:
*Candidates did reasonably well on this part. Most candidates received full credit for part c). The only statement some candidates struggled with was whether ERM was first or second line of defense although most candidates got this correctly.*

1. ERM department serves as a second line of defense in XYZ company. The ERM department is a control function that monitors and works closely with the first line of defense.
2. ERM team in addition to the CRO are the ones who should report and explain the results of the internal model since it is within their ownership.
3. XYZ company's risks are not siloed, and the dependencies must be considered while calculating the economic capital. Some risks can be uncorrelated in the normal times, however, in the stressed times, it moves together. Noting that the EC is calculated to assess the expected amount of capital needed to cover losses in the tail events (stressed times).

## 4. Continued

4. The EC calculated by the internal model should be developed in adequate time and should be rushed to be done within a short time to have proper time of validation and testing. Presenting the results shortly after quarter-end reporting will expose XYZ company to operational risk of reporting faulty EC results that might put the company solvency position at risk. ERM team should have time to make the proper validation of the data, process, models, results, aggregation

(d) **(LOs 1.3a, 2.2d)** In past cycles, XYZ has leveraged stress tests promulgated by regulators to demonstrate the strength of the business.

Explain why adopting an internal model could be viewed favorably by regulators.

**Commentary on Question**:
*Candidates did reasonably well on this part. Most candidates received at least a partial credit for their answers. For this part, the grading was fairly liberal in awarding points for responses that make sense beyond the 4 listed in the rubric.*

Adopting an internal model allows for better customization of the model by the company. This is favorable for regulators, given their primary goal is to ensure solvency. Improvement to modelling techniques are favored by regulators since it helps to ensure that the products are properly priced, and the reserves are better modelled.

Additionally, since the internal model XYZ is adopting will be using software from a third party, it is likely to be viewed favorably by regulators since external vendors typically update their products frequently and have the products go through vigorous testing before hitting the market

# 5. Fall 2022 ERM Exam (LOs 2.1a, 2.2h)

**Learning Objectives:**

2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |

**Sources:**

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion Ch. 13 Liquidity Risk

ERM-136-20: Managing Liquidity Risk: Industry practices and recommendations for CROs

ERM-145-21: IAA Paper: Importance of Climate-Related Risks for Actuaries

**Commentary on Question:**

*The question intended to identify candidates who understand the two types of liquidity risk, how each of the two types would arise from the operations of the company described, and actions that the company was taking or could take to manage the risk.*

*Many candidates answered the question parts in a somewhat unstructured way, for example providing recommendations on how to improve risk management as part of their discussion of current risk management, i.e. answering b-ii within their answers to parts a-ii or b-i. Marks were given regardless of the geography of the answer within the question parts.*

*More candidates understood the asset-related liquidity risk than the liability-related risk. Almost one third of candidates did not correctly describe cash-flow or funding liquidity risk.*

## 5. Continued

*Most candidates correctly referenced the challenge of cash flow volatility resulting from wild fire claims and COVID claims. Most also correctly noted the absence of and potential benefit of reinsurance in the property and health subsidiaries. Most correctly noted that the informal support from QRY to Homeguard should be formalized, and would only help if QRY had sufficient liquidity. Many noted the benefit of the ALM process, and properly suggested that it could be strengthened.*

*Some common errors or omissions:*

- *Incorrectly describing US Treasuries as illiquid investments.*
- *Omitting to note that the potential new acquisition would be expected to reduce current liquidity*
- *Most candidates neglected to mention elements of governance which would strengthen liquidity risk management, such as a liquidity contingency plan, risk appetite statement/limits or economic capital modelling.*

**Solution:**

(a) **(LOs 2.1a, 2.2h)**

(iii) Describe the two types of liquidity risk.

(iv) Evaluate how the current operations and planned activities expose QRY to each type of liquidity risk.

Solution: **Note: The term asset liquidity was changed to market liquidity to be consistent with the current source.**

(i) Market liquidity risk: inability to sell assets at their market price, due to impact from bid-ask spread or impact from price-market depth.

Funding liquidity risk: inability to fulfill liability obligations, often due to mismatch in timing of asset and liability cash flows.

(ii) All companies have potential timing mismatch between claim payments and asset cash flows. The concentration of policies in California for California HomeGuard without there being any reinsurance leaves QRY open to funding liquidity risk, as they may face larger than expect claims and not have the funds readily available to pay them.

Hollywood Life faces asset risk since it has added private placements and oil and gas investments to increase yield. These assets may not be as liquid and may have more price volatility that could result in them having to sell for a lower return than expected. This is especially true of oil and gas in light of transition risk due to climate change.

Investing in a new subsidiary can also result in liquidity risk since it will likely require an upfront investment of funds.

**5. Continued**

Weaker profitability may be draining capital from the holding company, which doesn't have any liquidity management.

(b) **(LO 2.2h)**

(i) Evaluate existing risk management techniques for liquidity risk for QRY and its subsidiaries based on the information provided above.

(ii) Recommend improvements to liquidity risk management for QRY and its subsidiaries, including both changes to existing risk management techniques and new approaches. Justify your response.

Solution:

(i) Hollywood Life: use of quota share reinsurance helps manage cash flow volatility, but 20% is too low and quota share doesn't limit tail risk. ALM is in place to manage the interest rate volatility and may help align cash flow timing.

California HomeGuard informally relies on holding company as catastrophe reinsurance. This may help the subsidiary but not overall QRY liquidity risk.

(ii) Hollywood Life: adjust investment mix to investments that are not at such high risk of losing value in the short and long term.

All subsidiaries: enter reinsurance contracts

Increase frequency of A/L rebalancing/checking

California HomeGuard: explore spreading out business geographically in order to diversify.

Begin monitoring liquidity position on a periodic basis (frequent enough to catch issues)

# 6. Fall 2022 ERM Exam (LOs 1.2c, 2.2c, 3.1a, 3.2a, 3.3b, 3.3e)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2c | Demonstrate an understanding of governance issues, such as agency, compliance and legal risks and the need for audit and market conduct compliance activities. |
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |
| 3.3e | Propose techniques of attributing the "cost" of risk/capital strategies to business units in order to gauge performance (e.g. returns on marginal capital). |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation (excluding section 18.6)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-121-25: Economic Value Added: A Primer For European managers

- CFE101-105-25: Agency Theory And Asymmetric Information

**Commentary on Question:**
*Candidates generally performed well on this question. Many candidates were able to perform the required calculations correctly and use the results to inform their responses for subsequent parts of the question. The best quality responses drew from specific details outlined in the question stem; more general responses were awarded points, but typically not full credit.*

**Solution:**

(a) **(LOs 3.1a, 3.2a)** A normal distribution is used to estimate the annual claim loss for each line of business below. The risk tolerance is set to the maximum annual claim loss for each line that management is willing to accept. ABC management defines the aggregate risk tolerance for the company as the sum of risk tolerances for each line of business.

**Annual Claim Losses**

| Line of Business | Mean ($ million) | Standard Deviation ($ million) | Risk Tolerance ($ million) |
|---|---|---|---|
| Auto | 200 | 20 | 210 |
| Property | 40 | 5 | 45 |

(i) Calculate the probability that annual claim losses are above the risk tolerance for each line of business. Show your work.

(ii) Calculate the probability that at least one of the lines of business losses is above the risk tolerance using the Clayton Copula function for the dependence below using the tab 'Q6(a)(i)(ii)' in the accompanying Excel workbook. Show your work.

$$C(u_1, u_2) = (u_1^{-2} + u_2^{-2} - 1)^{-1/2}$$

## 6. Continued

(iii) Recommend two risk management actions to lower the aggregate risk of the portfolio. Justify your response.

**Commentary on Question**:
*Many candidates performed well on the calculations for part (a)i; however, many candidates did not use the appropriate inputs from (a)i in the calculation for part (a)ii.*

*Most candidates were able to describe appropriate risk management actions to lower aggregate risk; however, responses related to modifying aggregation calculations/diversification did not receive credit since they do not address the underlying risk of the block of business.*

(a)i – see [Q6 (a)i-ii] tab for solution

(a)ii – see [Q6 (a)i-ii] tab for solution

(a)iii –

ABC can reduce the aggregate risk of its portfolio by ceding a portion of the business to a reinsurance company. By purchasing Excess of Loss reinsurance, ABC can limit total losses for one or both lines of business.

ABC can also reduce aggregate risk by modifying its product design to include risk sharing components. By introducing, say, a deductible to its auto policy, policyholders would share some of the risk with ABC and would potentially eliminate smaller claims from being submitted to ABC.

(b) **(LOs 2.2c, 3.2a, 3.3b. 3.3e)** A stochastic model was used to create 10,000 simulations of ABC's annual losses by line of business. The table in the accompanying Excel workbook, tab 'Q6(b)(i)(ii)(iii)', shows the 100 highest total simulated losses (in $ millions). The company uses Risk-Adjusted Return on Risk-Adjusted Capital (RARORAC) and Economic Value Added (EVA) in analyzing its results.

Assume the following:

- The total required risk capital for ABC is $200 million and the opportunity cost is 8%.
- The projected risk-adjusted return is $5 million for Auto and $4 million for Property.
- The projected net income is equal to projected risk-adjusted return for each line of business.

## 6. Continued

(i) Calculate the amount of risk capital to assign to each line of business using a Co-TVaR capital allocation approach at the 99.6 percentile. Show your work.

(ii) Calculate RARORAC for each line of business. Show your work.

(iii) Calculate EVA for each line of business. Show your work.

(iv) Recommend two risk mitigation actions for the company given the RARORAC and EVA for each line of business. Justify your response.

**Commentary on Question**:

*Many candidates performed well on the calculation components of (b). There were common themes for candidates who did not receive full credit for (b)i-iii:*

*1) they reordered the scenarios when calculating the product line Co-TVaRs,*

*2) they did not allocate the $200M required risk capital to the individual product lines (instead using just the Co-TVaR as the allocated capital), or*

*3) were unable to correctly calculate RARORAC or EVA.*

*Although RARORAC was not defined on the syllabus, it was defined in the stem of the question ("The company uses Risk-Adjusted Return on Risk-Adjusted Capital"). Candidates were provided the risk-adjusted return amounts later in the stem and were asked to calculate the risk-adjusted capital amounts in Part (b)(i) so the information to calculate this metric was contained within the question. Candidates who were able to develop the correct RARORAC values for the two lines of business used the information as described above.*

(b)i – see [F22 Q6 (b)i-iii Solution] tab for solution

(b)ii – see [F22 Q6 (b)i-iii Solution] tab for solution

(b)iii – see [F22 Q6 (b)i-iii Solution] tab for solution

(b)iv –

The RARORAC for auto falls below the cost of capital, and the EVA is negative – therefore ABC should consider exiting the auto line to free up capital for more profitable ventures – like the property business or expansion into new markets.

## 6. Continued

Alternatively, since the RARORAC and EVA for the auto line of business is lower than comparable metrics for the property line, and a higher amount of capital is required to support auto, a reinsurance program could be implemented. This will lower the amount of risk for the block of business by potentially eliminating or reducing large auto claims.

(c) **(LOs 1.2a, 3.2a)** ABC executives target a 20% growth in auto insurance sales.

A new bonus structure is being introduced to incentivize sales growth over a one-year horizon. You discover that the executive bonus structure is heavily tied to sales growth but does not consider risk.

(v) Explain what risk governance issues are created by this bonus structure.

(vi) Recommend two additions to the executive bonus structure to mitigate the risk governance issues you identified in (i). Justify your response.

**Commentary on Question**:
*Nearly all candidates were able to identify the key risk governance issue with the new bonus structure, but full points were only given to candidates that discussed multiple issues as the question directed.*

*Most candidates performed well on (c)ii. Candidates not receiving full credit on (c)ii typically made suggestions on changes beyond the bonus structure itself.*

(c)i –
The executive bonus plan rewards the executives to take on more risk without consideration of risk tolerances or adequate returns for the risks taken. By prioritizing sales at all costs, the risk profile of the auto line is likely to change in an adverse manner, potentially increasing future claim costs and further straining the viability of the auto line of business.

Additionally, a one-year time horizon is quite short and ignores risks that may arise further in the future. Profitability for each product line is heavily dependent on products remaining in force as large first year expenses need to be recouped through renewal premiums. Agents could boost short term growth sales by submitting policies and deliberately cancelling them after it they contribute to the calculation of the growth metric.

## 6. Continued

(c)ii –

The metrics determining bonus payout/eligibility should not solely be based on sales. Recommend basing it on profitability metrics, such as value of new business projections at issue, which will account for both risk and return.

The bonus structure should be changed to pay out after 3 years. This will diminish the incentive to put adverse risk on the books to boost sales figures followed by mass churn. This will motivate the executives to sell policies aligned with the desired risk profile of the company.

# 1. Spring 2022 ERM Exam (LOs 3.3a, 3.3b, 3.3d)

**Learning Objectives:**

3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 3.3a | Explain how to develop a capital model for a hypothetical organization. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |
| 3.3d | Demonstrate the use of techniques to allocate risk once aggregated. |

- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation* (Except Section 18.6)

**Commentary on Question:**

*This question tests candidates' ability to understand capital models, aggregation of risks, attributing capital, and how they are used in capital assessments.*

**Solution:**

(a) **(LO 3.3b)**

(i) Identify and describe four of Acme's ***key*** stakeholders.

(ii) Outline the RC considerations of each key stakeholder, reflecting Acme's recent experience.

## 1. Continued

**Commentary on Question**:
*This part asked candidates to identify and describe four key stakeholders. Most candidates did well on this part. Key stakeholders getting full credit included: Shareholders; Management; Policyholders; Regulators; Ratings Agencies; Employees; Board of Directors; Other Insurers; Lenders. Credit was given for the first four. Those closely related, i.e., Management and Employees was counted as only one key stakeholders. If more than four were listed, only the first four were graded. Candidates should tie to COVID experience.*

(i)
Shareholders – Interested in returning a good return on invested capital. Not interested in extremes beyond ruin.
Management – Risk loadings in pricing, assessing performance, allocating capital.
Policyholders – Most interested in extreme events that threaten ability to pay claims.
Regulators – Interested in extreme events. Will want to see COVID impacts.

(ii)
Shareholders – would want small RC, but higher distributable earnings.
Management – Accurate RC as possible, to determine performance of each BU managers.
Policyholders – Would want a large RC, offering more protection.
Regulators – Would want a large RC, to protect against further COVID losses.

(b) **(LO 3.3d)** Acme's management is considering a restructure, whereby some BUs would be divided and a new BU added. The proposed structure is described as follows:

- A is divided into two, unequal parts
- L is divided into two, identical parts
- P is unchanged
- N is the new business unit, which is considered risk-free.

The proposed new capital allocation is as follows:

| BU | RC |
|---|---|
| $A_1$ | 95 |
| $A_2$ | 4 |
| $L_1$ | 30 |
| $L_2$ | 20 |
| P | 15 |
| N | 5 |

## 1. Continued

Assess whether the new allocation satisfies the requirements of a Coherent Capital Allocation methodology by comparing the proposed RC allocation to the existing allocation.

**Commentary on Question**:
*Most candidates did well on this part. Candidates needed to state that this does not meet the requirements of a Coherent Capital Allocation method, and explain why using the three properties.*

A Coherent Capital Allocation method must satisfy:

No Undercut – a sub-portfolio's allocation should be no more than its standalone capital requirement. This is satisfied since A1+A2<=100; L1+L2<=50

Symmetry – If the risk of two sub-portfolios is the same, the allocation should be the same. This is not satisfied since L1 and L2 are said to be identical, but have unequal capital.

Risk-free allocation – capital allocated to a risk-free BU should be zero. Not satisfied, as N is allocated 5.

This new allocation does NOT satisfy the requirements of a Coherent Capital Allocation method.

(c) **(LOs 3.3a, 3.3b, 3.3d)**

(i) Demonstrate that the amount by which total capital can be reduced with diversification is 24.58. Assume that the risks are normally distributed.

(ii) Calculate the amount of RC for each BU using the Pro Rata (linear) approach. Show all work.

(iii) Calculate the amount of RC for each BU using the Discrete Marginal Contribution approach. Show all work.

(iv) Recommend either the Pro Rata or the Discrete Marginal Contribution method of allocation for Acme. Justify your answer.

**Commentary on Question**:
*Candidates did very well on parts (i) and (ii). Some did not know the formula for (iii). Candidates received full credit on (iv) if they explained the difference between the two methods, made as recommendation, and explained why this was a better method for Acme in particular.*

## 1. Continued

Parts (i), (ii), and (iii) in Excel spreadsheet.

(iv)
I recommend the discrete marginal contribution approach for Acme. While the Pro Rata method is simpler, it is not as accurate at taking into account diversification benefits. Since management wants to reduce EC by taking into account correlations between business units, the Discrete Marginal Contributions approach would be more helpful in achieving that goal.

# 2. Spring 2022 ERM Exam (LOs 2.2c, 2.2d)

**Learning Objectives:**

2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10 Economic Scenario Generators
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)

**Commentary on Question:**

*This question assessed the ability of the candidate to apply rules and best practices to a real-world problem involving model design, data quality and stress testing. Candidates were tested on their ability to evaluate materiality of issues and use provided information as well as judgement to justify appropriate solutions. Most candidates scored well on parts (a) and (c), although most candidates did not receive full credit since they failed to consistently justify their responses. Most candidates scored poorly on part (b) as they appeared unfamiliar with Moody's Data Quality Practices.*

## 2. Continued

**Solution:**

(a) **(LOs 2.2c, 2.2d, 2.2g)** The first objective of the external review is to assess the VaR model's design. Addison describes the methodology, data and assumptions as follows:

- The model uses parameters based on one year of historical market data as inputs to calculate VaR
- The calculation employs a Monte Carlo simulation and assumes that changes in risk factors follow a well-defined distribution, e.g., normal distribution or t-distribution
- To determine aggregated VaR, the model assumes correlations between the risk factors and a t-copula to incorporate increased correlation in the tail of the combined distribution
- The correlation assumptions are based on recent data and they have been backtested.

Critique the model design.

**Commentary on Question**:
*Candidates generally scored well on this question although few received full credit. Several candidates failed to comment on all pieces of the model design in their critiques or they failed to explain/justify why a component was deemed appropriate or inappropriate.*

- A common deficiency in calibration of distribution parameters is using a time-period of insufficient length to capture a representative range of conditions. One year of historical market data will therefore be insufficient and inappropriate for Addison's VaR calculations since most individual years will not include a wide range of conditions. Several years of data should be incorporated into the calibration to capture tail-type events if the focus of the analysis is on VaR.
- Monte Carlo design is appropriate for simulating investment returns since it is flexible and can capture complex non-linear relationships between variables. It may not always be the best methodology however, since even though it may show potentially disastrous results in the tail, it may not focus attention on the effect of the scenario to properly assess investment risk. Addison should ensure that her team can understand what is driving VaR results from the model and that the drivers align with the risk sources of interest for the Board. Also, Monte Carlo model designs can be resource intensive and require technical expertise. Addison should evaluate whether her team can appropriately maintain the model with their current resources.

## 2. Continued

- A normal/t-distribution for changes in risk factors may not be appropriate for market risks that can be more right-tailed. Addison's team should consider other distributions and determine the best fit for the market behavior the team is trying to model.
- The use of a t-Copula is appropriate for addressing the lack of sufficiently heavy tails in the probability distributions used. However, although the associated correlation assumptions may introduce heavier tails, there is always the possibility that they don't capture sufficient tail risk. Also, using a copula will require even more expertise since calibration can be complex and explaining the use of a copula may be difficult for the Board to understand. Addison should ensure her team has sufficient understanding and resources to calibrate the copula and provide necessary explanations.
- Basing correlation on recent data only, could be inappropriate, depending on whether or not recent relationships are reflective of the investment risk Addison's team is trying to model.
- Back-testing however, is one appropriate tool for validating the correlation assumptions being used. After backtesting is conducted, the team will have to use their judgement to determine if recent data should continue to be used or if more historical data should be added. As Addison's team reports model results, caution should always be suggested as history is not always a predictor or future results.

(b) **NO LONGER RELEVANT**

~~The company has an internal requirement to follow Moody's Data Quality practices.~~

~~(iii) Describe the most critical step in the Moody's recommended seven-step quality process that is not being followed. Justify your response.~~

~~(iv) Describe the two most critical data quality rules applicable to this data. Justify your response.~~

~~**Commentary on Question:**~~

~~*Candidates generally scored poorly on this part of the question because they did not appear to recall Moody's seven-step quality process or Moody's data quality rules. Several candidates incorrectly referenced EIOPA Data Quality Requirements from the same reading. Also, both subparts asked the candidate to describe the most critical steps. Partial credit was awarded for listing other steps/rules that were critical (but not the most critical), but only if sufficient justification was provided. In order to get full points in both subparts, justification of "most critical" needed to tie back to the issues listed and describe how the recommended step / data quality rule addressed the issue.*~~

**2. Continued**

(i) The most critical step they are failing to follow in Moody's seven-step data quality process is step 4, Data Standardization. Data standardization involves execution of a series of data quality checks and rules against the monthly data being appended. Best practice is to execute the data quality rules within the repository. In this case, Addison's team needs to check the format and quality of the data every time an update is made and implement a rule to ensure that it is consistent with previous data the team has stored in their repository. Currently, the monthly change in the formats of the reported data is likely leading to the large VaR fluctuations observed from month to month. Data standardization will address the issue.

(ii) The two most critical data quality rules that apply to Addison's monthly data are Range Constraints and Set-Membership Constraints.

- Range constraints will set minimum or maximum allowable values for the data based on typical ranges for the data type. In this case, negative expected returns are showing up in the data. The range should be restricted to exclude negative values to address this problem. Addison's team should also make note of any negative data points and investigate the issue.
- Set-Membership constraints will ensure values for a column come from a set of discrete values or codes. In this case, the rule is already being used for the risk type field, but the set of discrete values needs to be updated to include the 4$^{th}$ risk factor. Once the set-membership constraint is updated, the issue will be addressed.

(c) **(LO 2.2d)** Addison has decided to begin with a sensitivity analysis where there is a 5% decline in the equity markets. She would use the resulting impact to the investment portfolio to enhance the reporting to the Board.

(i) Critique Addison's decision.

You tell Addison that other scenario types should also be considered. Addison returns with the following scenarios:

- Single Factor Scenario – an unexpected spike in claims that requires the liquidation of 10% of the investment portfolio at current market prices
- Multi-Factor Stress Scenario – a 1-year recession that depresses the market value of equities in the portfolio, results in defaults in their bond portfolio and drives inflation resulting in increased claim costs and a slight dip in business volume late in the year

## 2. Continued

- Multi-Factor Multi-Period Stress Scenario – a severe, 2-year market downturn that increases the severity of the Multi-Factor Stress Scenario. Additionally, the scenario reflects a significant reduction to investment income and business volumes in year 2.

(ii) Evaluate each scenario type given the Board's needs and Addison's available resources.

(iii) Recommend the most appropriate scenario type based on your analysis in part (ii). Justify your response.

**Commentary on Question**:
*Candidates generally scored well on part (c). Most candidates received partial credit for subpart (i), but few received full credit since their critique of Addison's decision didn't tie back to all of the Board's requests. Several candidates received close to full credit for subpart (ii). Responses commonly fell short in consistently addressing all three components of the Board's requests for each scenario type. Candidates received full credit for subpart (iii) if their response included sufficient justification and it was consistent with subpart (ii). Responses for subpart (iii) were not contingent on answering subpart (ii) and candidates could receive full credit for subpart (iii) even if their response for subpart (ii) was incorrect or incomplete.*

(i) The Board has expressed a desire to better understand specific conditions that could result in tail losses and whether there would be any associated long-term impacts to their business. Addison is proposing the use of a single factor sensitivity test. Typically, Single Factor Sensitivity tests are low in complexity which makes them efficient for both time and resources and this is a positive for Addison since she appears to have limited resources. However:

- Single factor sensitivity tests are typically low in explanatory power
- A 5% drop in equities is not a severe stress scenario, as evidenced by recent events
- Equities are not the main asset of the company

Based on the above, the sensitivity test Addison has proposed will not enhance the reporting to the Board. To address the Board's needs, she should also incorporate a drop in the investment grade bond values as well as increased defaults to show something that can threaten the company's financial stability. She should also consider a sustained shock to interest rates that could affect the company's business plan, to reflect potential long-term impacts.

**2. Continued**

(ii) Each scenario type should be evaluated based on its ability to:

- Assess tail risk
- Incorporate stresses on multiple variables to address the investment portfolio and business impacts
- Evaluate these impacts sustained over an extended time-period since business impacts may take longer to materialize.

Once Addison has assessed the ability of each scenario type to address the Board's needs, she should also reflect on her current resources and the level of sophistication necessary to evaluate the scenarios.

Single Factor Scenario – Generally, these scenarios are used for medium stresses and are low in explanatory power. Although this scenario will help the company evaluate liquidity risk, it does not represent a tail scenario for investment risk. It also fails to capture any long-term business impacts. It will not address the Board's needs. It is a straightforward scenario however, and Addison's team should have sufficient resources and the sophistication necessary to implement the scenario.

Multi Factor Stress Scenario – Generally, these scenarios are high in explanatory power and consider multiple risk factors. A recession that incorporates equity losses and bond defaults appropriately represents a tail scenario. The scenario also incorporates business impacts through increased claim costs and reduced business volume, but they are only short term as it specifies 1 year. This scenario does a better job of addressing the Board's needs, but doesn't satisfy all of the requirements. Relative to the single factor scenario, the multi factor scenario will require more resources and sophistication to evaluate. This is likely manageable for Addison's team, but may begin to be a strain on their resources.

Multi Factor Multi Period Stress Scenario – These scenarios are typically highest in explanatory power and consider multiple risk factors over extended time periods. This scenario clearly addresses all of the Board's concerns. Relative to the other scenarios considered, the multi factor multi stress scenario will likely require significant resources and sophistication to evaluate. This will be difficult for Addison's team to manage.

**2. Continued**

(iii) Based on the analysis in part (ii), I would recommend the Multi Factor Stress Scenario. It goes further than the Single Factor Scenario in addressing the Board's needs and understanding. It will also require considerably less resources than the Multi Factor Multi Stress Scenario. Although my recommendation doesn't address all of the Board's concerns it's appropriately balanced with Addison's current resources and level of sophistication, making it the best solution in the short term.

# 3. Spring 2022 ERM Exam (LOs 1.3a, 2.1a, 2.2d, 2.2g, 2.2h, 3.3b)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.3a | Examine the impact of the external environment on an organization's ability to achieve its objectives. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8

**Commentary on Question:**

*This question tests a candidate's understanding of the ORSA report, specifically as it relates to Lyon from the Case Study. The Candidate is expected to know details on Operational Risk, and the candidate should be able to do an Extreme Value Theory analysis. The question used Describe for Comprehension assessment and used Evaluate, Explain or Justify for Analysis or Knowledge Utilization assessments. In a Fellowship level exam, the Candidate is expected to spend more effort in their explanations, drawing on the curriculum while using specific references to Lyon from the Case Study.*

## 3. Continued

**Solution:**

(a) **(LOs 1.3a, 2.1a)** The following feedback was provided by the regulator:

"A key weakness of Lyon's approach to the group capital assessment of the enterprise in the ORSA is the lack of group-level analysis."

Explain the issue raised by the regulator using two relevant examples from the Case Study.

**Commentary on Question**:
*Candidates did reasonably well on this part, explicitly and appropriately referencing the Case Study with examples and sufficiently providing possible issues.*

From page 48 of the Case Study:
"Excerpt from the Capital Assessment section of Lyon's ORSA Report:
Lyon determines its capital requirements based on the economic capital process that is already in place within its subsidiary companies."

The concern here is the lack of consistency across the company, on how risks are calculated and aggregated. This demonstrates an ERM program that is not mature.

From page 49 of the Case Study:
"The acceptance of risk is the primary responsibility of the subsidiary. Risk is first identified, measured and managed at the subsidiary entity level. Diversification across risk types is calculated at the subsidiary level. Risk aggregation to the corporate level is the sum of all subsidiary-level risks by risk category.

Lyon is ignoring intra-group creation of capital and contagion risks, such as reputational or strategic risk, or missing risk diversification benefits.

## 3. Continued

(b) **(LOs 2.2g, 3.3b)** Another key issue raised was that Lyon's Corporate capital quantification for credit risk is not modeled, even though credit risk is a key risk for the enterprise.

A consultant was hired to develop loss scenarios on the Corporate asset portfolio. He produced the following results.

| Percentile | Loss (in 000s) at end of year |
|---|---|
| 75% | $5,450 |
| 90% | $9,681 |
| 95% | $14,368 |
| 98% | $17,725 |

Evaluate the reasonableness of Lyon's Corporate Economic Capital value for Credit Risk given these scenario results.

**Commentary on Question**:
*Candidates were expected to evaluate critically Lyon's Corporate Credit Risk value from the Case Study or the scenario results in relation to that specific value. In some cases, candidates either referenced the wrong value and/or the wrong units or failed to make a substantial evaluation.*

From the financials in section 2.11, Lyon's Corporate Credit Risk EC is $18.58 million, developed by a simple factor-based approach. The scenarios provided show a potentially fat-tailed distribution with significant recession-level results (90-95%ile) and 98%ile that's nearly $18 million already.

Given credit risk is a concern of the group as well as the subsidiaries, Lyon should develop a consistent modeling approach across the enterprise. This would replace the factor-based approach for the Corporate Credit EC and would provide a better view of how much of the $178 million available EC is excess capital.

## 3. Continued

(c) **(LOs 1.3a, 2.2d, 3.3b)** Senior management has requested that the Corporate Risk Committee develop improvements to the ORSA for next year's submission.

(i) Explain how stress and scenario testing can improve Lyon's ERM framework and ORSA reporting.

(ii) Describe two items that regulators will consider when evaluating stress testing in the ORSA report.

**Commentary on Question**:
*Candidates generally did well on this part, though answers should have been more specific to Lyon in part (i).*

(i) Scenario and Stress Testing evaluates the strength of the business by subjecting it to varying combinations of economic, liquidity, operational, reputational conditions with differing degrees of severity. Lyon is in the process of developing an aggregate risk appetite statement which could be informed by enterprise-wide stress and scenario testing.

Linking risk drivers to actual historical events, for example, a recession or pandemic, can be helpful in improving senior management and board understanding of risks and then they can develop mitigating strategies.

(ii) Regulators want to understand the severity of the stresses, including how the scenarios and stresses were calibrated, including any model and assumption validations. They would also like to see reverse stress tests or "break the bank" scenarios.

Regulators want to know the completeness of stress testing, such that it includes risks material to the enterprise and considers combined risks and interrelationships among risks.

## 3. Continued

(d) **(LOs 2.1a, 2.2h)** Senior management has requested several enhancements to the group capital assessment and scenario/stress testing. The first recommendation is to develop an Operational Risk provision for the enterprise.

(i) Describe two quantitative approaches to modeling Operational Risk that would be appropriate for Lyon.

(ii) Explain the considerations of the following as they relate to data used in modeling Operational Risk:

- Internal vs External data
- Hard vs Soft data.

**NO LONGER RELEVANT**

~~For calculating Operational Risk capital, a colleague suggests using a Generalized Pareto Distribution with a threshold at $1 million, the calibrated shape parameter at 0.80 and the calibrated scale parameter at 0.5.~~

$$~~Q_a = d + \frac{b}{k}\left(\left(\frac{S_X(d)}{1-a}\right)^k - 1\right)~~$$

~~There are a total of 500 loss values collected across the businesses. You are provided the following table showing the top 30 largest losses, in millions of dollars.~~

| | | | | |
|---|---|---|---|---|
| ~~12.33~~ | ~~8.71~~ | ~~6.74~~ | ~~4.41~~ | ~~4.20~~ |
| ~~3.31~~ | ~~2.97~~ | ~~2.65~~ | ~~2.58~~ | ~~2.40~~ |
| ~~2.29~~ | ~~2.21~~ | ~~2.12~~ | ~~1.89~~ | ~~1.76~~ |
| ~~1.35~~ | ~~1.34~~ | ~~1.28~~ | ~~1.27~~ | ~~1.25~~ |
| ~~1.15~~ | ~~1.13~~ | ~~1.10~~ | ~~1.07~~ | ~~1.05~~ |
| ~~0.99~~ | ~~0.97~~ | ~~0.96~~ | ~~0.92~~ | ~~0.91~~ |

~~(iii) Calculate the 99$^{th}$ percentile of operational losses using the GPD. Show all work.~~

~~(iv) Evaluate the result from (iii) and discuss how it relates to the economic capital held by Lyon. Justify your answer using information from the Case Study.~~

## 3. Continued

**Commentary on Question**:
*Candidates did generally well with the shorter describe and calculate parts, but explanations and evaluations were limited. Some candidates choose to calculate the 99%ile using a different technique than the GPD requested or miscalculated the value, but if the explanations in part d(iv) were reasonable relative to the value in d(iii), credit was still given for that part.*

(i)

- Simple add-on model where the factor can be derived from costs at a certain confidence level with a certain degree of correlation would be easy to implement at Lyon.
- Monte Carlo Frequency/Severity simulation using stochastic scenarios developed from historical data and expert judgement would be better but take more time to develop and run.

(ii)

- Internal vs External data:
  Internal data can be collected directly by the company and reflect pertinent losses. However, there might not be adequate internal data to model and analyze operational risks in the tail. Therefore, external data should be used to supplement the data. However, external data needs to be reasonably unbiased, reflect similar operations of Lyon and is scaled to a level comparable to Lyon.
- Hard vs. Soft data:
  Hard data is collected intentionally on a prospective basis for short period of time and produces far more data points than soft data. For example, hard data would represent the day-to-day operational failures that tend to be high frequency but low severity. However, hard data does not capture tail events and therefore is not appropriate to use alone. Soft data collects fewer events looking back over time, but does capture extreme events, and it is the most appropriate to use when modeling/incorporating tail events. When modeling operational risks, it will be critical to include the low severity, high frequency events captured in soft data.

**(iii) NO LONGER RELEVANT**

~~Sx(d) = 25/500 = 0.05; ≥ 95%, so EVT appropriate~~
~~d=1.0, and k = 0.80 and b = 0.5 (given)~~
~~1 + (.5/.8)((0.05/.01)^.8-1) = $2.64 Million~~

**3. Continued**

(iv)

Based on the result, we expect that losses from a 1-in-100 Operational event to be greater than $2.64M. The result is between 10%-20% of Lyon's $18M Corporate EC, but that's only for Credit Risk and is too small if intended to be the Ops EC for the whole enterprise . This internal data from the businesses could be supplemented with external or soft data to reflect larger potential losses and then re-parameterize the GPD.

# 4. Spring 2022 ERM Exam (LOs 1.2a, 2.1a, 2.2b, 2.2h, 3.1a, 3.3b)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.2b | Describe the properties and limitations of common risk measures (e.g., VaR and TVaR). |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

## 4. Continued

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch.13: Liquidity Risk
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)

**Commentary on Question:**
*This question was trying to test candidates knowledge of liquidity risk. The question included two calculations, both involving market liquidity measures and the resulting impact on the financials of the company. Related subparts required an understanding of the results of the calculations as they related to liquidity considerations.*

*Parts of the question not related to the calculations required knowledge of liquidity risk frameworks and potential areas of risk. Candidates who scored higher on these parts tended to provide answers in the context of the liquidity risks specifically facing a health* ***(note: question was changed to make ABC a life insurer)*** *insurance company.*

**Solution:**

(a) **(LOs 2.1a, 2.2b, 2.2h, 3.1a)** In considering which asset to sell, the CIO asks you if any of the four assets have breached the individual market liquidity limit. Assume a normal distribution and critical value of 1.645.

(i) Determine which, if any, of the individual assets have breached the market liquidity limit. Show all work.

(ii) Recommend which asset to sell based on the results in (i). Justify your response.

**Commentary on Question**:
*Subpart (i)*
*Many candidates received full credit on these calculations and the interpretation of the results. Those that didn't tended to have errors in the LVAR formulas, or did not demonstrate an understanding of the breach limits (i.e. ratios above 35%).*

*Subpart (ii)*
*Candidates typically received either full credit or no credit here, which correlated highly with correct interpretation of the individual market liquidity limits and whether or not assets were in breach of those limits.*

## 4. Continued

(i) Refer to Excel for calculation solutions.

(ii) Both the BB Corporate bond and the B corporate bond have breached the individual asset equity limit. The BB Corporate bond should be sold, as its ratio (37.6%) exceeds the 35% limit by more than the B Corporate bond's ratio (35.5%).

(b) **(LO 3.1a, 3.3b)** Question statement.
ABC uses the NAIC Life RBC formula when calculating the RBC ratio. The following table shows book values and average post-tax RBC factors by risk category used by ABC to calculate its RBC ratio.

| RBC Category | Book Value | Average post-tax RBC Factor |
|---|---|---|
| H0 | 1,299 | 0.030 |
| H1 | 23,612 | 0.022 |
| H2 | 32,000 | 0.044 |
| H3 | 12,478 | 0.032 |
| H4 | 2,220 | 0.050 |

Total Adjusted Capital (TAC) = 5,527

(iii) Describe what RBC is intended to measure.

(iv) Assume that cash held on the balance sheet has a 0% RBC factor.

Analyze the impact on the company's RBC ratio of selling each individual asset from part (a). Show all work.

(v) Discuss whether your analysis performed in part (ii) has changed your prior recommendation to the CIO on which asset to sell. Justify your response.

**Commentary on Question**:
*Subpart (i)*
*Many candidates received either no credit or nearly full credit. Those who did not receive credit failed to mention that RBC is a regulatory tool that can lead to regulatory action, and not a standalone tool to measure the competitiveness or financial solvency of an insurance company.*

## 4. Continued

*Subpart (ii)*
*The large majority of candidates received less half of the available points here, as many struggled with the correct calculations. Many candidates correctly identified the formula for Health RBC, but most candidates did not correctly update the H1 factors or the Total Adjusted Capital figures to reflect the asset sales.* ***Note: question was changed to make ABC a life insurer.)***

*Subpart (iii)*
*Most candidates received little to no credit here, as the responses were based on incorrect calculations in the prior sub-question. Responses that did receive credit justified those responses with a correct interpretation of the impact to RBC ratios, even if their corresponding calculations were not fully correct.*

(i) RBC is a standard regulatory formula that represents the minimum capital requirement for insurers, and is used to determined when a regulator must take action against an insurer, up to and including taking control. RBC is not the amount of capital that an insurer would want to hold to meet growth or competitive objectives.

(ii) Refer to Excel for calculation solutions.

(iii) Based on the impact to the RBC ratios, the B Corporate bond should be sold. While the LVAR/VAR ratio for the BB Corporate bond is higher, selling the BB bond decreases the RBC ratio from 345.0% to 344.7%. Conversely, selling the B bond increases the RBC ratio to 345.5%.

(c) **(LOs 1.2a, 2.1a, 2.2h)** The CIO wants to review the company's liquidity contingency plan.

(i) Outline the main components of a well-designed liquidity contingency plan as part of a broader liquidity risk framework.

(ii) Explain how a catastrophic event could impact the liquidity needs of ABC.

(iii) Identify three factors, other than a catastrophic event, that could impact the level of ABC's available liquidity.

**Commentary on Question**:
*Subpart (i)*
*Many candidates did not identify components of a liquidity contingency plan (e.g. having a pre-defined list of liquidity contingency resources) and instead listed examples of liquidity contingency resources. A full listing all of the elements below was not required for full credit, but at least some demonstration of knowledge of these elements resulted in credit.*

## 4. Continued

*Subpart (ii)*
*The large majority of candidates received at least some credit on this part. Almost all candidates received credit for recognizing that a catastrophic event would lead to an increase in claims, but many failed to identify any potential impacts beyond that. This question was specifically testing candidates understanding of liquidity needs, and not liquidity resources.*

*Subpart (iii)*
*Many candidates received at least half of the potential credit on this question, though a large number received none. Those that received less credit failed to identify factors that could affect the available liquidity of a* ***health (note question was changed to make ABC a life insurer)*** *insurance company, and instead provided responses that were not applicable to ABC.*

(i) The main components of a liquidity contingency plan include:
- procedures to detect a potential liquidity stress event using early warning indicators
- a pre-defined list of contingency resources in the case of a stress event
- procedures and governance to activate the contingency plan
- procedures and governance to decide when to implement the appropriate response to a liquidity stress event, and monitor the implementation
- the process for internal and external communication
- the process to periodically test and update the plan

(ii) Catastrophic events trigger an increase of insurance payment obligations, leading to large unexpected liquidity needs or payment requirements within a short time. Catastrophic events may also trigger drastic changes in consumer behavior such as mass lapses, or could result in the downgrade of assets, making them ineligible for collateral posting.

(iii) Other factors that could impact the level of ABC's available liquidity include:
- A reduction in the market value of assets
- Limited access to external and internal funding
- Reduced funding from business operations (e.g. lower than expected inflow of premium income from new business)

# 5. Spring 2022 ERM Exam (LOs 2.2d, 3.2a, 3.2e)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2e | Analyze how ALM and similar risk strategies can be used to manage or reduce risk in an organization. |

**Relevant Sources:**

- CFE101-119-25: ERM-144-20: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) **(LO 3.2e)**

During your initial meeting with the company, Magenta Rock's CFO, Juan, states: "I believe we spend too much time worrying about the duration gap between our assets and liabilities. Given that Magenta Rock reports its financials on a book value basis, the primary focus of the ALCO should be to minimize absolute risk from asset volatility and minimize accounting volatility."

Evaluate the assertions made by Juan.

## 5. Continued

**Commentary on Question**:
*Candidates scored reasonably well on this question, however, several only addressed one of the CFO's assertions, rather than both as the question required.*

While book value and accounting volatility are important considerations, they are more related to a short-term view for regulatory and reporting purposes. Economic value should also be considered as it takes a long-term view on growth and profitability for the company.
The fact that the effective duration of liabilities is much longer than that of the assets may result in significant problems with funding risk especially in times of economic downturn with adverse interest rate changes. With liabilities having higher durations, the company will need to continually search for and roll new assets into its portfolio. When market stressed environments, it may be difficult or impossible to both find assets with sufficient duration as well as having to sell existing assets at depressed prices in order to meet cash outflow obligations.

(b) **(LO 3.2e)** At a follow-up meeting, the ALCO expresses concerns regarding the current low interest rate environment and the volatility of the economic surplus. The ALCO suggests immunizing Magenta Rock's portfolio.

(i) Describe two ways in which Magenta Rock would still be exposed to interest rate risk even if the portfolio is immunized using effective duration.

(ii) Recommend a strategic asset allocation framework that would help increase Magenta Rock's portfolio yield while still addressing its concerns of surplus volatility. Justify your response.

**Commentary on Question**:
*Part 5b(i) was a fairly easy question. Many candidates received full credit. Part 5b(ii) was more difficult, with few candidates receiving full credit. On part 5b(ii), several candidates presented a generic SAA framework without addressing the stated concern of surplus volatility. Several candidates also suggested specific investments rather than answering the question which called for a framework.*

b(i)

- Immunizing may work effectively only for small change of interest rate. If the volatility of interest rate is large, it may still face the risk.
- Sometimes it may be hard to find assets with long enough duration to fulfill the immunizing in the actual market. So, it may still face the interest rate risk in future.

## 5. Continued

b(ii)
Magenta Rock should constrain surplus volatility but relax the duration matching requirement. The surplus volatility will help to ensure assets are consistently sufficiently above liabilities. Relaxing the duration constraint will allow Magenta rock to seek higher yields through potentially riskier equity or alternative investment vehicles.

Note that Magenta could also look for assets with higher times to maturity which, in an upwards yield sloping environment would yield higher returns and would actually help with duration matching given the liability portfolio's long duration.

(c) **(LOs 2.2d, 3.2e)** To further test the impact of the current interest rate environment, an ALCO member suggests that the following scenario test should be conducted:

A 50 basis point parallel drop in the risk-free rates for one year followed by an additional 10 basis point drop for each of the next four years.

(i) Assess how Magenta Rock's ALM profile would be impacted under the stress test circumstances.

(ii) Recommend one additional method Magenta Rock could use to measure interest rate risk to complement the scenario testing. Justify your recommendation.

**Commentary on Question**:
*Candidates scored reasonably well on both parts of 5(c)*

c(i)
- On the asset side, the asset value will increase due to lowered yield curve, but it will suffer from reinvestment risks from any bonds maturing in the near future
- On the liability side, the liability value will increase and the magnitude will be more than the increase in asset because of the longer liability maturity.
- Magenta Rock will have a difficult time in funding the guaranteed minimum return on the fixed annuity business. In addition, it will face liquidity challenge in funding the withdrawal from the annuity business

c(ii)
Magenta Rock could use stochastic modelling to measure interest risk rate. Stochastic modelling makes use of ESG to generate a random process of financial variables in concern, interest rates in our case. It allows a wide range of scenarios to be modelled, providing a distribution of possible loss of Magenta Rock. This could better reflect the interest rate tail risk due to extreme market conditions.

## 5. Continued

(d) **(LO 3.2e)** During your review of ALCO's practices, you notice that credit risk was overlooked when analyzing future asset cash flows.

Describe how Magenta Rock could incorporate its credit risk exposure into the projected asset cash flows.

**Commentary on Question**:
*Candidates scored reasonably well on 5(d)*

A credit migration model can be used to model probability of default, exposure, and loss given default to incorporate credit risk exposure into the projected asset cash flows.

(e) **(LO 3.2a)** You suggest to the ALCO that the volatility of the liability cash flows could be minimized using risk transfer methods or derivatives.

Explain how each of the following methods could be used to minimize the volatility of Magenta Rock's liability cash flows:

- Reinsurance
- Interest rate swap

**Commentary on Question**:
*Part 5(e) was fairly easy for candidates and many received full credit.*

Using stop loss reinsurance for Magenta Rock's life product would transfer claims liability to a reinsurer after a specified threshold. This would put a cap on Magenta Rock's claims liability, resulting in less volatile liability cash flows.

Magenta Rock could use an interest rate swap to receive fixed interest rate payments in exchange for variable rates. This will help stabilize the annuity interest rate needs, resulting in less volatility in liability cash flows.

# 6. Spring 2022 ERM Exam (LOs 1.2a, 3.1a, 3.2b)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2b | Demonstrate the use of controls in an organizational process. |

**Relevant Sources:**

- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Section 1.5 & Sections 2 thru 5

**Commentary on Question:**

*Overall candidates did not perform well on this question. Parts (b) and (c) respectively scored the fewest grading points.*

**Solution:**

**(a) NO LONGER RELEVANT**

~~Big Ben is committed to maintaining a strong capital base to support the risk associated with its business.~~

~~Describe one residual risk and one inherent risk that apply to Big Ben. Justify your response.~~

~~**Commentary on Question**:~~

~~Residual risk is the risk that remains after taking into account all mitigating actions that can reasonably be taken in order to manage the risk. Liquidity risk is a residual risk that Big Ben still faces even after implementation of an ALM strategy.~~

## 6. Continued

~~Inherent risk is a function of exposure and impact, not considering any mitigation factors. Regulatory risk is an inherent risk that Big Ben faces regardless of the mitigation actions they put in place.~~

(b) **(LO 3.2b)** Big Ben is implementing the Model Governance framework.

(i) Define the three major types of internal controls.

(ii) Provide an example of an internal control used by Big Ben in the Model Governance framework, for each type you identified in part (i).

**Commentary on Question**:
*Many candidates did not correctly identify the three major types of controls for part (i). Candidates also did not focus their examples for part (ii) to the Model Governance framework as requested in the question.*

Part (i):
The three major types of internal controls include:
1. **Preventive** controls are designed to keep errors from occurring.
2. **Detective** controls are designed to identify errors that may have already occurred.
3. **Corrective** controls are designed to correct errors that have identified (or detected).

Part (ii):
1. Preventive example: Big Ben required that high risk models be validated on a strict 3-year rotation schedule through a centralized model validation group.
2. Detective example: Big Ben requires that models that are not subject to validation be reviewed by an independent analyst (e.g. someone who was not the model developer) who is familiar with the model's topic and purpose.
3. Corrective example: The formal model validation exercise will require a report with a pass or fail grade, regardless of the findings. If the model fails, a remediation plan will need to be created by the model developer and executed in a timely manner.

## 6. Continued

(c) **(LO 1.2a, 3.1a)** Big Ben is formalizing its risk appetite framework.

(i) Describe the three increasingly detailed levels of a risk appetite framework.

(ii) Provide two examples of risk appetite that Big Ben already utilizes or is considering. Justify your response.

(iii) Provide two examples of risk tolerances that Big Ben already utilizes or is considering. Justify your response.

**Commentary on Question**:
*Many candidates were unable to identify the detailed levels of the risk appetite framework in part (i) even though 2 of the 3 levels were given in parts (ii) and (iii). For examples provided in parts (ii) and (iii), the candidate was given credit for justification as either a risk appetite or risk tolerance, but not both.*

Part (i):

1. **Enterprise Risk Tolerance** – the aggregate amount of risk the company is willing to take.
2. **Risk Appetite** – enterprise risk tolerance needs to be allocated to a risk appetite for specific risk categories and business activities.
3. **Risk Limit** – the most granular level used for business operation. A risk limit translates enterprise risk tolerance and risk appetite for each category into risk-monitoring measures.

Part (ii):
**Example 1:** Big Ben uses internal models to determine its required economic capital based on VaR. The quantile used for the VaR calculation is 99.5% over a one-year horizon.

**Example 2:** Big Ben requires that each line of business maintain an Internal Capital Adequacy Ratio of 140%.

Part (iii):
**Example 1:** To manage liquidity risk, the contractual maturities of assets and liabilities are monitored, and the duration mismatch is not allowed to exceed a specific tolerance.

**Example 2:** To manage interest rate risk, Big Ben will monitor the sensitivity of assets and liabilities to changes in interest rates. The Board wants to be able to withstand a 200bp parallel shift in the yield curve.

# 1. Fall 2021 ERM Exam (LOs 2.2h, 3.1b)

**Learning Objectives:**

2: Risk Analysis and Evaluation

3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2.h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |

**Relevant Sources:**

- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 13: Liquidity Risk
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective By Kailan Shang (pp.12 -15 of Cybersecurity: Impact on Insurance Business and Operations)

**Commentary on Question:**
*This question applied the candidate's knowledge of liquidity and operational risk to the case study. Candidates performed well overall, as the answers generally were able to tie back to the case study and respond directly to the question asked.*

**1.** **Continued**

**Solution:**

(a) **(LO 2.2h)** Big Ben considers improving its operational risk analysis by implementing one of the following:

1. Using five years of Big Ben's operational failure frequency and loss severity data, which is collected internally.
2. Using five years of Big Ben's internal data combined with industry data.
3. Using stress testing and scenario analysis.

(i) Evaluate each of the three approaches.

(ii) Recommend the most appropriate approach for Big Ben. Justify your response.

**Commentary on Question**:
*Candidates performed well on this part of the question. Most were able to evaluate the three approaches. Recommendations sometimes only considered the accuracy of the approach in general and received partial credit as it was expected that the recommendation tie back to Big Ben's situation.*

(i) Approach 1: Using internal loss frequency and severity data is most relevant to Big Ben Bank. However, the 5 years of data may not be sufficient. The 99.5% VaR measurement requires the level of aggregate loss associated with a one in two-hundred year event. When the loss is heavy-tailed, 1000 years of relevant loss data may be required. For Big Ben Bank, the low frequency and high severity losses has not occurred before; using 5 years of internal data might result in very few data points which is not credible.

Approach 2: Combining internal and external data may allow Big Ben Bank to have sufficient data to model operational risks. When combining external data for frequency, data may need to be scaled for size. Since Big Ben Bank's primary product is wealth management for high net worth clients, using general banking industry's loss data might not be appropriate. Careful considerations need to be given when selecting the external data.

## 1. Continued

Approach 3: Stress testing and scenario analysis can be used when data are not sufficient or not available. It can also be used to assess other risks together like market risk, credit risk, where the information is sparse or non-existence in the tail. Big Ben Bank is considering the expansion of the Investment Banking and Asset Management businesses over next year, and expansion of the Commercial banking over next 3-5 years, it would be important for the Bank to understand how their risk landscape changes as the result of the strategic plan. Stress testing and scenario analysis is a flexible tool that is not over-reliant on historical data, but provide insights into what could possibly happen in the future for Big Ben Bank.

(ii) It's recommended to use stress testing and scenario analysis for two reasons:

- This approach is relatively easier compared to the other two approaches. No additional resources are needed to gather external or industry data. It is also less complicated to model and calibrate.
- The stress and scenarios can be adjusted quickly according to external environment and tailored towards company's strategic plan.

(b) **(LO 2.2h)** Big Ben is considering acquiring an online life insurance company.

Taylor, an actuarial student, suggests that Big Ben implement the following in its new Liquidity Assessment Program if Big Ben undertakes the acquisition:

5. Reflect the correlation between financial markets and insurance risks
6. Measure liquidity risk using liquidity ratio and excess/deficit of liquidity
7. Assess liquidity using 10 unique stress scenarios

(i) Describe the key drivers of liquidity risk for Big Ben.

(ii) Compare the liquidity risk profile between a life insurance company and Big Ben.

(iii) Critique Taylor's suggestion.

**Commentary on Question**:
*Most candidates performed well on this part. To receive full credit for subpart (i) it was expected that Big Ben's specific drivers according to information in the case study were addressed, however some were too general and only received partial credit.*

**1. Continued**

(i) Big Ben's on-demand cash is not enough to cover the on demand deposit due to banks, retails customers and corporate customers. And it's usually very difficult to raise new funds (such as new debt or new equity) when it's needed the most. Both Big Ben and its creditors might evaluate the likelihood of cash requests from debt or equities when the liquidity issue is industry wide. This will transform a small problem into a crisis.

Asset management is the main service Big Ben Bank provides, and Big Ben Bank is a world leader in the ETF market. Financial tech innovation, with an increasing share of electronic trading and use of ETFs is concern with respect to increased liquidity risk. This manifests through greater uncertainty, especially in times of heightened volatility when market makers have been observed to withdraw, just when liquidity is needed the most.

(ii) At a high level, insurance policyholders have little incentive to surrender their policies during market turmoil and, as insurance liabilities are better matched with assets, the risk of forced asset sales is largely reduced. However, for Big Ben, liquidity might be a significant issue during market turmoil. "Bank Run" may occur, and its creditors might default on their debts. The risk of forced asset sales might increase significantly during market turmoil.

Insurance companies are much less interconnected than banks and by pooling a large number of risks and by retaining the bulk of the risks underwritten on their balance sheet, potential liquidity issues are likely to be idiosyncratic without industry wide impact. For Big Ben, the liquidity issue can be industry wide. In market turmoil, the market value of assets would decrease significantly, the bank might have limited access to external fund.

(iii) Correlations: Since Big Ben is considering investing in an insurance company, it would be useful to consider the correlation between financial markets and insurance risks in the liquidity risk management framework.

Metrics to measure liquidity risk: Using multiple metrics consistently over time might provide more information on liquidity risk and can thus be beneficial. The use of a liquidity ratio (liquidity resources divided by liquidity needs, or vice versa) is the most common metric, followed by excess/deficit of liquidity (available liquidity minus liquidity needs).

**1. Continued**

Stress scenario and assumptions: Using scenarios can assess liquidity risk under normal and stress environments, considering multiple stress events together with additional stress assumptions for example: distressed financial markets; restrictions on internal flows of funds; credit rating downgrade. This is a good suggestion, but ten scenarios may be too many for Big Ben to evaluate.

(c) **(LO 2.2h)** Big Ben is evaluating its approach to managing its cyber risk given its strategy of creating a one-stop shop interface for its globally mobile clientele and its possibility of acquiring an online insurance company. Big Ben notes that cyber risk is gaining more attention given its increasing incidence rate and impact.

Big Ben's current cyber risk management framework includes:

- Hiring people with cyber risk expertise and providing training to employees
- Setting cyber risk limit using key risk indicators
- Real-time monitoring of internal, communication system, and social media data.

Taylor made the following suggestions:

- Big Ben should leverage its current infrastructure and available technologies. No new technology investment to address cyber risk should be made
- Big Ben should develop a contingency plan to cover additional financial losses that might occur
- No cyber risk insurance is necessary.

Evaluate Taylor's suggestions.

**Commentary on Question**:
*Candidates typically received only partial credit for this part of the question as either not enough detail for each response was given, or the answer did not address Big Ben's potential acquisition of an online insurance company.*

I disagree with Taylor's first suggestion. Big Ben should consider additional investment in new technologies, which can help identify the sources of cyber risk, prevent cyber attacks and maintain robustness of the internet system. New forms of cyber risk emerge every day, and technologies used to combat cyber risk evolves quickly. By investing in an insurance company, Big Ben may face new forms of cyber-attacks it has never experienced before.

## 1. Continued

Although experts would be hired and more training would be provided to its employees, if the infrastructure is not robust enough, the other measurements and controls would be less effective. Although new technologies may be expensive to use now, it is important to understand their functions and applications so that they can adopted when it is economical and necessary to do so.

Taylor's second suggestion is good but can be improved. A contingency plan is critical to managing losses caused by cyber risk events. For Big Ben, having the contingency plan to cover financial losses might not be enough. It also needs to consider the potential damage to the bank's reputation. Investing in an insurance company would also expose the bank to additional scrutiny from the insurance industry. Personal data leaks from the insurance side might result in tightened regulatory requirement for the Bank. These should also be considered in the contingency plan. An action plan can help the company quickly respond to a cyber risk event such as a data breach and a system failure. It can help minimize business disruption and avoid being a headline on cyber security, or at least demonstrate the company's determination and capability to manage cyber risk.

For Taylor's third suggestion, cyber insurance is an option for Big Ben Bank to consider depending on its overall exposure. It can be used to transfer severe impact of cyber risk events to a counterparty. Cyber insurance adds an extra layer of protection to cover unexpected losses. However, having the cyber insurance might expose Big Ben to additional counter party risk. Proactive cyber risk management is needed because cyber insurance does not cover all losses, and good cyber risk management can reduce the exposure to cyber risk and therefore get lower cyber insurance premiums

(d) **(LOs 2.2h, 3.1b)**Big Ben has hired Caerus to evaluate whether it should acquire an online life insurance company.

(i) Explain how the liquidity risk, operational risk, and cyber risk profiles might be impacted if Big Ben acquires an online insurance company.

(ii) Recommend whether Big Ben should consider acquiring an online life insurance company based on your response to part (i). Justify your response.

**Commentary on Question**:
*Most candidates were able to explain how these risks would change. Recommendations to acquire the company with some justification received partial credit.*

## 1. Continued

(i) Liquidity risk: After acquisition, due to the inverse product cycle of insurance business, the current liquidity situation might change. Big Ben might have adequate liquidity in the short term. However, life insurance liabilities are long-term in nature, the duration of assets in market might not be long enough to match the liability duration. Therefore, Big Ben might not have enough liquidity to cover long term liabilities.

Operational risk: According to Caerus, the current methodology is inadequate. Acquisition of the insurance company will increase Big Ben's exposure to operational risk. Big Ben will need to hire additional staff, provide trainings, and system testing and maintaining, which will increase operational risks. The additional operational risks need to be assessed and quantified using an updated approach before making the decision.

Cyber risk: Cyber risk will increase after acquisition. The volume of personal information collected from life insurance sector would significantly increase, which increases the exposure of cyber risk as Big Ben would face new forms of cyber attacks it's never exposed to before. The current cyber risk management needs to be improved before adding additional risk to it.

(ii) I recommend not to acquire the insurance company. It's exposure to liquidity, operational, and cyber risk will all increase post acquisition.

Big Ben might not be able to acquire the insurance company as it has liquidity issues in the next a few years. In addition, Big Ben has plans to expand its Investment Banking and Asset Management business next year, and expand its Commercial Banking in 3-5 years. The excess capital might not be enough to fund both the acquisition, and the expansions of its current business, while maintaining the internal capital adequacy ratio of 140%.

Big Ben Bank should also consider the impact on the economic capital by acquiring the insurance company. Insurance risk will be added to the EC framework, and the diversification benefit should also be reconsidered.

# 2. Fall 2021 ERM Exam (LOs 2.2f, 2.2g)

**Learning Objectives:**

2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.2f | Demonstrate an understanding of model risk. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 14: Model Risk and Governance

**Commentary on Question:**

*This question tests candidates' understanding of business use cases of Economic Scenario Generator and the ability to apply it to a small reginal insurance company.*

**Solution:**

(a) **(LOs 2.2f, 2.2g)** PIC considers implementing an Economic Scenario Generator (ESG) to enhance its risk management capabilities. Your colleague Hunter commented, "since the purpose of using ESG is to manage risk, it is more appropriate to develop real-world scenarios".

(iv) Describe three business uses demonstrating that an ESG could add value to PIC.

(v) Critique Hunter's comment.

**Commentary on Question**:

*To receive maximum credit, candidates needed to demonstrate understanding of how ESG could add value to a company, the differences between real-world and risk-neutral scenarios, and application of general knowledge to a specific company. Most candidates did well in subpart (i). Some candidates received partial credit as they did not comment on the use of ESG in managing its recently added variable annuity products in subpart (ii).*

(i) ESG could add value to PIC in the following business use cases:

- Price variable annuity products with embedded options
- Support Strategic Asset Allocation by evaluating financial risks and rewards under uncertain economic and capital market conditions
- Support internal stress testing and regulatory cash flow testing

## 2. Continued

(ii) Hunter's comment is partially correct.

- Hurter is correct that real-world scenario is more important for risk management purpose as real-world scenarios are concerned with forward-looking potential paths of economic variable and their impacts. These scenarios allow explorations of what-if analyses as it demonstrates the likelihood of future events and their business impact.
- However, the recently issued variable annuities have dynamic policyholder behaviors and the exposures to many alternative investment products, which generates path-dependent cash flows that do not have closed formula to compute. In this case, risk-neutral scenario should also be used to price these cash flows.
- A recommended approach could be use real-world scenario to assess overall risk and to measure the effectiveness of a hedging strategy, and risk-neutral scenarios projected forward from each current node of the simulation to price cash flows.

(b) **(LOs 2.2f, 2.2g)** An Excel-based ESG model developed and used by the Investment Office (IO) may be leveraged for risk management purpose.

The primary use of the IO's ESG is to generate interest rate paths for PIC's fixed income assets, which constitute 93% of PIC's investment portfolio. This real-word scenario generator derives the term structure of interest rates using a Vasicek model with parameters calibrated to historical treasury rates from 1980 to 2019 using a regression approach.

You note the following modeling choices made as part of the parameterization process:

- Outliers are eliminated to generate a steady-state level
- The underlying dynamics of interest rates are described using a long-term mean and standard deviation
- The recovery path from initial condition to a steady-state level is calibrated to be consistent with historical experience. Due to long run-time, recalibration of parameters and assumptions is performed annually.

(v) Assess the limitations of this ESG model for PIC based on the features of a comprehensive ESG.

(vi) Describe two sources of parameter risk in the current interest rate parameterization process.

(vii) Evaluate the appropriateness of this model for each of the three business uses you identified in part (a)(i).

## 2. Continued

**Commentary on Question**:
*This part of the question tests whether candidates could identify the weaknesses of an ESG based on descriptions of its design.*

*Most candidates were able to identify at least three limitations and receive full credit for subpart (i) based on information provided in the question stem. Some candidates did not receive full credit as they either listed generic limitations that are not applicable to the ESG described in the question stem or have inaccurate statements (e.g., Vasicek model should not be used in ESG).*

*Candidates did not do well in subpart (ii) as most candidates failed to identify the risk drivers in the parameterization process. Most candidates commented on the infrequent recalibration schedule, which is a proper risk but not a risk occurred during the parametrization process.*

*Most candidates received partial credit in subpart (iii) as conclusions were provided with minimal support. Full credit required an actual evaluation.*

(i) This ESG model has the following limitations:

- It has limited capability of producing extreme but plausible scenarios as indicated by its parameterization approach, e.g., limited tail events during selected time period
- This ESG model only simulates possible future paths of limited economic variables, i.e., interest rate and corporate bond (yield)
- This Excel based ESG model has long run-time which indicates some computationally inefficient

(ii) Parameter risk is the uncertainty as to whether the parameters are appropriate for the phenomenon that we are attempting to model. This uncertainty could be driven by the selected empirical treasury dataset is too short to reflect various characteristics of interest rate term structure, such as the high inflation period in the 1970s

The regression parameterization approach is not effective because the historical data for many economic variables violates one of the prime assumptions of these techniques: independent observations.

## 2. Continued

(iii) **Price variable annuity products which have embedded options:** This ESG could not support this business use since it is a real-world scenario generator that contains a significant amount of expert judgement to determine the veracity of the scenarios that result from the parameterization process. Pricing embedded options requires to reproduce the prices of traded derivative instruments in order to determine comparable prices for derivative instruments and insurance contracts with embedded options that are not traded but that require market valuation

**Support Strategic Asset Allocation by evaluating financial risks and rewards under uncertain economic and capital market conditions:** This real-world ESG fits this intended use as it reflects company's view on future economic conditions and the parameterization process reflects consideration of the entire distribution of outcomes such as selecting a consensus type of steady level (i.e., outliers are treated); using mean/standard deviation as stylized facts.

**Support internal stress testing and regulatory cash flow testing**: This ESG model is not able to support this business use case. Even though it is a real-world scenario that reflects expert opinion on future economic performance; it has limited capability to generate extreme while plausible scenarios for stress testing purpose. For example, the model is not able to reflect impacts of tail events by treating outliers, using mean/standard deviation as key parameterization targets.

# 3. Fall 2021 ERM Exam (LOs 2.2c, 2.2d, 2.2g, 3.3b)

**Learning Objectives:**

2: Risk Analysis and Evaluation

3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2c | Demonstrate risk aggregation techniques that illustrate the concept of risk diversification. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.3b | Demonstrate a conceptual understanding of economic measures of value and capital requirements (e.g., EVA, embedded value, economic capital, regulatory measures, and accounting measures) and their uses in decision-making processes. |

**Relevant Sources:**

- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 14: Quantifying Particular Risks
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

## 3. Continued

**Commentary on Question:**
*The question tested the candidate's ability to understand, apply, and evaluate an economic capital framework, as well as assessing and applying aggregation techniques and stress testing. Credit was commonly lost by candidates that did not use all of the provided information in the question, such as not referencing or considering the product features of LifeCo or not critiquing or commenting on all recommendations in the question.*

**Solution:**

(a) **(LOs 2.2d, 2.2g, 3.3b)**

(i) Evaluate LifeCo's approach to modeling EC for the three identified key risks.

(ii) Calculate credit risk EC and interest rate risk EC. Show all work.

(iii) Explain how you would incorporate lapse risk and reinvestment risk into LifeCo's EC framework.

**Commentary on Question**:
*There was a wide range of performance by candidates on part (a).*

*Many candidates lost credit on subpart (i) as they did not relate the responses to LifeCo's product features and rather provided generic answers.*

*A common mistake in subpart (ii) was confusing forward rates with spot rates for the interest rate calculations. In addition, it was determined that there were multiple reasonable ways to estimate the discount rate and credit (up to full credit) was awarded for such approaches. Approaches that produced nonsensical results were not awarded credit. Finally, some candidates calculated the Credit Risk EC as the expected loss, forgetting to add 20%.*

*If the final answer in subpart (ii) was incorrect, partial credit was given for the variables that were calculated correctly, as well as for the correct formulas used.*

*In subpart (iii), many candidates discussed the considerations to setting lapse or reinvestment assumptions rather than recommending how an EC calculation would be designed/modeled.*

## 3. Continued

(i) Credit:

- The historical data being used is out of date, and is missing the 2008 financial crisis which could materially impact the historic default rates.
- The model does not assume any changes in credit rating over the 3 years, which is not realistic.
- The 120% factor seems arbitrary. It would be more appropriate to set the EC using a specified risk metric (VaR, CTE) applied to a probability distribution with parameters that are market consistent.

Interest:

- The products have liability cashflows that vary with interest rates that also have guarantees which do not pass-through the downside risk to the policyholders. The interest rate risk should use a stochastic approach that also reflects the changes in liability cash flows as the interest rate changes.
- Rather than applying a deterministic spread between the base interest rates and the shocked interest rates, it is more appropriate to set the interest EC based on the VaR or CTE of many stochastic scenarios.
- The Ho-Lee model is more appropriate for modelling short rates but is not ideal for modelling full yield curves (30 years are used in the EC model).

Mortality:

- The RBC framework is a rules-based approach that may be reasonable but does not capture the specifics of LifeCo's mortality risk.
- Given LifeCo's Par block is closed with a high average attained age, it is likely that RBC does not accurately reflect LifeCo's risk, specifically the potential catastrophe risk.

(ii) Refer to Excel for calculation solutions.

(iii) Lapse – Deterministic

- LifeCo should test UL and Par separately to determine if they are lapse supported or lapse sensitive, and then apply EC shocks accordingly.
- LifeCo should determine shocks to lapse rates to represent a targeted risk metric. The shock should consider both internal and industry data.
- LifeCo should include a time zero mass-lapse shock.

## 3. Continued

Lapse – Stochastic

- LifeCo should determine the relationship between policyholder behavior (partial withdrawals and full lapse) and interest rates.
- Simulate withdrawals under a set of real-world economic scenarios and select the appropriate risk measure (VAR/CTE)

Reinvestment

- Generate real-world scenarios for reinvestment rates for fixed income assets backing the general fund
- Calculate liabilities under credited and discount rates derived from each scenario
- Select an appropriate risk metric (VAR/CTE) for required EC using liabilities obtained in the previous step

(b) **(LO 2.2c)**The following correlation matrix has been provided and is based on publicly available historical market data.

| | Correlation Matrix | | |
|---|---|---|---|
| | **Credit** | **Mortality** | **Interest Rate** |
| **Credit** | 1.00 | 0.03 | 0.30 |
| **Mortality** | 0.03 | 1.00 | 0.01 |
| **Interest Rate** | 0.30 | 0.01 | 1.00 |

(iii) Calculate LifeCo's aggregate EC using the given correlation matrix. Show all work.

(iv) Compare and contrast the following aggregation methods as they pertain to LifeCo:

- Correlation
- Copula.

(v) Describe the considerations for using copulas to aggregate risks in an EC framework.

**Commentary on Question**:
*Candidates generally performed well on this part. A common mistake candidates made was further explaining what a copula is in subpart (iii) rather than describing specific considerations associated with using copulas.*

## 3. Continued

(i) Refer to Excel for calculation solutions.

(ii) Correlation

- This approach is simple to apply and easy to understand. It is fairly easy to calibrate the correlations using company experience.
- This approach assumes that relationships between risks are linear throughout the distribution, which is generally not true in tail events. It is likely that the correlations between mortality and economic risks are higher in tail events.
- This approach assumes the distribution of each risk is normal, which is inappropriate for LifeCo, given there are guarantees on both products resulting in skewed loss distributions.

Copulas

- Copulas are better than the correlation approach at modelling tail dependencies. They do not require that each risk is assumed to follow a normal distribution, and can have changing relationships in the tail events, which is more accurate for modeling EC.
- Copulas are much more challenging to implement, operate and calibrate.

(iii)

- Identifying the appropriate marginal risk distribution for each risk.
- Selecting the appropriate copulas to aggregate the marginal risks.
- Consideration of the data availability and reliability to calibrate the parameters of the distributions and copula.
- Does LifeCo have the expertise and computational capacity to maintain and calculate EC using a copula?

(c) **(LO 2.2d, 3.3b)** Management suggests using the following scenario and the correlation matrix provided in part (b):

| Risk | Outcome |
|---|---|
| Credit | 10% decrease in recovery rates (e.g. from 70% to 60%) |
| Mortality | 5% increase in liability claim payments for all durations |
| Interest rate | 10 bps decrease in base discount rates for all years |

## 3. Continued

(i) Recalculate the total required EC under the pandemic scenario. Show all work.

(ii) Critique LifeCo's management's suggestion.

**Commentary on Question**:
*Candidates generally performed well on this part. Credit was lost in subpart (ii) for not critiquing each recommended change to the EC framework, not understanding how the EC calculations are impacted by the recommended changes, or not understanding what reasonably expected impacts of COVID-19 are.*

*Like question b(ii), if the final answer in subpart (i) was incorrect, partial credit was given for the variables that were calculated correctly, as well as for the correct formulas used.*

(i) Refer to Excel for calculation solutions.

(ii) Interest

- A shock to base discount rates has a minimal impact on EC because the spread between the base and shocked is not changed from 50bps. It would be more appropriate to increase the spread between base and shocked.
- The decrease in interest rates is not expected to be permanent, it would be more appropriate to shock discount rates in the short term with long term rates reverting back to expected.

Credit

- Although recovery rates may decrease, it is likely that default rates will also increase.

Mortality

- A permanent increase in mortality rates is likely excessive. It would be more appropriate to shock mortality rates in the short-term only.
- Due to the effects of COVID-19, it would be more appropriate to apply different mortality shocks for different age bands.

Correlation

- The correlations with mortality of 0.03 (credit) and 0.01 (interest) will understate the impact, given that COVID-19 resulted in a scenario where mortality was impacted as well as the economic environment. Significantly higher correlations would be more appropriate.

# 4. Fall 2021 ERM Exam (LOs 1.2a, 2.1a, 3.1a, 3.2a)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
    - Ch. 14: Quantifying Particular Risks

**Commentary on Question:**
*Overall, most candidates did well on this question. Parts (a) and (b)(iv) of the question are where candidates struggled the most. Most candidates did very well on the Excel calculation portion of the question as well as part (c).*

## 4. Continued

**Solution:**

(a) **(LOs 1.2a, 3.1a)**

(iii) Describe two primary benefits of having a well-defined risk appetite framework for key organizational risks.

(iv) Explain how risk appetite can be reflected in each of the following:

- Asset Allocation
- New Business Budgeting
- Performance Measurement.

**Commentary on Question**:
*Most candidates didn't understand what was being asked in subpart (i) and instead described what a risk appetite framework was rather than what the benefits were. Most candidates got at least partial credit on subpart (ii), struggling primarily with the "Performance Measurement" part of the question.*

(i) 1. Protecting and creating value for the business. Risk appetite describes risk with quantitative measures and facilitates the analysis of the risk/return trade-off. This helps senior management make informed decisions to maximize the risk-adjusted return for the shareholder.
2. Ensuring the consistency between risk appetite and risk limits. Both rating agencies and investors are concerned about whether risk appetite is properly aligned with the risk limits being set for business operations.

(ii) Asset Allocation: Strategic asset allocation (SAA) is used to determine a long-term policy portfolio reflecting the desired systematic risk exposure. Asset allocation objectives should incorporate key aspects of a company's risk appetite framework to guide decision-making and to monitor outcomes.

New Business Budgeting: Insurance companies normally prepare new business budgets of certain return or value measures each year while clients, shareholders, employees, and regulators are interested in understanding the amount of risk the company will take in the future. These return/value measures do not fully and accurately consider the level of risk being taken; therefore, other measures need to be used to explain the impact of the new business on the future risk profile.

## 4. Continued

Performance Measurement: Including appropriate key performance indicators (KPIs) regarding risk appetite in managers' performance scorecards would encourage employees to think in terms of both return and risk when making business decisions, which promotes alignment between the objectives of key stakeholders and the enterprise risk tolerance (i.e. RAROC, risk-adjusted value).

(b) **NO LONGER RELEVANT** ~~The details of the entire three-asset portfolio you have been asked to evaluate are given below. The CRO wants to evaluate risk metrics for monitoring the block and suggests that a 95% VaR may be an appropriate threshold.~~

| | | | | |
|---|---|---|---|---|
| ~~**A**~~ | ~~4%~~ | ~~$20~~ | ~~6%~~ | ~~40%~~ |
| ~~**B**~~ | ~~6%~~ | ~~$50~~ | ~~3%~~ | ~~60%~~ |
| ~~**C**~~ | ~~8%~~ | ~~$30~~ | ~~10%~~ | ~~10%~~ |

~~(vi) Calculate, net of recovery, the expected loss and the variance over a one-year time horizon. Show all work.~~

~~(vii) Calculate the 95% VaR using the results from (i) assuming that portfolio losses are normally distributed. Show all work.~~

~~(viii) Determine the empirical 95% VaR based on the distribution of potential portfolio losses calculated in (i). Justify your response.~~

~~(ix) Describe one key shortcoming for each metric calculated in (ii) and (iii) that should be considered when selecting an appropriate risk measure for QPT's risk appetite statement.~~

~~**Commentary on Question**:~~
~~*Candidates performed well on subparts (i)-(iii). If the final answer in subparts (i)-(ii) was incorrect, partial credit was given for the variables that were calculated correctly, as well as for the correct formulas used. For subpart (iii) full credit was awarded for a value between 20-27 with justification. Most candidates struggled with subpart (iv) and provided general answers, such as issues of coherency.*~~

~~(i) Model Solution is in Excel file attached~~

~~(ii) Model Solution is in Excel file attached~~

## 4. Continued

~~(iii) Empirical VaR95 based on distribution is 27 since there is at least a 95% probability that cumulative losses will fall below this value.~~

~~(iv) VaR 95 as calculated in b(ii):~~

~~- Actual distribution of potential net losses is deterministic and right skewed, thus the assumption of normality is violated.~~

~~VaR 95 as calculated in b(iii):~~

~~- 95th percentile may not be well defined (as seen in example), QPT would need to decide on whether a range is appropriate or rationalize their choice for a single value.~~

(c) **(LOs 2.1a, 3.2a)** QPT's CRO is planning a discussion with the internal audit department regarding risk assessment on credit risk in an inherent risk control matrix.

(iv) Identify and describe three ***key*** questions that should be considered during the risk assessment phase.

(v) Recommend the most effective action to mitigate the credit risk for the portfolio in part (b). Justify your response.

**Commentary on Question**:
*Candidates performed very well on both subparts (i) and (ii). Alternate answers were awarded full credit based on their merit.*

(i) 1. How vulnerable are you now to a certain risk? Considering the risk would occur, how vulnerable are you to this risk? In an extreme situation, you are entirely exposed to a risk.

2. How exposed are you? How often do risk events happen? The answer can be highly exposed on the one end and not or barely exposed on the other.

3. If the risk occurs and mitigation fails, what will be the impact? What happens when disaster strikes? What happens when all defenses are breached? What if all controls or systems fail? What will be the worst possible outcome? The answer can be catastrophic or may be immaterial.

**4. Continued**

(ii) Increase the number of issuers of the bonds holding. This would allow us to diversify the credit risk that are company specific. We could also select issuers among different sectors, and bonds of different credit ratings and duration.

# 5. Fall 2021 ERM Exam (LOs 1.2a, 2.1a, 2.1b, 2.1c, 2.2h, 3.2a)

**Learning Objectives:**

1: Enterprise Risk Management Foundations
2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 1.2a | Recommend an appropriate enterprise risk management framework for an organization. |
| 2.1a | Identify specific risks faced by an organization. |
| 2.1b | Detect emerging risks. |
| 2.1c | Determine an appropriate monitoring mechanism for emerging risks. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-113-25: Identifying and Evaluating Emerging Risks
- CFE101-110-25: IAA Paper: Importance of Climate-Related Risks for Actuaries (Pages 2-14)

**Commentary on Question:**

*The goal of this question was to test candidates' understanding of the role of ERM for a non-financial institution and extending to key risks such as cyber risk and climate change.*

## 5. Continued

**Solution:**

(a) **(LO 1.2a)** For Section I - The Three Lines of Defense:

(v) Summarize the function of the 2nd line of defense.

(vi) The CFO of Energetix has proposed that the new ERM team should report to the Manager, Engineering.

Assess this proposal.

**Commentary on Question**:
*This part was generally answered well. There were many possible answers that candidates could answer to receive full credit.*

(i) The 2nd line of defense reports to senior management, and includes but is not limited to risk management, compliance and other oversight functions. It provides expertise to 1st line management, providing assurance on risk control and limit setting. In addition, it also prepares risk reporting and disclosure to senior management to help better identify overall risk exposure and company risk profiles. There is a segregation of duties with first line of defense which owns the risk.

(ii) This proposal is not appropriate, as the Manager, Engineering is in the first line of defense and should not supervise the 2nd line ERM function, because it would compromise the objectivity. Also, this structure would likely limit the scope to operational risks, whereas ERM should also assess all other risks, including financial and strategic.

It would be better for the ERM team to report to a Chief Risk Officer (senior management). The CRO will be the one to share and help the Board understand the risk profile during their meetings. Based on the case study, it seems that Energetix does not currently have a CRO; they should hire one.

(b) **(LO 2.1a)** For Section II - Risk Identification:

Propose four risk identification tools and/or techniques for Energetix and explain how Energetix could use them.

## 5. Continued

**Commentary on Question**:
*Most candidates were able to adequately explain four identification tools or techniques, but few explained how the tools were suitable for Energetix which was a key part of the question. The answers shown below are a subset of those that would have received credit. Roughly half the credit for each tool or technique was given for explaining the tool, and half for connecting it to Energetix.*

Risk prompt lists - Use a Risk Prompt List such as PESTEL as a tool to identify macro-level environmental factors surrounding Energetix. For example, identifying the trends in the environment, then zoom in to industry specific and company specific factors. Focus on what other companies are doing in the industry, any trends in customer demands, regulatory changes, etc.

Case study - is a tool that looks at other cases in the industry of risks and helps Energetix to compare their risks to others. The tool would be used to identify key risks in the industry and how Energetix stands out or aligns with the industry. This could help them to specify their risk appetite and strategic initiatives. Learnings could feed both surveys and interviews.

Surveys are techniques to gather information from a range of sources and gather feedback into a repository, especially useful for a large company. The challenge with surveys is how Energetix frames the question, but it should still capture all potential risks if they survey all areas of the company. They can use the survey to propose key risks for Energetix to focus on, in order to prioritize risk management efforts.

Interviews - Energetix could perform interviews with different heads of the three main operating business segments to determine the risks that they face in each department. Senior leaders would be able to give detailed information and be able to answer questions right away (advantage compared to surveys).

(c) **(LOs 2.1a, 2.1b, 2.1c, 3.2a)** For Section III - Emerging Risks:

(iii) Explain how Energetix is exposed to cyber risk.

(iv) Identify four risk management strategies for cyber risk for Energetix.

(v) Identify two emerging risks, other than cyber risk, faced by Energetix. Justify why they are emerging risks.

(vi) Propose a methodology for monitoring early warning signals for each of the two risks identified in part (iii).

## 5. Continued

**Commentary on Question**:
*Subparts (i) and (ii) were answered consistently well. The quality of the responses on subpart (iii) responses was uneven, with many candidates failing to properly justify their responses. Simple identification of a risk received no credit; the candidate had to explain the risk for partial credit and discuss why it was emerging for full credit. Subpart (iv) was not answered well, with very few candidates providing suggested metrics or indicating how the information could be of use.*

(i) Energetix is exposed to cyber risk through the possibility of cybersecurity attacks. These attacks could not only disrupt operations at the company but steal consumer data. Energetix likely has important data on wholesale and retail consumers and the release of such data, as well as potential service disruptions, would create legal and reputational issues for Energetix.

(ii) IT controls – keep technology current
Training – provide ongoing cyber risk training to employees
Outsource to a cyber specialist
Cyber insurance – transfer severe impact to a counterparty

(iii) Climate risk – this is an extremely pertinent risk as climate change is increasing the frequency of natural disasters, which could impact Energetix operations and create extreme losses. Although climate risk is present today, it is also an emerging risk because it is difficult to predict the evolution of this risk and its potential impact in terms of frequency and severity.

Technology risk – New technology may be developed which changes the business model for Energetix's operations. This is emerging because it is unknown what technology may develop, how quickly it may become dominant, and how/when it will impact either Energetix or the energy usage of its customers.

(iv) Monitoring for climate risk - read publications, monitor trend of weather-related damages in relevant jurisdictions; establish a key risk indicator with thresholds for action such as strengthening distribution networks

Monitoring for technology risk - assign resources to read publications, attend conferences to remain aware of emerging technologies and new applications; incorporate knowledge of technological evolution into strategic planning

## 5. Continued

(d) **(LOs 2.1a, 2.2h)** For Section IV - Strategic Risk:

(i) The CFO has noted that climate-related damage to facilities and distribution channels may lead to service disruptions.

Provide three additional examples of how climate risk may impact the strategic planning for Energetix.

(ii) Assess which of the three categories of climate risk (physical, transition or legal and reputation) is the most impactful on Energetix.

**Commentary on Question**:
*For subpart (i), many candidates failed to receive credit because they pointed to physical risk which was already in the question stem. Any other climate-related risk was given credit as long as it was explained clearly. The biggest shortfall in responses was a lack of connection between the risks listed and strategic planning, such as increased costs, decrease or increase in customer demand (revenue reduction or potential supply issues respectively). Without that connection, no more than half the credit was awarded. For subpart (ii), which called for an opinion, any response earned full credit as long as reasonable justification was provided and the other two categories were also discussed to explain why they were not the primary choice.*

(i) Reputation: since Energetix provides gas utilities, it will be the subject of public discussion with respect to its impact on climate change. Groups and individuals will target the company if a move towards other power sources is not moving quickly enough, affecting its reputation. This will lead to reduced business and lack of ability to reach goals if reputation is significantly affected.

Legal: if Energetix does not do its part following government regulation (50% of all electricity in the state must be generated from renewable resources in the next 20 years), it will be subject to fines and legal costs as a result. This would affect Energetix's revenue and ability to continue to advance its business.

Transition risk: transition risk is related to the work and risk involved in moving towards more green energy. Energetix depends heavily on gas utilities for revenue. Converting to green energy will require significant costs and the development of new technologies to be able to capture these different energy sources. This makes it difficult for Energetix to work towards its other strategic goals.

**5. Continued**

(ii) Physical risk is certainly the most immediate risk which can impact Energetix. As the CFO noted, physical damages due to climate risk could halt business activities and impact all of Energetix's clients. This risk is present today; because of the immediacy of this risk and the significant cost and reputation issues which could result from it, it is the most impactful of the three categories.

Both transition and legal are important but less impactful, as they are likely to be felt later in the future as the transition to a greener economy picks-up. Moreover, legal/reputation are risks that would also follow the business disruption from physical risks or the failure to prepare for transition risks.

# 6. Fall 2021 ERM Exam (LOs 2.1a, 3.2a, 3.2d)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk
- CFE101-120-25: IAA Risk Book Reinsurance

Westover

**Commentary on Question:**
*The question tested candidates' understanding of different risks and mitigation strategies. Candidates were asked to identify risks/risk responses, compare/contrast, and describe advantages of different risk management tools.*

## 6. Continued

**Solution:**

(a) **(LO 2.1a, 3.2a)** The company has taken the following risk mitigation steps:

- Moved from entering into over-the-counter swaps to using exchange-traded interest rate futures
- Signed new YRT treaties to cede death claims of UL policies to a reinsurance company
- Implemented a data analytics system to help detect claim fraud.

(iv) Identify the risks being addressed in each step shown above.

(v) Identify the category of risk response for each risk mitigation.

(vi) Explain what risks are created by taking each mitigation step.

**Commentary on Question**:
*In general, candidates did well in identifying different types of risks before and after the risk mitigation actions. Candidates did not do well in identifying the type of risk responses. Partial credit was awarded for subpart (iii) if candidates correctly identified some of the risks but not all them.*

(i)
• Moved from entering over-the-counter OTC swaps to using exchange traded interest rate futures
Risk being addressed - Counterparty credit risk

• Signed new YRT treaties to cede death claims of UL policies to a reinsurance company
Risk being addressed - Mortality(insurance) risk

• Implemented a data analytics system to help detect frauds
Risk being addressed - Operational risk

(ii)
• Moved from entering into over-the-counter OTC swaps to using exchange traded interest rate futures
Category of risk response - Risk removal

• Signed new YRT treaties to cede death claims of UL policies to a reinsurance company
Category of risk response - Non-capital market mortality risk transfer

## 6. Continued

• Implemented a data analytics system to help detect frauds
Category of risk response - Risk reduction through more robust systems/processes

(iii)
• Exchange traded interest rate futures: basis risk. Future contracts are standardized; therefore they may not provide an exact hedge.

• Reinsurance: counterparty risk. Reinsurer may fail to honor its financial obligations.

• Data analytics system: technology risk, data risk.

(b) **(LOs 3.2a, 3.2d)** ABC Life has a wholly owned captive for its UL business. It is considering other risk transfer options because it believes the captive is too resource intensive.

(v) Compare and contrast traditional reinsurance, securitization and use of a captive.

(vi) Describe the advantages of each option for ABC Life.

**Commentary on Question**:
*Candidates did well in describing the differences among the three risk transfer options. However, many candidates had difficulty describing the advantages of each option. Partial credit was awarded on each subpart if candidates described correctly some differences between the risk transfer options and/or some advantages of the options.*

(i)
• They are all risk transfer risk management tool

• Commercial reinsurance is a form of non-capital market risk transfer - paying premium to another firm in exchange for protection from a risk.

• Wholly owned captive is also a non-capital market risk transfer – company self-insures itself by creating captive and transfer risk to captive.

• Securitization is a way of turning risk exposure into investment that can be sold to investors in capital market. It's a capital market risk transfer.

## 6. Continued

(ii)

• Captive: improving ABC's control over the purchase of insurance; tax benefits.

• Commercial reinsurance: increasing underwriting capacity; supporting entry into/exit from insurance markets.

• Securitization: market price can be determined for risks securitized; quicker way of raising capital to cover risks than issuing equity.

# 1. Spring 2021 ERM Exam (LOs 2.1a, 2.2h, 3.2b, 3.2f)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2.h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2b | Demonstrate the use of controls in an organizational process. |
| 3.2f | Demonstrate possible techniques for managing non-financial risks. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 14: Model Risk and Governance

**Commentary on Question:**

*This question was intending to test candidates' ability to identify and analyze various risks faced by an organization and test their understanding of different approaches available for an entity to manage risks and their applications.*

*Candidates were expected to demonstrate knowledge of controls for retained risks and choose appropriate techniques to manage various risks faced by an organization.*

*The most significant theme in candidates struggling was by simply restating the background information given in the problem. Those who scored high were able to expand on that information and draw conclusions from it.*

## 1. Continued

**Solution:**

(a) **(LOs 2.1a, 2.1h)** The VP is concerned that hiring DEF will increase ABC's operational risk.

(i) Explain why each of the following operational risks could increase.

- People Risk
- Reputational Risk

(ii) Explain how the new system could improve data quality.

**Commentary on Question**:

*Subpart (i)*

*Most candidates received about half of the potential credit. Multiple valid explanations were given across all submissions; however, the majority could have given more in terms of quantity of potential responses.*

*Subpart (ii)*

*Most candidates received anywhere from half to full credit. Those who scored lower did so because they were simply restating the background information that was given in the question, without taking it a step further to explain how it would actually improve the quality of the data.*

(i) **People Risk**

People risk will increase for ABC given they are working with an external company, whose employees may have a lack of formal training or knowledge around ABC's specific industry.

Additionally, ABC has no control over the hiring/firing practices or ethical standards of DEF.

Consulting an external company for such a large project may cause concern for ABC employees in regard to the need for their continued employment, or at least the need to learn a new system.

Given there is disagreement amongst ABC's senior management on whether to undertake this project, there is the possibility that taking on the project (or not taking it on) may result in turnover at the senior management level.

**1. Continued**

**Reputational Risk**

When transferring client data between companies, there always exists the possibility of a data breach, which would cause concern and possible loss of ABC's customer data and resulting business.

ABC's inability to develop a system in-house may cause a signaling effect to their clients and the market that they are not as strong of a reinsurance company as was previously believed.

Were any senior management to leave due to the disagreement surrounding this project, this would reflect poorly on client's view of ABC's ability to make decisions internally.

Lastly, the reputation of DEF is important given that ABC is placing business confidence in them – any negative events relating to DEF would reflect poorly on ABC as well.

(ii) By unifying all of the existing separate systems and geographies, data will be in a consistent format to streamline the data validation process and improve data reliability.

ABC's client data will now be complete and uniform, which will allow them to compare and analyze client data in the aggregate, across all clients and geographies, which is currently not an easy or even possible process.

The new system will allow all data to exist in a larger volume dataset which is assisted by new technology and the addition of big data. These new practices will further improve the potential of big data or improved technologies to highlight unknown data issues and improve the potential analysis and business insights.

Under a consistent process within one system for all clients, additional time will be available for the data validation and audit process. This will decrease some of the existing data and model risk, giving ABC more confidence in its business processes.

## 1. Continued

(b) **(LOs 3.2b, 3.2f)** If DEF is hired, the VP will organize a steering committee consisting of key internal stakeholders.

(i) List and explain the steps that need to be taken by the steering committee to ensure an effective development process for the new system.

**(ii)** Propose three review and testing procedures that ABC can adopt to validate the new system.

## 1. Continued

**Commentary on Question**:
*Subpart (i)*
*The majority of candidates either received either approximately half of the potential credit or all of the potential credit. Those who scored better not only identified more steps in the process, but also explained them well and tied them to the context of ABC and the new system, as opposed to generic steps in an implementation process.*

*Subpart (ii)*
*Almost all candidates received at least half credit. Many candidates focused on matching data output/results and less on overall system governance. Those who scored higher did a better job of providing context around the proposed testing procedures.*

(i) The steering committee should take the following steps to ensure an effective development process:

- Outline the existing processes under all current systems to identify the necessary changes for DEF to implement a single unified system.
- Specify key dates and deadlines to ensure the project can be completed as necessary within the two-year time period.
- Monitor the system development: define and enforce regular checkpoints between ABC and DEF to ensure that the project is moving as expected.
- Organize a team to test and validate the new system – the testing team should consist of representation of all critical business units and functions, to ensure that all data requirements are met, and that the platform is functioning as intended via robust testing.
- Following testing and validation, define final approval standards of the final system before implementation.
- Validate that documentation and ongoing controls are in place. Though DEF is immediately responsible for maintaining the system, there needs to be working knowledge of it within ABC and an existing contingency plan given that ABC is ultimately responsible to its customers, while DEF is not.
- Institute a collaborative training program between ABC and DEF employees to ensure effective implementation.

(ii) Historical backtesting testing: ensure that the aggregate output and results from the new system match selected aggregate results of all combined prior legacy systems. This should be validated for actual historical data at specified points in time, spanning multiple years of actual historical data.

## 1. Continued

Parallel seriatim testing: ensure that the new system matches expectation and calculations in prior legacy systems in all critical intermediate steps in addition to in the aggregate. Ensure that logic and output match not only historical situations but also unique and extreme data points that have not happened but that could realistically occur.

Model documentation and governance: appropriate and sufficient documentation of the new system and the associated testing and validation procedures should be created and maintained into the future. Robust validation standards should be created and assigned to specific parties, with appropriate segregation of duties to ensure multiple Change controls for future updates should be established in accordance with the level of testing put into place at the initial implementation.

(c) **(LO 3.2b)** You are asked to design and implement an internal control framework for ABC to effectively manage the risk of hiring DEF and implementing the new system.

Recommend four controls to be adopted in your design. Justify your answer.

**Commentary on Question**:
*Many of the candidates received substantial credit on this part. While there were many possible answers here, several candidates focused on specific system access restrictions and results testing without addressing the larger picture that a full internal control framework would likely need established.*

1. First line of defense: managers and employees of ABC should have a clear understanding of their responsibilities relating to the project. Managers and business owners need to hold their teams accountable to the risk inherent in such a large project. Clear authority needs to be outlined and internal controls such as the segregation of duties relating to the project should be established whenever possible.

2. Second line of defense: adjacent business units that are not directly related to ABC's core business model also need to support senior management in providing risk protection surrounding the implementation of the new system. Examples of this would include Risk Management, who should be thoroughly vetting DEF as a business partner, and Compliance, who should ensure that all elements of the agreement between ABC and DEF abide by legal standards.

## 1. Continued

3. Third line of defense: an internal audit function should be established if one does not already exist. This function should report above ABC's senior management, directly to the board or applicable governing body. The internal audit function should provide both broad oversight and detailed analysis on the implementation of the new system, and should work completely independent of business units that are both directly and adjacently involved in the first two lines of defense.

4. Senior management commitment and communication: commitment from the upper levels of ABC is a key contributing factor to the success of such a sophisticated undertaking. Effective support and communication in regards to the project needs to come from the top down to successfully disseminate throughout the organization. Ensuring that a positive and strong message is sent throughout the project will support success.

(d) (**LO 3.2f**) Recommend whether ABC should proceed with the proposal. Justify your response.

**Commentary on Question**:
*Almost all candidates received at least half credit, with many receiving full credit. Not only was a recommendation required, but it also needed to be justified using information drawn from the preceding parts of the problem. Those who received less credit typically failed to draw their own conclusions and instead restated the context provided in the background of the problem.*

ABC should proceed with the proposal in order to remain competitive and reduce the risk of their systems becoming dysfunctional or obsolete. While partnering with DEF provides potential people and reputational risks as discussed earlier, there exists the potential for far more severe risks if ABC is unable to keep up with its competitors and begins to lose customers as a result.

Contracting with DEF to develop and implement the system will give them technological advances that they very likely will need in the future, as well as a partner to help maintain and educate them throughout implementation. Adopting a system that provides a single source of truth for their customer data will further help ABC gain insight into their business to provide potential strides in strategic planning and competitive advancement.

# 2. Spring 2021 ERM Exam (LOs 2.1a, 3.2d)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
- CFE101-120-25: IAA Risk Book Reinsurance

**Commentary on Question:**

*This question intended to test the candidates' understanding of catastrophic mortality risk and assess the appropriateness of various risk mitigation methods for catastrophic mortality risk. The question also tests the candidates' understanding of liquidity risk, how it is quantified, and the various ways that it is experienced. Overall, candidates performed fairly well on the question, with the exception of part (d) due to candidates not using all available information to make quantitative assessments/recommendations or providing answers that were not directly relevant to the question.*

**Solution:**

(a) **(LO 3.2d)** ERM Life is considering the use of reinsurance to address its concerns with catastrophic mortality claims. The following reinsurance alternatives have been offered to ERM Life:

- 50% pro-rata reinsurance
- Per risk excess of loss reinsurance
- Per occurrence excess loss reinsurance
- Aggregate excess of loss reinsurance

Assess the suitability of each of these alternatives to mitigate ERM Life's catastrophe risk exposure.

## 2. Continued

**Commentary on Question**:
*Candidates generally performed well. Several candidates confused Per Risk and Per Occurrence reinsurance and did not understand how catastrophic mortality claims would be realized (high frequency rather than high severity) which led to incorrect assessments of the reinsurance options.*

- 50% pro-rata reinsurance cedes 50% of all claims, and will be the most expensive of the provided options. ERM Life will still be exposed to 50% of catastrophic mortality claims. This option is not appropriate to address ERM Life's concerns.
- Per risk excess of loss covers losses in excess of a threshold for each policy/contract. Catastrophic mortality claims would be realized as a high frequency of claims, rather than a small number of high face amount claims. This option would not be appropriate to address ERM Life's concerns.
- Per occurrence excess of loss would cover claims in excess of a threshold arising from a single event, subject to the wording of the treaty. If, for example, the treaty defined a pandemic event as a single occurrence, then this option would be appropriate to address ERM Life's concerns, and would come at a lower cost than alternative options.
- Aggregate excess of loss covers all losses in excess of a threshold over a given timeframe. Although this option would likely be more expensive than the alternative XoL options, this option would address ERM Life's concerns with catastrophic mortality claims.

(b) **For relevance, this question has been modified from the original exam format in this fashion: removed "Participating in a self-insurance pool"**

**(LO 3.2d)** ERM Life is also considering the following alternative risk transfer approaches to cover catastrophic mortality claims:

- Issuing a catastrophe bond sold through a dedicated Special Purpose Vehicle (SPV)
- ~~Participating in a self-insurance pool~~
- Setting up its own captive

(i) Describe each approach.

(ii) Analyze the appropriateness of each approach to mitigate ERM Life's catastrophic mortality risk.

## 2. Continued

**Commentary on Question**:
*Candidates generally performed well on this part. Candidates that did not perform well commonly made recommendations that were not specific to ERM's goals of mitigating catastrophic mortality risk, and focused on the risk financing aspects rather than the intention of risk transfer (specifically for captives, where the risk is still retained by the parent company).*

Issuing a catastrophe bond sold through a dedicated Special Purpose Vehicle (SPV)

- (b i) ERM Life would sponsor an off balance sheet SPV which would issue bonds to investors. If a catastrophic event occurs, ERM Life would be able to use the invested capital to pay off claims, while investors receive coupons and the return of principal if no catastrophic event occurs.
- (b ii) This approach would be appropriate for ERM Life. It provides funding when catastrophic mortality events occur and has low counterparty risk as funds are received initially. ERM Life should consider the risks and regulatory scrutiny associated with SPVs.

~~Participating in a self-insurance pool~~

- ~~(b i) ERM Life would participate in a pool of catastrophic claims with other insurers and would share overall claims results.~~
- ~~(b ii) This approach would not be very useful as catastrophic mortality claims would likely be experienced by all insurers in the group.~~

Setting up its own captive

- (b i) ERM Life would set up a captive reinsurance company for risk financing purposes that can be based in a jurisdiction with favorable capital and/or tax treatment.
- (b ii) This would not be appropriate for mitigating catastrophic mortality claims. Captives are for risk financing, not risk transfer. If ERM Life experiences catastrophic mortality claims, they are still responsible for the claims as a captive is not bankruptcy remote.

(c) **For relevance, this question has been modified from the original exam format in this fashion: the terminology was changed from "asset liquidity" to "market liquidity."**

**(LO 2.1a)** ERM Life is considering two options:

- 1st option: Liquidate 100,000 shares immediately
- 2nd option: Liquidate 20,000 shares each of the next five trading days

Describe the market liquidity impact of each option.

## 2. Continued

**Commentary on Question**:
*The majority of candidates answered this part of the question well and understood the tradeoffs and liquidity impacts of the two options.*

The first option will have a higher market liquidity impact as selling more shares at once will have a larger impact on the bid-ask spread and the price impact function. The second option will have a lower market liquidity impact by spreading the sale out over 5 days, however this will expose ERM Life to volatility in the share price over the week.

(d) **(LO 2.1a)** It has been suggested that ERM Life use liquidity-adjusted VaR (LVaR) to inform its decision on how to pay the reinsurance premium. You are given the following information for the liquidation options:

- Price impact of the 1st option: $257,500
- Price impact of the 2nd option: $51,500
- Asset portfolio VaR for 2nd option: $361,623

(i) Recommend which liquidation option ERM Life should implement in order to pay the reinsurance premium. Justify your answer.

(ii) Describe other aspects of asset and liability liquidity risks that ERM Life should consider when entering into this transaction.

**(iii)** Describe two other relevant risks that ERM Life should consider when entering into this transaction.

**Commentary on Question**:
*Many candidates did not consider the required premium amount when recommending an approach for subpart (i), and thus did not provide any quantitative reasoning for their recommendation. Many of the risks provided were not relevant to the specific transaction. Other reasonable answers not shown in the solution received credit.*

(d i)
The liquidity adjusted value of the position in stock company for the 2 options are:

- 1st option: 103*100,000-257,500 = $10.04M
- 2nd option: 103*100,000-51,500-361,623 = $9.89M

Given ERM Life needs $10M at the end of the week to pay the reinsurance premium, they should use option 1 to ensure enough funds are available.

## 2. Continued

(d ii)

- The impact of the bid-ask spread was not considered in the above but could result in less funds being available.
- If there is a lag between covered claims being incurred and provided to ERM Life, there may be a liquidity strain when ERM Life needs to pay contract holders before the reinsurance claims are received.
- The sale of these assets may have an impact on ERM Life's ALM position.
- ERM Life will need to be able to pay future premiums for this reinsurance which could impact the availability of liquid assets.

(d iii)

- Counterparty risk: There is a risk that the reinsurer will default on its obligations in the event of a catastrophe.
- Operational risks: For example, process risks related to the administration of the reinsurance agreement.

# 3. Spring 2021 ERM Exam (LOs 2.1a, 2.2g)

**Learning Objectives:**

2: Risk Analysis and Evaluation

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14 Quantifying Particular Risks

**Commentary on Question:**

*This question tested candidates' general knowledge and understanding of different quantitative approaches to credit risk analysis, and the utilization of knowledge of copulas in credit risk analysis using structural models.*

**Solution:**

(a) **(LO 2.2g)** There are several modeling approaches used for estimating default probabilities, including:

- Merton's model
- KMV Moody's
- Models incorporating bond prices

(vi) Compare and contrast the structure and use of reduced-form models and structural models.

(vii) Identify whether each of these models is a reduced-form model or a structural model. Justify your response.

## 3. Continued

**Commentary on Question**:
*This part of the question tested candidates' knowledge of market-based default models and application of the knowledge to identify reduced-form and structural models. To receive full credit, candidates needed to explain the differences between reduced-form and structural models. In general, candidates did better on explaining/identifying structural models than reduced-form models.*

(i)
Structural models model the value of an entity. Models are based on capital structure of companies.

Reduced-form models model default probability directly, for example, using bond-price yields.

(ii)
Merton and KMV models are structural model. They are based on capital structure of companies and model company values.

Models incorporating bond prices are reduced-form models, which calculate default probability directly.

(b) **(LO 2.1a)** Using bond prices, the credit spread of a bond can be calculated and used to estimate the expected credit loss. Thus, your colleague claims that if bond A has higher spread than bond B, bond A must have higher probability of default than bond B.

Explain whether your colleague's statement is correct.

**Commentary on Question**:
*This part tested candidates' knowledge and understanding of the reduce-form model of using bond price (spread) to calculate probability of default. To receive full credit, candidates needed to explain that other factors, beside probability of default, may affect credit spread. Overall candidates did well on this part.*

The statement is not correct.

Interest spread reflects not only credit loss risk due to default, but also other risks, for example, liquidity risk, systematic risk, etc.

## 3. Continued

(c) **NO LONGER RELEVANT**

~~Your team has been working on a project using simulations to estimate tail credit loss of the company's portfolio. You use copulas in the simulations to capture the dependencies between credit losses on bonds in the portfolio. You are given the following information:~~

- ~~The time horizon is one year.~~
- ~~The returns of each bond issuer's asset portfolio are simulated assuming they follow a lognormal random walk.~~
- ~~A correlation matrix of the returns of the bond issuers' assets.~~
- ~~The following have already been estimated for each bond issuer: the growth rate of the asset value, the volatility of the asset value, default threshold, exposure, and loss given default.~~

(i) ~~Describe the steps to simulate the asset values of the bond issuers and to calculate credit loss of your company's portfolio using a Gaussian Copula. You do not need to give any formulas.~~

(ii) ~~Your other choice of copula is Student's t.~~

~~Describe how the simulation process would need to change to incorporate a Student's t copula into the simulation. You do not need to give any formula.~~

(iii) ~~You run two simulations, each generating 10,000 samples – one using a Gaussian copula and the other using a Student's t copula. You then calculate the credit loss at the 99$^{th}$ percentile from each simulation.~~

~~Compare the VaR(99) results you would expect between the two simulations. Justify your answer.~~

(iv) ~~Recommend which copula should be implemented. Justify your recommendation.~~

**~~Commentary on Question~~**:

*~~This question tested candidates' knowledge of a simulation process involving different copulas, understanding of the differences between different copulas, and the ability of choosing an appropriate copula for a specific application and justifying the choice. To receive full credit, candidates were required to describe all the steps of simulation process in the right order and the changes in specific step(s) due to switching to a different copula. Candidates also needed to provide justifications for (iii) and (iv) to demonstrate good understanding of the real-world problem and differences between the two copulas.~~*

## 3. Continued

*Candidates generally did not do well in describing the correct steps of a simulation process using a copula. However, most candidates demonstrated a good understanding of tail dependence in financial crisis and were able to identify the appropriate copula for the real-world problem.*

(i)

1. Create a random correlated N(0,1) vector using the correlation matrix of the returns of bond issuers' assets.
2. Convert the above vector into uniform vector with Gaussian copula using standard normal distribution function.
3. Convert the vector from step #2 into marginal vector.
4. Calculate asset values of the bonds in one year using marginal vector from step3. Bond is in default if asset value is below its default threshold. Credit loss is "Exposure times Loss Given Default".

(ii)

1. After step #1 above, convert the vector into a student's t vector.
2. Convert the student's t vector into uniform vector with student's t copula, using student's t distribution function.

(iii)

99% VaR using student's t copula is likely to be higher than that using Gaussian copula.
Student's copula has tail dependence, or extreme event (bond default) are more likely to happen simultaneously with Student's t copula.

(iv)

Recommend Student's t copula. The simulation is for VaR calculation, so having no tail dependence with Gaussian copula may understate tail risk. In a financial crisis (tail event), financial correlations typically increase.

# 4. Spring 2021 ERM Exam (LOs 2.2d, 2.2g, 2.2h, 3.2c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2c | Demonstrate how derivatives or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 15: Risk Mitigation Using Options and Derivative
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

## 4. Continued

**Commentary on Question:**
*This question tests candidates' ability to model and mitigate counterparty risk in a nontraditional setting by using GAM, an auto company in the case study, as its subject. The last part of this question requires candidates to use information from the case study to design a stress scenario that applies to this company.*

**Solution:**

(a) **(LO 2.2g)**

(i) Assess the appropriateness of using the Merton model to measure the solvency of companies A and B.

(ii) Propose one alternative method GAM could use to measure the solvency of its supplier. Justify your proposal.

(iii) Demonstrate that Company B is preferable to Company A, as of December 31, 2020, using the Merton model. Show all work.

**Commentary on Question**:
*This part of the question asked candidates to demonstrate knowledge of weaknesses and strengths of the Merton model for credit risk, as well as knowing at least one other model for assessing credit risk. Candidates could argue for or against the appropriateness of the Merton model in subpart (i), as there are aspects of this specific situation that are relevant. There were various correct answers for subpart (ii), with the justification of the use of the alternative to the Merton model being the most important.*

*In general, candidates were able to address all three subparts of this question fairly well; however, there were some issues with people showing all their work on subpart (iii). Some candidates copied and pasted the formula and/or table given at the beginning of the problem and then replaced variables with the appropriate numerals, which led to full credit.*

(i) This model works best when used for large borrowers with liquid and frequently traded equity stock, since an accurate number for the volatility of the corporate equity is needed to model the default. This is true for both companies A and B.
Though this is not assessing credit risk for a bond held by GAM, GAM is at risk if the supplier defaults. The Merton model gives a probability for the companies defaulting, so GAM could use this to pick the firm with lower probability of default.

## 4. Continued

(ii) One could use the KMV model, which measures a "distance to default" based on firm's asset value, volatility, and debt structure. This model uses similar assumptions as the Merton model, so necessary information should be available for use. The output represents the number of standard deviations the firm value is from default, instead of the actual default probability. The model assumes that the price of the equity can be regarded as a call option on the underlying assets of the firm.

(iii)

$$\Pr(X_T \le B) = \Phi\left(\frac{\ln\left(\frac{B}{X_0}\right) - (r_x - \frac{\sigma_x^2}{2})T}{\sigma_x\sqrt{T}}\right)$$

| Company | $X_0 =$ Total Asset Value (in millions) | $r_x =$ Expected Growth Rate | $\sigma_x =$ Volatility of Growth Rate | B = Total Amount of Company's Borrowing (in millions) | T = Time of Lump Sum Payment of Company's Debt |
|---|---|---|---|---|---|
| A | \$5,000 | 5% | 35% | \$1,000 | 5 years from today |
| B | \$8,000 | 7% | 25% | \$2,000 | 5 years from today |

**Firm A:**

$$\Pr(X_T \le 1000) = \Phi\left(\frac{\ln\left(\frac{1000}{5000}\right) - \left(.05 - \frac{.35^2}{2}\right)5}{.35\sqrt{5}}\right) = \Phi(-1.98)$$

$$= .0239$$

**Firm B:**

$$\Pr(X_T \le 2000) = \Phi\left(\frac{\ln\left(\frac{2000}{8000}\right) - (.07 - \frac{.25^2}{2})5}{.25\sqrt{5}}\right) = \Phi(-2.83)$$

$$= .0023$$

So, the probability of default for firm B is less than that of firm A.

## 4. Continued

(b) **(LOs 2.2g, 3.2c)** GAM's management is concerned with the cost of lithium which heavily influences the price of the batteries and, therefore, the overall production cost of BEVs. Caerus has determined that lithium prices can be described using geometric Brownian motion.

(i) Describe a process for using Monte Carlo simulation to calculate VaR(99) for lithium prices over the next *n* years.

(ii) Explain how the volatility of battery prices could be mitigated using:

- A forward contract on lithium
- A futures contract on lithium

(iii) Recommend whether GAM should use a forward or a futures contract for lithium to hedge against battery price volatility. Justify your recommendation.

**Commentary on Question**:
*This part of the question focused on price volatility for lithium, looking at ways to model and measure the potential volatility as well as use of forwards or futures for mitigating the price volatility. Most candidates were able to address all parts of this problem. Some candidates confused forwards with futures. In subpart (iii), some candidates used the information from the case study that lithium futures were new to the exchange, but this observation was not required for full credit. For subpart (iii), either choice could be supported given the information, and the justification of the choice was the point of that subpart.*

(i)

1. To calculate VaR, you need several simulated values to approximate the distribution of lithium prices at the target horizon.
2. To do this, you will need to generate a sequence of random (from a random number generator) or pseudorandom numbers $\in\_1$ to $\in\_n$, from which prices are computed as S_(t+1), S_(t+2)… S_(t+n).
3. Next, using the stochastic process from the analyst, calculate the value of the lithium price at the target horizon n.
4. Repeat this process a large amount of times (e.g. 1000) to get a simulated distribution. This gives you distribution values F(T,1) to F(T,1000).
5. Sort the values and find the 99th percentile. Subtract the mean if you are computing VaR relative to the mean.

## 4. Continued

(ii)

1. **Forward:** GAM could enter into a forward contract with a lithium supplier. In this contract, GAM will agree to buy a fixed amount of an asset (in this case, lithium) for a fixed price at some point in the future. This will eliminate any price uncertainty, because the price and delivery amount will be locked in at issue. However, the amount and timing must be determined at issue, and is not flexible to changes. The actual delivery of lithium is part of this contract.
2. **Future:** GAM could take a long position on a lithium future in an exchange, where a broker will find a counterparty willing to take the short position. The contract is regularly marked-to-market, so if the price of lithium increases, GAM would receive payments and if it dropped, GAM would have to make payments to the short position. If needed, GAM could buy more futures or close out a futures position if they needed to adjust volume. Delivery dates are standardized as are futures amounts, and does not usually involve actual delivery of the commodity.

(iii) GAM should enter into a forward contract with a lithium supplier. Forwards are flexible with regards to timing and volume, and would involve the actual delivery of the lithium. GAM could tailor a forward contract to the exact amount they need at a specific time. Futures would not allow such flexibility, leading to basis risk.
Forwards do have counterparty risk, as the supplier could default on the contract and not deliver the specified volume at the specified time. GAM could require collateral to reduce this risk.

(c) **For relevance, this question has been modified from the original exam format in this fashion: the terminology was changed from "synthetic scenario" to "hypothetical."**

**(LOs 2.2d, 2.2h)** In response to the board meeting described in section 1.9 of the Case Study, your team has been asked to perform scenario analysis regarding GAM's strategy.

(i) Explain why using a synthetic scenario for the analysis would be more beneficial than a historical scenario in this situation.

(ii) Design a company-specific hypothetical stress scenario that could be applied to the situation where GAM remains in the PCV market. Support your answer using evidence from the Case Study.

## 4. Continued

**Commentary on Question**:
*For this problem, most candidates were able to address subpart (i) but some had difficulty in designing a company specific stress scenario for subpart (ii). There were many possible stress scenarios for subpart (ii), and we were looking for details in a stress scenario that were based on risks in the case study section 1.9. In some cases, candidates presented an upside scenario as opposed to a stress scenario.*

(i) Historical scenarios are based on experience over an observation period triggered by a certain historical event. Since historical circumstances will inevitably be different from the current or future situation, scenario adjustments will likely need to be applied. This would be the case for modeling the emergence of the new BEV market.
Given that the emerging BEV market is a new development, retrofitting a similar historical scenario with all relevant information could be difficult.
If a hypothetical scenario was used, it could be tailored specifically to GAM.

(ii) New government regulation affecting PCVs: suppose China bans the sale of PCVs in 5 years, and key U.S. markets tighten emissions and fuel economy standards with fines for vehicles that don't comply.
GAM would be directly impacted by increased government regulation of the PCV market, and 85% of its sales come from China and the U.S.
If the BEV market develops, the government could further discourage the manufacturing and use of PCVs by posing even stricter regulations on emission and fuel economy standards.
This could increase production costs for GAM because PCVs would have to be made to be more efficient, or GAM could face penalties and fines.
GAM could estimate the increased cost of continuing to make these vehicles in this situation, and ultimately estimate the impact on its profitability. This might eventually drive them out of the PCV market and push them towards solely making BEVs.

# 5. Spring 2021 ERM Exam (2.1a, 2.1b, 2.1c, 2.2d, 2.2h, 3.1a, 3.2a)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.1b | Detect emerging risks. |
| 2.1c | Determine an appropriate monitoring mechanism for emerging risks. |
| 2.2d | Demonstrate the use of scenario analysis and stress testing in the measurement of risks. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-113-25: Identifying and Evaluating Emerging Risks
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- Risk Appetite: Linkage with Strategic Planning Report

## 5. Continued

**Commentary on Question:**
*This question tests candidates' understanding of risk assessment, specifically for risks that are not easily quantifiable in the Energy Industry and Energetix from the Case Study. The candidate is expected to know details on Strategic Risk Analysis, Cybersecurity Risk, and the candidate should be able to evaluate Risk Appetite statements.*

**Solution:**

(a) **(LOs 2.1b, 2.1c, 2.2h)** Your initial task requires assessing key emerging risks that are relevant to Energetix.

(i) Describe the process of environmental scanning as part of an emerging risk review.

(ii) Explain how a balanced environmental scanning approach could be used by Energetix to assess the potential emerging risks related to:

- Regulatory change
- Cybersecurity threats

**Commentary on Question**:
*Candidates provided reasonable general process in (i), but many provided limited explanations on how to balance that process with or what they might do as a consultant assessing these risks for Energetix in (ii).*

(i) One approach to environmental scanning is to consider first the general macro-level environment, then consider the issues specific to the Energy Industry, as done by Caerus in the case study, and finally look within the company operations and strategic plan.

There are 4 Modes of scanning that could be used:

- Formal Search
- Conditional viewing
- Informal Search
- Undirected Search

The company should develop a common emerging risk vocabulary to facilitate internal communication of risk-handling activities to improve the ability to process information to optimize current activities as well as scanning for new emerging trends.

## 5. Continued

Environmental scanning is an ongoing process, so risks are catalogued, allowing the company to follow them as they develop. The frequency and attentiveness of reviews are based on the company's risk profile and complexity.

(ii) A balanced approach is important to manage costs and information. Too much focus on undirected viewing might result in huge costs, information overload and not least a lack of focus. On the other hand, while more cost-efficient, conditional viewing and formal search might result in a too-narrow scanning of the environment and might miss out on fundamental changes.

- For regulatory changes, Energetix could do more conditional viewing for information focused on specific sources. For example, one of their state regulators has already mandated a transition to renewable energy, so Energetix should monitor other state regulatory bodies for similar proposals or legislative bills, in addition to monitoring the rates that state utility commissions allow utilities to charge. They could balance this with a periodic unconditional viewing approach to try to uncover information they may not have thought about beforehand, such as climate research to see what sorts of regulatory changes climate activists might lobby government to enact.

- For cybersecurity threats, Energetix does not appear to have expertise here, as their main technology is focused on physical production and delivery of energy, not information technology. Therefore, they should consider starting with informal or undirected scanning to look broadly at global and industry trends in cybersecurity or leverage the Caerus engagement to determine key risk indicators the company could establish to provide a formal risk assessment of their current workforce, processes and technology which they can routinely monitor and update.

(b) **(LO 2.1a, 2.1b, 2.2d)** You plan to coordinate scenario planning for key risks across Energetix's various subsidiaries. Caerus has identified key risk factors related to the Energy Utility Industry, and you have elaborated major themes that characterize plausible developments as follows:

1. Regulatory changes related to the environment and the potential impact of global climate change
2. Operational activities that impact the reputation or financial condition of the company.

## 5. Continued

(i) Describe a relevant scenario, specific to Energetix, for each theme.

(ii) Outline the remaining steps in the scenario planning process.

(iii) Provide a relevant example for each step identified in (ii) using one of your scenarios from (i).

**Commentary on Question**:
*Most candidates provided reasonable scenarios. For the operational activities, though cybersecurity was mentioned in parts (a) and (c) of this question, there were other relevant examples for Energetix from the case study, such as infrastructure maintenance, nuclear waste disposal, or labor unions. Many candidates recognized the stem as steps 1 and 2 of the scenario planning process in ERM-107-12, with subpart (i) as step 3, and so put variations of steps 4 and 5 (or sometimes all 5 steps) in subpart (ii). For those who missed subpart (ii), but gave reasonable, relevant examples to their own steps in subpart (iii), partial credit was given.*

(i) 1. From the case study, "Last year, the state regulator for one of the EUI companies mandated that, within the next 20 years, 50% of all electricity in that state must be generated from renewable resources such as wind or solar energy." A plausible scenario for Energetix to consider is if all states or all EUI subsidiaries are required to meet this mandate.

2. Part of Energetix's EUI has a significant financial commitment to disposal of nuclear fuel due to the Nuclear Waste Policy Act (NWPA). A plausible scenario for Energetix to consider is the uncertainties with respect to the cost and long-term availability of disposal sites for spent nuclear fuel and other radioactive waste, either by increasing base costs in their operating plan or modeling significant fines or penalties for failure to comply appropriately.

(ii) Step 4: Evaluate the impact of key strategic risk factors in the scenarios and assess capacity for corporate responsiveness

Step 5: Formulate new strategic alternatives, and evaluate them in the different scenarios

(iii) For this part, referencing the Regulatory changes scenario:
Step 4:
1. Perform a sensitivity test on current projections, increasing costs for production or acquisition of renewable energy sources up to 50% over next 20 years. Consider impacts of 50% in 10 years, or 100% in 30-40 years.

## 5. Continued

2. Assess whether Energetix can maintain profitability under the investment in renewables: Is there adequate capital to fund the investments or does Energetix need to consider strategic alternatives?

Step 5:

1. Consider a strategic arrangement between the EUI and CR subdivisions or a new counterparty for EUI to facilitate the energy acquisition or share the costs / capital. The case study states "EUI companies also complete projections under various scenarios to test what actions would be needed if one or more counterparties failed to provide the contractual amount of energy", so these should be easy for Energetix to test.

2. Reevaluate the scenarios/sensitivities in Step 4 under each of these alternatives to assess which to advocate or pursue to senior management.

(c) **(LOs 3.1a, 3.2a)** The Energetix Board has developed a new qualitative risk appetite statement for cybersecurity risk as follows:

"Any material damage to Energetix's reputation or interruption of business from a cybersecurity event is unacceptable."

The Energetix CRO wants more specific limits and has asked you to help establish a quantitative risk appetite statement for cybersecurity risk.

(i) Identify the challenges with translating a qualitative statement into a quantitative one for cybersecurity risk.

(ii) Energetix initially proposes a quantitative risk appetite statement, as follows:

"The company cannot lose more than 20 percent of value in a cybersecurity event."

Propose a modification to the above statement incorporating each of the following:

- Energetix's current balance sheet and income statement
- Historical experience in data breaches and operational failures.

Explain your reasoning.

## 5. Continued

(iii) Recommend two enhancements that Energetix could implement to support compliance with the cybersecurity risk appetite statement that you proposed in (ii). Justify your response.

**Commentary on Question**:
*Candidates stated reasonable modifications in subpart (ii) and enhancements in subpart (iii), but in both places many failed to provide sufficient explanation or justification for them, especially ignoring the specifics to Energetix current situation and financials. Full credit was given in subpart (ii) if the explanations of what modifications should be done were sufficient but there was no "re-statement" of the risk appetite either for each item separately or both together, since that was not specifically requested.*

(i) A quantitative risk appetite statement for cyber risk requires experience data, expert opinions and sophisticated (fuzzy) modeling to incorporate a changing environment. There are issues with:

- Agreement on what constitutes a cybersecurity event and defining "material damage"
- Gathering and analyzing internal and industry data on operational risks, in general, and cyber risks specifically
- Difficulty assigning frequency / severity probabilities to historical events or providing plausible hypothetical scenarios to test.

(ii) I propose: "The company cannot lose more than 20 percent of the annual pre-tax income in the event of a 1-in-100 year cybersecurity incident."

The quantitative statement needs to provide specifics on what "value" and what determines an "event". For the value, 20% of pre-tax income is more reasonable than 20% of equity or surplus, which would be nearly 6 times the annual income, likely too much "material damage" for a single event. To define the "event", available experience on data breaches in the industry can be used to help calibrate the quantitative part of the model and set a 1-in-100 1-year loss or series of related losses. To enhance the data, including other company and industry operational losses in the modeling is reasonable, as the chance of cyber risk can also be roughly estimated as the percentage for noncyber operational risk multiplied by the relative extremity of cyber risk compared to noncyber operational risk.

**5. Continued**

(iii) Energetix should implement Key Risk Indicators for cyber risk in order to strengthen the governance of the risk. Possible KRIs include the number of system breakdowns per month, number of users with access to key sensitive data, the level of risk awareness measured by the training that has been taken by employees and the average length of time before a cyberattack is detected. If these KRIs are tied to manager scorecards, the company will benefit from encouraging continued and consistent appropriate risk/return decisions, while at the same time providing metrics that can adjust according to the company's situation and the evolving environment.

Energetix should also consider cyber insurance to offset some of the losses that would occur in a cybersecurity event. This would mean having a cyber insurance company reimburse losses as specified in a contract for a 1-in-100 year event's financial impacts. Energetix should still maintain KRI monitoring because cybersecurity risk is contagious: there is counterparty risk introduced as an incident can happen across several firms at one time, increasing the likelihood that the cyber insurance company defaults on its obligations.

# 6. Spring 2021 ERM Exam (LOs 2.1a, 2.2h, 3.2a)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |

**Relevant Sources:**

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

**Commentary on Question:**

*This question dealt with identification of key risks, identifying mitigations and controls to manage the risks. This question showed how different sources, appearing distinct at first, can have concepts that fit together in the context of a specific company, GAM in this case.*

*The three main ideas of this framework as tested by this question were:*

- *Review and assess strategic objectives and their relevant indicators.*
- *Review and assess key risks, their pertinence to the previous strategic objectives and the suitability of indicators to evaluate them.*
- *Review and assess relevant controls for those risks so that strategic objectives can be achieved.*

## 6. Continued

*Candidates generally struggled with this question, with most earning less than half credit. In order to get full credit, candidates had to apply what was given in the Case Study for Giant Auto Motors (GAM) as well as Automotive Consulting (the summary of the industry and its key risks) to the information provided in the question.*

*Most candidates applied only limited information available to them in the Case Study.*

**Solution:**

(a) **NO LONGER RELEVANT**

~~(i) Evaluate whether these objectives are the appropriate ***key*** strategic objectives for GAM.~~

~~(ii) Assess if the listed key metrics are suitable for measuring progress towards the stated objectives.~~

~~**Commentary on Question:**~~

~~*For (i) most responses provided limited justification as to why the objective should be viewed as a **key** strategic objective. Based on what was provided in the Case Study, candidates should have understood what the key strategic objectives were for GAM and evaluated the provided objectives to see if they were in alignment.*~~

~~*For (ii) many candidates confused the "current market share of JV" with "the current % ownership in the JV". Many candidates also confused BEVs and BEV Batteries. The 2nd and 3rd objectives were specific to the BEV Batteries, not to the BEV vehicle.*~~

~~(i) According to the company strategy, GAM is the largest auto maker in the U.S., but the objectives don't address maintaining this but focus on expanding in China. None of the objectives specifically address the US Market, for which they are the largest manufacturer. Although for manageability it is good to limit the number of objectives to three, two of the objectives focus on the same area - batteries.~~

~~The first objective aligns to their desire to focus on China.~~

~~The second objective does not appear to be a key strategic objective. GAM wants to move into the BEV market, but this doesn't mean they need to produce their own batteries. Is the 1 year time frame even feasible? Two years ago, it began developing its own automotive batteries for PCVs, and after two years GAM can produce enough PCV batteries to supply all of its small cars.~~

**6. Continued**

These batteries are different from BEV batteries. Does GAM currently have the funds needed to develop BEV batteries? We know there are high upfront costs to entering the BEV market and that batteries are the most expensive component of an electric vehicle.

The third objective does not appear to be a key strategic objective, as again it is focusing on BEV batteries and not BEV vehicles. Will there be a conflict of interest with their JV and providing batteries directly to the China market? The give-year time frame appears more reasonable.

(ii) **Current Market Share of JV in China** (not suitable)

- We are not concerned with the market share of the JV overall, but in GAM's ownership of the JV
- Even if it focused on the % ownership in the JV, this seems to be a very generic metric and doesn't have a baseline value

**Monthly reduce # of batteries that are purchased by 10%** (not suitable)

- it has a baseline value, but the reducing # of batteries without context is vague.
- Simply purchasing fewer batteries doesn't mean that GAM is able to produce more batteries. What if sales shot way up?

**% of BEVs (Battery Electric Vehicles) vs PCVs** (not suitable)

- this doesn't really align to any of the objectives, because the metric refers to % of cars sold, but the objective is referring only to the batteries for the BEV

(b) **(LOs 2.1a, 2.2h)**

(i) Evaluate whether the risks identified are appropriate for the corresponding objectives.

(ii) Assess if the risks identified are ***key*** risks for GAM. Justify your response.

**Commentary on Question**:

*Candidates struggled with this part of the question.*

*For (i) most candidates answered the question of whether each risk was applicable to the objective, not necessarily whether it was appropriate. Candidates would have benefitted by using this thought process: "What criteria should I use to determine if a risk is appropriate? Is what they are proposing appropriate? Is the risk defined correctly?"*

## 6. Continued

*Some candidates provided similar answers for (i) and (ii), which did not properly distinguish between the questions. For (ii), stronger responses included criteria for what would be considered a key risk for GAM, then assessed whether these risks met those criteria.*

(i) When identify key risks, you need to look at what type of risk events, defined by its originating source, would cause us to not attain our objective based on the key metric identified.

There should be more than just one risk identified for each objective.

**Risk: Regulatory Changes limiting JV** (appropriate)
This risk aligns with the objective, but the granularity needs to be improved.

**Risk: Ability to obtain material for batteries** (not appropriate)
The objective is to produce its own BEV battery within a year. More material would be needed when GAM moves into the production phase for BEV batteries than for the development phase. This risk is more appropriate for the 3rd objective.

**Risk: Having the skillset in-house for continued battery improvement** (not appropriate)
Being a top provider means you need to be able to supply the batteries on time and at the right price. Production generally relies on "just-in-time" processes from a global supply chain, indicating that material is a significant risk for this objective. This risk is more appropriate for the 2nd objective.

(ii) No, the three risks listed are NOT key risks for GAM. A SWOT analysis should be done to determine the key risks, including general environmental risks, industry risks, company risks. One strategic Risk identified in the Automotive Industry is self-driving car capability, this isn't addressed at all.

Although Regulatory Change in China is a risk, China isn't their largest market.

They are addressing the battery powered vehicle risk, but battery technology is expensive, and require large upfront costs per the case study - so liquidity risk is an issue, but not mentioned.

## 6. Continued

(c) **(LO 3.2a)** The following controls are suggested for the risks associated with achieving the stated objectives:

- Audit the entire production process of batteries quarterly
- Test each battery to ensure it meets the guidelines needed for all global markets in which GAM participates
- Have each order for component parts be double-checked for accuracy

Assess the effectiveness of the proposed controls for each risk when implementing a risk-based controls approach. Justify your answer.

**Commentary on Question**:
*Most candidates received at least partial credit on this part. To receive full credit, candidates needed to opine on each of the controls for the objectives listed in aggregate. Some candidates answered this part by applying each of the controls to the three risks, effectively opining on 9 different comparisons. Maximum credit could have been achieved in either situation.*

Having intensive checks would be very costly, and risk-based controls approach looks at the risks that have the most impacts. If the cost of control is greater than the benefit from the control, it is not recommended to take the control.

Audit the entire production process of batteries quarterly

- It is good to mitigate any production failures. However, quarterly full audit seems too costly. Maybe have full audit less frequently but have less comprehensive audits for particular/significant areas in production process.

Test each battery to ensure it meets the guidelines needed for all global markets in which GAM participates

- The cost of testing each battery will be intensive but testing a sample will be important. Based on the results of the same, more could be tested. The battery is the key risk in BEV, so to avoid the reputational risk and legal issues, there should be a strong control here, but not EVERY battery

Have each order for component parts be double-checked for accuracy

- Should depend on which component parts. Should be based on how material/fatal the component parts are. For example, seat belt is important, so should be given more attention. However, minor components should not be given much attention and double-checking for accuracy for each component part would be too costly without adding much benefit.

# 1. Fall 2020 ERM Exam (LOs 2.2h, 3.3c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.2.h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.3c | Apply risk measures (such as VaR and TVaR) and demonstrate how to use them in value and capital assessment. |

**Relevant Sources:**

- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Chapter 3: Risk Measures

**Commentary on Question:**
*Commentary listed underneath question component.*

**Solution:**

(a) **(LO 2.2h)** GED's ERM team proposes calculating the level of aggregate losses using raw empirical analysis. You are given the following information:

- GED has 50 years of annual data
- Target risk tolerance is based on the VaR(99.5) for a one-year time horizon

Assess whether GED should proceed with this approach.

**Commentary on Question**:
*Some candidates did not make a conclusion (i.e., decide that GED should not proceed with the approach) which resulted in less than full credit.*

GED should not proceed with this approach.
Estimating VaR(99.5) with historical data requires at least 200 years of relevant loss data, and preferably about 1,000 years of data. GED only has 50 years, which is not enough. Additionally, 50-year-old data may not be applicable today

**1. Continued**

(b) **(LO 2.2h)** To model the operational risk associated with vending machine failure, GED's ERM team proposes the following three approaches:

1. Use the most recent 24 months of GED's operation failure frequency and loss severity data, which has been collected by the GED's Data Management Team using a systematic process.
2. Use the most recent 10 years of operation failure frequency and loss severity data from Coca-Cola's media reports. Coca-Cola uses vending machines similar to GED's to distribute products, but it is much larger in size.
3. Use the most recent 24 months of GED electrician logs of machine failures and notes on losses. The data collection process by electricians on duty may not be robust, but the loss severity will be estimated based on reasonable inferences using notes.

Assess each of the three approaches.

**Commentary on Question**:
*Justifications were required for full credit on each approach. Many candidates did not conclude whether each course of action should be adopted, and therefore did not receive full credit. Generally, candidates that recommended a combination of all three approaches received the highest scores. Candidates did not need to assume the data set was heavy-tailed to receive full credit.*

The first-approach uses internal data, which is the most relevant data. However, if the risk is heavy-tailed then the data may be insufficient since there are only 24 months. GED should not use this approach in isolation. However, it can be used as a starting point for the model.

The second approach can be useful for risk analysis and may be used to supplement GED's internal data. However, GED should proceed with caution as external data may suffer from reporting bias. Additionally, they should consider scaling the data to account for the different size of the companies.

The third approach can be useful for risk analysis and may be used to supplement approaches 1 or 2. However, this process may yield only a few data points which may be insufficient on its own.

(c) **(LOs 2.2h, 3.3c)**

(i) Calculate the monthly VaR(95) and CTE(95) of the operational losses for running the machines using the historical method.

(ii) Evaluate quality of data provided in the ERM team's notes for operational risk modeling. Justify your response.

## 1. Continued

**Commentary on Question**:
*Credit was also awarded for candidates that concluded VaR(95) is the 7th worst loss instead of the 6th worst loss.*

*An opinion of the data quality (e.g., good or poor) was required for full credit on subpart (ii). Many candidates provided justification but did not state whether the quality was good or poor.*

95% VaR of the operational losses = 120 months x (1.00 - 95%) = 6. Therefore, the historical VaR would be about the 6th worst loss, or **$16,886.**

95% CTE of the operational loss is the average of the worst six losses = (16,886 + 17,907 + 18,237 + 19,133 + 19,140 + 19,157) / 6 = **$18,410**

The quality of the data is not good for operational risk modeling because:

1. Each entity or geographical region should be considered separately rather than lumped together.

2. The data combines routine execution errors with unauthorized activities for December 2001 and November 2014.

3. The ability to track and audit data lineage should be available on demand and be built into the data quality solution and this requirement was not included in the data.

# 2. Fall 2020 ERM Exam (LOs 2.1a, 2.2g, 2.2h, 3.2a, 3.2c)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 2.2.h | Analyze risks that are not easily quantifiable, such as operational, environmental and contagion-related risks. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2c | Demonstrate how derivatives or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 15: Risk Mitigation Using Options and Derivatives

## 2. Continued

**Commentary on Question:**
*This question is testing candidates' ability to understand, value, and analyze the use of derivatives to manage risks for a non-insurance company, in this case, an airline.*

**Solution:**

(a) **(LOs 2.1a, 2.2h, 3.2a)**

(i) Explain how each risk is relevant to BlueSky's operations.

(ii) Explain how BlueSky's risk mitigation approaches could be used to address the identified risks. Justify your answer.

**Commentary on Question**:
*The vast majority of candidates received full credit for both sections of part (a). Two different methods of answering for subpart (ii) were accepted. The candidates could either explain how each of the named mitigation approaches could be used by BlueSky, or by explaining how each of the named risks from subpart (i) could be mitigated by one or more of the named mitigation approaches.*

(i)

Engine failures - Increase in repair costs, might cause flight cancellation due to aircraft unable to fly, or potential fatal crashes if malfunction occurs during a flight. Possible reputational damage.

Climate change - Flight cancellations due to extreme weather conditions. Could cause shifts in travel sentiment as consumers recognize the impact of burning fossil fuels on climate change.

Fuel prices volatility - Directly impact BlueSky ability to control fuel costs and will lead to earnings volatility, especially with fuel being one of their largest expenses.

(ii)

Use of insurance - Buy third-party insurance with provisions covering cost of aircraft repair, potential passenger liability or aircraft replacement cost arising from crashes/accidents.

Use of derivatives - Implement hedging strategy using derivatives, such as purchasing future contracts for fuel, to manage oil prices volatility.

Transferring costs - Transfer costs related to climate change, such as flights cancellation due to extreme weather, to costumers by raising ticket prices/charging for carbon offsets.

## 2. Continued

(b) **(LO 3.2c)**

(i) Calculate the modified duration and convexity of each bond and for the reference portfolio. Show all work.

(ii) Determine the number of futures contracts BlueSky should enter into. Show all work.

(iii) Describe the shortcomings of this hedging strategy.

**Commentary on Question**:
*Students generally did well on calculating the reference portfolio and duration but struggled with convexity and calculating the correct $PVBP_p$. A common mistake seen with calculating the $PVBP_p$ was only using duration, but not convexity.*

*If a student struggled to get the correct answers, it greatly increased their chances of receiving partial credit if they provided commentary as to what they were attempting to do in different sections of their spreadsheet.*

*Students that did not receive full credit for subpart (iii) typically gave either only one shortcoming (instead of multiple) or they stated the shortcoming(s), rather than describing it/them.*

(i)
*The solutions for this subpart is located in cells B22:D23 of the part b tab of the accompanying Excel file. The work used for these final calculations is in rows 31 to 42. There, the values needed to calculate modified duration and convexity for each time step are calculated. This is not the only way to come to the correct answers and this level of detail was not required to receive full credit, but is meant to clearly outline calculations needed to reach the final answer.*

*The reference portfolio was the weighted average of bond 1 and bond 2. While the intent was to use 50%/50% for each bond, answers considering the price of each bond were also accepted.*

*A common error made by some candidates was to copy formulas from cell D22 to D23, without using absolute references or adjusting the references to the weights, which resulted in the wrong answer.*

## 2. Continued

(ii)
*A solution for this question is located in cell D25 of the part b tab of the accompanying Excel file. The work used for these final calculations is in rows 45 to 53. The question is asking how many contracts are to be entered into, and while the calculation gives a negative number, both positive and negative answers were awarded full credit.*

*A common error on this part was not scaling to the total portfolio value of $100M.*

(iii)
Because this strategy only hedges on duration and convexity, it will only be effective if the changes in interest rates are small. If they changes are large, this strategy will not fully protect BlueSky. Additionally, there are margin requirements to enter into futures contracts. This would be a potential additional cost that is not being incorporated in the current analysis.

(c) **(LOs 2.2g, 3.2c)**

(i) Calculate the expected risk-neutral payoff of each option under Strategy B. Show all work.

(ii) Determine the total cost of Strategy B. Show your work.

(iii) Elon says that Strategy A is more appropriate as there is no cost of entering a forward contract. Critique his assertion.

(iv) Calculate the profit or loss of this hedge under each strategy, relative to an unhedged position, assuming cash flows are accumulated at the risk-free rate. Show all work.

**Commentary on Question**:
*While many will see this as obvious, it is clear that students should be reminded that bps means basis points and that a basis point is 1/100$^{th}$ of a percentage point. 0.01% or 0.0001 would be ways to numerically show 1 bps. Even more important is that multiplying 100,000,000 by 0.0001 in one's head involves moving the decimal place enough for it to be prone to error. One or a combination of these two mistakes was seen extensively when calculating the transaction costs of the options, with few students showing evidence of doing the calculation in their Excel file.*

## 2. Continued

(i)

*A solutions for this question are located in cells B24 and B25 of the part c tab of the accompanying Excel file. The work used for these final calculations is in rows 29 to 40.*

*A common error was not recognizing that 0.065 was the simulated value to use in the calculation of the hundredth S(T) and students instead found the normalized value of 0.065. Answers were still reviewed for accuracy given this error to receive partial credit. For mistakes like this, it was very helpful to the graders for the students to clearly label where they calculated the simulated value to award partial credit.*

*Another common error was taking the average of the values shown in cell B19 and B20 and the appropriate simulated values, instead of weighting it 99 and 1 as the values in B19 and B20 were the average of the first 99 scenarios.*

(ii)

*Many candidates used the Excel file to their advantage for the calculations in this part of the question. Most candidates forgot to discount the risk neutral payoffs to get the present value.*

Call value = 0.0750*e^(-5%*0.5) = 0.0731
Put value = 0.0798*e^(-5%*0.5) = 0.0778

*The total cost of the hedge was the cost of purchasing the put, selling the call, and 2 transaction fees. The fee is where the note about bps in the commentary above came into play. Some students only used 1 transaction fee.*

Cost of purchasing the put and selling the call:
= 100,000,000*(0.0778 - 0.0731) = 470,000
Cost of the 2 transaction fees:
= 2.5 bps * 100,000,000 * 2= 50,000
Total cost = 470,000+50,000 = 530,000

(iii)

*The SOA guide for FSA exams defines critique as "analysis that covers both strengths and weaknesses. It may also include listing alternatives." Very few students were able to achieve full credit for this question as they would typically not cover both the strengths and weaknesses of Elon's statement. Comparing strategy A to strategy B was also given credit.*

Elon is only partially correct as it is possible to offset the upfront cost in Strategy B with upside gains in a scenario where the exchange rate is lower than 1.49. There is also counterparty risk with entering into a forward contract, which may not have an explicit cost but does have implicit ones.

## 2. Continued

Strategy A works well if the exchange rate is higher than 1.5. The company is protected against a rise in the exchange rate but will not capture the benefit from favorable movements in the exchange rate (lower than expected exchange rate values).

Strategy B allows to capture benefits from lower exchange rates if the rate is less than 1.49. The company will get the current the exchange rate is the values are between 1.49 and 1.51, but offers no protection if exchange rates are higher than 1.51.

(iv)
*Like subpart (ii), many students used the Excel file to their advantage for the calculations in this part of the question. The main reason students did not receive full credit was neglecting to accumulate the cost of the hedge at the risk-free rate. The text in the below solution was not required to receive full credit.*

If BlueSky hadn't entered into some type up hedge, in 6 months they would be able to exchange their 100M Euros for $152M.

Strategy A:
BlueSky will receive $150M in 6 months from the forward contract in exchange for the 100M Euros.
The payoff would be $150M - $152M = -$2M.

Under the forward contract resulted in a $2M loss relative to an unhedged position.

Strategy B:
BlueSky will exchange to receive $152M
The call option will be exercised and the holder will receive $1M from BlueSky:
($1.52-1.51)*100M = $1M
The put option will not be exercised and is worth $0
The cost of the hedge is accumulated at the risk free rate:
530,000*e^(0.5*0.05) = $543,417
The payoff would be ($152M – $1M - $543,417) - $152M = -$1,543,417

The option contracts resulted in a $1,543,417 loss relative to an unhedged position

# 4. Fall 2020 ERM Exam (LOs 2.1a, 2.2g, 3.1a, 3.1b)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 2.2g | Propose an appropriate modelling technique that meets organizational needs to analyze risks. |
| 3.1a | Describe how an organization can articulate its approach to risk using risk appetite and risk limits. |
| 3.1b | Assess the risk and return trade-offs for decisions (e.g. those targeting changes in the organization's risk profiles). |

**Relevant Sources:**

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks

**Commentary on Question:**

*This question was testing the concept of credit risk, looking at the sources of credit risk in a company's asset portfolio, different approaches to measuring that risk, and methods for managing this risk. Candidates generally were able to attempt most parts of this question, and performance on the calculation portion was generally very good. Some parts asked for recommendations, which allowed for several acceptable answers; graders were looking for sufficient support for any given recommendation as well as sufficient detail on the recommendation.*

**Solution:**

(a)

(i) **For relevance, this question has been modified from the original exam format in this fashion: question now asks for two risk factors instead of three.**
Define two risk factors of credit risk related to an asset portfolio.

(ii) Identify which credit risk factor is the most likely driver of the unexpected losses given XYZ's compliance with its RAS. Justify your response.

## 4. Continued

(iii) Explain why XYZ is still exposed to credit risk, even if it complies with its RAS.

(iv) Recommend an additional requirement XYZ could add to its RAS that would account for the risks identified in part (iii). Justify your response.

**Commentary on Question**:
*Most candidates were able to answer some parts of the question, and there were multiple acceptable answers for subparts (ii), (iii),and (iv) if sufficient support was given. A common issue was listing risks for subpart (i) instead of defining the risks. For part(iv), some recommendations were not realistic or were recommendations appropriate for swaps and not for corporate bonds.*

**(i) Default Risk** - the risk that the issuing company is unable to pay the full debt back to the asset holder

**Credit Exposure Risk** – the risk of fluctuations in market value of an asset due to the market's view of the creditworthiness of the issuing company

~~**Recovery Risk** – The exposure to the unknown amount that the asset holder is able to recover at default~~

(ii) The most likely risk is **credit exposure risk**, as the other two risks are not as likely. Due to the requirement of A- or AA-rated bonds, default risk is low. The recovery rate assumption is not that impactful, as it occurs only upon default.

(iii) The RAS requires high-rated assets, but there is still a non-zero chance of default in those assets, or the chance of downgrades. Default or downgrade risk is specific to the issuer of the bond, not a specific rating. If XYZ holds a lot of bonds from one company, if there is a credit loss from that issuer, that provides a lot of risk.

(iv) To reduce credit risk concentration from being exposed to a specific issuer, the RAS could be updated to indicate no more than 0.5% of XYZ's assets can be invested in a given issuer.

## 4. Continued

(b)

(i) Calculate the expected credit losses from default in the next year using the credit migration model. Show all work.

(ii) Calculate the expected amount of bonds that need to be sold after one year in order to satisfy the RAS. Show all work.

(iii) Explain a source of portfolio losses, other than defaults, that is captured in the credit migration model.

**Commentary on Question**:
*The solutions for subparts (i) and (ii) are in the accompanying spreadsheet. Common errors on subparts (i) and (ii) were to extend the migration model farther than one time step. Another common error on (ii) was to include the outcome of defaulted bonds, not simply downgrades to BBB. For (i) and (ii), it was possible to achieve full credit with a single formula in the answer cell. However, providing additional detail such as sub-steps often resulted in partial credit was the answer was not fully correct. This approach is shown in the model solution.*

(iii) The credit migration model captures credit losses from asset downgrades. If a bond is downgraded, it loses market value due to extra credit spread reflecting its increased risk of default.

(c) A portfolio manager determines XYZ's expected losses based on the Merton model, and you notice the results are different than the losses you calculated in part (b)(i).

(i) Explain how each input used in the Merton model affects the calculated probability of default.

(ii) Explain why the differences between the credit migration model and the Merton model could result in different estimated defaults.

(iii) Recommend which model XYZ should use going forward in order to address XYZ's unexpected losses. Justify your response.

## 4. Continued

**Commentary on Question**:
*For subpart (i), some candidates listed the inputs and the Merton model formula, but did not answer the question about how each input affects the probability of default. There were several acceptable answers for both (ii) and (iii). For subpart (iii), either model could be recommended, as long as there was appropriate support.*

(i) Five inputs to Merton model:
Amount of firm's debt – The higher the debt, the higher the probability of default

Firm's value – the higher the value, the lower the probability of default

Risk free rate – the higher the risk-free rate, the lower the probability of default

Volatility of the firm's value – the higher the volatility, the higher the probability of default

Time horizon for the issue – the longer the time horizon the higher the probability of default

(ii) Under the credit migration model, all companies with the same credit rating are assumed to have the same probability of default.

For the Merton model, the firm's value and volatility will be the key drivers of the probably of default, and can differ a great deal between companies with the same credit rating.

So, a company with lower value/higher volatility, but favorable credit ratings could look better under the credit migration model.

(iii) The credit migration model should be used – it is simpler to implement and easier to explain. It is also easier to design a RAS around credit ratings than having different credit risk assessments for each issuer. The inputs to use in a Merton model may not be as readily available as the inputs for the credit migration model.

# 5. Fall 2020 ERM Exam (LOs 2.1a, 3.2a, 3.2b)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2b | Demonstrate the use of controls in an organizational process. |

**Relevant Sources:**

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

**Commentary on Question:**

*Candidates generally did better on part (b) of this question, identifying advantages and disadvantages of retaining and transferring cybersecurity risk and recommending a mitigation option for each. The candidates who performed better on parts (a) and (c) generally utilized specific information on Big Ben from the case study and applied their analysis directly to Big Ben's particular situation and objectives.*

**Solution:**

(a) **(LO 2.1a)** Big Ben's strategic plans include the expansion of its Asset Management Business client base by lowering the minimum investable assets requirement. Big Ben also plans on formulating a one-stop shopping interface for its globally mobile clientele.

## 5. Continued

Assess how this strategy may affect Big Ben's:

I. Strategic risk
II. Business risk and its impact on profitability
III. Operational/technology risk in general and cybersecurity risk in particular

**Commentary on Question**:
*Full credit on this part required examples that related directly to Big Ben's risks. Candidates who provided a generic assessment of each risk without relating it to Big Ben and/or provided limited analysis of each risk received minimal credit. Some candidates only addressed the benefits of the strategic plan without identifying the downside risks, which resulted in significantly less credit.*

Strategic Risk
Big Ben currently has a strong brand and a loyal customer base. Lowering the minimum investable asset requirement may diminish the brand reputation in the perception of the current customer base. Big Ben may also face new competition from non-high net worth clients. This might force them to reduce the expense ratio for all clients.

Business Risk & Impact on Profitability
Big Ben does not have enough experience to assess impact on profitability in models. Risk models and assumptions will have to be revised and sensitivity tested. They also will likely incur additional marketing, training, and administration expenses which will impact profitability, at least in the near-term.

Operational/Technology Risk
According to Caerus, the existing technology is inadequate. Introducing a one-stop shopping interface will expand the current technology risk. Building the new interface will likely require additional staff, training, and testing, which would increase the current operational risk.

Cybersecurity Risk
The new shopping interface would increase cybersecurity risk, as it could provide an access point for cyberattacks into Big Bank's systems. Lowering the minimum asset requirement may also expand the vulnerabilities for cyberattacks to steal client's data or other valuable information, thereby increasing cybersecurity risk as well.

## 5. Continued

(b) **(LO 3.2a, 3.2b)** Big Ben is weighing a choice between retaining and transferring cybersecurity risks that would arise from the expansion strategy.

(i) Describe the advantages and disadvantages of:

- Retaining cybersecurity risk internally
- Transferring cybersecurity risk externally.

(ii) Recommend a mitigation / control option for each choice. Justify your response.

**Commentary on Question**:
*Candidates who performed well on this part of the question properly described multiple advantages and disadvantages of retaining and transferring cybersecurity risk, along with providing a substantial justification for their recommended mitigation / control option. Candidates who listed an advantage for one approach as a disadvantage for the other would not receive credit for both. Candidates who misinterpreted (ii) to choose between retaining and transferring, as opposed to recommending controls for each, received minimal credit*

(i)
Advantages of Retaining
Bank can control whole technology and invest in systems to control cyber risk
Can better monitor risk internally than if it is outsourced

Disadvantages of Retaining
Employees need to be trained in cyber risk to detect it
Retains liability in case cybersecurity breach happens

Advantages of Transferring
Impact of risk is shifted which would reduce capital required
May be cheaper in the near-term to transfer than to build up staff and technology

Disadvantages of Transferring
Introduces dependency on an external party for expertise, increasing counterparty risk
Less possibility to develop an internal risk culture about this particular risk

(ii)
Retaining
Implement thorough internal controls for data access, including testing and monitoring, to reduce the likelihood of a cyber breach.

## 5. Continued

Transferring
Purchase cyber risk insurance with a reputable third party to transfer financial responsibility while limiting counterparty risk.

(c) **NO LONGER RELEVANT**

~~As part of Big Ben's strategy to expand its Investment Banking business, the company decided to transfer cybersecurity risk and plans on utilizing a Special Purpose Vehicle (SPV) as a way for its clients to raise capital and transfer specific risks.~~

~~(i) Explain how an SPV could be structured to meet Big Ben's goal.~~

~~(ii) Assess the benefits and risks to Big Ben of this particular mitigation option. Justify your answer by using information from the Case Study.~~

~~**Commentary on Question**:~~

~~*Full credit required candidates to both explain how an SPV could be structured and how that structure related to Big Ben's goal, along with appropriately explaining the benefits and risks to Big Ben using information from the Case Study. Candidates who provided more generic responses or did not use information from the Case Study received minimal credit.*~~

~~*Many candidates who performed poorly on (i) missed key steps in the SPV process, mainly by not articulating how the assets moved between the key parties*.~~

~~*Some candidates' answers to (i) were more suited to (ii) responses. Credit was given for responses in (i) that pertained to (ii). However, these candidates generally did poorly as they missed (i) almost entirely.*~~

~~(i)~~

~~Big Ben first creates an asset that will be transferred to the SPV with a payoff based on Big Ben's cybersecurity exposure. An example of such an asset would be a "cybersecurity bond" that pays a fixed rate coupon payment as long as no cybersecurity breach occurs. Big Ben creates an SPV in order to sell this asset on its balance sheet to the SPV and obtain financing through the SPV. The SPV obtains funds to purchase the asset by way of debt financing from independent equity investors. With the capital relief/funds raised through the SPV, Big Ben can invest more into cybersecurity. The cybersecurity bond does not pay off should a cybersecurity breach harm Big Ben's financials and/or reputation.~~

**5. Continued**

(ii)

Benefits

One benefit of an SPV is the isolation of financial risk. It would allow for cyber risk transfer from Big Ben to an external party and enables Big Ben to retain other risks. Another benefit is the clarity of documentation, as Big Ben has flexibility in defining the extensiveness of the coverage (e.g. definition of data breach event).

Risks

One risk of an SPV is the signaling effect, as external investors may interpret the SPV use as Big Ben's relative non-confidence in its ability to manage cybersecurity risk and necessitating the risk transfer. Another risk is reputational risk. Despite the SPV arrangement providing protection against a cybersecurity event, such event will nevertheless damage Big Ben's reputation that could extend to Big Ben's other businesses.

# 6. Fall 2020 ERM Exam (LOs 2.1a, 3.2a, 3.2d)

**Learning Objectives:**

2: Risk Analysis and Evaluation
3: Embedding ERM into Decision-Making

**Learning Outcomes:**

| | |
|---|---|
| 2.1a | Identify specific risks faced by an organization. |
| 3.2a | Demonstrate application of the following responses to risk, including consideration of their costs and benefits: avoidance, acceptance, reduction without transfer, and transfer to a third party. |
| 3.2d | Demonstrate how reinsurance or similar methods may be used to manage or reduce risk. |

**Relevant Sources:**

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
    - Ch. 16. Responses to Risk
- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-120-25: IAA Risk Book Reinsurance

**Commentary on Question:**

*This question deals with identifying Key Risks using SWOT and analyzing ways to mitigate the risks through insurance or captive. Comments on each part are provided below.*

**Solution:**

(a) **(LO 2.1a)** Recommend whether CC is an appropriate company for DE to hire to perform the risk analysis based on CC's overview in the Case Study. Justify your response.

## 6. Continued

**Commentary on Question**:
*Candidates did a good job recognizing the experience that CC had with the auto industry. To get full credit candidates needed to recognize that there were some concerns with choosing CC.*

I recommend DE hire CC to perform the risk analysis. CC has significant experience in the auto industry, having consulted with 20 clients, so it should know that market well. It also has expertise in the robotics industry, which likely has some synergies. On the negative side, CC was involved with an auto company that went bankrupt.

(b) **(LO 2.1a)** An actuarial analyst at CC provides the following comments as part of the SWOT analysis for DE entering this new market.

- "(Strength) DE can quickly update all car systems via existing internet connections
- (Weakness) The market does not appear to be requesting artificial intelligence (AI) right now
- (Opportunity) Autonomous technology could easily be added to new products as they roll them out
- (Threat) DE currently doesn't have the expertise in house right now."

(i) Critique the comments provided.

(ii) Provide one additional item for each SWOT component.

**Commentary on Question**:
*(i) Most candidates identified that Strength and Weakness are internal, and Opportunity and Threat are external, and received minor credit. In order to get full credit candidates had to opine on the specific comment as well identify the comments that were classified incorrectly.*
*(ii) In order to get full credit, candidates needed to provide items that were relevant to DE **entering this new market**, not just relevant to DE.*

(i)

| | |
|---|---|
| Strength – | Yes, this is a strength for DE |
| Weakness – | Weakness should be internal weakness, this is a threat, and a valid threat for DE. |
| Opportunity - | An opportunity should be external. This is internal and does this really matter since they can update cars with new features? |
| Threat - | A threat should be external. This is internal and would be a valid weakness. |

## 6. Continued

(ii)

| | |
|---|---|
| Strength – | DE was the first significant manufacturer of battery-powered vehicles with performance and significant driving range. |
| Weakness - | DE has significant outstanding loan balances that could impact their ability to venture into a new market. |
| Opportunity - | Worldwide customer demand growing. There is little competition in the autonomous vehicle market. DE would be one of the first competitors. |
| Threat - | External competitors may attempt to steal technology |

(c) **(LO 3.2a)** The following three options for managing the risk associated with the indemnity plan were identified:

- Do nothing to mitigate the risk
- Set up a captive to insure this risk
- Buy insurance coverage from a third party

Evaluate each of these options for DE.

**Commentary on Question**:

*Candidates seemed to struggle on this part.*

- *Many identified that doing nothing could lead to liquidity risk, but few identified that it would be easy to implement.*
- *Several candidates incorrectly indicated that a high number of accidents would have a reputational impact for only some of the options. A high number of accidents would have a reputational impact on the company regardless of how they insure the indemnity plan.*
- *Candidates would sometimes only describe the options, and not really evaluate. Credit was awarded for evaluation of the options.*
- *Some candidates recommended a specific option, but the question didn't ask for this, so no credit was awarded for the recommendation.*

<u>Do nothing to mitigate this risk</u>

- Easier to implement than the other two
- This risk would be difficult to quantify without any expertise and potentially high reserves would need to be held.

<u>Set up a captive to insure the risk</u>

- Limits financial exposure but not reputational risk.
- DE has no expertise in this area
- Could be costly to set up and DE already has loans due soon, although if AI is new to DE, the insurance could also be very costly, and the risk of being newly offered would be added to the premium.

## 6. Continued

- Per the case study, investing in AI already has large upfront costs, so this would be an additional strain

Buy insurance coverage from a third party

- There would still be some reputational risk if the AI starts failing, but no reputational risk on both the Captive and AI failing
- This risk is difficult to quantify, and insurance companies will add this unknown as an additional cost
- Counterparty Risk would exist

(d) **(LO 3.2d)** A decision was made to purchase insurance. The following insurance structures are under consideration:

- Insurance that covers all life insurance losses
- Insurance that covers losses on a 50% quota share basis
- Excess of loss insurance above a fixed annual limit of $X

Recommend which structure to implement.

**Commentary on Question**:
*Most candidates were able to provide acceptable answers to this part. Some candidates explained why they were recommending one without including why the other options weren't good choices which earned them only minimal credit.*

Insurance that covers all life insurance losses

- DE may not have the incentive to look into this as much as they would if they had some cost other than reputational cost.
- This would be expensive as you are transferring all the risk.

Insurance that covers losses on a 50% quota share basis

- Cheaper than the insurance that covers all life insurance losses.
- It provides some benefit relief at initial impact, but a major system failure could still cause a large issue for the company (doesn't cover all the tail risk)

Excess of loss insurance above a fixed annual limit of $X

- The company would have the incentive to look at each failure, but it would cover any major system failure.
- Would probably be the cheapest option.

I recommend using the Excess of Loss insurance above a fixed annual limit of $X. It will be the cheapest option for DE as the insurance company will realize that DE has some skin in the game (less moral hazard risk). It will help DE protect against the tail risk, which is the biggest concern.