

ERM-GC Model Solutions

Fall 2021

1. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.
4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

- (1e) Propose ERM solutions or strategies that effectively manage risk under different real (case study) and hypothetical situations facing financial and non-financial organizations
- (4c) Analyze risks that are not easily quantifiable, such as liquidity, operational, and environmental risks

Sources:

Value-at-Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion
Ch. 13 Liquidity Risk (Except section 13.4) (LO 4)

SOA Monograph: A New Approach to Managing Operational Risk, Ch. 8 (LO 4)

Embedding Cyber Risk in Risk Management: An Insurer's Perspective (pp. 12-15 of
Cybersecurity: Impact on Insurance Business and Operations) (LO 4)

ERM-136-20: Managing Liquidity Risk: Industry practices and recommendations for
CROs (excluding section 4) (LO 4)

ERM-106-12: Economic Capital-Practical Considerations-Milliman (LO 4)

ERM-106-12: Economic Capital-Practical Considerations-Milliman (LO 1)

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) 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) 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:

1. Reflect the correlation between financial markets and insurance risks
2. Measure liquidity risk using liquidity ratio and excess/deficit of liquidity
3. 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) 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 be 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 requirements 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 counterparty 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) 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. Learning Objectives:

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

Learning Outcomes:

- (3f) Demonstrate an understanding of model and parameter risk
- (3g) Evaluate and select appropriate models to handle diverse risks, including models that use a stochastic approach

Sources:

Economic Scenario Generators: A Practical Guide, p. 7-17 (pp. 97-112 background only)

Parameter Uncertainty, CAS, CIA and SOA, 2017

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 regional insurance company.

Solution:

- (a) 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".
 - (i) Describe three business uses demonstrating that an ESG could add value to PIC.
 - (ii) 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) 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-world 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.
- (i) Assess the limitations of this ESG model for PIC based on the features of a comprehensive ESG.
- (ii) Describe two sources of parameter risk in the current interest rate parameterization process.
- (iii) 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. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.
3. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.
4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

- (1d) Assess the overall risk exposure arising from an organization's current and emerging risks
- (3a) Demonstrate how each of the financial and non-financial risks faced by an organization can be amenable to quantitative analysis
- (3b) Demonstrate organization-wide risk aggregation techniques that illustrate the concept of risk diversification by incorporating the use of correlation
- (3c) Evaluate and select appropriate copulas as part of the process of modelling multivariate risks
- (3d) Demonstrate the use of scenario analysis and stress testing in the measurement of current and emerging risks
- (3g) Evaluate and select appropriate models to handle diverse risks, including models that use a stochastic approach
- (4c) Analyze risks that are not easily quantifiable, such as liquidity, operational, and environmental risks

Sources:

ERM-106-12: Economic Capital-Practical Considerations-Milliman

Covid-19: implications for insurer risk management and the insurability of pandemic risk

Value-at-Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion
Ch. 18 Credit Risk Management

ERM-101-12: Measurement and Modeling of Dependencies in Economic Capital

ERM-119-14: Aggregation of risks and Allocation of Capital

Financial Enterprise Risk Management, Sweeting, 2017, Ch. 14 Quantifying Particular Risks

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)
- (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) 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

- (i) Calculate LifeCo's aggregate EC using the given correlation matrix. Show all work.
- (ii) Compare and contrast the following aggregation methods as they pertain to LifeCo:
- Correlation
 - Copula.
- (iii) 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) 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. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.
3. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.
4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.
5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

- (1a) Recommend an appropriate framework for an organization's enterprise risk management and an acceptable governance structure
- (1c) Demonstrate how to articulate an organization's risk appetite, desired risk profile, quantified risk tolerances, risk philosophy and risk objectives
- (3a) Demonstrate how each of the financial and non-financial risks faced by an organization can be amenable to quantitative analysis
- (4a) Determine risk exposures using common risk measures (e.g., VaR and TVaR) and compare the properties and limitations of such measures
- (5c) Demonstrate the use of controls for retained and residual risks
- (5f) Demonstrate the use of tools and techniques for identifying and managing credit and counterparty risk

Sources:

Risk Appetite: Linkage with Strategic Planning Report

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

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion
Ch. 18 Credit Risk Management

Exploring the Black Box: Working with inherent and residual risk.

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)

- (i) Describe two primary benefits of having a well-defined risk appetite framework for key organizational risks.
- (ii) 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) 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%

- (i) Calculate, net of recovery, the expected loss and the variance over a one-year time horizon. Show all work.
- (ii) Calculate the 95% VaR using the results from (i) assuming that portfolio losses are normally distributed. Show all work.
- (iii) Determine the empirical 95% VaR based on the distribution of potential portfolio losses calculated in (i). Justify your response.
- (iv) 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) QPT's CRO is planning a discussion with the internal audit department regarding risk assessment on credit risk in an inherent risk control matrix.

(i) Identify and describe three *key* questions that should be considered during the risk assessment phase.

(ii) 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.

(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. Learning Objectives:

1. The candidate will understand the ERM framework and process and be able to apply them to organizations.
2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.

Learning Outcomes:

- (1a) Recommend an appropriate framework for an organization's enterprise risk management and an acceptable governance structure
- (1e) Propose ERM solutions or strategies that effectively manage risk under different real (case study) and hypothetical situations facing financial and non-financial organizations
- (2a) Describe different definitions and concepts of risk
- (2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks

Sources:

ERM-131-18: Leveraging COSO Across The Three Lines Of Defenses

Financial Enterprise Risk Management, Sweeting, 2017, Ch. 8 Risk Identification

Embedding Cyber Risk in Risk Management: An Insurer's Perspective (pp. 12-15 of Cybersecurity: Impact on Insurance Business and Operations)

ERM-133-19: Emerging Risks and Enterprise Risk Management

IAA Paper: Importance of Climate-Related Risks for Actuaries

ERM-107-12: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis

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) For Section I - The Three Lines of Defense:

- (i) Summarize the function of the 2nd line of defense.
- (ii) 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) 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) For Section III - Emerging Risks:
- (i) Explain how Energetix is exposed to cyber risk.
 - (ii) Identify four risk management strategies for cyber risk for Energetix.
 - (iii) Identify two emerging risks, other than cyber risk, faced by Energetix. Justify why they are emerging risks.
 - (iv) 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) 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. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.
5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

- (2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks
- (5b) 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
- (5f) Demonstrate the use of tools and techniques for identifying and managing credit and counterparty risk
- (5g) Analyze how ALM and other risk management principles can be used to establish investment policy and strategy, including asset allocation
- (5i) Choose appropriate techniques to measure, model and manage various financial and non-financial risks faced by an organization

Sources:

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

ERM-128-17: The Breadth and Scope of the Global Reinsurance Market and the Critical Role Such Market Plays in Supporting Insurance in the United States, Ch. III, IV, and VI

ERM-122-14: Chapter 1 of Captives and the Management of Risk, 3rd Edition, Kate 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) 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.
- (i) Identify the risks being addressed in each step shown above.
- (ii) Identify the category of risk response for each risk mitigation.
- (iii) 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) 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.

- (i) Compare and contrast traditional reinsurance, securitization and use of a captive.
- (ii) 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.

7. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.
3. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models
4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.
5. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.
6. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

- (2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks
- (3b) Demonstrate organization-wide risk aggregation techniques that illustrate the concept of risk diversification by incorporating the use of correlation
- (3e) Demonstrate the importance of the tails of distributions, tail correlations, and low frequency / high severity events, and the use of extreme value theory to analyze these situations
- (3f) Demonstrate an understanding of model and parameter risk
- (3g) Evaluate and select appropriate models to handle diverse risks, including models that use a stochastic approach
- (4c) Analyze risks that are not easily quantifiable, such as liquidity, operational, and environmental risks
- (5h) Demonstrate possible risk management strategies for non-financial risks

7. Continued

- (6a) 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

Sources:

ERM-414-17: A Tale of Two Formulas

Risk Aggregation and Diversification, excluding Appendices

ERM-823-21: The Role of Human Resource Management in Risk Management

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

ERM-828-21: Developing a Business Continuity Strategy for a Post-Pandemic World

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a)
- (i) Derive, using the formula for standard deviation of a portfolio with two variables, the implied correlation assumptions embedded in the NAIC RBC formula.

Commentary on Question:

Many candidates stated generally that the RBC formula implies correlations of 0 and 1 (which earned half credit alone) but few candidates recognized the mathematics underpinning that in the RBC formula, namely that $p = 0$ results in $\sqrt{A^2 + B^2}$ and $p = 1$ results in $\sqrt{(A + B)^2}$ or $A + B$, and therefore were able to accurately say which parts of the RBC formula had correlations of 0 vs 1.

The answer shown below demonstrates more work than what was required for full credit under exam conditions.

The formula for the standard deviation of a portfolio with two variables, with A representing the capital for the first variable, B representing the capital for the second variable, and ρ representing their correlation, is: $\sqrt{A^2 + B^2 + 2\rho AB}$

If the correlation of the two variables is zero, meaning that they are independent, then the formula simplifies to $\sqrt{A^2 + B^2}$

7. Continued

If the correlation is 1, meaning they are perfectly positively correlated, then it simplifies to $\sqrt{A^2 + B^2 + 2AB}$ which, factored, gives $\sqrt{(A + B)^2}$ or $A + B$.

The NAIC RBC formula contains both the first scenario and the second scenario, meaning that it only reflects correlation of 1 or 0. The life RBC formula is $C0 + \sqrt{(C1_o + C3_a)^2 + C1_{cs}^2 + C2^2 + C3_b^2 + C4_b^2 + C4_a}$.

In this formula, $C0$ and $C4_a$ are perfectly correlated with all other variables. $C1_o$ and $C3_a$ are perfectly correlated with each other, but are independent from $C1_{cs}$, $C2$, $C3_b$, and $C4_b$, which are independent from (have zero correlation with) each other as well.

The health and P&C have different variables and more of them, but they too only reflect perfect positive dependence or independence. Therefore, all NAIC RBC formulas imply either a correlation of 1 or 0 between variables.

- (ii) Explain the drawback of these implied correlations, taking into consideration the products that SLIC sells.

Commentary on Question

A large number of candidates stated that life and annuity products have an inverse relationship to mortality risk and that economic capital is overstated because that product diversification isn't taken into account. While that answer earned partial credit, for full credit, candidates were expected to consider the question stem, and address the bigger issue that mortality, interest rate risk, and market risk are uncorrelated in the RBC formula, but are expected to be positively correlated in this pandemic.

The drawback of these implied correlations is that they may greatly understate or overstate the relationship between two variables, which will affect the overall level of capital needed.

In light of the pandemic scenario that Lyon is concerned about, which expects both catastrophically high mortality combined with a long-term economic downturn, this would imply a positive correlation between mortality risk ($C2$) and market risk ($C1_{cs}$ and $C1_o$). But the NAIC RBC formula expects zero correlation between these variables. If Lyon relies on the RBC formula as a primary risk measure, or uses a similarly-formulated economic capital formula, they could be severely understating the impact of the pandemic on their capital.

However, to understand the true overall impact of simplifying the correlation assumptions, SLIC's product distribution needs to be taken into account because each product has different correlations between risk factors.

7. Continued

For example, mortality risk and interest rate risk are highly positively correlated for universal life policies. But for SPIAs, increased mortality results in fewer annuity payments, meaning interest rate risk and mortality are negatively correlated for these products. For term life products, reserves are very low, thus reducing the sensitivity of the product to interest rates, and so mortality and interest rate risk, even in a pandemic, would have near-zero correlation.

It is important for SLIC and Lyon to understand that the NAIC RBC formula contains these simplified 0 or 1 correlation assumptions and investigate the impact on their block of business of more nuanced correlations.

- (b)
- (i) Describe two approaches to incorporating tail dependence in an economic capital model.

Commentary on Question:

For subpart (i), other answers were awarded full credit as long as they were correctly described, including VaR-CoVaR Matrix, generalized extreme value theory, or generalized pareto distribution. Specific copulas didn't have to be mentioned, so long as the concept of a copula was adequately described.

For subpart (ii), other answers including scenario-based aggregation were also awarded full credit if they were reasonable approaches for modeling tail dependence and were well justified.

One approach to incorporating tail dependence is to use a copula to connect the marginal distributions of the independent risks. The structure of the copula controls the amount of tail dependence. The Gumbel copula and Student's t copula can both be formulated to have a high degree of tail dependence.

Another approach to incorporating tail dependence would be to use scenario-based aggregation (also known as causal models). In this approach, you determine the state of the firm under specific events and sum profits and losses for the various positions under the specific event. This allows you to incorporate information that you know about dependence in the tail. For example, you might define a pandemic event as having a mortality shock combined with low Treasury rates, high credit spreads, and a severe economic downturn. In this modeling approach, you could also incorporate other items such as an increase in life insurance sales combined with higher adverse selection due to agency theory/asymmetric information (people know they've been exposed and so they buy life insurance).

7. Continued

- (i) Recommend which approach SLIC should use to incorporate tail dependence in its economic capital model. Justify your answer.

I recommend that SLIC use the copula approach. SLIC is currently modeling mortality and market risks independently, but they could improve their model with copulas. SLIC could create a copula that recognizes those risks are typically orthogonal in normal markets, but could experience a surge in correlation in crisis markets. Copulas would allow SLIC to define such pair-wise tail dependencies across risks. Copulas are more mathematically rigorous than scenario testing. One drawback to copulas is that they are complex and could lead to significant model risk if mis-specified.

(c)

- (i) Consider the three aspects of a company that can be affected by a disruptive event: physical facilities, electronic data, and personnel.

Critique Patrick Lyon's May 25, 2021 correspondence on business continuity planning in Section 3.6 of the Case Study.

Commentary on Question:

Candidates generally performed well on this part of the question. For subpart (i), most candidates recognized that the key failure point in the BCP was a lack of preparedness for a 100% work-from-home environment. Many candidates also pointed out that the tone of the correspondence did not inspire confidence that the team was treating the BCP as seriously as it should be.

On subpart (ii), some candidates failed to link the HR roles to the pandemic specifically as the question asked and only earned partial credit. Other roles were given full credit including: Employer/Employee Interaction (like mentorship), Evaluation / Performance Appraisal, and Compensation.

Physical facilities

A pandemic can significantly reduce or completely eliminate employee access to physical facilities. Government mandates can shut down movement and access to corporate offices. Ted Gato indicates that extra office space, computers, and other resources are available in another office across town. While this would be helpful if only the main office were shut down, allowing some people to work from another space, this other office may also be shut down in a widespread pandemic. The IT department should have plans to distribute equipment to key personnel in the event that offices are shut down in a widespread pandemic.

7. Continued

Electronic data

Electronic data is backed up nightly, which is a good practice because it does reduce the risk of losing significant amounts of data. However, only once a day still has some risk that important work done in a day will be lost. It may be more prudent to backup data more frequently, especially in a pandemic where many of SLIC's employees might be working from different locations.

Personnel

SLIC's BCP did not consider the possibility that the entire workforce would be unable to physically show up to work. Ted Gato indicates that they have extra equipment for two employees from each department to continue working while not in the office. While this is helpful for overall company stability in a pandemic, only two employees in each department of a large company may not be sufficient. If certain personnel aren't able to work and feel underappreciated by not being one of those two, they may become disgruntled and consider moving jobs.

- (ii) Consider the role of Human Resources in risk management as it pertains to this pandemic event.

Identify and describe three important roles Human Resources would need to play during this crisis.

Communication

A pandemic is a time of great uncertainty, and HR would play a key role for SLIC in answering employee questions and communicating information such as workplace safety policies, which may need to change frequently in response to local government mandates or company-specific issues.

Hiring

SLIC may experience large turnover during a pandemic as people may lose their lives to the illness or may reconsider their jobs or living situations in response to the crisis. Human resources will have an important role in maintaining hiring practices to ensure that SLIC has the right staff to keep the company going. Standard hiring and interviewing practices may look very different in a pandemic.

Orientation/Training

HR will have to adapt their standard orientation and training procedures to accommodate remote workers. Integrating a new person into a fully remote team may be difficult, but HR can help provide support to the employee and their team during this process.

8. Learning Objectives:

2. The candidate will understand the types of risks faced by an entity and be able to identify and analyze these risks.
3. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.
4. The candidate will understand how the risks faced by an entity can be quantified and the use of metrics to measure risk.
6. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

- (2c) Identify and analyze specific risks faced by an organization, including but not limited to: financial, environmental, operational, legal, reputational and strategic risks
- (3a) Demonstrate how each of the financial and non-financial risks faced by an organization can be amenable to quantitative analysis
- (3d) Demonstrate the use of scenario analysis and stress testing in the measurement of current and emerging risks
- (4b) Analyze quantitative financial and non-financial data using appropriate statistical methods to assist in quantifying risk
- (4c) Analyze risks that are not easily quantifiable, such as liquidity, operational, and environmental risks
- (6b) Apply risk measures and demonstrate how to use them in value and capital assessment

Sources:

ERM-120-14: IAA Note on Stress Testing and Scenario Analysis

ERM-723-20: Issues Paper on Climate Change Risks to the Insurance Sector

Commentary on Question:

Candidates generally did well with this question. For subpart (b)(i), some candidates missed describing the timing of the stress event and didn't illustrate the specific product impacts of SLIC's products (SPIA, UL, VA or Term Life)

8. Continued

Solution:

(a) Consider the following forms of stress testing and scenario analysis.

- I. Sensitivity Test
- II. Reverse Scenario
- III. Historical Scenario
- IV. Synthetic Scenario

Propose an example of each of the four tests that is specific to one of Lyon's subsidiaries and informative to the Lyon Board of Directors.

Commentary on Question:

Some candidates had trouble explaining a Reverse Scenario. Most candidates were able to give good examples of the other three scenarios.

- I. Sensitivity Test: SLIC could perform a sensitivity test on its financial plan based on a +/- 50 bps interest rate shift
- III. Reverse Scenario: Pryde could create a reverse scenario to determine the level of negative sales, claims, and investment experience needed to reach CAL levels for the NAIC RBC
- III. Historical Scenario: Helios could craft a historical scenario to determine how international economic impacts similar to the 2008 financial crisis are likely to impact its financial plan.
- IV. Synthetic Scenario: SLIC could create a synthetic scenario to better understand the interplay of a poor economic environment with catastrophic claims levels within their financial plan.

(b)

- (i) Outline a synthetic scenario for SLIC that focuses on climate change risk and stresses multiple risk categories and products.

Include:

- A detailed description of the stress event and its relation to climate change risk
- Timing of the stress event
- Product impacts
- Key stakeholders and departments needed in the analysis
- Risk measures

8. Continued

You may assume organizational details not explicitly listed in the Case Study such as the existence of specific teams or specialties within SLIC.

- (ii) Recommend additional stress testing or scenario analysis techniques that would complement your synthetic scenario. Justify your response.

Commentary on Question:

For (b)(i), many candidates provided a scenario that only involved a single risk category (e.g. mortality) which did not receive full credit. For risk measures, some candidates only listed a measure such as VAR or TVAR, but didn't describe how the measure would be applied. For key stakeholders and departments, stronger responses listed stakeholders with an explanation of how the stakeholder was helpful to the scenario analysis.

For (b)(ii), most students were able to receive partial to full credit for mentioning stress testing, historical scenario testing, or any other additional testing that can help fill in the gaps of a synthetic scenario.

(b) (i)

Scenario Brief: A financial crisis in 2021 is followed by significant flooding and loss of life due to storms across the east coast. Interest rates do not recover while bond credit ratings plummet with significant levels of fixed security defaults. Life claim experience spikes while sales especially of group business drops due to increased unemployment

Scenario Timing: The scenario would model the stresses occurring in 2021 with lasting impacts projected for 2022-2025.

Product Impacts:

- Universal Life is impacted by both the catastrophic claim shock, as well as the interest rate shifts depending on policy provisions. Sales are likely to go down during the financial crisis, and lapse rates are likely to rise.
- Term Life is impacted by the catastrophic claim shock, but interest rates have a much smaller impact on the product. Sales may go down further if this product has significant group business, lapse rates are likely to rise.
- SPIAs may see some relief from the catastrophic life claim shock due to their longevity risk, but not to the same magnitude as the life losses. SPIAs will be very likely to see impacts from the interest rate and macroeconomic environment, this will affect both SLIC's ability to fund the SPIA payments, as well as the level of interest in the product by consumers depending on set interest rate.

8. Continued

- Variable annuities will be less impacted by the low interest rate compared to SPIAs, but their sales and lapses will be heavily dependent on the current macroeconomic environment combined with what SLIC is willing/able to offer.

Key Stakeholders and Departments

- Leadership and modelers from each product line to help set claims, sales, and lapse assumptions
- IT representatives to facilitate any data needs
- Investment team to help set interest rate assumptions and estimate the impact to asset losses
- ALM team to help understand impact of asset and interest rate changes as well as any potential liquidity concerns
- Compliance to better understand state regulator needs relating to Climate Change

Risk Measures

- Statutory impacts based on RBC ratio
- Economic capital
- CTE of claim amounts

(b)(ii)

Additional stress testing could be built to complement what a robust synthetic scenario would provide. This should include sensitivity tests on key assumptions such as interest rates, lapse rates, and mortality to provide the board views that are closer to “normal conditions”. This synthetic scenario should not replace existing SLIC scenario modeling for EC, or other purposes which also serve to supplement a synthetic scenario.