

ERM-INV Model Solutions

Fall 2018

1. Learning Objectives:

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

- (4a) Demonstrate and analyze applicability of risk optimization techniques and the impact of an ERM strategy on an organization's value. Analyze the risk and return trade-offs that result from changes in the organization's risk profile.
- (5a) Describe the concepts of measures of value and capital requirements (for example, EVA, embedded value, economic capital, regulatory measures, and accounting measures) and demonstrate their uses in the risk management and corporate decision-making processes.

Sources:

Risk Appetite: Linkage with Strategic Planning Report (LO 5)

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 (LO 5)

Commentary on Question:

Candidates are expected to know how to calculate Economic Value Added (EVA) as a performance measure for different business functions. They are also tested on their understanding of how reinsurance can be used to improve EVA for the business management function. Candidates generally struggled on the more complex concepts and calculations with the EVA for the Investment function in part (a)(i) and performed better with the EVA for the ALM and Business Management functions in parts (a)(ii), (a)(iii), (b)(i), and (b)(ii).

1. Continued

Solution:

- (a) The Investment function anticipated the market movement correctly and positioned the portfolio at the beginning of the measurement period to maximize the function's performance measure according to the limits imposed by the TAA.
- (i) Verify that EVA for the Investment function = 0.95. Show your work.
- (ii) Verify that EVA for the ALM function = -6. Show your work.
- (iii) Recommend an action to improve EVA for the ALM function.

Commentary on Question:

Part (a) required the recollection and application of the concepts and formulas in the "Risk Appetite: Linkage with Strategic Planning Report" source reading. Many candidates failed to recall these concepts and struggled with these calculations, particularly for the Investment function in part (a)(i). Many candidates failed to recalculate the market values at the end of the period and incorrectly interpreted the cost of capital direction. For part (a)(i), full credit was awarded to candidates who calculated the EVA for the Investment Function using either 90 for short-term bonds and 110 for long-term bonds or 95 for short-term bonds and 105 for long-term bonds. With the 90/110 interpretation, the EVA for the Investment Function would be 1.73.

- (i)
MV_i: market value of asset class i
r_i: interest rate of asset class i
D_i: duration of asset class i

$$\begin{aligned}\text{Expected change in asset value of the SAA portfolio} &= \sum MV_i \cdot (-\Delta r_i) \cdot D_i \\ &= 100 \cdot (-(+0.5\%)) \cdot 5 + 100 \cdot (-(-0.5\%)) \cdot 20 = 7.5 \\ \text{Asset duration} &= \sum W_i \cdot D_i = (MV_1/MV_{\text{total}}) \cdot 5 + (MV_2/MV_{\text{total}}) \cdot 20 = 12.5\end{aligned}$$

$$\text{Duration mismatch} = \text{liability duration} - \text{asset duration} = 15 - 12.5 = 2.5$$

As the short-term interest rate was expected to increase and the long-term interest rate was expected to decrease, within the allowable range, \$5 million (i.e. 100*5%) short-term bonds would have been sold for long-term bonds to take advantage of the market movement.*

The new asset portfolio after repositioning would be:
Short-term bond: $MV_1 = 200 \cdot 0.5 \cdot (1 - 5\%) = 95$
Long-term bond: $MV_2 = 200 \cdot 0.5 \cdot (1 + 5\%) = 105$

1. Continued

$$\text{Actual change in asset value after repositioning} = 95 \cdot (-0.5\%) \cdot 5 + 105 \cdot 0.5\% \cdot 20 \\ = 8.125$$

$$\text{Extra investment income over SAA} = \text{Actual change} - \text{Expected change of the SAA portfolio} \\ = 8.125 - 7.5 = 0.625$$

After the interest rate change, the asset values and in turn the duration of the asset portfolio has also changed.

$$MV_1 = 95 + 95 \cdot (-0.5\%) \cdot 5 = 92.625$$

$$MV_2 = 105 + 105 \cdot 0.5\% \cdot 20 = 115.5$$

$$MV_{\text{total}} = MV_1 + MV_2 = 208.125$$

$$\text{Asset duration} = \sum W_i \cdot D_i = (MV_1 / MV_{\text{total}}) \cdot 5 + (MV_2 / MV_{\text{total}}) \cdot 20 = 13.3243$$

$$\text{Duration mismatch} = \text{liability duration} - \text{asset duration} = 15 - 13.3243 = 1.6757$$

$$\text{Required capital} = \text{duration mismatch} \cdot 10 = 16.757$$

$$\Delta \text{ required capital} = 16.757 - 25 = -8.243$$

$$\Delta \text{ cost of capital} = \text{cost of capital rate} \cdot \Delta \text{ required capital} = 4\% \cdot (-8.243) \\ = -0.3297$$

$$\text{EVA}_{\text{Inv}} = \text{Extra investment income over SAA} - \Delta \text{ cost of capital} \\ = 0.625 - (-0.3297) = 0.9547$$

*Note: Credit was also awarded to candidates who allocated 90 to the short-term bond and 110 to the long-term bond.

(ii)

$$\text{Return on Replicating Portfolio} = \Delta \text{ MVL, due to change of interest rate} \\ = (\text{MVL}) \cdot (-\text{change in interest rate}) \cdot (\text{duration of liability}) = 180 \cdot (-(-0.5\%)) \cdot 15 \\ = 13.5$$

$$\text{EVA}_{\text{ALM}} = \text{Expected return of SAA portfolio} - \text{Return on Replicating Portfolio} \\ = 7.5 - 13.5 = -6$$

1. Continued

(iii)

ALM performance management is based on the return on the SAA over the return on a replicating liability portfolio. Any action to improve EVA-ALM is dependent on the movement on interest rates. If there is a belief that interest rates will decrease, then SAA should have an increased allocation to longer-maturity bonds and vice-versa if it is believed that interest rates will increase. Given the interest rate movements in this scenario, the EVA-ALM could be improved by increasing the allocation of SAA to long-term bonds and reducing the duration mismatch with the liability portfolio.

(b)

(i) Calculate EVA for the Business Management function.

(ii) ReaLife's senior management is not satisfied with the performance of the Business Management function with regard to new business and has asked you to explore the use of these two types of reinsurance to improve it:

- I. Pro rata
- II. Excess of loss

Recommend one of these two types of reinsurance for this purpose.
Justify your recommendation.

Commentary on Question:

Part (b)(i) required the recollection and application of the concepts and formulas in the "Risk Appetite: Linkage with Strategic Planning Report" source reading. Part (b)(ii) required the application of the concepts in the "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" source reading. Candidates that could recall the formula for the Business Management EVA generally did well on part (b)(i). Candidates that could appropriately apply the reinsurance concepts in the source reading to ReaLife did well on part (b)(ii).

(i)

Expected Return on Replicating Portfolio = expected 15-year interest rate • MVL
= (4.5%) • (180) = 8.1

Cost of capital = cost of capital rate • maximum of overall capital on various basis
= (4%) • (30) = 1.2

EVA_Bus = MCEV of new business + expected return on replicating portfolio +
experience G/L – cost of capital
= 1 + 8.1 - 2.4 – 1.2 = 5.5

1. Continued

(ii)

Excess of Loss reinsurance:

Under excess of loss reinsurance, a cedent may choose to purchase coverage attaching at high levels of loss, thereby obtaining protection for a relatively modest premium. By indemnifying the insurer for losses above a specified level, excess of loss treaties help stabilize the net losses in an insurer's portfolio.

Pro Rata reinsurance:

Surplus relief - Pro rata reinsurance treaties provide the cedent with surplus relief and the capacity to write more business so that MCEV of new business underwritten can increase.

New business strain - Regulatory based accounting rules generally provide that insurers must recognize premium revenues as earned over the duration of a policy whereas acquisition costs are expensed immediately. A ceding commission, paid by the reinsurer to the cedent under a pro rata reinsurance agreement, can be immediately recognized by the cedent as income for regulatory accounting purposes, partially offsetting the burden of expensing associated upfront acquisition costs.

Pro-rata reinsurance would thus allow ReaLife to increase new business sales and increase the MCEV of new business. Since management's concern is with regard to new business, pro-rata is the more appropriate option because it provides relief from new business strain.

2. Learning Objectives:

1. 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 how the risks faced by an entity can be quantified and the use of metrics to measure risk.
4. The candidate will understand the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

- (1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.
- (3b) Analyze and evaluate the properties of risk measures (e.g., Delta, volatility, duration, VaR, TVaR, etc.) and their limitations.
- (4f) Analyze the practicalities of market risk hedging, including dynamic hedging.
- (4g) Demonstrate the use of tools and techniques for analyzing and managing credit and counterparty risk.

Sources:

ERM-110-12: Derivatives: Practices and Principles

ERM-124-15: Counterparty Credit Risk, First Edition, Jon Gregory, Chapter 2: Defining Counterparty Credit Risk

ERM-124-15: Counterparty Credit Risk, First Edition, Jon Gregory, Chapter 2: Defining Counterparty Credit Risk

ERM-702-12: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Pages 9–38

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion Ch. 12 Monte Carlo Methods

ERM-127-17: Quantitative Enterprise Risk Management, Hardy, Ch. 2 Risk Taxonomy

Commentary on Question:

The goal of the question is to consider issues around hedging, modeling, and quantifying credit risk. The candidate is expected to apply the syllabus materials to a new situation.

2. Continued

Solution:

- (a) XYZ's Chief Investment Officer (CIO) is familiar with VaR and wants to use it as the risk measure. You would like to use Monte Carlo methods to evaluate the effect of the hedge but your department is struggling with computer runtime issues in trying to generate stochastic Monte Carlo results.

Propose an alternative technique that could lead to a faster and more accurate VaR estimate. Justify your response.

Commentary on Question:

The key to scoring well was to support a recommendation by describing both the accuracy and speed improvements compared to Monte Carlo results.

Sample stratification - This allows for oversampling in the tail to find a more accurate estimate by partitioning the simulation region into two zones and then oversampling in the tail around the VAR level desired.

- (b) The CIO is convinced that hedging is the right risk management approach. As there are no exchange-traded options for this commodity, the trade would be executed in the OTC market. There is concern from the Board of Directors (BoD) about managing the counterparty risk.
- (i) Explain how Expected Mark to Market, Expected Exposure and Potential Future Exposure quantify the company's counterparty credit exposure to the OTC counterparty. Use graphs to support your explanation.

You propose creating a Risk Dashboard to be reported monthly to the BoD.

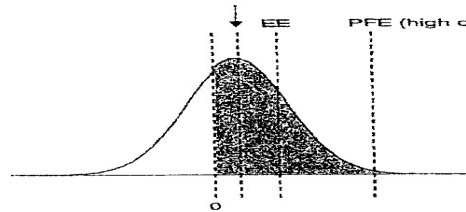
- (ii) Recommend which one of the metrics in part (i) you would reflect in the Risk Dashboard. Justify your recommendation.

Commentary on Question:

Candidates needed to get the relative positions correct in the graph to receive full credit for the graph. Most candidates answered PFE in (ii), which did receive credit, if a valid justification was provided.

- (i) Expected MtM is the expected value of the transaction at some point in the future and represents how much value is expected to be realized from the hedge.
Expected Exposure is the expected value of the transaction conditional on the hedge being in the money.
Potential Future Exposure is more of a tail risk metric - it is the potential exposure at some point in the future at a certain confidence level. It is analogous to VaR.

2. Continued



- (ii) Expected Exposure (EE) would be a good metric to report, since the board is concerned about the counterparty risk and EE captures the average positive exposure to the counterparty.
- (c) The BoD has asked you to create a plan for implementing the commodity hedge. The company has an existing hedge program to manage its interest rate risk exposure. Your colleague sends you a brief email:

“Great news on the board approving the hedge plan! Now we just need additional master agreements with our counterparty to reflect this new risk, and since we were already hedging interest rate risk there’s no need to update the firm’s risk tolerance statement.”

Critique your colleague’s message.

Commentary on Question:

Most candidates identified the issues with the risk tolerance statements. Very few candidates identified any issues with the master agreements strategy, which was required to receive full credit.

The risk tolerance statement sets out quantitative or qualitative tolerance levels for relevant and material risks. Since the board is less tolerant of commodity price risk (as evidenced by decision to hedge away risk), the statement should be updated appropriately. The statement will need to adequately distinguish between interest rate and commodity risks that the company bears.

A single master agreement is preferred. Master agreements cover derivative transactions, not risks - as such, would need to include the commodity hedges in the agreements, not the commodity price risk. Master agreements should provide for netting of agreements.

- (d) In preparation for your annual report to the BoD on the company’s solvency and risks, your Risk Management Team is reviewing the list of key risks on the company risk register.

Identify and describe four risk exposures that have changed because of the new commodity hedge. Justify your response.

2. Continued

Commentary on Question:

Most candidates did a good job of identifying relevant risks that changed. The key to receiving substantial credit was describing the direction of the change as well as the reasoning. A wide range of answers were accepted.

1. Credit risk the company is exposed to has increased with the addition of the new OTC counterparty.
2. Operational risks increase - potential risk of human error in executing hedge or following Board's directions.
3. Basis risk on the hedge is new - local price disruptions in the commodity markets are possible, since commodities are physical assets.
4. Liquidity risk increases - There is additional risk in the solution because the OTC counterparties may decline to continue selling hedges for the commodity if the price drops, or the cost of hedging may increase substantially.

3. Learning Objectives:

2. 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 the approaches for managing risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

- (2f) Analyze the importance of tails of distributions, tail correlations, and low frequency/high severity events.
- (2h) Construct approaches to modeling various risks and evaluate how an entity makes decisions about techniques to model, measure and aggregate risks including but not limited to stochastic processes.
- (4k) Apply best practices in risk measurement, modeling and management of various financial and non-financial risks faced by an entity.

Sources:

ERM-118-14: Model Validation Principles Applied to Risk and Capital Models in the Insurance Industry

SOA Monograph - A New Approach to Managing Operational Risk - Chapter 8

ASOP 23 Data Quality pg. 1-8

ERM-104-12: Study Note on Parameter Risk, Venter and Sahasrabuddhe

Commentary on Question:

This question centered on operational risk. It covered topics related to the underlying principles of creating a model from two separate perspectives, evaluation of model components, and considerations around model data and assumptions.

To receive full credit for these questions, a candidate had to relate concepts from the readings to the contextual facts provided in the question stem.

Solution:

- (a) Compare and contrast the application of each principle relative to both proposed operational risk modeling approaches. Justify your response.

Commentary on Question:

In order to receive full credit for this question, a candidate had to discuss all six principles for both approaches by providing valid statements that either compared or contrasted the models for each principle. This question tested the capacity of the candidate to provide valid, separate and justified statement that supported an argument for each principle for both models.

3. Continued

Most students were capable of covering all principles, though not as extensively as expected. Both compare and contrast statements were accepted as long as they were not purely theoretical but referred back to the context of the question as provided.

1 – Design: Consistent with intended purpose

The Risk Map approach satisfies this criteria since the goal is to gain a broad understanding of risk.

Similarly to the Risk Map approach, the Actuarial approach satisfies this criteria since the goal is to improve operational risk assessment and management processes.

2 – Validation: Part of an independent process

The Risk Map approach does not satisfy this criteria. The Risk Map is produced by the manager himself with no input from other groups. Compared to the Actuarial approach, there is no peer review, no overall discussion prior to publishing it, and no independent review.

In contrast, the Actuarial approach satisfies this criteria as it is under the purview of an independent group - the ERM function.

3 – Owner: Accountability stated and applied

Both approaches satisfy this criteria. The Risk Map approach satisfies this criteria as the business line manager is the owner while the Actuarial approach is clearly the responsibility of an independent ERM group.

4 – Complexity & Materiality: Proportional to context

Both approaches satisfy this criteria. The Risk Map approach satisfies this criteria for less complex/routine risks while the Actuarial approach is used for the estimation of operational risk capital, which is usually driven by infrequent/large events.

However, the Risk Map approach is usually used to estimate only average/expected loss while the Actuarial approach is used to estimate direct/indirect losses, impact on reputation, and interaction with other risks.

3. Continued

5 – Elements: Inputs, calculation, output, and limits must be validated

The Risk Map approach does not satisfy this criteria. For example, we do not know how impact was assessed or which input data was used. For the output, the risk categories may not be defined consistently or the size of output circles may not have been calculated properly given likelihood/frequency and severity/impact.

The Actuarial approach better satisfies this criteria as its components allow for a better calculation and more explicit output. The output measures direct/indirect/legal impact and interaction of risk.

6 – Documentation: Analysis of supporting details produced

The Risk Map does not satisfy this criteria as there is no explicit reference to any kind of documentation used to produce the risk map. All information sits in the manager's head and there is a lack of accountability for his justifications.

The Actuarial approach better satisfies this criteria as the ERM group must produce documentation as part of their work. The ERM group is required to share their documentation with many stakeholders: rating agencies, regulators, ABC Board, financial analysts, SEC/SOX.

- (b) Assess the appropriateness of the proposed actuarial approach to adequately model both routine and exceptional operational risk exposures. Justify your response by discussing the suitability of each model component.

Commentary on Question:

In order to receive full credit, a candidate had to assess each component of the proposed actuarial model for both routine and exceptional risk exposures (as shown in the stem table). In addition, proper and valid justifications from the context of the question had to be provided.

Most students were capable of identifying appropriate and valid considerations, outlining where the proposed actuarial method was appropriate and areas where it was not. Issues related to the business environmental factors were less developed.

Exposure/Capital measurement:

3. Continued

Routine exposure:

Using VaR is an appropriate metric given the stability and other theoretical features of this metric. It would be suitable for people, process and system risks as events/losses can be estimated using historical data and industry knowledge.

Exceptional exposure:

The use of the VaR metric, by definition, underestimates the unexpected loss component of exceptional exposure, i.e. the “fat tail” impact of exceptional exposure. It would have to be enhanced by using other method/metric such as TVaR or Expected Shortfall.

Calculation Method

Routine exposure:

The Actuarial method as stated would be appropriate since frequency/likelihood could be calculated using some statistical distribution and a historical correlation matrix. Also, the method as stated limits the calculation of severity to direct consequences/impact to ABC, which is appropriate for routine exposure and events.

Exceptional exposure:

The Actuarial method as stated is inappropriate since the modeling of frequency for exceptional events cannot be done purely from a statistical curve. It must go beyond basic statistical considerations, using expert judgment, scenarios/stress tests, and/or predictive modeling.

In addition, the interaction with other risks must be taken into account, going beyond historical correlation matrix by using method such as copulas.

Data and assumptions:

Routine exposure:

The Actuarial method can be implemented easily for routine exposure as hard data (internal) is usually available. There are not many outliers and the risk events can usually be assumed to be independent and identically distributed. However, we must be aware of the use of truncated data as small losses may not be accounted for because of the use of thresholds in reporting systems.

3. Continued

Exceptional exposure:

The Actuarial method would have to be enhanced as little hard data (internal) is usually available. Consortium and external data would be needed to assess this exposure. However, there are issues with using external data: scalability, suitability to ABC's context, choice of method to integrate external data with ABC's own data, etc.

Business environment:

Routine exposure:

The Actuarial method as proposed integrates aspects of the business environment as it is easier to identify control failures/lack of controls that would affect losses.

It is also easier to identify remedies taken at the business level to control losses.

Exceptional exposure:

The Actuarial method as stated would have to assess if existing controls are still relevant and not simply assume their relevance. In order to do this, relevant stress test/scenarios could be developed to assess if the control environment works or if there is an absence of controls. Control level assessment has to be done at the company level, not just at the business unit level.

- (c) Recommend improvements to the individual business line manager based on the ERM department's analysis with respect to each of the following items. Justify your response.
- I. Collection of data relevant to modeling of operational risk losses
 - II. Ensuring accuracy of operational risk loss data
 - III. Setting of assumptions for variables used in operational risk modeling.

Commentary on Question:

In order to receive full credit, candidates had to provide at least two valid and justified recommendations to improve the existing situation context provided in the question. Analysis of the actual situation with no recommendation for improvement was not the purpose of the question.

3. Continued

(I) **Collection of data relevant to modeling of operational risk losses**

- Instead of the business line manager, the ERM group should assess the indirect impact relevant for other risks: external and sales business practices as data collected by the business line manager clearly indicates that he focused only on estimating direct impact based on the incorrect positions on map and size of circle.
- Data collection should be centralized, under the stewardship of the ERM group. They could conduct interviews with staff to complement the manager's data collection, or consult relevant external data sources. The ERM group should assess the impact of potential risks like terrorism.

(II) **Ensuring accuracy of operational risk loss data**

- Since the business line manager relied upon his own judgment to obtain data, there are several inconsistencies between the Risk Map and the ERM team's analysis. For example, risk 5 is positioned correctly on map but its size is 10 times larger than that of risk 2. Therefore data must be accurate and validated against other sources and there should be a common definition of the various risks adopted by the company.
- When using external data, a suitability review should be performed in order to assess the relevancy to ABC.

(III) **Setting of assumptions for variables used in operational risk modeling**

- An internal governance/review process should be implemented to determine the assumptions used to produce the risk map.
- Integrating some statistical methods in the production of the risk map could be relevant, e.g. MLE or credibility theory.

4. Learning Objectives:

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

Learning Outcomes:

- (1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.
- (4b) Demonstrate means for transferring risk to a third party, and estimate the costs and benefits of doing so.
- (4c) Demonstrate means for reducing risk without transferring it.
- (4e) Develop an appropriate choice of a risk mitigation strategy for a given situation (e.g., reinsurance, derivatives, financial contracting), which balances benefits with inherent costs, including exposure to credit risk, basis risk, moral hazard and other risks.
- (4k) Apply best practices in risk measurement, modeling and management of various financial and non-financial risks faced by an entity.

Sources:

ERM-122-14: Chapter 1 of Captives and the Management of Risk, Kate Westover

ERM-117-14: AAA Practice Note: Insurance Enterprise Risk Management Practices (pages 4-26)

ERM-119-14: Aggregation of risks and Allocation of Capital (Sections 4-7)

Commentary on Question:

This question tests the candidate's ability to evaluate the risk profile of a captive insurance company. Overall candidates performed well in part (a) and many were able to at least get partial credit in part (b). Most candidates struggled with the calculation portion of part (c). Performance on part (d) was average as many candidates failed to realize that investment risk mitigation strategies are not effective for managing catastrophic claim risk.

4. Continued

Solution:

(a) Compare and contrast the characteristics of PQR and RRG as they relate to the following:

- Target Market
- Required Risk Capital
- Regulation
- Policyholder Protection

Commentary on Question:

Candidates did relatively well on this part of the question. Candidates that did not evaluate each item from both a PQR and RRG perspective were only awarded partial credit. No credit was given for answers that stated PQR and RRG were similar without further justification.

Target Market

PQR - Sells insurance to various medical associations and products are designed to return profits to shareholders. Offers a wide variety of features/options to help policyholders achieve their insurance goals.

RRG - Owners and Insured are the same entity and the product is primarily designed to pool/transfer medical malpractice claims and lowering the cost of insurance. The product will be tailored to cover medical malpractice allowing cardiologist to achieve their insurance needs.

Required Risk Capital

PQR - Required to maintain a large amount of Required Capital. Risk Capital will be provided by shareholders (for public company) or policyholders (for mutual companies).

RRG - Easier and less expensive to setup but requires a large initial capital investment (Risk capital). Usually less required Capital held due to less stringent regulation.

Regulations

PQR - Should comply with regulation in every state in which they conduct business.

RRG - Not subject to the same federal and state regulation as traditional insurance companies. Should comply with regulation of its State of domicile.

4. Continued

Policyholder Protection

PQR - Policyholders are generally protected if the company becomes insolvent.

RRG - No such protection offered by RRGs.

(b) Explain how the exposure to each of the following risks will affect the associations participating in RRG. Justify your response.

- Catastrophe Claim
- Investment Risk
- Operational Risk
- Legal Risk
- Regulatory Risk

Commentary on Question:

Candidates generally did well on this part, though many candidates did not understand what was meant by 'Catastrophe Claim' in the context of this question. Answers that were too general and not specific to RRG only got partial credit.

Catastrophic Claim

The RRG is exposed to catastrophe (early claim) risk arising from newly filed or outstanding lawsuits. RRG is not likely capitalized to absorb the cost of large claims in the early duration, therefore there is the risk of unexpected capital contributions required to cover losses.

Investment Risk

Unexpected changes in interest rates, credit spread or liquidity may cause adverse movements in the assets backing liabilities. Generally low risk for liability malpractices claims due to the short term nature of liabilities.

Operational Risk

Claim processing or policy forms construction is now the responsibility of the RRG. May create unexpected expenses or even lawsuits/regulatory intervention due to operational failure.

Legal Risk

Substantial legal risk associated with claims litigation, reserving requirements; risk of anti-selection.

Regulatory Risk

The RRG is exposed to changes in the current rules that might reduce the benefits of setting a captive entity to operate in a less regulated environment. RRG may see an increase in expenses related to lobbying.

4. Continued

(c) You are also given:

- Risk adjusted net income is assumed to be 70% of net income before tax
- Tax rate is 25%
- Interest on reserve and available capital is 5%
- Only cash and short-term notes back the required capital; therefore, investment income on required capital can be ignored

(i) Calculate the following metrics. Show your work.

- ROE
- RAROC

(ii) Propose an additional risk metric appropriate for assessing RRG's performance based on the data given. Justify your response.

(iii) After assessing the metrics produced by your analysis, your colleague makes the following statement:

"I recommend we adopt RAROC as the primary risk metric for evaluating the performance of RRG as it currently produces a higher return than all other metrics considered."

Critique your colleague's recommendation.

Commentary on Question:

- *Overall, candidates did poorly on part (i). Almost no candidates included the Change in Reserve item in the Net Income calculation. Credit was given to candidates that used time 0 values of Shareholder Equity and Available Economic Capital. Partial credit was awarded for stating the correct formulas of ROE and RAROC.*
- *RARORAC measure was recommended by almost all the candidates in part (ii) but credit was also given for other risk measures if they were correctly justified.*
- *Many candidates only said that using the measure with the highest value is inappropriate without further details and did not receive any credit for part (iii). Answers related to principal-agent risk as it applies to the colleague's recommendation were given credit.*

4. Continued

(i)

	Description / Step	Value
Premiums		11
Maintenance Expenses		-2
Expected Claims		-5
Change in reserve	(Reserve t_1 - Reserve t_0)	-5
Investment income	(Reserve t_0 + Available Capital t_0) * Interest Rate	3.5
Before tax NE	Sum of preceding items:	2.5
After tax	Before Tax NE * (1-25%)	1.875
Shareholder Equity	Assets - Liability at $t = 1$	65
ROE	(Net Income After Tax) / (Shareholder Equity) = $(2.5 * (1-25\%))/65$	2.88%
RAROC	Pre-Tax NE *(1+ Risk Adjustment)/Available Economic Capital = $(2.5 * (70\%))/55$	3.18%

(ii) **RARORAC**

Measures risk adjusted return relative to required capital required to generate it.

Can be calculated at any level where comparison of performance is desired - e.g. company level, business unit level, product level.

Can be used directly in management decisions.

(iii) RAROC is often used as a performance measure. RAROC is a measure of the profitability of a portfolio, taking account of the risk assumed in order to generate profits.

RAROC is considered more accurate and comparable (between portfolios and insurers) than the more traditional return measures such as ROE and ROA.

Overreliance on a single metric might only provide partial assessment of the RRG's performance. A combination of metrics (RARORAC, VAR, Economic Value) might provide a stronger measure of performance.

It is unlikely that RRG will realize the benefit of premium reduction in 1 year. A longer period of appraisal (5 or 10 years) would have been more appropriate.

4. Continued

- (d) Based on the metrics considered, RRG is not performing well after one year of operation.

Recommend two risk mitigation strategies that could improve RRG's performance.

Commentary on Question:

To receive full credit, answers needed to be specific to the RRG situation.

Recommendations without justification received little credit.

Answers related to asset allocation or operational changes did not receive any credit as they were not appropriate risk mitigation strategies for catastrophic claims.

Other valid recommendations such as repricing or capital contribution increase were also given credit.

Change the structure from pure captive to sponsored captive. A sponsored captive could be structured by an existing entity and reinsure malpractice claims so that NCMA members are not directly participating in ownership of the captive facility. The sponsor could charge an access fee allowing NCMA to reduce capital contribution required to cover losses.

RRG could purchase quota share reinsurance directly from existing reinsurers. This would allow RRG to transfer a portion of claims to a third party in exchange of contractual allowances.

Consider pooling claim risk with other medical associations to increase capital contribution.

5. Learning Objectives:

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

Learning Outcomes:

- (4d) Demonstrate how derivatives, synthetic securities, and financial contracting may be used to reduce risk or to assign it to the party most able to bear it.

Sources:

ERM-115-13: Creating an Understanding of Special Purpose Vehicles, PWC

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Identify three key benefits to OSZ from using an SPV for the new product. Justify your response.

Commentary on Question:

Candidates generally did well on this part. Some candidates tried to list general benefits associated with the use of an SPV without considering which benefits actually apply to OSZ's proposed SPV.

- Freedom of jurisdiction/meeting regulatory requirements: Capital requirements in Country A are high, OSZ could set up the product in a more favorable jurisdiction to reduce required capital and be able to meet profit targets.
 - Bankruptcy remoteness: Offering minimum guarantees with such volatile returns makes the possibility of bankruptcy quite likely. Using a separate legal entity means OSZ is not obligated to pay investors in adverse scenarios.
 - Raising capital/financing: OSZ could use investors' funds to finance the capital requirements for the new product.
- (b) The following risks are generally associated with the use of SPVs:
 - Liquidity and funding risk
 - Reputational risk
 - Lack of transparency
 - (i) Describe each risk as it pertains to an SPV.
 - (ii) Rank the risks based on relevance to OSZ's proposed SPV. Justify your ranking.

5. Continued

Commentary on Question:

Many candidates discussed risks in general but did not explain how they related to the use of an SPV, specifically with funding risk. Misunderstanding the risks that were being asked caused candidates to also have difficulty reasonably ranking the risks as they related to OSZ's use of this SPV.

(i)

- Liquidity and funding risk: The poor performance of an affiliated SPV may affect the firm's access to the capital markets.
- Reputational risk: The firm's own perceived credit quality may be blemished by the underperformance or default of an affiliated or sponsored SPV.
- Lack of transparency: The complexity of SPVs - often in the form of layers upon layers of securitized assets - can make it near impossible to monitor and track the level of risk involved and who it lies with.

(ii)

1. Reputational risk is the most relevant. If the SPV were to default it could cause OSZ investors and policyholders to lose confidence in OSZ, having impacts on share price, lapse rates on inforce business, and new business sales.
2. Liquidity and funding risk is second most relevant. If the SPV performs poorly and investors receive little or no return on investment, OSZ will have a difficult time accessing the capital market for future projects.
3. Lack of transparency is least relevant. The structure of the proposed SPV is straightforward as all investors have proportionate participation so it is clear how much risk lies with each party.

(c) You've created a table to track capital and distribution to investors.

t	Attained Age	R_t	B_t	Capital Requirement	Capital Before Distribution to Investors	Distribution to Investors	Capital After Distribution to Investors
0	65	N/A	N/A		25,000,000	N/A	
1	66	25%					
2	67	-75%				0	

(i) Determine the missing values. Show all work.

(ii) Explain why there was no distribution to investors in year two.

5. Continued

Commentary on Question:

Candidates generally did well on this part.

(i)

t	Attained Age	R_t	B_t	Capital Requirement _t	Capital Before Distribution to Investors	Distribution to Investors	Capital After Distribution to Investors
0	65	N/A	N/A	20,000,000	25,000,000	N/A	
1	66	25%	160,000	17,280,000	28,240,000	6,640,000	21,600,000
2	67	-75%	160,000	16,960,000	15,737,600	0	15,737,600

$$B_1 = 10 * 80\% * 1,000,000 / (120 - 65) * \max(1, 1 + 40\% * 25\%) = 160,000$$

$$B_2 = B_1 * \max(1, 1 + 40\% * -75\%) = 160,000$$

$$CR_0 = 10 * 200\% * 1,000,000 = 20,000,000$$

$$CR_1 = 200\% * (120 - 66) * 160,000 = 17,280,000$$

$$CR_2 = 200\% * (120 - 67) * 160,000 = 16,960,000$$

$$CBDI_1 = 25,000,000 * (1 + 40\% * 25\% + 60\% * 6\%) - 160,000 = 28,240,000$$

$$\text{Distribution}_1 = \max(0, CBDI_1 - 125\% * CR_1) = 6,640,000$$

$$CADI_1 = CBDI_1 - \text{Distribution}_1 = 21,600,000$$

$$CBDI_2 = 21,600,000 * (1 + 40\% * -75\% + 60\% * 6\%) - 160,000 = 15,737,600$$

$$\text{Distribution}_2 = \max(0, CBDI_2 - 125\% * CR_2) = 0$$

$$CADI_2 = 15,737,600$$

(ii) The large decrease in the cryptocurrency pool in year 2 resulted in the total capital being lower than 125% of required capital, and thus no payment was made to investors.

(d) The Head of Capital Management has sent you an e-mail containing the following arguments and recommendation:

- Since the SPV is a separate legal entity, OSZ has no legal obligation to transfer additional capital.
- Transferring OSZ's capital to the SPV would have a negative impact on earnings and thus is not in the best interest of their shareholders.
- Allowing the SPV to default could impact OSZ's ability to access capital markets for future projects, which would have a negative long term impact.
- Recommendation: OSZ should make a one-time transfer of 1,000,000 ACU to the SPV, contingent on the investors agreeing to the following restructuring:

5. Continued

- Distributions to investors will be changed from the excess of capital over 125% of required capital to the excess of capital over 250% of required capital
- No future transfers of capital from OSZ to the SPV will occur under any circumstances.

Critique each of the arguments and the recommendation.

Commentary on Question:

Candidates did not receive credit for simply agreeing/disagreeing with statements. Candidates that fully critiqued the email did well on this part of the question.

1st bullet: This is correct. Because the SPV is a separate legal entity, it is not OSZ's responsibility to ensure the SPV meets capital requirements, although it may be in their best interest to do so.

2nd bullet: While it is true that there would be an adverse impact on earnings, it is not necessarily true that it would be in the shareholders' best interests to not transfer capital to the SPV. Letting the SPV fail could have a material impact on OSZ's market value, and thus would also impact the shareholders.

3rd bullet: This is describing liquidity and funding risk, which is a correct observation. The potential impact is not only a long term impact, as signaling risk could result in immediate impacts.

Recommendation:

- A transfer of 1,000,000 would not be sufficient to meet capital requirements, more should be transferred.
- Increasing the capital threshold for distributions will hurt investor relations, as investors will not receive payments for a long time.
- Making a statement that no future transfers will occur signals to investors and to the market that OSZ has abandoned the SPV, which can have reputational impacts. This recommendation should not be supported.

6. Learning Objectives:

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

Learning Outcomes:

- (1b) Explain risk taxonomy and its application to different frameworks.
- (4j) Demonstrate risk management strategies for other key risks (for example, operational, strategic, legal, and insurance risks).

Sources:

Financial Enterprise Risk Management, Sweeting, 2011, Ch. 8, Risk Identification

Financial Enterprise Risk Management, Sweeting, 2011, Ch. 16, Responses to Risk

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

Commentary on Question:

This question tests the candidate's ability to understand both the limitations and appropriateness of tools used in risk identification, risk analysis, and risk management. This question also tests the candidate's ability to make decisions and recommendations as well as to provide support or explanation for how a determination was made. Candidates generally did not demonstrate the depth of knowledge required for this question. In particular, candidates generally struggled with parts (b)(i), (c)(i), and (d) where demonstration of higher cognitive levels were required for full marks, whereas candidates generally did well in parts (a)(i), (a)(ii), (b)(ii), and (c)(ii) where lower cognitive levels were required for full marks.

Solution:

- (a) You have asked your actuarial student to assist with developing a risk register for the VA block. Your student wants to organize a survey to complete the risk register based on the responses of the current staff.
 - (i) Identify two key limitations generally associated with the survey approach.
 - (ii) After discussing the limitations with surveys with your student, you recommended the Independent Group Analysis technique as an alternative to conducting a survey.

Explain how this recommendation addresses both limitations you identified in (i).

6. Continued

Commentary on Question:

Part (a)(i) required candidates to identify two limitations with the survey approach. Responses were not required to be specific to the company to receive credit. Partial credit was given for fewer responses than asked for.

Part (a)(ii) required candidates to explain how the Independent Group Analysis (IGA) technique addressed limitations identified in part (a)(i). Full credit required explaining how IGA addresses both limitations. Partial credit was given for explaining how IGA addresses only one of the limitations. No credit was given for describing IGA without addressing the limitations.

- (i)
1. Framing: survey responses are influenced by the questions asked
 2. Method of data collection: multiple choice may limit possible responses to the survey
- (ii) Independent Group Analysis is a technique where all participants write down risks in silence without collaboration. These responses are aggregated by a facilitator after which there is a discussion.
1. Independent Group Analysis participants provide justification for the risks they identified while writing down risks individually. This addresses the framing bias by allowing participants to explain their thought process for identifying a risk and justify its inclusion in the risk register.
 2. There is no censoring of responses with Independent Group Analysis. All risks identified are included for discussion by the group, not just preselected options available via a multiple choice survey.
- (b) Your student rounded all correlations to the nearest 0.5 for credibility (for example, 0.3 is rounded to 0.5) and has started populating the influence matrix as provided below.

Influence Matrix

Asset Class	Sector		1	2	3	4
Fixed Income	US High Yield Bonds	1	N/A		0	
Equity	US Large Cap	2		N/A		
Equity	Euro Large Cap	3	1		N/A	
Alternatives	US Commodities	4				N/A

- (i) Determine the missing values (0, 1, or 2) in each cell. Show your work.
- (ii) Identify two sectors that will require direct risk mitigation based on the influence matrix. Justify your response.

6. Continued

Commentary on Question:

Part (b)(i) required the recollection of the influence matrix from the “Strategic Risk Management Practice” study note. Full credit was given for a completely correct influence matrix, along with showing work. Partial credit was given, although more marks were given to candidates showing their thought process by showing their work.

Part (b)(ii) required the candidate to analyze the influence matrix created in part (b)(i), and was testing whether candidates understood how to interpret the influence matrix rows (influence score) and columns (passive score). There were ultimately 3 different answers accepted for part (b)(ii): (1) mitigating the two sectors with the highest influence score, (2) mitigating the two sectors with the lowest passive score, or (3) mitigating the sector with the highest influence score and the sector with the lowest influence score. Full credit was given for correctly identifying two sectors that required risk mitigation and provided justification. Partial credit was given, with more weight given to justifications. No credit was given for candidates who identified mitigating risks with the highest passive scores.

(i)

Step 1: Round correlations to nearest 0.5

Asset Class	Sector		1	2	3	4
Fixed Income	US High Yield Bonds	1	1	1	0.5	0.5
Equity	US Large Cap	2	1	1	1	-0.5
Equity	Euro Large Cap	3	0.5	1	1	0
Alternatives	US Commodities	4	0.5	-0.5	0	1

Step 2: Take absolute value

Asset Class	Sector		1	2	3	4
Fixed Income	US High Yield Bonds	1	1	1	0.5	0.5
Equity	US Large Cap	2	1	1	1	0.5
Equity	Euro Large Cap	3	0.5	1	1	0
Alternatives	US Commodities	4	0.5	0.5	0	1

Step 3: Correct for magnitude of influence matrix (0, 1, 2). The diagonal changed to N/A.

Asset Class	Sector		1	2	3	4
Fixed Income	US High Yield Bonds	1	N/A	2	1	1
Equity	US Large Cap	2	2	N/A	2	1
Equity	Euro Large Cap	3	1	2	N/A	0
Alternatives	US Commodities	4	1	1	0	N/A

6. Continued

Step 4: Apply influence. Rows influence columns. Cells where the row sector does not influence the column sector changed to 0 because of no influence.

Asset Class	Sector		1	2	3	4
Fixed Income	US High Yield Bonds	1	N/A	0	0	1
Equity	US Large Cap	2	2	N/A	2	0
Equity	Euro Large Cap	3	1	2	N/A	0
Alternatives	US Commodities	4	0	1	0	N/A

(ii)

Total rows and columns are needed to analyze the influence matrix.

Asset Class	Sector		1	2	3	4	Total
Fixed Income	US High Yield Bonds	1	N/A	0	0	1	1
Equity	US Large Cap	2	2	N/A	2	0	4
Equity	Euro Large Cap	3	1	2	N/A	0	3
Alternatives	US Commodities	4	0	1	0	N/A	1
	Total		3	3	2	1	9

US Large Cap equities have the highest influence score. They have the largest risk impact and should receive top priority.

US Commodities have the lowest passive score. They need to be mitigated directly because they are least influenced by other sectors.

(c) You are concerned that the consultant did not mention any VA operational risks in the risk report. You have identified the following key VA operational risks in the risk register:

- Regulatory risk
- Technology risk
- Process risk
- Reputational risk

(i) Evaluate whether the scenario planning approach is an appropriate risk management strategy for each operational risk identified.

(ii) Recommend an alternative risk management strategy for each risk. Support your recommendation.

6. Continued

Commentary on Question:

Part (c)(i) tested whether candidates could recognize that scenario planning is typically used to challenge rooted beliefs about external environmental factors that are outside the direct influence of corporate management. Many candidates confused the strategic and qualitative nature of scenario planning with the financial results of quantitative scenario testing. Full credit required all of the operational risks identified to be evaluated. Partial credit was given when all risks were not evaluated.

Part (c)(ii) tested candidates' ability to recommend risk management strategies for operational risks. Most candidates did well with part (ii), with many candidates receiving full marks. Recommendations and support for all of the four operational risks was required for full credit. Partial credit was given for each operational risk that received a recommendation and support. No credit was given for failing to provide support for the risks.

(i)

1. Regulatory risk is external to the organization. Therefore, scenario planning is appropriate.
2. Technology risk is internal to the organization. Therefore, scenario planning is inappropriate.
3. Process risk is internal to the organization. Therefore, scenario planning is appropriate.
4. Reputational risk is internal to the organization. However, scenario planning appropriate since oftentimes the source of reputational risk is how the firm response to another risk which is generally external to the organization.

(ii)

1. Regulatory Risk – Recommend keeping abreast of regulatory changes. I recommend hiring a consultant due to lack of expertise from existing staff with VA products.
2. Technology Risk – Due to many unknown factors creating technology risk, I recommend real options analysis. Creating a portfolio of projections and opportunities that can be executed when needed to mitigate a specific technological event.
3. Process Risk – I recommend risk focused process analysis. This approach constructs flow charts for every process, which identifies and analyzes points where risk can occur.
4. Reputational Risk: I recommend a sound ERM framework and respond quickly if the company's reputation has been damaged. It might be possible to define every possible action for potential reputational damage, but such a strategy would make the company slow to respond.

6. Continued

- (d) The BoD has scheduled a meeting for next week to review the proposed purchase and make a decision whether or not to purchase the VA block. They would like to review your risk analysis at that meeting.

Assess whether the influence matrix can help support your recommendation. Justify your response.

Commentary on Question:

Most candidates struggled with this part, with many candidates failing to recognize that the influence matrix was not an appropriate tool to support capital markets recommendations. Very few candidates received full credit, which required candidates to recommend against using the influence matrix, justify why the influence matrix was inappropriate, recommend an alternative method or information that should be presented to the BoD to make a decision, and justify why the additional information was appropriate to use. More partial credit was given to candidates who provided information that supported why the use of the influence matrix was inappropriate.

The influence matrix should not be used to support the recommendation. An alternative method is more appropriate, because an influence matrix is used to evaluate the interaction between various risk factors in the absence of exact relationships. It is primarily used for operational or strategic risks where it is difficult to determine how these risks will interact.

I recommend performing a Monte Carlo simulation to further assess the risk inherent in the VA block. Stochastic simulation is a tool for considering many possible assumptions and distributions, and it is much more appropriate for capital market risks. Creating a distribution of results would allow further quantitative risk analyses to be performed, including VAR or CTE analysis to investigate tail risk.

7. Learning Objectives:

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

Learning Outcomes:

- (4a) Demonstrate and analyze applicability of risk optimization techniques and the impact of an ERM strategy on an organization's value. Analyze the risk and return trade-offs that result from changes in the organization's risk profile.
- (4h) Analyze funding and portfolio management strategies to control equity and interest rate risk, including key rate risks. Contrast the various risk measures and be able to apply these risk measures to various entities. Explain the concepts of immunization including modern refinements and practical limitations.

Sources:

ERM-612-17: Modern Investment Management: An Equilibrium Approach Chapter 7: Beyond Equilibrium, the Black-Litterman Approach, Litterman

Commentary on Question:

This question tested the candidate's understanding of the methodology and application of the Black-Litterman vs. Mean-Variance Optimization methods.

Solution:

- (a) Compare and contrast standard MVO with the Black-Litterman approach.

Commentary on Question:

Four points discussing the approaches were required for full credit. There were more acceptable answers than in the solution below, such as discussing CAPM and other methodology to produce the weights.

- Both methods provide optimized portfolio weights given a set of constraints
- Optimal weights under traditional MVO are sensitive to small changes in expected excess returns, while Black-Litterman is better behaved
- Traditional MVO portfolios may appear unreasonable without imposing significant constraints such as no shorting, while Black-Litterman does not require these constraints
- In traditional MVO the investor specifies a vector of excess returns, while in Black-Litterman the investor focuses on one or more "view portfolio" weights given a set of constraints

7. Continued

- (b) Describe the three main steps to implement the Black-Litterman asset allocation model.

Commentary on Question:

Candidates tended to do well on this part. Typical omissions were the degree of confidence of the views, or concluding with finding the optimal allocation.

1. Start with an optimal portfolio with market capitalization weights and equilibrium expected excess returns
 2. Investors formulate their views in terms of return expectation and degree of confidence
 3. Produce the optimal portfolio asset allocation
- (c) Identify which approach was used to construct each portfolio above. Explain your rationale.

Commentary on Question:

Many candidates failed to recognize that the second portfolio used Black-Litterman. Often, candidates used absolute changes in the weights rather than the relative weights as shown in the source. While the relative weights do show a clearer pattern, the absolute weight changes are still less extreme in portfolio 2 than portfolio 1.

Region	Portfolio 1 vs Market - % Change	Portfolio 2 vs Market - % Change
United States	5.5%	6.0%
Canada	50.0%	6.0%
Europe	-47.3%	-22.0%
Asia	87.0%	30.0%

The first portfolio was completed using standard MVO, while the second portfolio used Black-Litterman.

Both portfolios show a significant decrease in Asian weight and decrease in European weight vs. the initial portfolio.

However, the relative changes in weights for portfolio 2 are smaller, and reallocation is closer to the market capitalization. We would expect this from Black-Litterman.

Portfolio 1 experiences large relative swings, commonly seen in MVO.

7. Continued

- (d) Identify the two market views expressed with respect to the Black-Litterman Portfolio above. Justify your response.

Commentary on Question:

Candidates were typically able to identify the two views regardless of performance on part (c). Full credit required justification using the shifts in portfolio weights.

The manager's views of the market are:

1. A long position in Asia
2. A short position in Europe

This can be determined by examining the relative portfolio weight changes for each region. Asia shifted by +30%, indicating a long position. Europe shifted by -22%, indicating a short position. The United States and Canada experienced equal changes of 6% - this is the residual impact of the optimization.

8. Learning Objectives:

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

Learning Outcomes:

- (2b) Evaluate how risks are correlated, and give examples of risks that are positively correlated and risks that are negatively correlated.
- (2d) Apply and analyze scenario and stress testing in the risk measurement process.
- (3a) Apply and construct risk metrics to quantify major types of risk exposure such as market risk, credit risk, liquidity risk, regulatory risk, etc., and tolerances in the context of an integrated risk management process.
- (3b) Analyze and evaluate the properties of risk measures (e.g., Delta, volatility, duration, VaR, TVaR, etc.) and their limitations.
- (4d) Demonstrate how derivatives, synthetic securities, and financial contracting may be used to reduce risk or to assign it to the party most able to bear it.
- (4e) Develop an appropriate choice of a risk mitigation strategy for a given situation (e.g., reinsurance, derivatives, financial contracting), which balances benefits with inherent costs, including exposure to credit risk, basis risk, moral hazard and other risks.

Sources:

ERM-611-17: Investment Management for Insurers, Chapter 26, The Use of Derivatives in Managing Equity Portfolios

ERM-110-12: Derivatives: Practices and Principles

Value at Risk, Jorion, Chapter 11, VAR Mapping

Commentary on Question:

Candidates generally did well in part (a) and (b) and struggled with the remainder of the question. This question tests candidates' understanding of the static and dynamic hedging processes and their application in three different hedging strategies. Many candidates did not attempt the calculations underlying these strategies, which were tested in parts (d), (e) and (f).

8. Continued

Solution:

(a)

- (i) Define dynamic hedging and static hedging approaches.
- (ii) Identify advantages and disadvantages of using each approach to hedge Guaranteed Living Benefit (GLB) variable annuity products, in general.

Commentary on Question:

Candidates did well on this part. Most were able to identify one advantage and one disadvantage of each hedging approach, which will earn full credit.

- (i) Dynamic hedging is the process of continuously rebalancing the hedge positions according to the market movement.
Static hedging is the process of entering a hedge and then leaving it without continuously rebalancing it.
- (ii)
 - Dynamic hedging advantage: Can continuously adjust the hedge positions to better match liability's risk from GLB variable annuity.
 - Dynamic hedging disadvantage: More expensive, particularly if the actual volatility turns out greater than expected.
 - Static hedging advantage: Simple to implement and less computationally intensive than dynamic hedging.
 - Static hedging disadvantage: The liability risk profile may change when the actual policy holder behavior is different from the expectation.
- (b) The junior actuary states "This monthly report is all we need to run a great hedge program for our GLBs."

Critique the junior actuary's statement.

Commentary on Question:

Candidates were able to point out that the statement is inaccurate. Two justifications were needed for full credit.

The junior actuary's statement is not accurate.

The estimation doesn't work well if there is a significant market move.

The estimation doesn't work well if there is a larger time lag as the liability characteristics may change and cause the risk profile to change.

8. Continued

- (c) A half-month has passed since the hedge report was produced. The equity market has increased by 2.00%, the interest rate curve has increased by 0.10% and equity volatility has dropped by 0.50%.

Estimate the change in the fair value of the liability since the hedge report date.

Commentary on Question:

Few candidates were able to correctly recite the full formula for the change in liability Fair Value. Most candidates only included Delta, Rho and Vega without considering Theta and the second derivative Gamma. Only a small number of candidates calculated the correct sign for Theta.

$$\begin{aligned}\text{Change} &= \text{Delta} * \text{Equity Market Change} \\ &\quad + 0.5 * \text{Gamma} * \text{Equity Market Change}^2 \\ &\quad + \text{Rho} * \text{Interest Rate Change} \\ &\quad + \text{Vega} * \text{Volatility Change} \\ &\quad + \text{Theta} * \text{Time Change}\end{aligned}$$

$$\begin{aligned}\text{Change} &= -7 * 2\% / 1\% \\ &\quad + 0.5 * 0.1 * (2\% / 1\%)^2 \\ &\quad + -1.2 * (0.1\% / 0.01\%) \\ &\quad + 24 * (-0.5\% / 1\%) \\ &\quad + 1 * (-0.5 / 1) \\ &= -14 + 0.2 - 12 - 12 - 0.5 \\ &= -38.3\end{aligned}$$

- (d) SLIC's current equity dynamic hedging strategy uses only equity futures to hedge 100% of liability equity delta. The hedging program uses E-Mini S&P future contracts. The notional value of one E-Mini future contract is 50 times the value of the S&P 500 index.
- (i) Calculate the number of E-Mini future contracts needed at time period 0 and time period 1, respectively. Round to nearest whole number of contracts. Show your work.
- (ii) Calculate the total hedge asset gain/loss at the end of time period 2 using your results from sub-part (i). Show your work.

Commentary on Question:

Very few candidates did well on this part. Most candidates were unable to recall the formula to calculate the delta of the future contract. Many candidates multiplied the liability equity delta by the fair value, which led to erroneous answers. In both subparts (i) and (ii), some candidates used an incorrect sign for the number of contracts (implying a purchase rather than a sale) and thus failed to get full credit.

8. Continued

(i)

1 Unit Future Delta = 1% of S&P 500 at current time period

1 Contract Future Delta = 50 * 1 Unit Future Delta

Number of Contracts = Liability Equity Delta / 1 Contract Future Delta.

Time period 0 contracts = $-7000 / (50 * 1\% * 2500) = -5.6$ or short 6 contracts

Time period 1 contracts = $-8000 / (50 * 1\% * 2000) = -8$ or short 8 contracts

(ii)

Gain/Loss = Number of Future Contract * 50 * S&P 500 Level Change

Gain/Loss from time period 0 to 1 = $-6 * 50 * (2000 - 2500) = 150,000$

Gain/Loss from time period 1 to 2 = $-8 * 50 * (1600 - 2000) = 160,000$

Total hedge asset Gain/Loss from time period 0 to 2 = $150,000 + 160,000 = 310,000$

- (e) You model another hedging strategy using both put options and equity futures to hedge 100% of the liability equity delta. The at-the-money put options are used to hedge 50% of the liability equity delta at time period 0 and then are held constant through time. The equity futures are used to dynamically hedge up to 100% of the liability equity delta for all time periods.

(i) Calculate the number of the at-the-money put options needed at time period 0. Show your work.

(ii) Calculate the number of E-Mini future contracts needed at time period 0 and time period 1, respectively. Round to nearest whole number of contracts. Show your work.

(iii) Calculate the total hedge asset gain/loss at the end of time period 2 under this strategy. Show your work.

Commentary on Question:

The calculations in this question are similar to part (d), and candidates tended to perform similarly. However, unlike part (d) which is only using dynamic hedging, this part tests candidates' understanding of a combination of static and dynamic hedging.

(i)

Number of put options needed at time period 0 = $50\% * \text{liability equity delta} / \text{unit put option delta}$

Number of put options needed at time period 0 = $50\% * -7000 / -10 = 350$

8. Continued

(ii)

At period 0:

As 50% of liability equity delta is hedged with equity futures at time 0. The number of future contracts is half from part (d)(i) = -3 contracts

At period 1:

Unit future delta = 1% of S&P 500 at time period 1 = 1% * 2000 = 20.

Unit contract future delta = 50 * unit future delta = 50*20 = 1000

Put option delta = number of put options * unit put option delta at time period 1 =
-12 * 350 = -4200

Thus, the residual delta that needs to be hedged by equity futures = -8000 - (-4200) = -3800

Number of equity futures contract needed at time 1 = -3800 / 1000 = -3.8, or short 4 contracts

(iii)

The future contract Gain/Loss from time period 0 to 1 is 50% of the same period result from Part (d)(ii) = 50% * 150,000 = 75,000 as the number of contract is -3

The future contract Gain/Loss from time period 1 to 2 is 50% of the same period result from Part (d)(ii) = 50% * 160,000 = 80,000 as the number of contract is -4.

Each put option's market value gain from period 0 to 2 = 950 - 300 = 650
Gain/Loss from put options from time period 0 to 2 = 350 * 650 = 227,500

Total Gain/Loss from period 0 to 2 = 227,500 + 75,000 + 80,000 = 382,500

- (f) You are concerned with the initial cost of the hedging strategy in part (e).
- (i) Construct a hedging strategy using a put spread to hedge 50% of the liability equity delta at time period 0.
 - (ii) Calculate the initial cost. Show your work.

Commentary on Question:

Overall, candidates did not perform well on this part. Many candidates did not recognize that a put spread is constructed by buying one at-the-money put and selling one out-of-the-money put. Instead, many candidates incorrectly pursued a zero-cost strategy.

8. Continued

(i)

Put spread = long at-the-money put and short out-the-money put

Unit put spread delta = at-the-money put option delta – out-the-money put option delta = (-10) - (-2) = -8

Number of put spread needed = 50% of liability equity delta / unit put spread delta = 50% * -7000 / -8 = 437.5 so buy 438 put spreads

Number of future contract needed to hedge the remaining 50% of liability equity delta = similar to part(e)(ii) = -3 contracts.

(ii)

There is no cost to enter future contracts.

Unit cost of put spread = at-the-money put option market value – out-the-money put option market value = 300 – 100 = 200

Total cost = number of put spread x unit cost = 438 * 200 = 87,600

(g)

- (i) Recommend one of the dynamic hedging strategies to the investment committee. Justify your choice.
- (ii) Propose two changes to SLIC's current GLB hedging process that would improve the hedging program.

Commentary on Question:

Candidates generally were able to provide a recommendation from one of the three hedging strategies. A sample solution for each of the hedging strategies is shown below. (Only one was needed for full credit). At least 2 reasonable justifications are needed for full credit in subpart (i). For subpart (ii), 2 recommendations are needed for full credit.

(i)

Sample solution 1:

- I would recommend a hedging strategy using only equity futures.
- This strategy has the lowest initial cost as there is no cost to enter equity futures.
- This strategy may not hedge well when there is a significant market move.
- However, the total cost may still be lower compared with the put options.

8. Continued

Sample solution 2:

- I would recommend a hedging strategy using both equity futures and put options.
- The cost might be higher than futures-only strategy, but it has better protection for the large market moves.
- Using both equity futures and put option is a good balance in terms of cost and protection.

Sample solution 3:

- I would recommend a hedging strategy using both equity futures and put spreads.
- This strategy further reduces the cost of put option
- This strategy can still provide better protection for the large market moves compared to using equity futures only.

(ii)

The current reports are produced and hedges are adjusted about 6 weeks following each quarter end. I would propose to produce the reports and rebalance more frequently: monthly, weekly or daily.

The current hedging process focuses only on delta. Vega is very large and therefore should be hedged, for instance, using VIX futures.