

ILA LAM Model Solutions

Fall 2020

1. Learning Objectives:

2. The candidate will understand and be able to assess issues and concerns common to actuarial models and their development and management.

Learning Outcomes:

- (2d) Describe and evaluate key components of model risk management
- (2e) Describe and apply model validation techniques and methods
- (2g) Describe best practices documentation and governance over assumptions used in models

Sources:

Model Validation for Insurance Enterprise Risk and Capital Models, Stricker et. al., 2014, (exclude appendices)

LAM-134-19: Supervisory Guidance on Model Risk Management, SR Letter 11-7, Board of Governors of the Fed Reserve System, 2011

LAM-133-19: Model Risk Mitigation and Cost Reduction Through Effective Documentation, PWC, 2013

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Critique each statement below in the context of Model Risk Management.
 - A. *There are five elements of model risk defined in “Model Validation for Insurance Enterprise Risk and Capital Models”. With respect to the management of this actuarial software, ABC should be concerned with all five risks.*
 - B. *To assess and manage model reporting risk, ABC plans to survey business users as to whether they consider the reports to be useful and meaningful for decision support. To avoid asymmetric user feedback, only users that are significantly affected by the model’s output are included in the survey.*

1. Continued

- C. *Allowing only in-house data and assumptions is the most effective way to manage vendor risks.*
- D. *An internal review group within XYZ performed a validation of the calculation engine prior to releasing the software to ABC. No further validation of the software is required by ABC.*
- E. *ABC's actuarial model validation framework is deemed satisfactory because ABC periodically reviews the quality and conceptual soundness of the model design and construction, and the methodologies used.*

Commentary on Question:

To get full credit, candidate must give a critique instead of only stating true or false with critique covering the key points. Most candidates did well on this section by providing correct judgement and reasonable justification.

- A. This statement is incorrect
 - Only 3 of the 5 elements are applicable to ABC: Input risk, Output risk, and Reporting risk.
 - ABC will not have to manage conceptual risk and implementation risk since this is maintained and developed by XYZ.
- B. This statement is incorrect
 - These users might also be motivated to provide asymmetrical feedbacks. These users often mix the report's usefulness with the effect the report's numbers have on the user's business. If the model results are favorable, then these users are inclined to give a more positive review than if the model outputs are putting the manager's unit under pressure
- C. This statement is incorrect
 - This statement assumes non-in-house input data cannot be properly reviewed for reasonableness and relevance.
 - If the company can develop a framework to properly investigate whether vendor provided input data or assumptions is relevant for the company's situation, the restriction of only using in-house data/assumptions is not the best approach.
- D. This statement is incorrect
 - Independence is not an end in itself but rather helps ensure that incentives are aligned with the goals of model validation.
 - ABC is required to judge the actions and outcomes to ensure objectivity and prevent any bias in XYZ's process of selecting staffs for the model validation work.
 - ABC also needs to evaluate the extent and clarity of the model validation documentations provided, the issues identified and the actions taken by XYZ to address any modeling issues.

1. Continued

E. This statement is incorrect

Validation does not only include assessment of the conceptual soundness of the model and ongoing monitoring for process verification and benchmarking, but also includes assessing if the model is performing as intended.

This means comparing model outputs to corresponding actual outcomes, such as back-testing.

(b) Identify the types of model documentation ABC should develop. Justify your answer.

Commentary on Question:

To receive full credit, candidate must justify their response and give a reasonable explanation of what additional document is needed.

Most candidates did not perform well on this part. Most candidates did not cover the three type of documentation or only knew the partial contents of model documentation.

- The user guide alone is not sufficient documentation to manage model risk. Comprehensive documentation includes model development documentation, model implementation documentation and on-going model governance documentation.
- The user guide provided by XYZ is considered model implementation documentation and is only 1 category of model documentation.
- ABC should also enhance the model implementation documentation to include information such as ABC-specific inputs and assumptions, description of ABC's process for the model, and how the model outputs will be used.
- While XYZ may not be able to provide specific detail around the proprietary information on the model development, they should still provide model development documentation.
- This documentation should include developmental tests performed on the model by XYZ, intended use and limitations of the model, and developmental data that can be shared with ABC, such as a data dictionary.
- ABC will also have to create on-going model governance documentation. This documentation will include plans for on-going model performance monitoring and outline the process for implementing and reviewing model changes.

2. Learning Objectives:

2. The candidate will understand and be able to assess issues and concerns common to actuarial models and their development and management.
3. The candidate will understand the principles of Asset-liability Management ("ALM"), and be able to describe and evaluate various techniques for addressing the mitigation of risk.

Learning Outcomes:

- (2c) Describe and evaluate best practices for actuarial model governance over process and controls
- (2e) Describe and apply model validation techniques and methods
- (2k) Describe and evaluate considerations related to modeling investments, discount rates, inflation and catastrophic mortality
- (3a) With respect to Asset-Liability Models:
 - Describe and apply the fundamental elements of the theory and practice of ALM in an insurance company, including assessing the dangers of mismatched assets and liabilities.
 - Describe and demonstrate how ALM can be used to identify and manage product and asset risks, including:
 - Major product risks for which ALM can be a useful tool for their management.
 - Using ALM as a means to manage interest rate risk, equity risk, and risks from optionality.
 - Describe how common insurance contracts and variations generate embedded options in an insurer's balance sheet, and assess basic strategies for managing exposures created by such embedded options.
 - Describe and apply the basic concepts of cash flow matching, immunization, duration/convexity matching, segmentation.
 - Describe and apply Key Rate Durations (KRD) and their use in evaluating interest rate sensitivities of portfolios, including understanding the derivation of KDRs, the profiles of KDRs for selected major asset types, and assessing KRDs in a portfolio context.
 - Describe and evaluate the Goldman Sachs' ALM/Strategic Asset Allocation approach for integrating ALM into an enterprise's risk and financial management framework.
 - Describe and evaluate ALM modeling considerations in the context of modeling risk aggregation, dependency, correlation of risk drivers and diversification.

2. Continued

Sources:

LAM-144-19: Framework for Use of Discount Rates in Actuarial Models

Data Visualization for Model Controls, Financial Reporter, Mar 2017

LAM-117-14: Key Rate Durations: Measures of Interest Rate Risk

Commentary on Question:

This question requires candidates to

- *Describe and apply different discount curves construction approaches*
- *Describe and apply data visualization controls*
- *Describe and apply Key Rate Durations (KRD) and their use in evaluating interest rate sensitivities of portfolios, including understanding the derivation of KDRs, the profiles of KDRs for selected major asset types, and assessing KRDs in a portfolio context.*

Solution:

- (a)
- (i) Compare the following principles used to construct discount curves:
- Matching Principle
 - Budgeting Principle
- (ii) Recommend which principle should be used to construct the discount curve. Justify your answer.

Commentary on Question:

Candidates did well in this question. For (i), most candidates understood the basic concepts of Matching and Budgeting Principle but need to provide 3 features/limitations respectively to receive full credits. For (ii) most candidates recommended Matching Principle but did not provide sufficient justifications.

- (i)
- Matching Principle
This is the family of calculations where the liability is valued by reference to market instruments (or models to simulate market instruments) that seeks to match the characteristics of the liability cash flows. Generally, the discount rates used are those implicit in the market prices of the matching market instruments or a reasoned best estimate if there is no deep liquid and transparent market.

2. Continued

Matching calculations can be particularly appropriate for transactional work. This includes the calculation of liabilities for company accounts, solvency reserves, capital adequacy requirements and in circumstances where it is desired to create an investment portfolio to match or hedge a liability.

Limitations: A matching framework does not imply the adequacy of assets to meet liabilities at all times unless the investment strategy provides a perfect match. Often there are no assets that replicate the liability cash flows exactly. In such circumstances, where matching calculations develop an appropriate proxy discount rate that is market consistent, it is appropriate to highlight:

- **Budgeting Principle**

This is the family of calculations where the valuation of the liability is approached from the viewpoint of how the liability is going to be financed and so the discount rate is often based on the expected returns from an agreed investment strategy.

Budgeting calculations can be appropriate in long term financial planning where a portfolio of investments is expected to accumulate to meet a liability.

It should be noted that the increased embedded risk (typically) in budgeting calculations puts a greater onus on actuaries to communicate the risks and the implications of adopting a budgeting calculation approach. Limitations: A budgeting calculation provides no information about the adequacy of assets in the matching framework (either currently or in the future). A budgeting calculation provides no information on the transactional value of the future cash flows.

(ii)

Recommend using the **matching technique** for the following reasons:

- The desire is to value the liability from a transactional perspective
- You have detailed information on asset holdings and can construct the replicating portfolio
- The investment strategy requires cashflow matching, so it is likely the existing portfolio can be considered a reference portfolio, and the value of the assets can be referenced for setting a discount curve that sets the value of the liability equal to the assets

(b)

- (i) Describe how data visualization could be used as an effective control.
- (ii) Recommend one effective data visualization control.

2. Continued

Commentary on Question:

Candidates did well in this question. For (i), most candidates were able to describe two effective uses of data visualization, some provided four to get full credits. For (ii), most candidates were able to provide an example but some did not provide any justification to their recommendation.

(i)

The best controls provide immediate and effective feedback on potential model exceptions. Usually the simpler a control is, the more effective it becomes. The key to making such controls effective is understanding the normal range of results as well as what typically causes outliers.

Some general rules for visualization in controls:

- Make controls as simple as possible, but as complex as necessary
- Provide immediate indications of actuals versus expectations
- Emphasize the critical data
- Changes in output values are often more informative than either the beginning or ending values
- Orient the data in the most user- friendly way
- Color draws the eye quicker than black and white
- Use a visualization style suitable to the purpose

(ii)

Any example with descriptions and justifications of the control:

For example, A line chart plotting the discount rate over time. Judgement could be used to apply a reasonableness bound around the line. This would allow user to identify outliers that may indicate an issue. One example could be to use a 1 standard deviation corridor.

- (c) After completing your task, you ask your manager to review and approve your work. Your manager sends the following response:

“I have reviewed for reasonableness, consider this my approval.”

Critique the response from your manager

Commentary on Question:

Candidates did poorly on this question. Some did not clearly state that manager’s response was not effective. Most candidate were able to provide at least one reason. Almost no candidate hit the last bullet point.

The signoff statement received is **NOT effective** for several reasons:

- It's not clear what model output has been scrutinized for reasonableness. May be an oversight in what precisely was reviewed.

2. Continued

- There is no definition of what constitutes reasonableness or where the boundaries of reasonableness lie. The model reviewer may have different judgement on what is reasonable vs. the model designer.
- With such a simple assertion of signoff, if the review was time sensitive, the depth and extent of review could be subject to variability.

(d)

- (i) Calculate the values for X, Y, and Z in the chart.
- (ii) Calculate the income impact from the following movement in interest rates:

In basis points	1 Year	5 Year	10 Year	20 Year	30 Year
Interest Rate Change	20	15	-30	-20	-5

Show all work, including writing out relevant formulas used in any calculations

- (iii) Recommend changes to the asset portfolio to reduce interest rate exposure.

Commentary on Question:

Part (ii) of this question could not be answered with the information given so it was excluded from grading. For (i), candidates did very well. For (iii), candidates did poorly as many candidates only discussed the interest rate exposure for asset only or effective duration only, without recommending any changes to address asset liability KRD mismatches.

(i)

Two answers were accepted for this question

Answer 1:

The candidate assumes the table is n-individual portfolios and the table uses effective durations.

$$X = \text{weighted average of asset durations} = (0.1*100,000 + 0.5*200,000 + 0.9*100,000 + 2*300,000 + 9.9*300,000)/1,000,000 = 3.77$$

$$\text{Asset Exposure} = (-0.1\%)*1,000,000*3.77*(-1) = 3770$$

$$\text{Liability Exposure} = -3770+(-200) = -3970$$

$$Z = -3970/1,000,000/(-0.1) = 3.97$$

$$Y = (Z - \text{weighted sum of other durations}) / \text{portfolio weight for Y} =$$

$$(3.97*1,000,000 - 0.05*100,000 - 0.4*100,000 - 1*300,000 - 12*300,000) / 200,000 = 0.125$$

2. Continued

Answer 2:

The candidate assumes KRDs and the portfolio size is irrelevant

$$X = \text{sum of asset KRDs} = 0.1 + 0.5 + 0.9 + 2 + 9.9 = 13.4$$

$$\text{Asset Exposure} = (-0.1\%) * 1,000,000 * 13.4 * (-) = 13400$$

$$\text{Liability Exposure} = -13400 + (-200) = -13600$$

$$Z = -13600 / 1,000,000 / (-0.1) = 13.6$$

$$Y = Z - \text{sum of Liability KRDs} = 13.6 - 0.05 - 0.4 - 1 - 12 = 0.15$$

(iii)

The portfolio is exposed to non-parallel curve movements because it is not key rate duration matched, particularly at the 30 year point where assets are shorter than liabilities.

To reduce the interest rate risk, the asset portfolio could be traded longer to close the key rate gaps. For example, buying more 30 year assets and selling some 10 and 20 year assets would close the majority of the risk.

(e) Explain how the key rate duration profile will change if:

(i) The coupon rate of the callable bond is the same as the non-callable bond.

(ii) The coupon rate of the callable bond is higher than the non-callable bond.

Commentary on Question:

Candidates did well in this question. Most candidates correctly described the behavior at short-term KRD but did not mention the behavior for long-term KRD. Also some candidates did not explain why callable bonds with same or higher coupon would result the corresponding behavior.

(i)

Callable bonds can be exercised at any time, so the duration is naturally lower than a non-callable bond. Short-term KRD will increase and long-term KRD will decrease comparing to non-callable bond

(ii)

There is a higher probability the bond will be called so the effective duration is shorter. Short-term KRD will further increase and long-term KRD will further decrease comparing to non-callable bond with lower coupon rate

3. Learning Objectives:

1. The candidate will understand, evaluate and use stochastic, generalized linear, multi-state, projection and transition matrix models. The candidate will demonstrate an understanding of their underlying methodologies, strengths, limitations, and applications.

Learning Outcomes:

- (1b) With respect to generalized linear models:
 - Describe and apply the basic principles of GLMs, and evaluate where GLMs might be useful in a Life Insurance context.
- (1c) With respect to multi-state and transition matrix models:
 - Describe and apply the methodologies for constructing multi-state and transition models in an insurance context.

Sources:

LAM-135-19: Stochastic Modelling, Theory and Reality from an Actuarial Perspective

NEW: Beware of Stochastic Model Risk!, Stroman, Risk & Rewards, SoA, Aug 2019

Common Misunderstandings of Risk-Neutral Valuation, Stroman, Financial Reporter, SoA, June 2019

Commentary on Question:

The purpose of the question was to test the Candidates knowledge of modeling concepts, random number generators and the application of risk neutral vs real world cash flow scenarios. Candidates performed fairly consistently across all subject areas and sub-questions.

Solution:

- (a) Critique the following statements about stochastic modeling:
 - A. *A stochastic model with a Normal distribution is a good option if it is difficult to determine the actual underlying distribution of the process being modeled.*
 - B. *Stress testing is always a good alternative to stochastic modeling.*
 - C. *When using an Economic Scenario Generator, real-world scenarios will produce a more realistic expected present value of cash flows than risk-neutral scenarios. This is because the real-world scenarios use a discount rate that reflects the risk associated with the cash flows.*
 - D. *Real-world scenarios cannot be used for a market-consistent valuation.*

3. Continued

- E. Risk-neutral scenarios are calibrated using observed market prices and therefore the calibration requires very little judgment.*
- F. The difference between the risk-neutral and real-world scenario paths is smaller when valuing long-term insurance contracts than when valuing short-term contracts.*

Commentary on Question:

The candidates that offered well defended and focused opinions regarding the statements did the best on this question.

- A. Using a Normal Distribution should not be the default for uncertain distributions. The Normal distribution does a poor job addressing distributions with fatter tails and other distribution alternatives may need to be considered.
- B. Stress testing is not always a good alternative to stochastic modeling. It is a good alternative if a model is sensitive to a particular assumption but stress testing does not address tail concerns adequately.
- C. Expected PV of cash flows is identical under real world or risk neutral valuations. Real world scenarios adjust the discount rate for risk while risk neutral scenarios adjust the cash flows.
- D. Real world scenarios can be used for market consistent valuation if they are calibrated on the valuation date for interest rates, volatility and the market price of risk.
- E. While this is not completely correct, it was important to note that significant judgment is required to determine the choice of the underlying stochastic process, volatility assumptions and the appropriate risk free rate.
- F. This is an incorrect statement since the difference is larger as time progresses. Real world interest rates have a term premium, which is a form of a risk premium, which increases by the length of time from the valuation date.

- (b) Recommend which Random Number Generator BNT should use. Justify your answer.

A Pseudo Random Number Generator would be appropriate since it is efficient and reproducible, if the same seed is selected. Defending why Pseudo Random Number Generator would be the best choice for BNT life, such as allowing for an audit trail, would also be required for full credit.

- (c) The Chief Actuary recommends that BNT use Monte Carlo modeling instead of Nested Stochastic modeling because it is more straightforward, and simulations would take less time.

Assess the Chief Actuary's recommendation. Justify your answer.

3. Continued

- For full credit, the candidate must defend either a recommendation for Monte Carlo or Nested Stochastic simulations based on the business case presented.
- Drawback of Monte Carlo simulation is the time required for convergence.
- Recommendation needs to address VA with guarantees issues: if BNT implements hedging, then Nested Stochastic would be best. Nested Stochastic uses an outer path (economic conditions) and inner path (fair market liabilities at select periods). Various shocks to the inner path can be used to determine the “Greeks”, which help to improve hedge effectiveness.
- Procedures exist that can be used to make Nested Stochastics perform more efficiently, such as distributed processing. Other techniques BNT could use to increase efficiency without losing much accuracy include reducing the number of model points, or reducing the number of outer paths, inner paths, or nodes. For example, they could only use the “worst case” inner paths.

4. Learning Objectives:

3. The candidate will understand the principles of Asset-liability Management ("ALM"), and be able to describe and evaluate various techniques for addressing the mitigation of risk.
4. The candidate will understand the basic design and function of Economic Scenario Generators and Equity Linked Insurance Models.

Learning Outcomes:

- (3a) With respect to Asset-Liability Models:
- Describe and apply the fundamental elements of the theory and practice of ALM in an insurance company, including assessing the dangers of mismatched assets and liabilities.
 - Describe and demonstrate how ALM can be used to identify and manage product and asset risks, including:
 - Major product risks for which ALM can be a useful tool for their management.
 - Using ALM as a means to manage interest rate risk, equity risk, and risks from optionality.
 - Describe how common insurance contracts and variations generate embedded options in an insurer's balance sheet, and assess basic strategies for managing exposures created by such embedded options.
 - Describe and apply the basic concepts of cash flow matching, immunization, duration/convexity matching, segmentation.
 - Describe and apply Key Rate Durations (KRD) and their use in evaluating interest rate sensitivities of portfolios, including understanding the derivation of KDRs, the profiles of KDRs for selected major asset types, and assessing KRDs in a portfolio context.
 - Describe and evaluate the Goldman Sachs' ALM/Strategic Asset Allocation approach for integrating ALM into an enterprise's risk and financial management framework.
 - Describe and evaluate ALM modeling considerations in the context of modeling risk aggregation, dependency, correlation of risk drivers and diversification.
- (3b) With respect to asset adequacy analysis and cash flow testing, describe and evaluate actuarial practice with respect to:
- Modeling and selecting assets and related assumptions (incl. modeling assets with contingent cash flow risks).
 - Handling liability cash flow contingencies and risks.
 - Setting up projection model parameters and assumptions.
 - Describe how Interest Rate Forwards and Futures and Swaps can be used in ALM, and apply the mathematics in given situations.

4. Continued

- (4a) With respect to Economic Scenario Generators:
- Describe the need for ESGs and explain the structure of ESG models and components.
 - Describe and apply basic default free interest rate models, including one-factor continuous time models.
 - Assess the propriety of a particular ESG model and related assumptions for particular applications.
- (4b) With respect to Equity-Linked models:
- Describe and apply methods for modeling long-term stock returns and certain guarantee liabilities (GMMB, GMDB, GMAB).
 - Describe and evaluate the Actuarial and Hedging risk metrics for GMAB and GMDB models.
 - Describe and apply methods for modeling Guaranteed annuity options and Guaranteed Minimum Income Benefits (GMIB), and EIA guarantees.

Sources:

LAM -139-19: Simulation of a Guaranteed Minimum Annuity Benefit, Freedman, 2019;
Excel Model - Stochastic Simulation of a GMAB Option (Accompanies Simulation of a GMAB)

Economic Scenario Generators: A Practical Guide, SoA, 2016, Chapters 1, 2, 4.1, 5, 6, 9, 10, 11.1, 11.3

Investment Guarantees Ch 6, Hardy, 2003

LAM-131-19: Life Insurance Accounting, Asset/Liability Management Ch 22

Commentary on Question:

This question tested the candidate's understanding of Economic Scenario Generators and products with various forms of financial guarantees

Solution:

- (a) You are developing an Economic Scenario Generator (ESG) suitable for this product.
- (i) Identify the key market variables required for the ESG.
- (ii) Justify why these variables are important for determining the liability of this product.

Commentary on Question:

Most Candidates identified at least to relevant variables with the foreign exchange rate being the most common one missed.

4. Continued

- Sovereign Interest Rates
 - Interest rates are used to discount the liability cash flows. Liabilities will increase as interest rates decrease
 - Nikkei Equity Returns
 - The company credits the policyholders with the Nikkei return. Decreases in the Nikkei index will increase the guaranteed benefit payout and increase the liability
 - Foreign Exchange Rates
 - ABC Life is a U.S. based company and its reserves is based in U.S. dollars. Even if the Nikkei index does not change the change in the foreign-exchange rate will impact the how much reserve ABC Life will need to hold
- (b) Based on historical returns of the Nikkei 225, YYG decided to adopt a regime-switching log-normal model to project real-world equity returns.

Discuss the pros and cons of this ESG choice.

Commentary on Question:

Most candidates identified the advantage of having fat-tails and having more than a single volatility regime as an advantage. Very few identified the path dependency advantage.

Pros

- It has a sound foundation, balancing practicality and completeness. This model is based on the logic that equity return volatility is different under recession and expansion conditions.
- It exhibits the fat-tail behavior, or it produces some extreme but plausible outcomes. When markets become more volatile, the risk of sudden decline in equity price is elevated.
- It is path dependent, the variable depends on the prior value of the variable
- It can accommodate many types of calibration across a range of benchmarks
- It can reflect historical equity returns and volatilities at different time horizons

Cons

- It may not be computationally efficient, having longer run times than a single-regime model
- Calibrating parameter and regime-switching probabilities can be complex and require significant expertise

4. Continued

- (c) Calculate the Expected Nikkei 225 Index Return in year 7 if the present value of future profit YYG expects to earn for this product is 0.
Show all work, including writing out relevant formulas used in any calculations

Commentary on Question:

Overall most candidates did and adequate job projecting fund values and decrements. Common mistakes included, reflecting company expenses as a charge against the fund value, excluding the rider fee as a charge against the fund and not including the M&E fee in the company profit calculations.

Model solution provided in excel

- (d) To improve competitiveness, the Marketing Officer has proposed a new voluntary reset feature for the GMAB rider:

“Policyholders are allowed a one-time reset of the GMAB guarantee to the current fund level at any time prior to maturity. If the reset is exercised, the maturity date of the Variable Annuity policy is reset to 7 years from the exercise date.”

- (i) Describe the additional risks YYG may face by adding this feature.
(ii) Recommend possible ways to mitigate these risks.

Commentary on Question:

While most candidates identified the risks inherent in introducing the feature, very few provided recommendations on ways to mitigate the risks for all of the risks identified

- (i)
- ABC would need policyholder behavior assumptions for how policyholders will choose to exercise this option. If ABC does not have the data to establish this assumption it would present a significant modelling risk
 - Usually GMAB does not appear very valuable but adding a reset can significantly increase tail risk as policyholder will reset when account values are higher than the guarantee increasing the change of a payout at a higher guarantee level
 - Increases the effect of concentrating risk across cohorts. Policyholders tend to reset when markets are good. In an extreme case all policyholders would have the same maturity date. If following returns are poor there will be a significant loss to fulfill the GMAB. Time diversification is lost

4. Continued

- It would create liquidity issues. Without the reset feature the maturity benefit is due at dates set at issue. With the reset the maturity date could extend at any time which makes liquidity planning more difficult.

(ii)

- Run full simulations to assess policyholder behavior under several possible responses to capture a range of possible reset option possibilities.
- Incorporate restrictions on the timing of the exercise the reset option.
- Establish frequent liquidity forecasts and conduct minimum liquidity access tests

(e) Critique the following statement from YYG's ALM department.

“For this product we recommend dynamically hedging delta and rho by rebalancing our hedge portfolio daily to ensure a close match. We are confident this is a cost-effective way to eliminate all risk for the company.”

Commentary on Question:

Most candidates identified daily rebalancing as being potentially very costly and that not all risks were hedged using just rho and delta. Very few identified that dynamic hedging can be ineffective in extreme market circumstance or the introduction of basis and operational risks.

- Hedging delta and rho only hedges the first order liability sensitivity to changes in the price of the stock index and interest rates respectively. These are the main market risks of this product and closely managing these exposures through dynamic hedging is a sound approach
- The company is not hedging second order sensitivities (gamma/convexity), nor are they hedging volatility (vega). Hedging these sensitivities could improve effectiveness.
- Daily rebalancing could be too frequent and not cost effective. Hedging second order risks or volatility may not be cost effective either as the options required to hedge these risks are more costly than futures/swaps
- Dynamic hedging may be temporarily ineffective in extreme circumstances
- Other risks such as basis risk and operational risks are created