CP 312 Model Solutions
November 2025

1. **Learning Objectives:**

1. The candidate will understand, develop, and evaluate cash flow models for various types of long-term insurance business. The candidate will demonstrate an understanding of underlying modeling methodologies: their strengths, limitations, and applications.

3. The candidate will understand and be able to apply appropriate model governance to assess and address issues common to the development and management of models.

Learning Outcomes:

(1a) Describe, develop, and evaluate models for insurance products including those with complex components such as:
- dynamic policyholder assumptions
- multi-states
- equity-linked guarantees
- index-linked credits

(1b) Describe, develop, and evaluate nested models

(3a) Describe and apply model governance best practices such as:
- Determining fit for purpose
- Model design and development
- Model risk management
- Model validation
- Model maintenance and change management
- Model and model governance documentation and disclosures

Sources:

- 1-8 – *Long-Term Actuarial Models, Part II* - Chapter 9 Fixed and Fixed Indexed Annuities
- 1-4 CP312-101-25: Stochastic Modeling, Theory and Reality from and Actuarial Perspective, sections I.A, I.B-1.B.3.a, I.B.4, III (4)
- 3-3 - Model Risk Management, American Academy of Actuaries, May 2019 (3)
- 3-1 - ASOP 56: Modeling Dec 2019, pp1-9 (1)
- 3-5 - Model Validation for Insurance Enterprise Risk and Capital Models, CAS/CIA/SOA, 2014 (excluding Appendices) (5)
- 3-2 - CIA Educational Note: Use of Models, Jan 2017 (2)

1. Continued

- 2-6 – CP312-104-25: Derivatives Theory and Practice by Jiri Witzany, Springer 2020, Chapter 7 -Interest rate models (6)
- 1-7 - Considerations Regarding Dynamic Lapses in Actuarial Modeling, AAA (7)

Commentary on Question:
Commentary listed underneath question component.

Solution:

(a) Describe two differences in modeling FIAs and MYGAs.

Commentary on Question:
Candidates performed was mixed on this question. Candidates who received full credit described the differences in credited rate, renewal cap and participation rate practices.

- FIAs require an expanded asset model to model the hedges required to support the index credits.
- MYGAs use a simple spread amount and for FIAs the spread amount is instead used to purchase options to cover the index credits.

(b) Recommend a possible modeling improvement to each of the following:

(i) The implied volatility rate assumption

(ii) The risk-free rate assumption

Commentary on Question:
Candidate performance was mixed on this question. For part (i), many candidates struggled to recommend an improvement that appropriately addressed stochastic volatility. For part (ii), most candidates were able to recommend using a yield curve of interest rates.

(i) The implied volatility rate assumption

- Introduce a volatility surface to the model to capture volatility nuances
- Model volatility stochastically – enhance the economic scenario generator to include VIX

(ii) The risk-free rate assumption

- Rather than hold the rate constant, use a vector of future interest rates based on the current yield curve.

1. Continued

(c) Recommend two methods to reduce the runtime. Justify your recommendation.

Commentary on Question:
Candidates performed well on this question. Candidates who received full credit were able to accurately elaborate on methods including reducing inner-loop calculation points, reducing the number of inner and/or outer scenarios, and compressing the liability cells.

- Reduce the number of inner-loop calculation points – consider the need to run the loop at that granular of a level. Switching to annually should reduce the run-time significantly.
- Reduce the number of liability cells by compressing the liabilities for similar policies. This would reduce the number of calculation points for both the inner and outer-loop calculations.

(d) Critique each of the following statements from a draft email response written by a coworker to management:

A. *Since the pricing model has been validated by the pricing team there is no further need for validation.*

B. *The assumptions used by pricing should be reviewed for appropriateness in a reserving calculation.*

C. *We have added the necessary functionality to model current and future assets, with all the assumptions provided by our investment team.*

D. *The pricing team is considered experts regarding this product, and we rely on their expertise; this reliance will be documented in our model documentation.*

E. *Since the pricing model for this product is included in the model inventory list, it is not necessary to add a new entry for the version used to calculate the reserve.*

Commentary on Question:
Candidates performed well on this question. Full credit was awarded to candidates critiqued the statement and provide valid supporting.

1. Continued

A. This is not correct – when a model has a new use case, limitations should be reconsidered from that lens.
B. This is also a correct statement – some of the assumptions that pricing uses could be too aggressive in a reserve calculation
C. This statement is correct. The statement also includes the disclosure of reliance on an assumption established by a party other than the actuary
D. Documenting reliance on outside experts is good, however the expertise in the product does not necessarily mean expertise in reserving or modeling.
E. A model inventory should be maintained by the ERM department, additionally there's evidence based on other statements that the model is materially different and could have a different risk rating.

(e) Management is provided a report with the following information (in millions):

Run Description	**VaR(90)**	**CTE(80)**
Base Run	-14.7	-16.0
Lapse up 10%	-15.5	-29.0
Interest Rates up 100bps	-15.0	-22.4

(i) Recommend a product feature that will help address the risks implied by the results.

(ii) Evaluate the quality of the report in the context of model validation. Justify your response.

Commentary on Question:
Candidates struggled on this question. For part (i), some candidates recommended assumption changes such as lapse assumptions instead of product features. For part (ii), few candidates commented on reporting risk.

(i) Recommend a product feature that will help address the risks implied by the results.

- Market Value Adjustments - this would work dynamically to increase or decrease the amount the policyholder could withdraw in different interest rate environments to share the market risk with the policyholder. This could help with the interest rate risk.
- Surrender Charge schedule - this would allow for recooping some of the initial expenses and potentially deter policyholder actions.
- Introduce a free partial withdrawal - this could keep full surrenders at bay by allowing some amount of money to come out of the contract without a fee
- Provide commissions upon renewals - this could get agents to help keep business inforce.

1. Continued

- Provide competitive renewal rates on inforce business - this would allow policyholders to participate in the increased interest rate environment while staying with the company

(ii) Evaluate the quality of the report in the context of model validation. Justify your response.

- The format of this report lends itself to being misinterpreted. If the decision-makers focused just on the VaR measure they might not think there's much lapse or interest risk. Because the model output is misleading this would be considered reporting risk.

2. Learning Objectives:

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Learning Outcomes:

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(3a) Describe and apply model governance best practices such as: • Determining fit for purpose
- Model design and development
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Sources:

- 1-6 - Predictive Analytic & Machine Learning -practical applications for actuarial modeling (nested stochastic) Sections 1.2-1.3, 3-6 SOA Research Institute May 2023 (6)
- 3-4 – C312-110-25: Model Governance in the Insurance Industry: A Comprehensive Guide – June 2024 (4)
- 3-7 – CP312-111-25: Machine Decisions: Governance of AI and Big Data Analytics (7)
- 1-9 – CP312-102-25: Heavy Models, Light Models and Proxy Models Chapters 1-5 (9)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Evaluate whether Black-Scholes should be used to model the crediting strategy for this product.

2. Continued

Commentary on Question:
Candidate performance was mixed on this question. Most candidates were able to identify that Black-Scholes would not be appropriate, but some candidates were unable to adequately elaborate on the reasoning.

Using Black-Scholes would be inappropriate for this crediting strategy. The monthly point-to-point crediting method does not have a payoff like a typical call or put option. Additionally, the use of a proprietary volatility control index would add additional complications to that calculation.

(b) Assess the appropriateness of the following steps to calibrate and test a machine learning proxy model using Monte Carlo valuation of this product.

(i) Overview and problem statement: Perform the valuation of the non-traditional option using deterministic equity paths and stochastic interest rates.

(ii) Preparation: Decide which software to use to build the model.

(iii) Data Generation: Randomize the features or input fields driving change in the market value of the options. Target 1,500 - 3,000 observations with 50% of them being reset and 50% being in between annual resets.

(iv) Feature Engineering and Selection: Not needed because enough data was generated in an earlier step. This step is only needed to reduce runtime.

(v) Model Testing and Selection: Select and test various machine learning models. Calculate R2 and a mean absolute error for each model tested to assess the fit.

(vi) Actuarial Evaluation: Compare results from the machine learning model to the results by the actuarial model, assessing the fit of the model against industry benchmarks.

Commentary on Question:
Candidates performed well on this question overall. Full credit was awarded to candidates who assessed the statement and provided valid supporting points.

(i) This is not a correct statement. The appropriate modeling would involve using deterministic interest rates and stochastic equity paths.

2. Continued

(ii) This statement is not complete. Part of preparation includes loading external packages, and defining user functions and inputs

(iii) This statement is not correct. The target number of observations is too low, and the split of the reset/between reset observations is too heavily weighed on reset.

(iv) This is not a completely correct statement. Based on the number of observations targeted in iii this is not enough. The second sentence is correct.

(v) This is a correct statement

vi) This statement has an error in it. Industry benchmarks would not exist for this sort of comparison. Instead, actuarial first principles should be used and statistical measures.

(c) Recommend two features to include in the proxy model to provide greater predictive power. Justify your recommendations.

Commentary on Question:
Candidates performed poorly on this question. Credit was not awarded for responses that referenced the initial index level or volatility, as these inputs are fixed and not candidate features.

- Monthly Index Level – with the monthly point-to-point crediting this feature would capture possible payout options.
- Cap rate – this is the maximum that would be credited each month
- Current Index Level - include this feature as a core product feature in measuring option payouts
- Risk-free rate - current risk-free rate
- Monthly Index level to current - engineered feature that would assist in seeing how historical results would look at the current index level
- Black-Scholes valuation (call spread) - engineered feature approximation of each option price at the current index with caps in place
- Black-Scholes valuation (at the money call) - engineered feature approximation of option prices without caps
- Reset Indicator - binary variable to indicate if the policy is at the annual reset or not - this would be important to consider since the time to maturity could be fixed with this structure of product
- Discount Factor - engineered feature - another variable that could have high predictive power.

2. Continued

(d) Recommend two validation techniques to gain assurance that the results from the proxy model are appropriate for this use case. Justify your recommendations.

Commentary on Question:
Candidates struggled on this question. Few candidates cited validation techniques relevant for this use case, which related to feature interpretability. Full credit was also rewarded to responses that identified other interpretability techniques, such as visualization, feature importance analysis, model-agnostic explanations and provided a sound rationale for each.

1) Global variable importance - ranks the overall impact of features on model predictions. This is one that should be included to understand each of the features' importance in the predictions
2) Partial dependency plots - show how the overall prediction varies over the range of values for that feature
3) LIME (Local Interpretable Model-Agnostic Explanations) – this would help the user to understand the impact of locally important features in explaining a single result.
4) SHapley Additive exPlanations (SHAP): Alternative to LIME. It explains the result in terms of the weight of different features in giving rise to that prediction. Connects game theory with local explanations.

(e) DFW Life's ERM team is concerned about the regulatory environment regarding AI and bias.

(i) Assess the Monte Carlo proxy model developed in part (b) for bias and fairness. Justify your response.

(ii) Contrast the AI regulatory environment between the United States and other countries.

Commentary on Question:
Candidates performed poorly on part (i) but performed well on part (ii). For part (i), most candidates were able to explain model bias in general but did not adequately assess the Monte Carlo proxy model. For part (ii), candidates received partial credit if they commented solely on the U.S. AI regulatory environment without explicitly contrasting it with other countries.

(i) A Monte Carlo simulation that is designed to replicate the results of an actuarial model does not have much of a bias concern.
The concern regarding bias is generally focused on models that introduce unfair consequences to individuals.

2. Continued

(ii) The EU has a set of regulations that apply to public and private entities. The US, however, does not have regulations that apply to the entire country. The NAIC is working to provide guiding principles, and some states have passed regulations governing aspects of machine learning models.

3. Learning Objectives:

2. The candidate will understand, apply, and evaluate non-cash flow and supplementary models for various types of financial business. The candidate will demonstrate an understanding of underlying methodologies: their strengths, limitations, and applications.

3. The candidate will understand and be able to apply appropriate model governance to assess and address issues common to the development and management of models.

Learning Outcomes:

(2a) Describe, apply, and assess types of models such as the following and evaluate the appropriateness of their usage:
- Economic Scenario Generators (ESGs)
- Market Risk Models
- Other statistical models

(2c) Describe, apply, and evaluate model *efficiency* techniques

(3a) Describe and apply model governance best practices such as: • Determining fit for purpose
- Model design and development
- Model risk management
- Model validation
- Model maintenance and change management
- Model and model governance documentation and disclosures

Sources:

2-6 - Derivatives Theory and Practice by Jiri Witzany, Springer 2020, Chapter 7 -Interest rate models (6)
2-14 - Ch 1-3, 6 of Metamodelling for variable Annuities, Gan and Valdez (14)
3-3 - Model Risk Management, American Academy of Actuaries, May 2019 (3)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Hull-White (HW) 1-factor model and Libor Market Model (LMM) are models used to stochastically project future interest rate scenarios.

Identify the following features for each of the two models:

(i) Type of model (i.e., short rate or term structure)

3. Continued

(ii) Ability to reflect mean reversion of interest rates

(iii) Possibility of forecasting negative interest rates

(iv) Other notable strengths of each model

Commentary on Question:
Candidate performance was mixed on this question. For part (i), most candidates did well. For parts (ii) and (iii), many candidates did fairly well; however, a few candidates didn't attempt these parts. Candidates struggled more on part (iv) to identify an additional notable strength for each model.

(i) Type of model (i.e., short rate or term structure)
- HW is a short rate model - models the instantaneous interest rate r(t)
- LMM is a term structure model - models the entire yield curve

(ii) Ability to reflect mean reversion of interest rates
- HW is a mean reverting model
- LMM is not a mean reverting model

(iii) Possibility of forecasting negative interest rates
- HW can forecast negative interest rates
- LMM cannot forecast negative interest rates

Note: The following responses are also acceptable:
- Shifted LMM can forecast negative interest rates
- LMM can produce negative forecasted interest rates if the yield curve is downward sloping

(iv) Other notable strengths of each model
- HW other strength: Can exactly fit current term structure of interest rates
- LMM other strength: Often considered the best candidate for a universally acceptable interest rate model

(b)

(i) Describe the general method for calibration and validation of interest rate models

(ii) Assess the applicability of the method to the HW and LMM models

3. Continued

Commentary on Question:
Candidate performance was mixed on this question. For (i), most candidates were able to describe the key ideas of the calibration and validation process. For (ii), while many candidates correctly identified the HW and LMM models as non-arbitrage models, most candidates were not able to make the connection that calibration would not be required.

(i) Describe the general method for calibration and validation of interest rate models

General calibration process is an optimization procedure, goal to minimize differences between observed & modeled prices

Total Loss = Sum from i = 1 to n of w(i) x L(P(i), PM(i)), where

- n is number of calibration instruments,
- w(i) is weight assigned to point I,
- P(i) is observed price at point I,
- PM(i) is modeled price at point I,
- L is loss function taking the form of $L(x,y) = (x - y)^2$ or L(x,y) = absolute value of (x – y)

Models can be validated by comparison to benchmark models, testing for stability with respect to calibration inputs, inspection of distribution characteristics with respect to actual / historic data

Independent validation includes qualitative assessment of method and implementation correctness, consistency, appropriateness

(ii) Assess the applicability of the method to the HW and LMM models

HW and LMM are non-arbitrage models, for which the term-structure is automatically fit by construction of the model, so no calibration is required

(c) A fixed indexed annuity (FIA) profitability model measures present value of net income at CTE(70) for a large in-force block, using 1,000 projected economic scenarios. The model owner is investigating methods to reduce runtime.

(i) Describe the scenario ranking method.

(ii) Outline the steps to improve the accuracy of scenario ranking method.

(iii) Describe the cluster modeling method.

3. Continued

Commentary on Question:
Candidates performed well on this question. In general, candidates had a good understanding of scenario ranking and cluster modeling topics.

(i) Scenario ranking
- Select random subset of policies
- Run subset through all 1,000 scenarios
- Order results to identify worst 300 scenarios
- Run all policies through worst 300 identified above
- Calculate CTE 70 based on this result

(ii) Improve accuracy
- Apply clustering techniques to select subset of policies
- Run all policies through worst 400 scenarios selected on the basis of this subset
- Base CTE 70 on 300 worst scenarios from among the 400 scenarios run

(iii) Cluster modeling method
- Select representative policies that resemble characteristics of the full in-force
- Convert portfolio of policies to a matrix with one row for each policy, normalize each column using z-score or minimax
- Apply clustering algorithm to divide rows into clusters, select a representative policy closest to center of each cluster
- Scale each representative policy to represent size of its cluster, and use set of representative policies in place of portfolio

(d) The FIA profitability model is an Excel model that is not part of a production environment.

Propose a process control plan for this model.

Commentary on Question:
Candidates performed well on this question. Overall, most candidates were able to propose several different process controls with explanation.

- Process controls
  - Data integrity: reconcile model data to actual data
  - Model validation: review inputs, mechanics, parallel test, back test, performance monitoring, appropriate for use
  - Projection dynamics: verify model growth rates are consistent with start assets, reinvest strategy, asset growth assumptions

3. Continued

- Increase focus on process controls because spreadsheet is not in a production environment
- Restrict model location to prevent unintended access
- Require password to access the model
- Develop detective controls to identify unauthorized changes

4. Learning Objectives:

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Learning Outcomes:

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- Other statistical models

(2c) Describe, apply, and evaluate model *efficiency* techniques

Sources:

2-5: Quantitative Enterprise Risk Management, Hardy, Mary and Saunders (5)

2-13: CP312-102-25: Heavy Models, Light Models and Proxy Models Chapters 1-5 (13)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Describe three aspects of a proxy model that need to be evaluated before using it for this purpose.

Commentary on Question:

Candidates performed fairly on this question. Most candidates were able to describe one or two aspects adequately for partial credit, but candidates generally struggled to describe all three.

The quality of fit:

The accuracy of the results can be determined using a variety of statistical methods. One aspect of this is comparing distribution accuracy versus scenario accuracy.

In the case of EWR Life, the distribution accuracy is more of the focus as compared to the individual scenarios themselves as the model output is designed to show the range of stochastic possibilities and not focused on any individual scenario.

4. Continued

Ease of Implementation and Cost:
There are competing challenges of speed and quality that can drive the implementation ease and ongoing maintenance cost.
For EWR Life, the results of the quarterly projections are for internal reporting and decision making, so the calibration standard may not be as strict as it would be for external reporting for regulators.

Model stability:
The proxy model output should not change significantly for small changes to inputs.
Changes to the proxy model results should be similar to changes in the heavy model results.
For EWR Life, we would not want the quarterly model results to swing wildly in any back-testing of the model, including for the random number generator seeding of the scenarios.

Complexity:
All models are simplifications of real-world results. There is a tension between the complexity of a proxy model and the accuracy of its representation of the real world.
The more straightforward a proxy model, the higher the level of intuitive understanding it provides but also typically the less relation it might have to reality.

For EWR Life, it is important that senior management (and the board) trust the model. Therefore, they need to trust the information that the model provides or understand the model enough themselves. The decision was to make the model simply enough to describe what is occurring even if this reduced the dependability of the model.

(b) Calculate the probability for each of the following events occurring for each of the stochastic processes at the end of policy year 3:

(i) There is no index benefit paid.

(ii) An index benefit of 7% is paid.

You are provided output from the current scenario generator for 1000 scenarios in the Excel workbook, tab "Q4_Returns".

(iii) Compare the results from parts (i) and (ii) with the provided returns.

4. Continued

Commentary on Question:
Candidates performed poorly on this question. For (i) and (ii), many candidates could identify the probability they needed to calculate, but very few candidates were able to perform the necessary calculations. For (iii), some candidates successfully calculated the probabilities from the AAA scenarios, but very few candidates were able to compare these results with those from the ILN and GARCH models due to difficulties with parts (i) and (ii).

Model solution for this question is attached in the excel spreadsheet.

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- index-linked credits

(1b) Describe, develop, and evaluate nested models

Sources:

1-3: Long-Term Actuarial Models Part II (Tim's Book & Excel Workbook), Chapter 1 Introduction to Modelling (excluding section 1.5) (3)

1-8: Long-Term Actuarial Models Part II (Tim's Book & Excel Workbook), Chapter 9 Fixed and Fixed Indexed Annuities

3-1: ASOP 56: Modeling Dec 2019, pp1-9 (1)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Evaluate the impact of each of the following simplifications on model accuracy, reliability, and efficiency:

(i) Reserves are set equal to account value.

(ii) Policyholder behavior modeled using a static lapse assumption.

Commentary on Question:

Candidates performed well on this question. Candidates who received full credit demonstrated a clear understanding of the pros, cons, and impact for each simplification.

5. Continued

(i) Reserves are set equal to account value.

Pros: simplifies calculation, ignores statutory, GAAP, or economic capital requirements

Cons: may understate reserves, especially in stressed interest environments

Impact: inadequate for solvency, valuation or realistic capital planning

(ii) Policyholder behavior modeled using a static lapse assumption.

Pros: simplifies modelling by applying a constant lapse rate across time and scenarios, reducing data and calibration requirements

Cons: ignores how lapses may vary with economic conditions, crediting rates, or surrender charge schedules

Impact: may mis-state projected cash flows and reserve levels, especially during interest rate shifts when lapse behavior tends to be highly sensitive

(b) Critique each of the following statements for a MYGA pricing model:

A. An annual time-step will greatly reduce model runtime with minimal loss of accuracy.

B. An effective way to model a portfolio crediting rate strategy is to use the updated asset portfolio rate at the end of the current time-step as the crediting rate for the next time-step.

C. If a proxy model is being used for asset portfolio yields, the projected portfolio rate should be adjusted downward whenever there is negative cash flow.

D. Lapses can be adequately projected using a static lapse assumption.

Commentary on Question:
Candidates performed fairly on this question. Candidates were required to critique the statement and provide valid supporting points to receive full credit.

5. Continued

A – False

While it is true that an annual time-step reduces model run time and simplifies calculations, the assumption of "minimal loss of accuracy" doesn't hold for fixed annuity products with complex guarantees. An annual time step removes the need to model "interim values and policy activity including in-the-moneyness and policyholder behavior". This omission can lead to material inaccuracies.

B – True

This is a common practical method for modeling the relationship between asset returns and credited rates for MYGAs.

C – False

The statement is false. Under the asset proxy modeling approach, the portfolio rate is held constant when negative cash flow occurs. The model does not adjust the portfolio rate downward to reflect asset liquidation or reinvestment at lower yields.

D – False

While static lapse assumptions can be used for simplicity, they often fail to capture the dynamic and economically sensitive nature of policyholder behavior in real-world applications. A MYGA model usually uses a dynamic lapse formula that adjusts lapse rate based on who the credited rate compares to a scenario-based competitor rate, reflecting variation in lapse behavior across economic conditions. To conclude, static lapse assumption is not adequate for realistic projection for behaviorally sensitive products.

(c) YYZ plans to invest MYGA funds in government bonds, corporate bonds, mortgages, and asset-backed securities.

Evaluate the advantages and disadvantages of using a proxy model for asset portfolio yields that allocates a fixed percentage of investable cash flow to 5-year, 10-year, and 20-year corporate bonds, assuming a single Portfolio Spread.

Commentary on Question:
Candidates performed well on this question. Candidates who received full credit cited more than one advantage and more than one disadvantage, demonstrating a clear understanding of key ideas including computational simplification, duration management, and omissions like credit risk and spread volatility.

5. Continued

Advantages

- Using an asset proxy model for portfolio yields simplifies the implementation, a gain of computational efficiency. It avoids the need for full asset-liability modelling or stochastic reinvestment modelling.
- Using a constant spread within a projection scenario and across all scenarios is one of many strong simplifications
- Allocating a fixed percentage of cash flows to multiple bond tenors allow for a basic approximation of duration management, which supports liability-driven investment strategies for MYGAs.

Disadvantages

- The simplification omits critical asset characteristics such as credit ratings, spread volatility and duration effects, which are key to accurate Pricing.
- The single spread approach doesn't account for spread volatility across market cycles. In practice, spread varies across scenarios.
- The asset proxy models ignore price changes from interest rate risk, capital gains and losses, and credit risk.

(d) You are thinking about using a third-party model to price YYZ's MYGA product. You have limited access to the source code and assumptions but have been provided with high-level documentation and output reports.

Describe two considerations about this model before relying on it based on guidance from ASOP 56.

Commentary on Question:
Candidate performed fairly on this question. Most candidates were able to cite considerations from ASOP 56; however, many candidates did not relate these considerations back to the MYGA model specifically and therefore received only partial credit.

- Intended purpose - confirm the model is designed for pricing fixed deferred annuities like MYGAs, including features such as guaranteed multi-year crediting and early withdrawal options.

- General operation - understand how the model projects account value, apply credited interest and handle surrender/free withdrawals.

5. Continued

- Major sensitivities and dependencies - identify which assumptions (e.g. lapse rates, crediting rates) materially affect the model output for MYGA profitability.

- Key strengths and limitations - evaluate whether the model adequately represents important MYGA elements (e.g. surrender charge, expense), and what might be missing or oversimplified.

6. Learning Objectives:

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Learning Outcomes:

(3a) Describe and apply model governance best practices such as: • Determining fit for purpose
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Sources:

3-5 : Model Validation for Insurance Enterprise Risk and Capital Models, CAS/CIA/SOA, 2014 (excluding Appendices) (5)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) You are tasked with creating a new pricing model for the VUL product. Your manager proposes to start with the current ULSG pricing model and only update the interest rate scenarios, since these products have the same risks.

Evaluate your manager's proposal.

Commentary on Question:

Candidates performed well on this question. Candidates who received full credit clearly explained the differing risks between ULSG and VUL and noted that the equity returns need to be incorporated for the VUL product.

The manager is correctly stating that you can start with the ULSG pricing model to create a new pricing model for the VUL product. However, these products do not have the same risks, and the VUL model needs to include stochastic equity scenarios. The VUL product includes market risk since crediting is tied to the equity funds while the ULSG has interest rate risk that the VUL product will not have.

(b) Propose a way to benchmark performance between the VA model and the new VUL model.

6. Continued

Commentary on Question:
Candidates performed well on this question. Full-credit responses explained that benchmarking to the VA model should include only equity returns and should exclude fixed income returns.

The VUL pricing model can benchmark its results with the VA separate account returns by taking the S&P500 returns and regressing the funds being offered with the VUL with the S&P500. It is important that the benchmark does not include any fixed income returns due to VUL only offering equity funds. Back-testing using the last 30 years and benchmarking with those returns is also necessary to include market returns that are not relevant to the current market environment.

(c) Recommend the depth of a validation report for the VUL model.

Commentary on Question:
Candidates performed fairly on this question.

The depth of the validation should be categorized as superficial, furth validation required. The main reason for this being that ABC does not have the expertise to validate the model because the staff contains one director and a student who has less than a year of experience.
The results of the validation are also inadequate, requiring improvement.