

AFE Complete Illustrative Solutions

Fall 2011

1. Learning Objectives:

1. The candidate will understand the types of risks faced by an entity and be able to identify and analyze those risks.

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

Learning Outcomes:

- (1a) Identify and analyze financial market risks faced by an entity, including but not limited to: currency risk, credit risk, spread risk, liquidity risk, interest rate risk, and equity risk.

- (1e) Identify and analyze systemic risks faced by an entity, including but not limited to financial contagion.

- (4e) Describe and evaluate risk management techniques that can be used to deal with financial and non-financial risks.

- (4q) Define liquidity risk.

- (4r) Explain methods for managing this risk, both pre-event and post-event.

- (4s) Evaluate examples of company disasters that were the result of these types of risks – what the exposure was, what occurred, the sequence of events, what actions management took, didn't take and could have / should have taken, what the financial impacts and general consequences were.

Sources:

FE-C174-10: Deciphering the Liquidity and Credit Crunch 2007-2008, Brunnermeier

Liquidity Risk Measurement, CIA Educational Note

FE-C102-07: General American Life Can't Pay Investors, Looks at Suitors

Operational and Reputational Risks: Essential Components of ERM by M. Rochette, Risk Management, December 2006

1. Continued

Commentary on Question:

This question was focused on liquidity risk. Candidates generally did well on this question.

Part (a) is retrieval, parts (b) and (c) move up in cognitive level to analysis, and part (d) is knowledge utilization.

Solution:

- (a) Define liquidity risk.

Commentary on Question:

Most candidates were able to give the basic definition of liquidity risk. However, many candidates ignored the means of meeting financial commitments through ongoing cash flow.

- Inability to meet financial commitments as they fall due through ongoing cash flow or asset sale at fair market value.

- (b) Evaluate the liquidity risk for each of Zoolander's four lines of business.

Commentary on Question:

Candidates were able to describe the liquidity risk either from the perspectives of product feature or asset allocation. Not many candidates were able to evaluate the liquidity risks from both perspectives for all four product lines. For the variable annuity line of business, many candidates missed the point that VA is a separate account product.

- GIC:
 - Downgrade put option greatly increases liquidity risk
 - Surrender charge decreases liquidity risk
 - High allocation to illiquid assets
 - Asset/Liability mismatch
- Disability:
 - Base policy poses little liquidity risk due to not having a cash-out position
 - Return of premium rider increases liquidity risk
 - Base policy is reinsured but the ROP rider is not
 - Less allocation to illiquid assets
- Term:
 - Non-cashable
 - Reinsurer was downgraded
 - High allocation to illiquid assets

1. Continued

- VA:
 - Separate account product
 - Guarantees increase liquidity risk
 - High allocation to illiquid assets

(c) For each scenario:

- (i) Classify the scenario as a reputational or a market-wide liquidity crunch event.

Commentary on Question:

Many candidates misinterpreted this part of the question, which was supposed to be classifying two different types of liquidity crunch events.

- The first scenario is a reputational liquidity event since it impacts Zoolander only.
- The second scenario is a market-wide liquidity event since it impacts the entire market.

- (ii) Describe the risks to Zoolander's ability to operate as a going concern and the consequences if those risks materialize.

Commentary on Question:

For the first scenario, many candidates did not address the consequences from the ratings perspective. Most candidates did better for the first scenario than the second scenario.

- Scenario I:
 - Lower new sales
 - Surrenders increase
 - Possible downgrade, which might trigger the put option on the GIC
- Scenario II:
 - Unable to liquidate any assets for normally occurring cash outflows
 - ROP or GICs may cause crisis due to not being able to sell any assets besides government bonds
 - Be forced to liquidate all its government securities

- (d) Evaluate the appropriateness of each action as a means of Zoolander improving its liquidity risk profile.

Commentary on Question:

Most candidates were able to identify the pros of each option, not the cons.

1. Continued

- Revise product design to increase surrender charges
 - Improves the liquidity risk profile through deterring surrenders
 - Might be less competitive in the market
 - Appropriate from the long-term perspective
- Reallocate the fixed income portfolio to hold more Treasury securities
 - Treasury securities are more liquid and have low risk
 - Might lower asset returns, thus lowering crediting rate (making GICs less competitive)
 - Appropriate since the current allocation percentage is low
- Establish a \$2 million line of credit with a bank at a cost of \$20,000 per annum
 - Would be able to alleviate some liquidity risk
 - There would be additional counterparty risk
 - Might not be enough in case of liquidity crisis
 - Appropriate for reputational liquidity crunch but not appropriate for market-wide liquidity crunch events

2. Learning Objectives:

1. The candidate will understand the types of risks faced by an entity and be able to identify and analyze those risks.
4. The candidate will understand the means available for managing various risks and how an entity makes decisions about appropriate techniques.
5. The candidate will understand the components of an ERM framework and be able to evaluate the appropriateness of a framework in a given situation.
6. The candidate will understand the structure of an ERM process in an entity and be able to demonstrate best practices in enterprise risk management.

Learning Outcomes:

- (1d) Identify and analyze strategic risks faced by an entity including, but not limited to
 - Product sustainability risk
 - Distribution sustainability risk
 - Consumer preferences and demographics
 - Geopolitical risk
 - Competitor risk
 - External relations risk
 - Legislative/Regulatory risk
 - Reputation Risk
 - Sovereign risk
- (4t) Define strategic risk.
- (4u) Explain methods for managing this risk, both pre-event and post-event.
- (4w) Define operational risk.
- (4x) Explain methods for managing this risk, both pre-event and post-event
- (5b) Describe the fundamental concepts of risk management and evaluate a particular given risk-management framework.
- (5c) Demonstrate how an organization can create a risk management culture including: risk consciousness, accountabilities, discipline, collaboration, incentives, and communication.
- (6a) Demonstrate the ERM process steps to be followed once the ERM framework is in place:
 - Risk identification
 - (i) Defining and categorizing risk
 - (ii) Qualitative risk assessments

2. Continued

- Risk quantification
 - (i) Scenario development / types of scenarios
 - (ii) Individual risk quantification, including inherent vs. residual exposures
 - (iii) Quantifying enterprise risk exposure, including correlations of risks
 - Risk management
 - (i) Defining risk appetite
 - (ii) Managing enterprise risk exposure towards risk appetite
 - Internal reporting
 - (i) Performance measurement
 - (ii) Performance management and incentive compensation
 - External disclosures
 - (i) Shareholders
 - (ii) Rating agencies
 - (iii) Regulators
- (6c) Articulate risk objectives; demonstrate how to define and measure an organization's risk appetite; and demonstrate how an organization uses risk appetite to make strategic decisions.

Sources:

Segal, *Corporate Value of Enterprise Risk Management*, Ch. 3

FE-C159-09: Countering the Biggest Risk of All, by Slywotzky and Drzik - Harvard Business Review, April 2005

Economic Capital Modeling – Practical Considerations - Milliman

FE-C106-07: Mapping of Life Insurance Risks, AAA Report to NAIC

Operational and Reputational Risks: Essential Components of ERM, by M. Rochette, Risk Management, December 2006

Commentary on Question:

The question was trying to test the candidates' understanding of a value-based risk measurement approach and applying it in a real-world case (using the case study). Parts (a) and (d) of this question were retrieval. Part (b) was comprehension. Part (c) was analysis. Part (e) was knowledge utilization.

Candidates did not elaborate on their responses especially for sections that were worth more points (such as part (e)). Candidates also often provided generic responses versus addressing the issue at hand that was related to Zoolander.

Candidates did well in identifying the strategic risks and providing recommendations on how to mitigate this risk. Most candidates were successful in identifying the major components of the FMEA technique.

2. Continued

Solution:

- (a) Define and describe both operational risk and strategic risk.

Commentary on Question:

Candidates did well on this part of the question.

- Operational risk is the risk of loss due to failure in the course of operating business such as human resources/people, technology/systems, or processes.
- Operational risk can also be due to ineffective internal control policies, inadequate information systems, fraudulent or unforeseen circumstances, or blind reliance on third parties or vendors.
- Strategic risk is the risk of loss due to external factors that change the business paradigm and affect a company's trajectory and shareholder value.

This risk can also be caused by the company's choices as it relates to:

- Products to sell
- Distribution channel to use
- Customer markets to sell/cater to
- Value proposition to offer

Strategic risk can also arise from an entity's inability to implement appropriate business plans, to make decisions, to allocate resources or to adapt to changes in the business environment.

- (b) Explain the benefits of a value-based ERM approach in measuring operational and strategic risks.

Commentary on Question:

There were two main sources that candidates used to respond to this question and credit was given for either case. In general, candidates did not expand on their answers and often outlined comparisons to the Traditional approach that the question did not ask.

Source 1: Segal, *Corporate Value of Enterprise Risk Management*, Ch.3, p.93

- Ability of Metrics to Support Decision Making
 - The value-based approach quantifies all key risks
 - The value-based approach quantifies them in terms of the impact on company value, which robustly supports decision-making

2. Continued

- Availability and Appropriateness of Data
 - The data is available, by definition, since the company is developing its own data primarily using internal personnel
 - The data developed is company and culture specific, since it is based on the specific situation within the firm
- Risk-Based Approach
 - The value-based ERM approach is risk-based, since it begins with the company-specific risk scenarios, and the exposures properly rise and fall with the level of exposures
- Ability to Fully Quantify Risk Impacts
 - The value-based approach allows for full quantification of the risks, since the baseline company value captures the full projection of future revenues, expenses and other distributable cash flows, and risk is measured as shocks to the baseline

Alternate solution

Source 2: Segal, *Corporate Value of Enterprise Risk Management*, Ch.3, p83-108

A value-based approach satisfies the 10 key criteria of an ERM program:

- Criteria 1: A value-based approach offers a metric that can work across both financial and non-financial services operations
- Criteria 2: A value-based approach includes all risk categories
 - A value-based approach gives a balanced focus to all risk categories including strategic and operational
 - A value-based approach uses FMEA for quantification, which more accurately reflects the risk compared to percentage of revenue or just giving qualitative treatment
 - Advantages of FMEA include using risk's subject-matter-experts' guesses, giving a range of results, reducing bias, and allowing for relative comparisons
- Criteria 3: A value-based approach focuses management on the key risks
- Criteria 4: A value-based approach allows for integration across risk types that leads to completeness, efficiency, and internal consistency
- Criteria 5: A value-based approach allows enterprise-wide aggregation of metrics and facilitates the appropriate top-down allocation of risk appetite to risk limits
- Criteria 6: A value-based approach can be integrated into decision-making through:
 - Robust metrics for all types of risks
 - Metrics with both risk and return information
 - Practical models with regards to reliability, speed, transparency, and balance of significant digits

2. Continued

- Appropriate level of input from business segments
 - Support of business segment goals and initiatives
 - Criteria 7: A value-based approach balances risk and return management
 - Criteria 8: A value-based approach can inform risk disclosures
 - Criteria 9: A value-based approach measures value impacts
 - Criteria 10: A value-based approach focuses on the primary stakeholder
- (c) Based on Cobalt's assessment of the strategic risks faced by Zoolander and Zoolander's proposed risk appetite statement:
- (i) Identify four of the major strategic risks facing Zoolander. Support your answer.

Commentary on Question:

Candidates generally did well on this part of the question. There were instances where candidates did not factor in Zoolander's proposed risk appetite statement and/or did not provide the rationale behind their selections.

Another common response that did not receive full credit was to only identify the category of risk (such as Industry, Technology, Brand, Competitor) versus the type of risk (such as Margin Squeeze, Commoditization). There were types of risks within these categories that were within the risk appetite and would not qualify as an appropriate answer.

Candidates were only given credit for four strategic risks identified.

Major strategic risks must have a greater than 25% loss of earnings with a greater than 20% probability of being outside the risk appetite statement's allowable earnings loss.

- Project: New Product Development Failure
 - This risk has a 50% probability of earnings loss outside risk appetite with a 70% probability of occurrence
 - The expected timing of this risk occurring is less than 1 year
- Stagnation: Flat or declining volume
 - This risk has a 50% probability of earnings loss outside risk appetite with a 70% probability of occurrence
 - The expected timing of this risk occurring is less than 1 year

2. Continued

- Industry: Commoditization
 - This risk has a 50% probability of earnings loss outside risk appetite with a 50% probability of occurrence
- Industry: Margin Squeeze
 - This risk has a 50% probability of earnings loss outside risk appetite with a 40% probability of occurrence
- Industry: New Regulations
 - This risk has a 40% probability of earnings loss outside risk appetite with a 30% probability of occurrence
- Stagnation: Volume up, margin down
 - This risk has a 30% probability of earnings loss outside risk appetite with a 65% probability of occurrence
- Customer: Overreliance on a few customers
 - This risk has a 30% probability of earnings loss outside risk appetite with a 40% probability of occurrence
- Project: Business development failure
 - This risk has a 30% probability of earnings loss outside risk appetite with a 40% probability of occurrence
- Competitor: Gradual market share gainer
 - This risk has a 30% probability of earnings loss outside risk appetite with a 30% probability of occurrence
- Customer: Customer priority shift
 - This risk has a 60% probability of earnings loss outside risk appetite with a 25% probability of occurrence
- Project: Merger or acquisition failure
 - This risk has a 30% probability of earnings loss outside risk appetite with a 25% probability of occurrence

- (ii) For each of the strategic risks identified in part (i), recommend an approach to manage it, and explain why your recommendation is appropriate for Zoolander.

Commentary on Question:

Candidates that identified the appropriate strategic risk (in part (i)) of this question did well on this section. Candidates used their background/knowledge when providing responses to this part. Answers outside those summarized here were also accepted and given credit as long as they were appropriate for the given strategic risk.

2. Continued

- Project: New Product Development Failure
 - Smart sequencing - take on most likely to be successful parts of VA project first, such as adding a small number of new funds and GMDB (as opposed to all funds and GMDB and GMIB)
 - Stepping-stone - release early version of GMDB/GMIB and then better version later once more market share is there
- Stagnation: Flat or declining volume
 - Generate “demand innovation”; understand GIC clients' needs
- Industry: Commoditization
 - Encourage product innovation – introduce distinctive features such as a 30-year ROP
- Industry: Margin Squeeze
 - Shift from competition to collaboration
 - Work with reinsurer on new updates to term product
- Industry: New Regulations
 - Redesign product to counter regulation change
 - Work with reinsurer to counter regulation change
- Stagnation: Volume up, margin down
 - Change in business design to avoid direct competition with Periwinkle and other entrants
- Customer: Overreliance on a few customers
 - In-market testing to aid in experimentation with new product design
 - Get feedback from producers on new product features that could open up different sectors of the market
- Project: Business development failure
 - Develop designs for different GMIBs/GMDBs and then pick best option
- Competitor: Gradual market share gainer
 - Encourage product innovation to counter competitors
 - Shift in business design to minimize product overlap
- Customer: Customer priority shift
 - Shift in product offering to respond to customers' behavioral change
- Project: Merger or acquisition failure
 - Develop controls to manage surplus/capital more closely
 - Perform thorough due diligence of opportunities prior to closing any transaction/deal(s)

2. Continued

- (d) Identify the major components of the FMEA technique.

Commentary on Question:

Majority of the candidates successfully answered this question and received maximum points.

The value-based ERM approach uses a technique, called Failure Modes and Effects Analysis (FMEA) to develop the individual deterministic risk scenarios for strategic and operational risks.

- Identify Interviewees/ subject-matter experts for the risk in question
- Develop Risk Scenarios
- Assign Likelihood to Risk Scenarios
- Estimate Quantitative Impacts of Risk Scenarios

- (e) Apply the FMEA technique to the operational risk in the disability claims process. Use estimated values as needed.

Commentary on Question:

Most candidates provided a generic response to this question versus paying heed to the disability claims process. Candidates also did not always provide sufficient explanation despite the weight of this part relative to the overall question.

The expectation was of candidates to demonstrate their understanding of the FMEA technique. The solution included here is one of several ways a candidate can show that; however, most candidates did not successfully demonstrate this.

- Identify Interviewees/ subject-matter experts for the risk in question
 - Head of claims, admin, IT and actuarial
 - Claudette Dove, Odette Bird, Frances Seal, Wanda Fox
 - Claims and admin are important because these are the two areas impacted by doing manual processes. Thus, they are the most important to interview for potential impact since they are closest to the risk
- Develop risk scenarios
 - Understand from the interviewees a set of risk scenarios for the key risk in question
 - Upside: Upside of manual claims processing for disability: No outlay of cash for system upgrade; no errors are made.
 - Moderate downside: Several small errors slip through undetected. Errors turn out to be immaterial but time is spent reconciling and correcting; system upgrade commences.

2. Continued

- Severe downside: Large errors slip through undetected. Restatement of financial filings; fraying of relationship with Kelly and reinsurer; system upgrade required immediately to pacify Kelly so have to hire consultants to implement.
- Catastrophic downside: Large errors slip through undetected. Errors include certain claims not being paid as well as not being reserved for. Claimants sue Zoolander; Kelly downgrades Zoolander for lack of controls; system upgrade required immediately by legal team to prevent further errors so have to hire consultants to implement; liquidity spiral due to downgrade provision in GICs.
- Assign Likelihood
 - This is another area where skill in conducting the FMEA process is required to bridge the gap between the qualitative “language” used by the interviewees and the quantitative language needed for the ERM model
 - Interviewers can provide qualitative responses such as:
 - Upside very unlikely and optimistic
 - Moderate downside most likely by far
 - Severe downside somewhat likely
 - Catastrophic downside very unlikely
 - These responses will need to be translated into probabilities such as:
 - Upside – 5%
 - Moderate downside – 75%
 - Severe – 15%
 - Catastrophic – 5%
- Estimate Quantitative Impacts of Risk Scenarios
 - The final step in the FMEA interview is to develop estimates of the quantitative impacts of each deterministic risk scenario on the baseline company value.
 - Upside: Frances Seal may be able to comment on the cost of the system upgrade, which would be a saved expense in this scenario.
 - Moderate downside: Reserves increase by \$0.5 Million; system upgrade expensed.
 - Severe downside: Reserves increase by \$15 Million; system upgrade is expensed immediately and have to hire consultants to implement, which doubles cost.

2. Continued

- Catastrophic downside: Expense system upgrades immediately and costs double due to implementing with consultants; reserves increase by \$50 Million; unpaid benefits are \$3 million and lawsuit results in another \$3 million in damages. Liquidity spiral could send Zoolander into DOI supervision.

3. Learning Objectives:

2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.
5. The candidate will understand the components of an ERM framework and be able to evaluate the appropriateness of a framework in a given situation.
6. The candidate will understand the structure of an ERM process in an entity and be able to demonstrate best practices in enterprise risk management.

Learning Outcomes:

- (2c) Describe the concept of economic measures of value (e.g. MCEV) and demonstrate their uses in the risk management and corporate decision-making processes.
- (5d) Explain the elements of risk governance, and demonstrate how governance issues are resolved through organizational structure.
- (5f) Explain the perspectives of regulators, rating agencies, stock analysts, and company stakeholders and how they evaluate the risks and the risk management of an organization.
- (6a) Demonstrate the ERM process steps to be followed once the ERM framework is in place:
 - Risk identification
 - (i) Defining and categorizing risk
 - (ii) Qualitative risk assessments
 - Risk quantification
 - (i) Scenario development/types of scenarios
 - (ii) Individual risk quantification, including inherent vs. residual exposures
 - (iii) Quantifying enterprise risk exposure, including correlations of risks
 - Risk management
 - (i) Defining risk appetite
 - (ii) Managing enterprise risk exposure towards risk appetite
 - Internal reporting
 - (i) Performance measurement
 - (ii) Performance management and incentive compensation
 - External disclosures
 - (i) Shareholders
 - (ii) Rating agencies
 - (iii) Regulators

Sources:

Segal, *Corporate Value of Enterprise Risk Management*, Ch. 7

3. Continued

FE-C117-07: Doherty, Integrated Risk Management, Ch. 7, Why Is Risk Costly to a Firm?

FE-C186-11: Methodology: Assessing Management's Commitment to and Execution of Enterprise Risk Management Processes – S&P publication

Commentary on Question:

This question was designed to test the candidates' ability to link compensation to risk/reward trade-off and value creation at Zoolander.

The question required the candidates to demonstrate Analysis and Knowledge Utilization cognitive skill levels by asking them to relate concepts from the readings to the case study.

Candidates performed adequately on this question, but could have earned more credit if they had shown more familiarity with the case study by applying the theory to provide specific examples.

Solution:

(a)

- (i) Describe concerns regarding Zoolander's incentive compensation program as an effective tool to align management and shareholder objectives.
 - Mismatch of information between management and shareholders - can be exploited by management.
 - 100% stock options, vested immediately
 - Only in the money if stock price of Zoolander can rise above the exercise price of the stock options (encourage risk)
 - Discourages hedging
 - There are poor metrics used to calculate stock option awards.
 - The amount of stock options allocated is determined by comparing past single-period financial results against Plan results (accounting-based)
 - Arbitrary weights applied to each factor
 - Result in lower increase in value than if weights had been determined to maximize company value
 - CIO sets stock option price
 - Examples of flaws with current formulae:
 - Marketing: premium over plan, regardless of value added
 - Investments: bonus is like an option on investment return (encourage risk by CIO)

3. Continued

(ii) Recommend improvements to Zoolander's incentive compensation program to mitigate the concerns identified in part (i). Justify your recommendations.

- Replace the actual stock with phantom stock.
 - Baseline company value calculation is used as the basis for the phantom stock value.
 - Unit in charge of calculating the phantom stock value should have high level of independence.
 - Zoolander should not have 100% incentive compensation based on either stocks or stock options.
 - Stocks ownership encourages management to hedge.
 - Stock options encourage some risk.
- Use ERM metrics to determine value of award.
 - Superior alignment between management and shareholders – amount and value of award based on baseline company value.
 - Should not be a percentage based on balance sheet/income statement items - does not represent the true value of Zoolander.
 - Use some economic measures that incorporate risk/returns characteristics and are a better measure of Zoolander's value.

(b)

(i) Assess how the new incentive program may alter the behavior of senior management.

- Company Value captures changes that altered the projection of future distributable cashflows.
- Danielle Wolfe's marketing area will be more focused on profitable sales instead of just more sales in general.
 - Rewarded based on whether new sales generate positive distributable cashflows.
- No longer discourages investments that need an initial outlay of capital but are still positive NPV projects. Future benefits are now captured.
 - Encourages increase in baseline company value.
- CIO Peter will make better risk/return decisions since Company Value will change when Zoolander is riskier
 - Company value captures changes that may alter the riskiness of Zoolander.
- Wanda's incentive compensation is related more closely to Zoolander's risk profile and now is linked to value creation of Zoolander.
 - Previously was formulaic statutory RBC.

3. Continued

- (ii) Evaluate the new incentive program from the perspective of Kelly Ratings & Analysis.

Commentary:

Candidates were expected to apply the S&P paper and relate the criteria back to the case study. Candidates could have performed better by being more familiar with the case study and commenting on how the new program would generally positively affect each of the criteria.

Kelly evaluates Zoolander's compensation with the following criteria:

- ERM culture or policies
 - Incentive compensation rewards managers based on analysis of risk/return tradeoffs and value creation.
 - Additional risk taking will lower Company Value through higher discount rate. Peter and Wanda will be discouraged by risk taking activities that do not increase Company Value.
- Risk Controls
 - Kelly is looking for relationship between management performance and their risk limits.
 - Wanda is no longer compensated based on statutory RBC.
- Strategic risk management
 - Management compensation programs should be designed consistently with company goals and be consistent across business or functional groups.
 - In the new incentive compensation program, all senior management incentive compensation is based on the same driver: Company Value creation. So, it is consistent.
- Risk models
 - Kelly is looking for evidence the models are robust and well documented.
 - It is not clear whether Zoolander currently has Company Value models or what state they are in. It is something Zoolander should look into.

Overall, Kelly would look favorably on the new incentive program.

- (c) Describe two advantages and two disadvantages of using an Economic Capital model in support of Zoolander's incentive compensation program.

3. Continued

Commentary:

This part of the question was intended to determine whether candidates could apply information in the case study and recognize benefits and flaws of using an economic capital model as a base for incentive compensation. Credit was given for alternate responses.

Advantages:

- EC incorporates company-specific approach to measuring risk.
 - Alignment between Zoolander's risk/return profile and management actions.
- Zoolander is developing an EC model.
 - Saves time and resources to use the same model for incentive compensation.

Disadvantages:

- Zoolander is ignoring some risk exposures that are not currently reflected in the EC model.
 - Management could maximize their utilization by taking on risks that are not modeled.
- EC does not capture future new business and thus may not reflect future risks taken on.
 - May encourage management to take on risky projects to improve returns.

4. Learning Objectives:

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

Learning Outcomes:

- (1a) Identify and analyze financial market risks faced by an entity, including but not limited to: currency risk, credit risk, spread risk, liquidity risk, interest rate risk, and equity risk.
- (4b) Demonstrate means for transferring risk to a third party and analyze the costs and benefits of doing so.
- (4d) Evaluate the performance of risk transference activities.
- (4e) Describe and evaluate risk management techniques that can be used to deal with financial and non-financial risks.
- (4f) Develop an appropriate choice of hedging 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) Analyze the practicalities of market risk hedging, including dynamic hedging.

Sources:

Kalberer, *Variable Annuities*, Chapters 11-14

Commentary on Question:

This question aims to test the candidate's understanding of the various risk management strategies that can be used to manage Variable Annuities' equity exposure. In addition, this question tests whether the candidate can apply these risk management strategies to the case study, Zoolander.

Solution:

- (a) John Badger suggests that his dynamic hedging program will be an effective tool in managing the VA equity risk exposure.
 - (i) Describe three challenges VA writers face in dynamically hedging their VA guarantee risks.

Commentary on Question:

Candidates did well when recalling general challenges VA writers face in this retrieval question.

4. Continued

1. Optimizing trade frequency to balance transaction costs and hedge breakage
2. Addressing basis risk between VA funds and hedging instruments
3. Adjusting hedge positions for deviations from policyholder behavior assumptions

Other answers were also accepted.

- (ii) For each challenge in part (i), explain the specific concerns Zoolander faces in dynamically hedging its VA Plus product.

Commentary on Question:

Most candidates gave general answers about each challenge; candidates who did well in this comprehension question targeted their answers specifically to Zoolander.

1. Optimizing trade frequency: transaction costs on Zoolander's relatively small block (about \$4 billion) are relatively significant and could have a large impact on profit margins. Also, the limited computer power Wanda is concerned about may not allow for daily liability Greek calculations in a timely manner.
2. Addressing basis risk: the proprietary funds offered in VA Plus (ZooBalanced, ZooEquity500, etc.) are not actively traded on public stock exchanges. Also, John Badger's model for these funds assumes management charges are zero, affecting the calculation of Delta used for hedging.
3. Policyholder behavior: Zoolander has little history selling guarantees on its VA block, compromising its ability to set meaningful policyholder behavior assumptions.

Other answers were also accepted.

- (b) Danielle Wolfe suggests altering the product design to reduce VA equity risk exposure.
- (i) Recommend product features that would reduce equity risk exposure on a typical VA guarantee. Justify your recommendations.

4. Continued

Commentary on Question:

Candidates who did well on this knowledge-utilization question elaborated on the product features, rather than simply listing them.

1. Fund investment restrictions: by limiting the amount invested in high-risk funds and/or requiring the investment in allocated funds (“funds of funds”), the likelihood of large drops in account value are lessened, reducing the risk of the VA guarantee.
2. Less generous guarantees: lowering the guarantee level or reducing the frequency of ratchets/resets would result in fewer expected claims overall, reducing the equity risk exposure.
3. Apply guarantee charge to guarantee value: when the guarantee charge is a percentage of the account value, a reduction in account value both increases the value of the guarantee and decreases the charges to pay for it; changing the charge basis to the guarantee value removes this second equity risk factor.

Other answers were also accepted.

- (ii) Evaluate the feasibility of Zoolander implementing each feature recommended in part (i).

Commentary on Question:

Many candidates struggled to relate the recommendations specifically to Zoolander in this analysis question.

1. Fund investment restrictions: due to system challenges, Zoolander is adding funds one family at a time, so it may take a while for Zoolander to add enough funds to enable allocated funds across fund families. Adding investment restrictions is unlikely given the current system challenges.
2. Less generous guarantees: Zoolander’s distributors are clamoring for living benefit guarantees, and it could be difficult for Zoolander to retract quickly on its recent decision to offer a generous GMDB. In light of recent experience, management may need to revisit how generous the guarantees are despite disappointing distribution partners.

4. Continued

3. Guarantee charge on guarantee value: Zoolander management and distribution are both unlikely to have issues with this change, but there are concerns already about the VA admin system, and this would compete with other projects such as adding funds.

Other answers were also accepted.

- (c) The following two reinsurance premium structures are available:
- I. Premium equals (constant factor) \times (account value)
 - II. Premium equals (YRT mortality rate) \times (net amount at risk)
- (i) Define the amount reimbursed by the reinsurer in a typical GMDB reinsurance treaty.

Commentary on Question:

Most candidates did well on this retrieval question.

The reinsurance benefit is the GMDB net amount at risk, specifically the positive difference between the death benefit guarantee value and the actual account value at the time of claim.

- (ii) For each of the following scenarios:

- Scenario 1: Up equity market
Scenario 2: Down equity market

Describe the premium and benefit cash flows for the two reinsurance structures, I and II.

Commentary on Question:

Candidates had more trouble with this comprehension question.

The benefit cash flows are the same for structures I and II:

- Up equity market: positive difference between guarantee and account value is smaller, so reinsurance benefit is smaller or zero if out-of-the-money.
- Down equity market: positive difference between guarantee and account value is greater, so reinsurance benefit is larger if in-the-money.

4. Continued

Premium cash flows for structure I:

- Up equity market: account value is higher, so reinsurance premium is higher.
- Down equity market: account value is lower, so reinsurance premium is lower.

Premium cash flows for structure II:

- Up equity market: positive difference between guarantee and account value is smaller, so net amount at risk and hence reinsurance premium are smaller.
- Down equity market: positive difference between guarantee and account value is larger, so net amount at risk and hence reinsurance premium are larger.

- (iii) Recommend one of the two reinsurance premium structures. Justify your response.

Commentary on Question:

Either premium structure could have been recommended with appropriate justification, but candidates generally did not justify their recommendation well in this knowledge-utilization question.

Either of the following was acceptable:

Structure I is recommended because, when equity markets are down, reinsurance premiums also decrease, leaving more cash available to cover the corresponding increase in statutory reserves and reducing surplus strain for Zoolander.

Or,

It is likely that the reinsurer will give a better deal on the YRT premium rate for Structure II because they will have less premium risk in down equity market scenarios. Therefore, Structure II is recommended.

5. Learning Objectives:

2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.
6. The candidate will understand the structure of an ERM process in an entity and be able to demonstrate best practices in enterprise risk management.

Learning Outcomes:

- (2b) Analyze a specific company financial situation by demonstrating advanced knowledge of balance sheet and income statement structures.
- (6d) Determine a desired risk profile and appropriate risk filters, and analyze the risk and return trade-offs that result from changes in the organization's risk profile.
- (6e) Demonstrate quantitatively and qualitatively how ERM is able to contribute to shareholder value creation.

Sources:

FE-C138-07: Managing the Invisible: Measuring Risk, Managing Capital, Maximizing Value

Segal, *Corporate Value of Enterprise Risk Management*, Ch. 6

Commentary on Question:

This question was designed to test candidates' understanding of how a simple ERM model can be used to determine the level of surplus that maximizes shareholder value for a given set of risk exposures. Part (b) was retrieval. Parts (a), (c) and (d) were analysis.

Solution:

- (a) Calculate the value added of SRC.

Commentary on Question:

Most candidates were able to correctly calculate the single period after-tax income for the firm, but many only considered current period earnings in determining value. Finally, many candidates did not subtract current surplus from the total value of the firm to determine the value added.

Probability of Firm Survival = 1 - Probability of Default

Probability of Firm Survival (for C = 5) = $1 - 0.7/(21 * 5 - 14) = .9923$

Discount Factor = D = (Probability of Firm Survival)/(1 + risk-free rate)

D = $.9923/(1 + .05) = .9451$

Income Statement for CRC (all values in \$ millions)

Premiums = 100

C.Losses = Premium * Projected Loss Ratio = $100 * 70\% = 70$

Expenses = Premium * Expense Ratio = $100 * 20\% = 20$

5. Continued

$$\text{UW Income} = \text{Premium} - \text{C.Losses} - \text{Expenses} = 100 - 70 - 20 = 10$$

$$\begin{aligned}\text{Investment Income} &= \text{Yield} * (\text{Premium} - \text{Expense} + \text{Capital}) \\ &= 5\% * (100 - 20 + 5) = 4.25\end{aligned}$$

$$\text{Net Income} = \text{UW Income} + \text{Investment Income} = 10 + 4.25 = 14.25$$

$$\text{After-tax Net Income} = (1 - \text{Tax Rate}) * \text{Net Income} = (1 - 20\%) * 14.25 = 11.4$$

$$\begin{aligned}\text{After-tax Value of Firm} &= (\text{After-tax Net Income}) * D / (1 - D) \\ &= (11.4) * (.9451) / (1 - .9451) = \$196.25\text{M}\end{aligned}$$

$$\text{Value-added} = \text{After-tax Value of Firm} - \text{Capital} = \$196.25\text{M} - \$5\text{M} = \$191.25\text{M}$$

- (b) List the steps to accomplish each of I and II.

Commentary on Question:

Most candidates were able to identify at least some of the steps of the process.

Recalculate Risk and Return Metrics

Revise distributable cash flows

Revise discount rate

Re-calculate baseline company value

Revise key risk scenarios

Recalculate Enterprise risk exposure

Evaluate Risk-return Tradeoff

Evaluate the impact on Enterprise Risk Exposure

Evaluate the impact on downside standard deviation

Evaluate the impact on Baseline Company Value

Evaluate the impact on Probabilistic Expectation of Company Value

- (c) Calculate the optimal level of capital.

Commentary on Question:

As with part (a), many candidates did not use a multi-period model. Candidates who recognized the need to take the first derivative of the value function to determine the capital value that maximizes firm value were able to distinguish themselves.

$$\text{Probability of Firm Survival} = 1 - 0.7 / (21C - 14) = (21C - 14.7) / (21C - 14)$$

$$D = [(21C - 14.7) / (21C - 14)] / (1 + 0.05) = (20C - 14) / (21C - 14)$$

$$1 - D = 1 - (20C - 14) / (21C - 14) = C / (21C - 14)$$

$$D / (1 - D) = [(20C - 14) / (21C - 14)] / [C / (21C - 14)] = 20 - 14 / C$$

Income Statement for CRC (all values in \$ millions)

UW Income = 10 (not affected by capital)

$$\begin{aligned}\text{Investment Income} &= \text{Yield} * (\text{Premium} - \text{Expense} + \text{Capital}) \\ &= 5\% * (100 - 20 + C) = 4 + 0.05C\end{aligned}$$

5. Continued

$$\begin{aligned}\text{Net Income} &= \text{UW Income} + \text{Investment Income} = 10 + 4 + 0.05C = 14 + 0.05C \\ \text{After-Tax Net Income} &= (1 - \text{Tax Rate}) * \text{Net Income} = (1 - 20\%) \times (14 + 0.05C) = \\ &= 11.2 + 0.04C \\ \text{After-tax Value of Firm} &= (\text{After-tax Net Income}) * D / (1 - D) \\ &= (11.2 + 0.04C) * (20 - 14/C) = 0.8C + 223.44 - 156.8/C \\ \text{Value-added} &= \text{After-tax Value of Firm} - \text{Capital} = 0.8C + 223.44 - 156.8/C - C \\ &= -0.2C + 223.44 - 156.8/C\end{aligned}$$

The optimal capital level occurs when value-added is maximized.
To find the optimal capital, set $d(\text{Value-added})/dC = 0$

$$\begin{aligned}d(\text{Value-added})/dC &= -0.2 + 156.8/C^2 = 0 \\ C &= 28\end{aligned}$$

The optimal level of capital is \$28 million.

- (d) Evaluate whether SRC should implement the new claims management system.

Commentary on Question:

Candidates had similar issues to those described in part (a). In addition, some candidates did not include a recommendation as required by the question.

Of those who did, either recommendation was supportable depending on the capital assumption made. Some candidates assumed $C = 5$ (from part (a)), leading to a recommendation to implement:

$$\begin{aligned}\text{Probability of Firm Survival (for } C = 5) &= 1 - 0.1/(21 * 5 - 2) = .9990 \\ D &= .9990 / (1 + .05) = .9515\end{aligned}$$

Income Statement for CRC (all values in \$ millions)

Only change to After-tax Net Income is from Expenses increasing from 20 to 21, with the following effects:

- UW Income decreased by 1 from 10 to 9;
- Investment Income decreased by $5\% * 1 = 0.05$ from 4.25 to 4.20; and hence
- Net Income decreased by 1.05 and After-tax Net Income decreased by $80\% * 1.05 = 0.84$ from 11.4 to 10.56.

$$\begin{aligned}\text{After-tax Value of Firm} &= (\text{after-tax net income}) * D / (1 - D) \\ &= (10.56) * (.9515) / (1 - .9515) = 207.17\end{aligned}$$

$$\text{Value-added} = \text{After-tax Value of Firm} - \text{capital} = 207.17 - 5 = 202.17$$

5. Continued

Since the value-added after adopting the new claims management system (\$202 million) is more than the value-added at the original capital level (\$191 million), SRC should adopt the new claims management system.

Commentary on Question:

Other candidates assumed capital should be optimized again (from part (c)), leading to a recommendation not to implement:

Before adopting the new claims management system:

From part (c), optimal capital level = \$28 million

Value added at optimal capital level = $-0.2 \times 28 + 223.44 - 156.8/28 = \212.24 million

Recalculate value added if new claims management system is adopted:

Probability of Firm Survival = $1 - 0.1/(21C - 2) = (21C - 2.1)/(21C - 2)$

$D = [(21C - 2.1)/(21C - 2)] / (1 + 0.05) = (20C - 2)/(21C - 2)$

$1 - D = 1 - (20C - 2)/(21C - 2) = C/(21C - 2)$

$D/(1 - D) = [(20C - 2)/(21C - 2)] / [C/(21C - 2)] = 20 - 2/C$

Income Statement for CRC (all values in \$ millions)

Only change to After-tax Net Income is from Expenses increasing from 20 to 21, with the following effects:

- UW Income decreased by 1 from 10 to 9;
- Investment Income decreased by $5\% \times 1 = 0.05$ from $4 + 0.05C$ to $3.95 + 0.05C$; and hence
- Net Income decreased by 1.05 and After-tax Net Income decreased by $80\% \times 1.05 = 0.84$ from $11.2 + 0.04C$ to $10.36 + 0.04C$.

After-tax Value of Firm = (After-tax Net Income) * $D/(1-D)$

$$= (10.36 + 0.04C) \times (20 - 2/C) = 0.8C + 207.12 - 20.72/C$$

Value-added = After-tax Value of Firm - Capital = $0.8C + 207.12 - 20.72/C - C$
 $= -0.2C + 207.12 - 20.72/C$

The optimal capital level occurs when value-added is maximized.

To find the optimal capital, set $d(\text{Value-added})/dC = 0$

$$d(\text{Value-added})/dC = -0.2 + 20.72/C^2 = 0$$

$$C = 10.18$$

With $C = 10.18$, Value added = $-0.2 \times 10.18 + 207.12 - 20.72/10.18 = \203.05 million

5. Continued

Since the value-added after adopting the new claims management system (\$203 million) is less than the value-added at the original capital level (\$212 million), SRC should not adopt the new claims management system.

A counterargument is that much less capital would need to be raised to optimize value-added, perhaps a benefit if capital sources are limited or increasingly expensive as more is raised.

6. Learning Objectives:

3. The candidate will understand how the financial risks faced by an entity can be quantified and the use of metrics to measure risk.
5. The candidate will understand the components of an ERM framework and be able to evaluate the appropriateness of a framework in a given situation.

Learning Outcomes:

- (3b) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of integrated risk management process.
 - Demonstrate how each of the financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, scenario analysis, and stress testing.
 - Describe and evaluate risk aggregation techniques, incorporating the use of correlation, integrated risk distributions and copulas.
 - Describe how and why risks are correlated and give examples of risks that are positively correlated and risks that are negatively correlated.
 - Assess the overall corporate risk exposure arising from financial and non-financial risks.
- (5e) Compare and contrast various regulatory/industry frameworks: Basel, Sarbanes-Oxley Act, Dodd/Frank, Solvency II, UK FSA guidelines, and COSO.
- (5f) Explain the perspectives of regulators, rating agencies, stock analysts, and company stakeholders and how they evaluate the risks and the risk management of an organization.
- (5g) Identify regulatory capital requirements and describe how they affect decisions.

Sources:

FE-C184-11: A Comparative Analysis of U.S., Canadian and Solvency II Capital Adequacy in Life Insurance

Regulatory Capital Standards for Property and Casualty Insurers Under the U.S., Canadian and Proposed Solvency II (Standard) Formulas, Sharara, Hardy, Saunders

Commentary on Question:

The question was generally testing understanding of the different capital regimes. It was a little off-the-wall in that it “allows” the company to decide which capital regime it will use. It also tested both the property/casualty side and life side. Note, the question was trying to test a very unique situation that is not based in regulatory reality. Quoting that because the company is European it should adopt the Solvency II (or pointing out that CALM is moving to Solvency II so why adopt the Canadian regime) is irrelevant to the question.

6. Continued

Candidates missed the requirement that defining a term broadly that doesn't really apply to each of the various regulatory systems is not satisfactory.

Candidates overall did well in parts (a), (d) and (e), but struggled with parts (b) and (c). The cognitive skill level for this question ranged from retrieval to knowledge utilization. Retrieval and Comprehension type questions are (b)(i) and (d), while knowledge utilization questions were the rest.

Solution:

Question Wording:

- (a) Rank the level of diversification benefits allowed in each of the three capital regimes, U.S., Canadian and Solvency II, for the life and annuity business. Support your ranking

Commentary on Question:

This section was done well overall. Points were given for ranking the results as well as explaining the rationale behind which is most beneficial.

Solvency II > US RBC > Canadian regime

Solvency II has largest diversification benefit due to recognition of correlation amongst risks.

US RBS has a bit of diversification benefit due to the covariance adjustment in the RBC formula.

Canadian regime has no diversification benefit and is the sum of the underlying required capital.

- (b) For each of the following components of the total balance sheet requirement for life and annuity business:
- I. Best estimate liability
 - II. Solvency margin
 - III. Interest rate risk amount
- (i) Describe the component.

Commentary on Question:

This section was weaker than the other sections. Overall candidates gave a general description of the components but did not define them within the context of the capital regimes being asked about.

Best estimate liability (BEL) is the present value of expected cash flows using a best estimate discount rate.

6. Continued

Solvency margin:

Under solvency II, this is calculated at the 99.5% CI level over a one-year period at the enterprise level. Other than cost of capital, all solvency margins are included in capital.

Under Canadian regime, the solvency margin is included in margins for adverse deviations.

In US, the solvency margin is implicit due to conservative nature of assumptions.

Interest Rate Risk amount:

The Canadian and US regimes use a factor approach.

The Solvency II calculation is based on the change in economic surplus under adverse, non-parallel movements of the yield curve.

- (ii) Compare the relative size of the component across the three capital regimes.

Commentary on Question:

The answers below are examples, but other justified responses were accepted.

BEL: Same under all regimes.

Solvency Margin: Solvency II > Canadian regime > US regime (other answers accepted with justification)

Interest Rate Risk: Solvency II > US Regime > Canadian Regime

- (c) Evaluate which of the three capital regimes will be the most beneficial from the perspective of Slavic's life and annuity business head.

Commentary on Question:

Multiple answers were accepted based on arguments given.

Diversification benefit is maximized under Solvency II.

The US and Canadian regime are more conservative than Solvency II, so US or Canadian regimes are options to maximize reserve.

6. Continued

To minimize the total balance sheet requirement, the US and Canadian regimes have factors applied to calculate margins, which are smaller than the Solvency II regime. Consider US and Canadian regimes.

Best option is US regime, since it has some diversification benefit, maximizes reserves and minimizes total balance sheet.

- (d) Describe the charges for the following risks under each of the three capital regimes for the auto insurance business:
- (i) Catastrophe risk
 - (ii) Operational risk
 - (iii) Interest rate risk

Commentary on Question:

Candidates needed to realize that auto insurance has slightly different capital requirements than traditional life blocks.

Canada and Solvency II charge for catastrophe risk. The US regime doesn't.

Only Solvency II charges for operational risk.

Solvency II charges a variable amount for interest rate risk. The US regime doesn't change with interest rates

- (e) Evaluate which of the three capital regimes will be the most beneficial from the perspective of Slavic's auto insurance business head.

Commentary on Question:

This section was done well.

US doesn't charge for catastrophe and operational risk. Canada charges for catastrophe and Solvency II charges for both, so the recommendation is the US regime.

7. Learning Objectives:

3. The candidate will understand how the financial risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

- (3b) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of integrated risk management process.
 - Demonstrate how each of the financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, scenario analysis, and stress testing.
 - Describe and evaluate risk aggregation techniques, incorporating the use of correlation, integrated risk distributions and copulas.
 - Describe how and why risks are correlated and give examples of risks that are positively correlated and risks that are negatively correlated.
 - Assess the overall corporate risk exposure arising from financial and non-financial risks.
- (3c) Evaluate the properties of risk measures and explain their limitations.
- (3e) Define and evaluate model and parameter risk.

Sources:

Hardy, *Investment Guarantees*, Ch 9 and Ch 11

Summary of “Variance of the CTE Estimator”, Risk Management, August 2008

Commentary on Question:

This question was meant to emphasize the quantitative skill in estimating risk measures along with qualitative discussion on those risk measures.

Cognitive levels tested were retrieval (part (a)), comprehension (parts (b) and (d)), and analysis (parts (c), (e) and (f)).

Candidates did well defining VaR and CTE in section (a) and applying the definition in section (b). There were very few candidates that answered section (c) correctly.

Solution:

- (a) Define VaR and CTE with parameter α ($0 < \alpha < 1$) and explain how to estimate these metrics from the simulations.

Commentary on Question:

The majority of candidates were successfully able to define VaR and CTE.

Several candidates described VaR and CTE in the discrete form instead of continuously. If the discrete definition was provided, candidates received full credit.

7. Continued

- $\text{VaR } \alpha = \inf(V: \Pr[L_0 \leq V] \geq \alpha)$
- VaR takes a single ordered outcome from many simulations. In this case it is equal to the $(-1000\alpha^{\text{th}})$ value of the ordered liabilities.
- $\text{CTE at } \alpha = E[L_0 | L_0 > \text{VaR } \alpha]$
- CTE takes an average of the largest ordered outcomes. In this case it is the average of the largest ordered liabilities greater than the VaR (1000α) above.

- (b) Explain why less sampling error is expected for the CTE 90 as compared to the VaR 95.

Commentary on Question:

Most candidates were able to expand on the definitions of VaR and CTE to explain why there is less sampling error with CTE.

Because CTE takes an average of the largest outcomes, it is less sensitive to sampling variability or outliers than a point estimate (like VaR). Because the average will converge faster than a point estimate, fewer simulations are needed to converge to CTE than VaR.

- (c) Assess whether the methodology used in calculating the CI for CTE fully captures the uncertainty associated with this risk measure.

Commentary on Question:

This section was answered poorly by most candidates. There were very few candidates that were able to identify why the methodology did not capture the uncertainty with the risk measure.

With simulation output, the estimate will have uncertainty attached from sampling variability. The standard deviation of the CTE, computed from the sample standard deviation of loss exceeding the estimated VaR, is biased low due to this uncertainty. Additional uncertainty of VaR will increase the estimated standard deviation.

- (d) Determine the number of simulations needed to reduce the standard deviation of the CTE to 20% of its current level.

Commentary on Question:

This calculation seemed to be straight forward as most candidates were able to successfully calculate the number of simulations needed to reduce the standard deviation of the CTE.

$\text{VAR}(\text{CTE})$ is proportional to $1/n$

$\text{StDev}(\text{CTE})$ is proportional to $1/\sqrt{n}$

7. Continued

Solve for 20% of current standard deviation: $.2 = \frac{1}{\sqrt{n}}$

$$\sqrt{n} = \frac{1}{.2} = 5, n = 25$$

Increase sample size by 25 times to reduce the standard deviation.

Original sample size is 1000.

New sample size = $1000 * 25 = 25,000$ simulations.

- (e) Define control variate, and explain whether using the estimated VaR as a control variate can significantly reduce the variance of the estimated CTE.

Commentary on Question:

Most candidates were able to define the control variate. However, in order to get full credit for this sections the candidate needed to explain whether using the estimated VaR as a control variate could reduce the variance of the estimated CTE. Often candidates were unable to correctly explain whether using the control variate method could reduce the variance of the estimated CTE based on the definition.

Control variate is a function of the projected scenarios with the following characteristics:

1. The value of the control variate can be analytically calculated.
2. The value of the control variate is highly correlated with the value of the output variable.

The control variate acts to calibrate the simulation.

In this case, you cannot use the estimated VaR as a control variate. The control variate method requires the control variate's value to be available analytically, but the quantile is not available in analytical form. The quantile is positively correlated to CTE as seen in the covariance formula, but that is only half of what is needed.

- (f) Define antithetic variate, and explain whether use of an antithetic variate can significantly reduce the variance of the estimated CTE.

Commentary on Question:

This section was similar to section (e) in that candidates were able to define antithetic variate, but often made incorrect recommendations to use the antithetic variate method to reduce variance of the estimated CTE.

The antithetic variate method is a variance reduction technique related to moment matching. It is commonly used with normal or uniform distributions.

7. Continued

Let us denote an input Z and an output E . If we take $-Z$ to get E' , we may take the average of E and E' , denoted by E^* . The idea is that since Z and $-Z$ are negatively correlated, so are E and E' , leading to a more efficient estimate, E^* .

Antithetic variates work well when:

1. Output is a monotonic function of underlying random numbers
2. Focus is the middle of the distribution

It does not do well for deep out-of-the-money options.

For this purpose, I do not recommend using it as a variance reduction technique because we are looking at the GMWB tail events and they are not necessarily a monotonic function.

8. Learning Objectives:

1. The candidate will understand the types of risks faced by an entity and be able to identify and analyze those risks.
2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.
3. The candidate will understand how the financial risks faced by an entity can be quantified and the use of metrics to measure risk.
4. The candidate will understand the means available for managing various risks and how an entity makes decisions about appropriate techniques.

Learning Outcomes:

- (1a) Identify and analyze financial market risks faced by an entity, including but not limited to: currency risk, credit risk, spread risk, liquidity risk, interest rate risk, and equity risk.
- (2c) Describe the concept of economic measures of value (e.g. MCEV) and demonstrate their uses in the risk management and corporate decision-making processes.
- (3b) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of integrated risk management process.
 - Demonstrate how each of the financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, scenario analysis, and stress testing.
 - Describe and evaluate risk aggregation techniques, incorporating the use of correlation, integrated risk distributions and copulas.
 - Describe how and why risks are correlated and give examples of risks that are positively correlated and risks that are negatively correlated.
 - Assess the overall corporate risk exposure arising from financial and non-financial risks.
- (3c) Evaluate the properties of risk measures and explain their limitations.
- (4f) Develop an appropriate choice of hedging 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.
- (4j) Demonstrate how derivatives, synthetic securities, and financial contracting may be used to manage equity risk, in particular, equity market guarantees found in variable annuities.

8. Continued

(4k) Analyze the practicalities of market risk hedging, including dynamic hedging.

Sources:

Kalberer, *Variable Annuities*, Ch. 5

FE-C177-11: CRO Forum, “A Market Cost of Capital Approach to Market Value Margins”

Milliman – Economic Capital Modeling – Practical Considerations

FE-C140-07 –Risk Measurement, Risk Management, and Capital Adequacy in Financial Conglomerates

Commentary on Question:

The concept of MVM on liabilities with a focus on calculating it using the MCOC method recommended by the CRO forum in the context of a company acquisition is tested.

The required candidate cognitive skills for answering this question properly span Retrieval to Knowledge Utilization. Part (a) was Retrieval, part (b) was Analysis, part (c) was Comprehension and the last two sections were Knowledge Utilization.

The most distinguishing criteria between candidates were the abilities to explain the reasons for or against acquisition and successfully organize the thought process behind the MVM using MCOC.

Generally candidates did well in the MVM calculation and could list the reasons why the MCOC approach is preferred to the percentile approach. They generally knew which types of risk (credit, business, insurance, and operation) were hedgeable. Candidates had more trouble with part (d), where they are asked for the different levels of diversification. Generally, they either didn't answer it at all or tried to do some kind of calculation of the diversification effect that was not appropriate. The final part, where they were asked to recommend a course of action on an acquisition, was a mixed bag with many candidates writing something but often failing to put into words what they really meant or not explaining it as well as they could have.

Solution:

(a)

- (i) Define Market Value Margin (MVM).

The MVM is a margin added to the present value of liability cash flows that accounts for the risk required to manage the business on an ongoing basis. It applies only to non-hedgeable risks.

8. Continued

- (ii) Compare and contrast the Market Cost of Capital (MCoC) approach and the Percentile approach to calculating MVM.

There are two distinct approaches to calculating the MVM. The percentile approach holds enough capital to meet liabilities at a given confidence level while the MCoC holds enough to run off the inforce business

MCoC is preferred by the forum because it supports and reflects risk management better, allows better crisis response, is easy and transparent and passes the use test.

- (b) All applicable risks of Blossom are shown in Table 2.

- (i) Market risk has already been classified as hedgeable. Classify the remaining risk categories as hedgeable or non-hedgeable.

Business, insurance, and operational risks are non-hedgeable; no market instruments exist to replicate those risks. Credit risk is hedgeable; there are CDS type instruments that can be used.

- (ii) Calculate the MVM using the MCoC approach.

Diversified SCR = SCR(i) * DiversificationFactor(i) for all non-hedgeable risks, and MVM = Diversified SCR * COC. This includes the business, insurance, and operation risk categories above:

$$\text{Diversified SCR} = 15\% * (230 * 70\% + 50 * 55\% + 10 * 15\%) = 28.5$$

- (iii) Calculate available economic capital (defined as market value of assets less market value of liabilities).

$$\text{Market Value of Liability} = \text{PV of liability cash flows} + \text{MVM} = 900 + 28.5 = 928.5. \text{ EC} = \text{MVA} - \text{MVL} = 1,000 - 928.5 = 71.5.$$

- (c) Provide two reasons why market risk may not always be hedgeable for variable annuities.

There is basis risk on fund options and policyholder behavior risk. A high basis risk on the fund options can exceed the benefit of hedging, and policyholders may behave differently than assumed.

8. Continued

- (d) Describe the levels of diversification benefits that would apply if Huckleberry acquired Blossom.

There are three levels: within a single risk factor, across factors in a line of business, and across different business lines. Level III is applicable for this merger (combining Life and Annuity).

- (e)
- (i) Based on the information above, recommend whether Huckleberry should acquire Blossom at a price of 70 million USD. Justify your recommendation.

Huckleberry should acquire Blossom. Blossom's MCEV of 71.5 million is higher than the purchase prices of 70 million. It is also apparent that there will be some diversification benefit at the holding company level.

- (ii) List three additional significant considerations that you would want to evaluate before making the acquisition decision.

Different regulatory environments across companies, shareholder perspective, and operational environment differences.

Other answers were also accepted.

9. Learning Objectives:

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

Learning Outcomes:

- (3b) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of integrated risk management process.
- Demonstrate how each of the financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, scenario analysis, and stress testing.
 - Describe and evaluate risk aggregation techniques, incorporating the use of correlation, integrated risk distributions and copulas.
 - Describe how and why risks are correlated and give examples of risks that are positively correlated and risks that are negatively correlated.
 - Assess the overall corporate risk exposure arising from financial and non-financial risks.
- (4l) Define and evaluate credit risk as related to fixed income securities.

Sources:

Saunders and Allen, *Credit Risk Management: In and Out of the Financial Crisis*, Chapters 5 and 7

Commentary on Question:

This question tests the candidate's ability to apply a reduced form model to hypothetical credit spreads in determining the probability of default.

The first part of the question was comprehension. The rest of the sections were calculation-type analysis.

To receive maximum points, the candidate should have clearly labeled and defined the variables and formulas being used, in addition to the steps in the backward recursion calculation process.

There are two methods that can be used to arrive at the correct answers for parts (b), (c), and (d), with one being much more efficient than the other. In an effort to not bias against either method, full credit was awarded for a right answer under either approach. However, exam points were allocated to these sections based on the less efficient method. Candidates generally scored very well in section (a), moderately well in section (b), and tended to struggle in sections (c) and (d). Many candidates did not use the risk-free rates or the backward recursion approach needed for the calculations.

Solution:

- (a) Identify three factors that can affect the Loss Given Default (LGD) for a bond. For each factor, state whether the correlation with LGD is positive or negative.

9. Continued

Commentary on Question:

Although only three factors are identified here, there were other answers that were acceptable. Note that recovery rate was **not** an acceptable answer as this is part of the definition of loss given default, not a factor that impacts it.

- Value of the collateral backing the bond - negative correlation
- External credit ratings – negative correlation
- Short term default-risk-free interest rates –positive correlation

- (b) Calculate the two-year cumulative probability of default for both an HQ-rated and an LQ-rated two-year, zero-coupon bond. Assume LGD is 100% and that the bonds cannot change in rating aside from defaulting.

One year forward rate on treasury bond:

$$(1 + \text{two-year spot rate})^2 = (1 + r)(1 + \text{one-year spot rate})$$

$$(1 + 7\%)^2 = (1 + r)(1 + 5\%)$$

$$r = 9.04\%$$

HQ Bond

One year forward rate:

$$(1 + 12\%)^2 = (1 + a)(1 + 8\%)$$

$$a = 16.15\%$$

Probability of default (PD) in year one:

$$(1 + \text{one-year treasury spot rate}) = (1 - \text{PDA1})(1 + \text{one-year HQ spot rate})$$

$$(1 + 5\%) = (1 - \text{PDA1})(1 + 8\%)$$

$$\text{PDA1} = 2.78\%$$

PD in year two:

$$(1 + \text{one-year treasury forward rate}) = (1 - \text{PDA2})(1 + \text{one-year HQ forward rate})$$

$$(1 + r) = (1 - \text{PDA2})(1 + a)$$

$$\text{PDA2} = 6.12\%$$

$$\text{Cumulative PD on HQ bond} = 1 - (1 - \text{PDA1})(1 - \text{PDA2}) = \underline{\underline{8.73\%}}$$

LQ bond

One year forward rate:

$$(1 + 13.5\%)^2 = (1 + b)(1 + 10.5\%)$$

$$b = 16.58\%$$

PD in year one:

$$(1 + 5\%) = (1 - \text{PDB1})(1 + 10.5\%)$$

$$\text{PDB1} = 4.98\%$$

9. Continued

PD in year two:

$$1 + 9.04\% = (1 - \text{PDB2})(1 + 16.58\%)$$

$$\text{PDB2} = 6.47\%$$

$$\text{Cumulative PD on LQ bond} = 1 - (1 - \text{PDB1})(1 - \text{PDB2}) = \mathbf{11.13\%}$$

An alternate solution:

HQ Bond

$$1.12^2 * (1 - \text{PD}) = 1.07^2$$

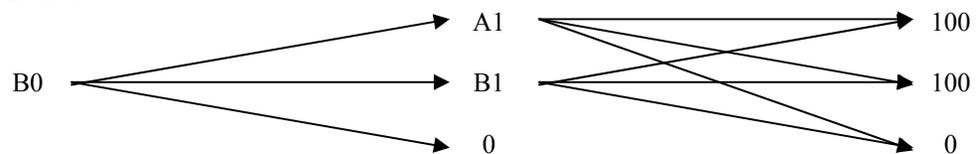
$$\text{PD} = 8.73\%$$

LQ Bond

$$1.135^2 * (1 - \text{PD}) = 1.07^2$$

$$\text{PD} = 11.13\%$$

- (c) Calculate the credit spread of a two-year, zero-coupon LQ-rated bond assuming LGD is 100%.



Using backward recursion risk neutral valuation,

$$A1 = 90\% * (100/1.0904) + 8\% * (100/1.0904) + 2\% * (0/1.0904) = 89.88; r = 9.04\% \text{ in year 2 from part (b)}$$

$$B1 = 5\% * (100/1.0904) + 85\% * (100/1.0904) + 10\% * (0/1.0904) = 82.54$$

$$B0 = 5\% * (A1/1.05) + 85\% * (B1/1.05) + 10\% * (0/1.05) = 71.10$$

To find the credit spread,

$$B0 = 100 / [(1 + .05 + \text{CS}) * (1 + .0904 + \text{CS})]$$

$$\text{CS}^2 + 2.14\text{CS} - .26 = 0$$

$$\text{CS} = \mathbf{11.59\%}$$

An alternate solution:

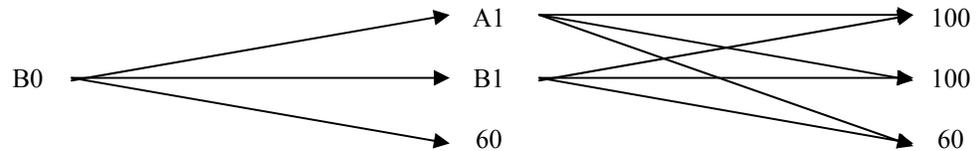
$$\text{Find the total PD for the LQ Bond} = .1 + .05 * .02 + .85 * .1 = .186$$

$$\text{Then } 1 - \text{PD} = 1.07^2 / (1 + .07 + \text{CS})^2$$

$$\text{PD} = 11.59\%$$

9. Continued

- (d) Calculate the value of a two-year, zero-coupon LQ-rated bond assuming LGD is 40% and the par value is \$100 million.



Using backward recursion risk neutral valuation,

$$A1 = 90\% * (100/1.0904) + 8\% * (100/1.0904) + 2\% * (60/1.0904) = 90.98; r = 9.04\% \text{ in year 2 from part (b)}$$

$$B1 = 5\% * (100/1.0904) + 85\% * (100/1.0904) + 10\% * (60/1.0904) = 88.04$$

$$B0 = 5\% * (A1/1.05) + 85\% * (B1/1.05) + 10\% * (60/1.05) = \underline{\underline{81.32}}$$

Alternate solution:

Determine expected payout at each time t and discount to time 0 at risk free rates:

Time 2 discounted: $[100*(1-PD) + 60*(PD-.1)] / 1.07^2 = 75.60$, where $PD=.186$

Time 1 discounted: $60 * (.1) / 1.05 = 5.71$

Sum = 81.32

10. Learning Objectives:

1. The candidate will understand the types of risks faced by an entity and be able to identify and analyze those risks.
2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.
3. The candidate will understand how the financial risks faced by an entity can be quantified and the use of metrics to measure risk.

Learning Outcomes:

- (1a) Identify and analyze financial market risks faced by an entity, including but not limited to: currency risk, credit risk, spread risk, liquidity risk, interest rate risk, and equity risk.
- (1b) Identify and analyze insurance risks faced by an entity, including but not limited to: mortality risk, morbidity risk, catastrophe risk, product risk, and embedded options.
- (1c) Identify and analyze operation risks faced by an entity, including but not limited to:
 - Market Conduct (e.g., sales practices)
 - HR risk, e.g., productivity, talent management, employee conduct
 - Process risk, e.g., supply chain R&D
 - Technology risk, e.g., reliability, external attack, internal attack
 - Judicial risk, e.g., litigation
 - Compliance risk, e.g., financial reporting
 - Internal and external fraud
 - Execution risk
 - Governance risk
 - Supplier/partner risk
 - Disaster risk, e.g., natural disaster, man-made disaster
- (2d) Demonstrate an understanding of economic capital as reported by financial institutions.
- (3a) Demonstrate how to calculate required capital on an economic capital basis:
 - Define the basic elements and explain the uses of economic capital.
 - Explain the challenges and limits of economic capital calculations and explain how economic capital may differ from external requirements of rating agencies and regulators.

10. Continued

- (3b) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of integrated risk management process.
- Demonstrate how each of the financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, scenario analysis, and stress testing.
 - Describe and evaluate risk aggregation techniques, incorporating the use of correlation, integrated risk distributions and copulas.
 - Describe how and why risks are correlated and give examples of risks that are positively correlated and risks that are negatively correlated.
 - Assess the overall corporate risk exposure arising from financial and non-financial risks.

Sources:

FE-C178-11: Economic Capital Modeling – Practical Considerations - Milliman

FE-C151-08: Ch. 13 (Sections 13.1 – 13.4), Annuity and Investment Products of Atkinson & Dallas, *Life Insurance Products and Finance*

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) For each product, SPIA and EIA, describe the exposure to the following risks:
- (i) Pricing Risk
 - (ii) Market Risk
 - (iii) Operational Risk

Commentary on Question:

This question was a Comprehension question that tested the candidates' understanding of the risks that a SPIA and EIA are exposed to.

To get full credit, a candidate had to identify the pricing risks, market risks and operational risks that apply to the product and describe how they apply. This question did not require candidates to rank the risks.

This part of the question was not answered well; the common errors were as follows:

- Lack of understanding of the risks that a SPIA and EIA are exposed to.
- Simply ranking Pricing, Market and Operational Risks as Low, Medium and High.
- Not listing how the risk applies to the product; for example, it is not sufficient to list Mortality as a risk. Candidates need to expand on how Mortality is a risk for a SPIA.
- Lapse risk is not a pricing risk for SPIA products.

10. Continued

SPIA

Pricing Risk:

- (Pricing risk is risk that prices charged for insurance contracts are insufficient to cover liabilities.)
- Longevity risk, the risk that annuitants will live longer than priced for, is the primary SPIA pricing risk.
- SPIAs are exposed to anti-selection as healthy lives are more likely to choose life annuities than unhealthy lives.

Market Risk

- (Market Risk is risk of potential fluctuations in interest rates, equity markets and foreign exchange and the impact on liabilities.)
- There is market risk for SPIAs if interest rates fluctuate or change and there is an asset / liability cash flow mismatch.
- Reduction in asset returns will cause reinvestment risk, which is the risk of cash flows being reinvested at lower rates than expected.

Operational Risk

- (Operation risk is the risk of loss from inadequate or failed internal process, people or systems.)
- Examples of possible SPIA operational risk are:
 - System error in calculating SPIA annuity rates.
 - Erroneous investment selection and inadequate investment management process.

EIA

Pricing Risk

- Risk of offering interest rate guarantee higher than can be supported by fixed income investments.
- Risk of mispricing participation rate, cap and/or indexing method.
- Pricing risk arising from company's inability to purchase appropriate hedging securities.
- Difficult to set assumption for policyholder behavior since behavior linked to interest rates and equity rates.

Market Risk

- Risk of fluctuating interest rates since guaranteed rate is fixed.
- Risk of higher hedge costs due to market volatility and lower than expected fixed income return.
- Risk of asset cash flows not matching liability cash flows. Liability cash flows are hard to predict.

Operational Risk – Examples are:

- Hedging Operation risk failure
- Incorrect hedging strategy for EIA

10. Continued

- (b) Describe three potential deficiencies of a formulaic internal capital requirement.

Commentary on Question:

This is a knowledge utilization question.

Candidates were able to provide deficiencies of a formulaic approach to economic capital.

- There is no link in a formulaic approach to the company's risk management and risk mitigation strategies.
- Formulaic approaches do not deal with all types of risks.
- Formulaic approaches do not adapt to changing market conditions and financial environment.

Other acceptable answers:

- Formulaic approaches do not accurately measure and optimize the business' capital resources.
- Formulaic approaches generally do not give credit for a hedging program.
- Formulaic approaches generally do not allow for the benefit of diversification.

- (c) Calculate the Required Economic Capital for each of the two products, SPIA and EIA, separately.

Commentary on Question:

This was an analysis part of the question that tested candidates' ability to calculate economic capital.

Candidates were able to calculate CTE 95, but very few candidates calculated the Market Value of Liabilities (CTE 0) or the correct Required Economic Capital.

The question marks were weighted equally between CTE 95, CTE 0 and the final Economic Capital calculation.

Market Value of Liabilities = CTE 0

CTE 0 = Average of the 100 Scenarios

SPIA:

Market Value of Liabilities =

$(340+250+315+375+275+320+225+330+230+290+75*90)/100$

CTE 0 = 97.0 M

CTE 95 = Average of worst 5 scenarios = $(340+315+375+320+330)/5$

CTE 95 = 336M

EIA:

Market Value of Liabilities =

$700+1250+650+900+1100+850+675+1350+925+800+250*90)/100$

CTE 0 = 317.0M

10. Continued

CTE 95 = Average of worst 5 scenarios = $(1250+900+1100+1350+925)/5$

CTE 95 = 1105M

Economic Capital is additional capital in excess of the Market Value of Liabilities

Economic Capital = CTE 95 - CTE 0

Economic Capital SPIA = $(336- 97)$

Economic Capital SPIA = \$239M

Economic Capital EIA = $1105 - 317$

Economic Capital EIA = \$788M

(d)

- (i) Explain why a diversification benefit might exist from combining SPIA and EIA.

Commentary on Question:

This was a difficult analysis question, where candidates had to think about how a diversification benefit could exist between a SPIA and EIA.

Candidates did not fare well on this part, and were unable to provide examples of where a diversification benefit could exist.

- Diversification benefit exists because the worst outcomes do not all happen at the same time.
- Diversifiable component of mortality and longevity (volatility risk) decreases as policies increase; combining EIA and SPIA diversifies mortality.
- For SPIA, higher mortality rates are more profitable and reduce benefits. For EIA, higher mortality requires liquidation of assets which may be less profitable and reduces future fee income.
- Policyholder behavior risk is significant for EIAs, but not for SPIAs.
- Adding more unrelated risks to the portfolio reduces volatility of results.

- (ii) Calculate the diversification benefit from combining SPIA and EIA in the Required Economic Capital calculation.

Commentary on Question:

This was an analysis question that tested the candidates' ability to recognize the diversification benefit that exists between SPIAs and EIAs.

Candidates did well in this question, and were able to make the connection on how a scenario can affect each product differently providing a diversification benefit.

10. Continued

$$\text{Scenario 1: } 340 + 700 = 1040$$

$$\text{Scenario 2: } 250 + 1250 = 1500$$

$$\text{Scenario 3: } 315 + 650 = 965$$

$$\text{Scenario 4: } 375 + 900 = 1275$$

$$\text{Scenario 5: } 275 + 1100 = 1375$$

$$\text{Scenario 6: } 320 + 850 = 1170$$

$$\text{Scenario 7: } 225 + 675 = 900$$

$$\text{Scenario 8: } 330 + 1350 = 1680$$

$$\text{Scenario 9: } 230 + 925 = 1155$$

$$\text{Scenario 10: } 290 + 800 = 1090$$

Worst 5 Scenarios: Scenario 2, 4, 5, 8 & 9

$$\text{CTE 95} = (1500+1275+1375+1170+1680)/5$$

$$\text{CTE 95} = 1400$$

$$\text{Economic Capital} = \text{CTE 95} - \text{CTE 0}$$

$$\text{Economic Capital} = 1400 - (97+317)$$

$$\text{Economic Capital} = 986.0$$

$$\text{Diversification Benefit} = 1027 - 986 = \$41\text{M}$$