AFE Complete Illustrative Solutions
Fall 2010

1. Learning Objectives:

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:

(5d) Demonstrate how an organization can create a risk management culture including: risk consciousness, accountabilities, discipline, collaboration, incentives and communication.

Sources:

FE-C139-07: "No Assurance of Good Governance: Observations on Corporate Governance in the U.S. Insurance Sector"

Commentary on Question:

This question was testing the candidate's understanding of board/governance structure and best practices. Some students gave more examples than requested. There is no extra credit for detailing 5 items when a question asks for 3. Candidates generally did well on this question.

Solution:

(a) Describe four characteristics of insurance company Boards of Directors which lead to good governance.

Independence – Directors do not have significant ties to the company beforehand such that their decisions are impaired by how they will be affected. This also ensures good management.

Knowledge of Industry – Able to understand who the business works, products, risks, etc.

Committee structure set up to facilitate involvement from all board members; not insular.

Appropriate Size – Too small (5-6) is ineffective or dominated by one or 2 people; too large (18+) is unwieldy; right would be 10-12 or similar.

1. Continued

Because more options are available in source literature, additional correct answers would score points. Examples are:

- *Compensated appropriately – no stock options*
- *Senior management independent of board; board sets policy, managers do day-to-day*
- *Board governed by maintaining high ratings*

(b) Describe how Zoolander's Board of Directors meets or does not meet these criteria.

1. Does not meet independence; 4 of 5 have previously worked at Zoolander, their decisions are based on how the decisions affect them, not the shareholders or customers; audit committee does not have any independent directors

2. Meets knowledge criteria; mostly all have insurance knowledge (former admin assistant may not), from working for the company and being the former insurance controller for the state

3. Committees not good structure; do not meet frequently enough; investment committee didn't even meet in the last year

4. Not large enough; only 5 people, so don't have good spread of covering various committees

Note: Based on the additional options listed above, the board would be evaluated as follows:

- Compensation – no stock options…
- Management seems not independent of board; CEO is also board member
- Concerned about keeping high rating with Kelly

(c) Identify three characteristics for Hermine Dauphin's replacement that would strengthen the composition of Zoolander's Board of Directors.

Commentary on Question:
Similar to part (a), the candidate could know more than was required for this section but be limited to 3 answers by the question itself. Also, the question asks to "identify" rather than "explain" or "describe", so these answers need not be much more than single words.

Independence – Not a former employee of Zoolander or having ties to company

Holds management accountable

1. Continued

Understand insurance industry

Risk Management background

Note: Other options include:

- Financial expert.
- Has equity stake in Zoolander (stocks, not options)

2. 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.

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:

(3a) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of an 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.

(4s) Define strategic risk.

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

(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.

(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.

Sources:

FE-C159-09: Countering the Biggest Risk of All

FE-C170-09: Why COSO is Flawed

Crouhy, Chapter 5 Measuring Market Risk: The VaR Approach

Hardy, Chapter 9 Risk Measures

Damoradan, Chapter 11 Strategic Risk Management

2. Continued

Commentary on Question:
Candidates scored decently on this question. Since the question pulled material from many sources, candidates who were not expert at one reading or topic (such as COSO) were able to collect many points by knowing the other readings.

Solution:
(a)

(i) Define strategic risk.

Commentary on Question:
Key ideas that were expected from the candidates here are: "external events" and effect on company's growth and shareholder values. Specific external events could also earn grading points.

One acceptable definition would be: The array of external events that can devastate a company's growth trajectory and shareholder values.

(ii) Explain the threat strategic risk poses.

Commentary on Question:
The impact on the business was what we were looking for, not a list of threat that may have been used for part (a)(i).

Can disrupt or even destroy the business.

(iii) Explain the potential opportunity available through appropriate strategic risk management.

- -When a risk is common to companies in an industry, taking early steps to mitigate it can put company in a much stronger position.
- -Strategic risk may mask growth opportunities.

(b) Assess and rank the six strategic risks using:

(i) The COSO approach to measuring operation Risk;

Commentary on Question:
Some candidates interpreted the mean as the expected loss instead of mean severity and therefore ranked the means. Either interpretation would receive credit.

2. Continued

1. (6) Stagnation 70%x$10 = $7.0
2. (4) Project 70%x$ 7 = $4.9
3. (5) Customer 60%x$ 5 = $3.0
4. (3) Competitor 20%x$14 = $2.8
5. (1) Industry-Rising capital cost 20%x$10 = $2.0
6. (2) Industry New regulations 30%x$ 5 = $1.5

(ii) A risk metric consistent with a risk management approach.

Same ranking using CTE(95) or VAR

1. (3) Competitor
2. (1) Industry – Rising capital costs
3. (2)Industry – New regulations
4. (6) Stagnation
5. (4) Project
6. (5) Customer

(c) Explain why the risk management approach to assessing strategic risk is more appropriate than the COSO approach used by Tomas Lyon.

Commentary on Question:
The main idea is that it is unexpected loss that should be managed. A risk measure based on expected loss is not very useful.

- COSO approach focuses on expected loss. Strategic risk is about unexpected loss.
- Risk management approach takes the distribution of loss into consideration.
- Lyon should be taking the full set of likelihood and impact combos.
  - One full set of points would produce a severity distribution, a distribution of single-event losses.
  - Another full set of points produces the frequency distribution, a probability distribution for the number of losses.

(d) Calculate and compare the aggregate VaR(95) between Lyon's top three risks and the top three risks identified in part (b)(ii).

Matrix multiplication using formula in Crouhy Ch.5, pg. 201
Values for VaR vector and correlation matrix provided in stem but needed to recognize to apply formula.

Risk management top three risks using VaR or CTE:

- -Competitor
- -Industry – Rising Capital Costs
- -Industry New Regulations

2. Continued

$$(25\ 40\ 16)\begin{pmatrix} 1 & 0.4 & 0.5 \\ 0.4 & 1 & 0.6 \\ 0.5 & 0.6 & 1 \end{pmatrix}\begin{pmatrix} 25 \\ 40 \\ 16 \end{pmatrix}^{1/2} = 66.70$$

Lyon's top 3 risks:

- Project
- Customer
- Stagnation

$$(12\ 9\ 15)\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} 12 \\ 9 \\ 15 \end{pmatrix}^{1/2} = 21.21$$

(e) Calculate and compare the greatest possible aggregate CTE(95) risk between Lyon's top three risks and the top three risks identified in part (b)(ii).

(i) Risk management top 3 risks:

1. (3)Competitor
2. (1)Industry Rising capital Costs
3. (2)Industry new Regulations

Agg. CTE(95) <= Σ CTEi(95) = $CTE_3(95) + CTE_1(95) + CTE_2(95)$
Agg. CTE(95) <= $35 + $50 + $20
Agg. CTE(95) <= $105

(ii) Lyon top 3 risks:

1. (4)Project
2. (5)Customer
3. (6)Stagnation

Agg. CTE(95) <= Σ CTEi(95) = $CTE_4(95) + CTE_5(95) + CTE_6(95)$
Agg. CTE(95) <= $15 + $11 + $18
Agg. CTE(95) <= $44

Conclusion: Lyon's top 3 aggregate CTE is significantly lower than risk management top 3 aggregate CTE.

2. Continued

(f) Recommend one of the three risk metrics Cobalt suggested Zoolander use when performing its strategic risk review and justify why this metric is preferable to each of the other two options.

Commentary on Question:
Cobalt's report did not explicitly suggest that Zoolander use particular metrics, instead the report implicitly showed that they valued using these metrics by including them in the report. Although nearly every candidate correctly interpreted the intention of the statement, because it was not explicitly stated, the grading outline was expanded to include any reasonable metric chosen by the candidates.

VaR over Mean:

- Mean loss relates to expected loss, risk management should focuses on unexpected aggregate loss.
- VaR is well understood by management and accepted in the industry.
- VaR provides an aggregate measure of risk in a single number.

CTE over VaR

- Both are simple to work with.
- CTE is subadditive; VaR is not.
- CTE is a coherent risk measure; VaR is not.
- CTE taking on average of a set of the largest outcomes, it is less sensitive to sampling error and does not create anomalies associated with quantile measure.

(g) For each of the following strategic risks, elaborate on Cobalt's summary of the particular risks facing Zoolander, and identify a potential countermeasure:

(i) Industry: Rising Capital Costs;

Risks:

- Zoolander is facing a possible downgrade
- A downgrade will lead to higher capital costs.
- Shareholders may lose confidence in Zoolander's stock and require a higher return.
- High funding costs will cause a lack of strategic flexibility.

2. Continued

Countermeasure:

- Needs to focus on removing negative outlook from rating agencies.
- Address Kelly's concerns about lower liquidity, lower profitability and processes and procedure.
- Improve asset/liability management; internal control; credit risk control; market risk control.
- For example increasing collaboration with competitor firm in the same market.

(ii) Stagnation: Flat or Declining Volume

Risks:

- Zoolander is facing a mature market.
- Growth rates expected to be low, unless Zoolander reduces its margin.
- Volume of business may even decline.

Countermeasure:

- Generate demand innovation by offering more services and/or more benefits and thus provide more value to customers.
- Conduct market surveys to determine customer priority and benefits and services that they value.

(h)

(i) Identify and describe three ways in which Zoolander could exploit the strategic risk from Competitor: Emerging Global Rivals.

1. Info Advantage
   - Access better and more timely information about events, allowing a superior response
2. Speed Advantage
   - Speed of response to changed circumstances
   - By acting faster than competitor can turn threat into opportunity
3. Experience/Knowledge Advantage
   - Past experience with similar crises and knowledge of effect on market enables better response than other firms

(ii) Propose how each could be achieved.

1. Info Advantage
   - Conduct market survey
   - Use their own employees as source of information
   - Invest in information network

2. Continued

2. Speed Advantage
   - Have small teams that are allowed to make decisions without senior management overview
   - Share information widely across the organization
3. Experience/Knowledge Advantage
   - Hire personnel that have different experience
   - Acquire firm in unfamiliar market

3. Learning Objectives:

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.

Learning Outcomes:

(4c) Demonstrate means for reducing risk without transferring it (internal hedges).

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

(5b) Describe the fundamental concepts of financial and non-financial 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.

(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.

Sources:

Crouhy, Galai, & Mark, *Risk Management,* 2001, Ch. 3, Structuring and Managing the Risk Management Function in a Bank

FE-C117-07: Doherty, *Integrated Risk Managemen*t:
Ch. 1, The Convergence of Insurance Risk Management & Financial Risk Management
Ch. 7, Why Is Risk Costly to a Firm?
Ch. 8, Risk Management Strategy: Duality and Globality

FE-C171-09: Insurance Criteria: Refining the Focus of Insurer Enterprise Risk Management Criteria, Standard & Poor's, June 2006.

FE-C173-09: Risk Management and the Rating Process for Insurance Companies, Best Rating Methodology, January 2008.

Commentary on Question:

The question tested candidate's ability to apply material by identifying and recommending improvements to weaknesses in a real-world example. Candidates who did well not only identified risk reducing strategies and ERM program weaknesses but also provided strong supporting statements explaining why and how the weakness affects Zoolander. They also strongly supported and stated the benefits of the recommended improvements.

3. Continued

Most candidates got some partial points by knowing the case study and commenting on a few obvious areas of strength/weakness. The question was fairly open-ended so many alternative responses were accepted. Candidates were able to earn many more points for part (c) by choosing actions that were Board-appropriate actions.

Solution:

(a)

(i) Identify three risk reduction strategies Zoolander is currently pursuing.

- -Zoolander is exploring alternatives to reinsuring its Term Block.
- -Zoolander dynamically hedges its VA guarantees.
- -Zoolander is considering adjusting VA product features to control its exposure.

(ii) Explain how improved ERM processes at Zoolander would enhance the effectiveness of each strategy.

<u>Reinsurance</u>

- ERM allows reinsurance purchases to be based on overall corporate risk tolerances and provide protection from risk aggregation across lines or divisions.

<u>Dynamic Hedging</u>

- ERM enhances the ability to determine effectiveness of company-implemented risk mitigation techniques such as reinsurance and hedging.

<u>VA Product Features</u>

- ERM helps management demonstrate how risk/return decisions will improve the value of the company.

(b) Describe four existing weaknesses in Zoolander's ERM program and recommend a Board action the RMC could suggest.

<u>Bill Buck, head of ERM, reports to Henri Jay in Planning.</u>

- ERM functions should report to Board to ensure independence and access to senior management of the firm.

<u>There is an ineffective risk culture.</u>

- The Board does not take ERM seriously.
- For ERM to be effective, the tone must be set at the top.
- The Board should adopt a Risk policy.

3. Continued

There is not effective allocation of capital.

- Currently factor-based regulatory capital approach is used.
- Board should recommend to the CFO that he allocate capital according to economic risk.
- This will ensure firm is properly evaluating risks and ensuring they appropriate rewarded for taking on these risks.

John Badger in Derivatives has total control of model, risk and ad-hoc strategy.

- Badger runs front and back office hedging operations by himself.
  - This leads to risk of fraud and human error.
- Badger developed model independently with no peer review.
  - This leads to model risk.
- Increase staff on Derivatives team, do a peer review of the model and create separate and independent front/back office functions.

(c) Recommend which one of these four actions the Board should implement first.

The Board should adopt a Risk Policy.

- This is costless.
- Setting a tone from the top will help ERM gain traction within the organization.
- This will set up the firm for future success to address other ERM weaknesses.

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.

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

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:

(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 operational risks faced by an entity, 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

(3a) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of an 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.

4. Continued

- 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.

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

FE-C140-07: Risk Measurement, Risk Management and Capital Adequacy in Financial Conglomerates (Excluding Appendices)

FE-C151-08: Ch. 13 of Atkinson & Dallas, *Life Insurance Products and Finance*

FE-C173-09: Risk Management and the Rating Process for Insurance Companies, Best Rating Methodology, January 2008.

Economic Capital for Life Insurance Companies, SOA Monograph, 2008

4. Continued

Risk Aggregation for Capital Requirements Using the Copula Technique, Song Zhong, Risk Management Newsletter, March 2005, Issue #4

Commentary on Question:
This question tests the candidate's ability to not only recognize the risks inherent in Zoolander's product lines, but also the correlation between each of these product lines. In order to score well, candidates needed to able to correctly identify the type of correlation between product lines, and how ratings are affected by this relationship.

Solution:

(a) Between each of six pairs of risk categories (i-iv), recommend whether Wanda should apply a significantly positive, near zero or significantly negative correlation.

Commentary on Question:
Candidates generally were weak in justifying their responses. Those that were able to justify their responses often earned the full 2 points.

- -Liquidity-Mortality Correlation: Near Zero
- -Liquidity-Operational: Significantly Positive
- -Liquidity-Interest Rate: Significantly Positive
- -Mortality-Operational: Significantly Positive
- -Mortality-Interest Rate: Near Zero

(Note: This is fairly subjective (Econ Capital p. 49), with sources giving modest and sometimes conflicting guidance; negative correlation was not acceptable as an answer, and alternate responses were given credit if logically supported. Some example justifications are listed below.)

- Operational risk is assumed as constant and additive (i.e., perfectly correlated) with other risks.
- Mortality risk for life insurance policies is commonly considered to be uncorrelated with other risks (aside from operational risk).
- Exposures to other risks are magnified by insufficient risk management, a significant operational risk for Zoolander, suggesting that operational risk is highly correlated with other risks.
- Within GICs, interest rate risk and liquidity risk are highly entwined, as interest rates will determine the level of impact in a "run on the bank" scenario.
- For Term, the main contributor of mortality risk, interest rate risk and liquidity risk have minor effects.

4. Continued

(b) For each of the four risks, identify two product lines that contribute significantly to that risk.

Commentary on Question:
As stated in the question, candidates are allowed to choose different products for each risk. Most candidates did so.

Liquidity Risk

GICs

- GICs allow early surrender in the event of a ratings downgrade of Zoolander
- The liquidity risk from a similar covenant brought down General American Life, demonstrating the enormity of the risk
- Backing assets include illiquid private placement bonds and real estate

Term

- The assets backing Term include a high proportion of relatively illiquid real estate
- The assets backing Term include a high proportion of relatively illiquid private bonds
- If Rose Re failed and large claims were incurred, the rather illiquid corporate block (lots of privates, real estate) would be backing claims in excess of required capital

Mortality Risk

Term

- Mortality risk is partially controlled by reinsurance from Rose Re, which also provides facultative underwriting
- A significant amount of retained death benefits remains for Zoolander, as seen in income statements

VA

- GMDB or GMIB option in the enhanced product adds mortality risk because of the guarantees

Operational Risk

VA

- Inadequate testing of GMDB, GMIB when determining generosity of features broad assumptions being made about riskiness
- There is not enough computing power to properly price the enhanced VA product
- Trusting hedging VA feature risk to John Badger on ad hoc basis

4. Continued

Term
- Single reinsurer for Term, with falling ratings, is operational risk
- Success of Term block depends strongly on underwriting process, which is subject to operational risk

Interest Rate Risk
GIC
- Profitability primarily comes from interest margin
- Assets supporting GICs have been lengthened significantly, increasing interest rate risk
- Higher guarantees have been made on GICs, also increasing interest rate risk

Disability Insurance
- Return of premium rider priced at high asset returns, creating incentive for aggressive investments

(c) Within each of the four risks, recommend whether Ms. Fox should apply a significantly positive, near zero or significantly negative correlation between the two product lines chosen in part (b).

Commentary on Question:
Answers provided here are based on the product lines chosen in (b). Other answers are accepted provided the candidate can justify the correlation between the product lines they chose.

Liquidity Risk
Significantly Positive (Term and GICs)
- For GICs, a ratings downgrade at Zoolander is a liquidity risk trigger
- For Term, the failure of Rose Re is a liquidity risk trigger
- The factors contributing to downgrades at both Zoolander and Rose Re, such as overall market conditions, are likely significantly correlated
- Because the liquidity triggers are correlated, this would lead to the liquidity risk itself being correlated

Mortality Risk
Significantly Positive (Term and GMDB; GMIB and Disability)
- Natural and man-made disasters and infectious disease pandemics contribute to systematic mortality risk that would apply to both Term and VA

4. Continued

Operational Risk
Significantly Positive (Term & VA)

- Sources of operational risk at Zoolander mostly have to do with internal processes and people
- The generally ineffective controls for operational risk at Zoolander are a result of a lax risk policy
- Improvement or failure to improve overall risk practices will affect all product lines

Interest Rate Risk
Significantly Negative (GICs and DI)

- Increased interest rates will improve profitability due to higher investment income
- If there is a ratings downgrade, increased interest rates will reduce profitability on GICs due to lower asset values available in "run-on-the-bank" scenario, especially given the lengthening of the portfolio
- Zoolander's ratings have had a negative implication for two years, making a downgrade somewhat likely
- With a downgrade somewhat likely, the correlation of interest rate risk between GICs and other blocks is significantly negative

(d) Propose, with supporting reasons, how Kelly Ratings will rate this economic capital process assuming Kelly uses the same rating methodology as A.M. Best.

Commentary on Question:
Candidates either gave answers about the result of the rating evaluation using AM Best's methodology or about the process used to rate Zoolander. Both sets of answers were acceptable.

Rating Result:

- Zoolander EC Model does not address all risk categories, missing Credit Risk and Strategic Risk.
- There is not staff dedicated to the EC model.
- On balance, Kelly would assign a weak rating to the EC process.

Rating Process:
AM Best looks at risk and capital management to be core areas of assessment in determining a rating. AM Best's rating components:

4. Continued

Business Profile:
Product lines, segments, reinsurance, management team.
There are inherent risks within each of Zoolander's product lines due to either product design or struggling reinsurer.

Operating Performance:
Level, volatility, and sustainability of earnings
BCAR scores are used. Based on the correlations above, Zoolander would get a poor BCAR score.
Revenue composition and growth pattern

Balance Sheet Strength:
Capital structure, liquidity, reinsurance program, etc.
Zoolander has significant liquidity risk, and issues with their reinsurance program.

5. 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:

(3c) Define and evaluate model and parameter risk.

Sources:

Investment Guarantees (Hardy) Ch. 9 and 11

Commentary on Question:

Question tested the candidates understanding of CTE levels, their impact on a hedging program and the limitations of CTE. The question was used to test the candidates understanding of how CTE applies to model risk and parameter risk.
Conceptually, this was one of the easiest questions on the exam. Cognitive levels were comprehension and analysis.

- Part (a):
  - A majority of candidates were able to calculate the CTE levels.
  - The standard deviation and standard error were where students encountered problems, with only a small percentage able to get the question completely right.
  - Students did not calculate the biased standard deviation.
  - A majority of students did not know how to calculate the standard deviation.
  - Most students were able to calculate the confidence interval.
- Part (b):
  - This question was a basic question, and a majority of candidates got full marks on the question.
- Part (c):
  - Because the question referenced a non-existent memo, students were given full credit for part (c). The solution written below lists additional points the candidate could earn without referring to the case study.
- Most students got part (b), but only a very small percentage of students scored perfectly on part (a).

Solution:

(a) Approximate the 95% confidence interval for the CTE (95) estimate.

CTE(95) = (1+1.02+1.05+1.1+1.83)/5 = 1.2
$s^2 = (1 / (100 \times (1 - .95) - 1)) \times ((1 - 1.2)^2 + (1.02 - 1.2)^2 + (1.05 - 1.2)^2 + (1.1 - 1.2)^2 + (1.83 - 1.2)^2)$
$s^2 = .12545$
$s = .35419$
Standard Error CTE = $.35419/ \sqrt{5} = .1584$
CTE 95% CI = $1.2 \pm 1.96 * .1584 = (0.8894, 1.51046)$

5. Continued

(b) Calculate the excess CTE due to parameter uncertainty.

CTE without parameter uncertainty = 1.2 (from part a)
CTE with parameter uncertainty =
CTE95 = (1+1.01+1.02+1.03+1.04+1.05+1.06+1.07+1.08+1.09+1.1+1.83+2.22+3.3+3.6)/15
Excess CTE due to parameter uncertainty = 1.5 – 1.2 = 0.3

(c) Explain the impact of the CTE calculation's standard error and parameter uncertainty on Badger's VA risk management program.

100 or 300 scenarios are too small to run hedging calculations to be reliable. Should consider running no fewer than 1000 scenarios, otherwise standard error will be too high.

6. 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.

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

Learning Outcomes:

(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.

(2c) Describe the concept of economic measures of value (e.g. EVA; embedded value) and demonstrate their uses in the risk management and corporate decision-making processes.

(4h) Demonstrate how derivatives, synthetic securities and financial contracting may be used to manage interest rate risk, including key rate risks.

Sources:

FE-106-07

FE-128-07

Modern Valuation Techniques, Fair Valuation of Insurance Liabilities (AAA Monograph)

AAA Monograph

FE-169-08: Fixed Annuities in a Low Interest Rate Environment

FE-130-07: Liquidity Risk Management

Commentary on Question:

This question was design to test students understanding of interest rate risks in a very simplified setting (single product, extreme risk scenario, simplified investment strategies). To score well on this question candidates needed to provide full evaluations and descriptions for (a) and (d) rather than scribbling buzzwords. Candidates did well on part (c) and not so well on parts (a) and (d). For part (b), many did not know how to calculate fair value.

6. Continued

Solution:

(a) Identify and describe the categories of the interest rate risk. For strategy 1, evaluate the importance of each risk as high, medium, low or not applicable.

Commentary on Question:
Most students understood what the question asked though a sizable minority wrote risks related to equity products (an SPDA is not a variable annuity). Furthermore, the request was related to interested rate risk. This is fairly tightly defined and candidates who spend time writing about non-interest rate risks are wasting valuable examination time.. Please note that grading was flexible on the "name" of the risk, focusing more on definition and correctly identifying its importance.

Yield Curve Risk: Movement of the yield curve will adversely affect value of liabilities. High Risk

Basis Risk: Risk that assets and liabilities, based on different interest rate bases, impact financial results. High Risk.

Reinvestment Risk: Risk related to assets being shorter term then liabilities and rates being lower, forcing reinvestment into assets with lower yield. Medium to High Risk.

(b) Assuming Risky Life executes Strategy 2, calculate the fair value of the liabilities.

Commentary on Question:
A lot of students mixed up strategy 1 and 2. Also, a lot of students missed that, in using strategy 2 for scenario 1 and 2, the liabilities last for the entirety of the projection, i.e. 20 years. For scenarios 3 and 4 the entire block will lapse. However, this does not mean the liability is 0. It is the value of the account value leaving.

Scenario 1: Liability at end of projection: 100*(1.03)^20 =180.6 million
Discounted to time 0 using 2% = 180.6/(1.02)^20 = 121.5 million
Scenario 2: Liability at end of projection: 100*(1.03)^20 = 180.6 million
Discounted at 3%: 180.6/(1.03)^20 = 100 million
Scenario 3: Liability lapses immediately, worth 100 million
Scenario 4: Liability lapses immediately, worth 100 million

Fair Value: 30% * 121.5 + 70% * 100 = 106.45

6. Continued

(c) Describe the events that will likely happen and calculate the effect on the balance sheet using the duration approach.

Commentary on Question:
This section was the best section of the question for the candidates. Two possible answers were accepted depending on how the candidate assumed the yield curve shifted.

Duration of invested assets is 12. Rate jumps to either 10% or by 5% (depending, we accepted either interest rate movement assumption).

Everyone lapsing means all assets need to be sold at **market value** while the liability will be paid out at **book value**.

Market Value of Bond: 100 million - 12*(.03)*100 Million = 64 Million

Surplus loss is 64 million minus 100 million or 36 million.

(d) Describe strategies available to Risky life to alleviate disintermediation risk, as related to:

(i) Product design

Commentary on Question:
This was by far the worst section of the question for candidates. Please note that a 3 point question with the word describe means that more is expected than a general list of design ideas without supporting descriptions.

Surrender Charges: Charges on account value would diminish policyholder incentive to leave, mitigating disintermediation risk

Market Value Adjustments: Application of market value adjustments could be used to eliminate disintermediation risk entirely

(ii) Investment choices

Increase Liquidity: Mitigates cost of people leaving by having assets available to fund withdrawals

Duration Match: Duration matching should reduce the risk of adverse interest rate movements causing big changes in market values in liquidation

7. Learning Objectives:

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

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:

(1c) Identify and analyze operational risks faced by an entity, 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

(6e) Demonstrate how ERM is able to contribute to shareholder value creation and how the performance of a given firm or venture may be evaluated against its objectives including total returns.

(6f) Demonstrate how risk metrics can be incorporated into the risk monitoring function as part of an ERM framework.

(6g) Explain means for managing risks and demonstrate measures for evaluating their effectiveness.

Sources:

Crouhy, Chapter 14, Capital Allocation and Performance Measurement

Commentary on Question:

Part (a) was a straight-forward calculation. Part (b) requested that the candidate elaborate on each RAROC component. Candidates mostly did well especially on part (a). A typical problem was signs (positive or negative) in the calculation. The question tested the cognitive levels of Comprehension and Analysis.

7. Continued

Solution:

(a) Determine whether TL is meeting its hurdle rate on the loan portfolio.

To meet hurdle rate, RAROC must be > Hurdle Rate

Revenue from loans
= loan rate x loan portfolio balance
= 6% of 1 billion
= 60 million
Economic Capital (EC)
= the remainder of the loan portfolio not backed by the 90% deposits
= 10% of 1 billion
= 100 million
Investment income on EC, (invested in risk-free assets)
= risk-free rate x EC
= 3% of 100 million
= 3.0 million
Deposits (90% of the loan portfolio)
= 90% x 1 billion
= 900 million
Income paid on deposits
= 2% of 900
= 18 million
Losses due to default
= 1% of 1 billion
= 10 million
Operating costs
= 20 million (given)
Risk Adjusted Return
= revenue from loans + inv income on EC - income paid on deposits - losses due to default - operating costs
= 60 + 3.0 - 18 -10 - 20
= 15.0 million
RAROC
= Risk adj return / EC
= 15 / 100
= 15%

RAROC > Hurdle Rate since 15% > 12%, so exceeding hurdle rate

7. Continued

(b) Explain how each of the individual components of the RAROC calculation for TL might change if TL were to participate in the government program.

Revenue from existing loans plus a higher loan rate for loans in amount of government program taken.
EC expected to be higher than 10% due to higher credit risk.
Investment income rate on new total EC: Prorata increase if investing in government securities.
Income paid on deposits as before plus interest charges on government loan amount.
Losses are due to default at 1% of current book plus higher expected loan loss rate on new loans.
Operating costs increased due to underwriting risky loans.

8. **Learning Objectives:**

2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.

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.

Learning Outcomes:

(2c) Describe the concept of economic measures of value (e.g., EVA; embedded value) and demonstrate their uses in the risk management and corporate decision-making processes.

(2d) 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.
- Demonstrate the ability to develop an economic capital model for a representative financial firm.

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

(5b) Describe the fundamental concepts of financial and non-financial risk management and evaluate a particular given risk-management framework.

Sources:

Babbel, Fair Value of Liabilities: The Financial Economics Perspective

Damoradan, Strategic Risk-Taking. Chapter 11

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

Economic Capital for Life Insurance Companies, SOA Monograph, 2008

Mueller, An Overview of Embedded Value

Commentary on Question:

This question tested cognitive skills of Retrieval, Comprehension and Analysis. Candidates did poorly on part (a) because they did not answer it within the context of Economic Capital. Candidates could have done better on part (b) if they had included more details. On part (c), many candidates did well on the straight-forward calculation.

8. Continued

Solution:

(a) Outline the considerations that XYZ needs to make when implementing EC for performance measurement and compensation.

Commentary on Question:
The question was trying to get at specific issues to implementing EC. Many candidates wrote general comments about compensation rather than specifically address considerations in using EC for performance measurement and compensation.

- When EC is used to measure and manage, performance requires a level of granularity appropriate to the performance management framework (business unit level)
- Needs to be consistent across business units
- Frequency of EC calculation should be appropriate for performance management and match changes in company risk profile
- EC approach needs to be robust and not open to manipulation
- EC approach must be easily explained to affected individuals
- EC does not directly give a measure of performance by itself, and could be combined with a measure of return such as RORAC

(b) Evaluate the components of Ashe's compensation package with respect to its effects on his strategic risk-taking.

Commentary on Question:
The goal of this question was to walk through each component of the compensation package and discuss the impacts on risk taking. Most candidates were on the right trail here but could have been more descriptive.

Cash Component: Too much cash component can lead to Ashe owning little stake in the company and making decisions to further his own interests. For example, Ashe might take less risk to assure job security.

Equity Component: If Ashe is able to maintain a significant equity investment in the firm, but as a part of a diversified portfolio, there will be more balanced risk taking. However, if the equity component is too high, Ashe will become risk adverse.

Bonus Component (applies to both % of Value In Force and % of Distributable Earnings): Risk taking might be focused on investments with short term earnings impacts, especially for distributable earnings component.

8. Continued

Lack of a Stock Option: Could lead to less risk taking since volatility increases option price. However, he wouldn't avoid behaviors that lower stock option prices, such as increasing dividends.

(c) Determine whether or not Mike Ashe would accept this project.

Commentary on Question:
Candidates did well here, as this question was testing a fairly straight forward utility function. However, there were many instances of incorrectly applying the scenario weightings before calculating the utility, and quite a few arithmetic errors. Remember, if all else fails, it is important to write down the applicable formulas and get the problem set up. Full credit was also given to candidates if they did the calculation in thousands rather than dollars with final answers of 133.05 for not accepting and 132.89 for accepting.

Component	Weighting	Good Scenario (without)	Bad Scenario (without)	Good Scenario (with)	Bad Scenario (with)
Base Salary	1	200,000	200,000	200,000	200,000
VIF	0.0005	500 mil	400 mil	560 mil	280 mil
Dist Earnings	0.0001	100 mil	-100 mil	125 mil	-115 mil
Shares	750	24	16	24	16
Total Earnings		$478,000	$402,000	$510,500	$340,500

Expected Utility if doesn't accept the project:
$= 66\% * 478{,}000^{0.8} + 34\% * 402{,}000^{0.8}$
=33,420

Expected Utility if accept the project:
$=66\% * 510{,}500^{0.8} + 34\% * 351{,}700^{0.8}$
=33,380

Conclusion: Ashe's utility is higher if he does not accept the project.

9. Learning Objectives:

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

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:

(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.

(3a) Demonstrate the use of risk metrics to quantify major types of risk exposure in the context of an 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.

(3b) Evaluate the properties of risk measures and explain their limitations.

Sources:

FE-C169-09: Ch. 3, Atkinson - Pricing Assumptions

CSFB Copula Study Note (Ch. 2 and 4)

Commentary on Question:

This question aimed to test candidates' understanding both of the implications of the underwriting changes at Bear Life and in the mathematics and theory of Copulas in a joint life calculation.

The cognitive levels tested were Comprehension, Analysis and Knowledge Utilization.

In general candidates found this to be a challenging question; however, many scored fairly well on some parts.

9. Continued

One of the key concepts in the answer to (a) was anti-selection by policyholders. Many students missed this key concept.

Parts (b) and (c) were the most difficult with many candidates struggling to articulate why mortality declined under Mr. Pato and to suggest appropriate ideas for improving the experience study. A decent number of students demonstrated preparedness by doing well on these parts.

Part (e) was the highest scoring part of the question, with many candidates getting full credit for the copula calculation in (e)(ii), though many candidates were not able to discuss the theory of copulas in (e)(i) or give a strong recommendation in (e)(iii).

Some students also did fairly well on part (f) even if they were unsuccessful on earlier parts of the question. They could have scored more with fully developed explanations and more than partial reasoning.

Solution:

(a) Explain Mr. Pato's statement.

Commentary on Question:
Most candidates understood that policyholders are biased to the higher mortality ranges but failed to discuss the shopping-around aspect to the dividing line changes.

- Policyholders and their agents will shop around for the best rate they can qualify for so changing the dividing line will cause policies to move.
- If the dividing line is lowered then the better risks in the standard class will be inclined to lapse, increasing standard mortality. Riskier standard policies will be added to the preferred class, increasing that class's mortality as well.
- If the dividing line is raised the good risks moved from preferred to standard will lapse, increasing standard mortality. Fewer new policyholders will qualify for the preferred class, raising its mortality as well.

(b)

(i) Provide three examples of how Mr. Pato's actions may have favorably influenced the aggregate mortality claims rate.

Commentary on Question:
Candidates performed poorly, usually failing to mention Mr. Pato's influence.

- Improved underwriting training
- Introduction of new underwriting requirements
- Better approach to borderline risks

9. Continued

(ii) Provide three examples of other influences, not attributable to Mr. Pato's actions, and briefly describe how they may have impacted the aggregate mortality claims rate.

Commentary on Question:
Candidates did better than in part (a), often getting at least two of the major answers.

- Change in distribution due to addition of national broker
- Overall improvement due to medical advances
- Changes in the demographics of the block

(c) Recommend four improvements to BL's experience study methodology.

Commentary on Question:
Candidates were usually able to name two of the major improvements but would often reword them to try to get four.

- Split Claims By Product – Smart Start and Safe Choice target different age groups and policy sizes
- Split Claims By Distribution Type – The new national brokerage firm extends geographic reach and impacts demographics
- Split By Underwriting Class – Just totaling the claims will not show performance by class and allow management to judge underwriting
- Split By Duration – The recent underwriting changes will only impact policies sold after 2007 with results that are mixed into the 2008-2009 totals

(d) You have been asked to consider a 3% reduction to all mortality rates in the pricing assumption. Evaluate the appropriateness of this assumption change.

Commentary on Question:
Candidates were usually able to articulate that this reduction is not appropriate and many were able to give at least one reason why this is so.

- The data gathered so far does not have a high degree of credibility
- The new product targets a different age group with different underwriting requirements, a reduction across the board will skew overall mortality
- Not appropriate based on the data provided

9. Continued

(e)

(i) Explain how copulas simplify the task of creating a correlated mortality assumption.

Commentary on Question:
Students generally performed poorly on this part. Many wrote that they are related to the marginal distributions but not much else.

- Copulas base the correlation of two variables on their marginal distributions
- Using them avoids the need to determine full joint distribution for all combinations, often there is not enough industry data to do this

(ii) Calculate the probability of BL paying a death benefit in the ten year period following the issue of Smart End UL on two lives both ages 75.

Commentary on Question:
Candidates did very well on this part, often surpassing minimum adequate knowledge.

- These are applied to the cumulative probability of death for each life
- $F_x(10) = F_Y(10) = 1 - 0.56 = 0.44$ represents the probability of death in the next 10 years for each life
- Clayton Copula: $C(0.44,0.44) = (0.44^{-0.3}+0.44^{-.03}-1)^{-1/0.03} = 0.2278$
- FGM Copula: $C(0.44,0.44) = (0.44)(0.44)[1+ (-0.1)(1-0.44)(1-0.44)] = 0.1875$

(iii) Recommend one of the copulas above by comparing the results to that when independent deaths are assumed.

Commentary on Question:
Candidates did well on this part as well. They were often able to calculate the independent lives probability and then subsequently make a recommendation. They were usually not able to adequately express why the Clayton model was better.

- If they were independent lives the probability of paying a benefit would be $(0.44)(0.44) = 0.1936$.
- The two lives covered are related (heartbreak syndrome) so the probability of paying a benefit should be higher than under independence, thus the Clayton copula is the better model.

9. Continued

- A key point to why the selected copula is better is that it increases the joint life probability of death rather than decreasing it. If we are intending to introduce correlation between the two lives, then a result which decreases the mortality rate relative to the independent calculation is inappropriate.

(f) Explain how the presence of the preferred class can affect the expenses and lapse pricing assumptions.

Commentary on Question:
Candidates did well on this part with a fairly wide range of answers.

- Expense assumptions should vary by class due to differing underwriting and acquisition costs.
- Expenses should be lower for the preferred class; the average policy size for this class will be higher leading to lower unitized expenses.
- Lapses should be lower for all business in the preferred class since they feel they are getting a good deal.
- Lapses will be higher in the standard class; customers will get the impression that they could get a better deal elsewhere.

10. Learning Objectives:

2. The candidate will understand measures of corporate value and be able to analyze the data in corporate financial statements.

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

Learning Outcomes:

(2d) 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.
- Demonstrate the ability to develop an economic capital model for a representative financial firm.

(4k) Define and evaluate credit risk as related to fixed income securities.

(4m) Explain how to incorporate best practices in credit risk measurement, modeling, and management.

(4n) Define credit risk as related to derivatives, define credit risk as related to reinsurance ceded, define counter-party risk and demonstrate the use of comprehensive due diligence and aggregate counter-party exposure limits.

(4o) Describe and evaluate risk mitigation techniques and practices: credit derivatives, diversification, concentration limits and credit support agreements.

Sources:

Mueller – EC for Life Ins Co

Crouhy, Chapter 8

Tilman, Chapter 9

Commentary on Question:

The question was trying to test whether students understood the credit VaR concept and the relationship to Economic Capital (EC).

Students generally did well in the part (a)(i), (a)(ii), and (c)(i). Part (a) was more of a retrieval type of question and students received added points for expanding on the concept. Part (c) involved an expected value calculation and most students received maximum points from this question.

10. Continued

Solution:
(a)

(i) Explain the calculation challenges that credit VaR poses relative to market VaR.

Commentary on Question:
Students generally did well on this part as this was more of a Retrieval type of question.

- Credit VaR is far from being a normal distribution
  - (i) Credit returns are highly skewed and fat-tailed
  - (ii) Credit quality improvements have limited upside potential to an investor while credit quality downgrades or defaults would result in significant downsides
  - (iii) Percentile levels of the distribution cannot be measured from mean and variance only and consequently requires a simulation of the full distribution of changes in value of a portfolio

- Measuring the portfolio effect due to diversification is more complex than for market risk as the correlation of the credit quality changes for all pairs of obligors is not directly observable

- The information on loans is not as complete as compared to traded instruments such as bonds

(ii) Outline the steps used to calculate credit VaR for a single bond instrument under the Credit Metrics framework.

Commentary on Question:
Similar to part (a)(i), students were mostly able to identify the key steps in calculating credit VaR under the Credit Metrics framework with only limited number of students expanding on the concepts.

Step 1: Specify the transition matrix – This includes identifying the credit rating categories and determining the probabilities of migrating from one credit quality to another. The transition matrix can be internally developed or from an external source such as Standard & Poor's.

10. Continued

Step 2: Specify the credit risk horizon – The risk horizon is usually set to one year but can vary from a few days to several years. The credit risk horizon is dependent on the availability of data especially for longer horizons. The credit risk horizon should be consistent with the transition matrix.

Step 3: Specify the forward pricing model – The valuation of a bond is derived from a zero curve corresponding to all the possible ratings of the issuer. This requires a unique spread curve for each credit rating. In cases where a bond defaults, a recovery rate estimated from historical data is used as the salvage value of the bond when the credit quality reaches this state.

Step 4: Derive the forward distribution of changes in portfolio value – This pertains to the distribution of the changes in the bond value due to an eventual change in credit quality for a given credit horizon.

(b) Calculate the year-end credit migration component of EC for the MMIC portfolio.

Commentary on Question:
There were some common mistakes made by students that included:

- Miscalculating the probability weighted (expected) bond value which entailed calculating the bond value at every possible credit rating at the end of the first year and comparing this to the worst possible credit quality at the end of the first year;
- Ignoring the coupon payment at the end of the first year in determining the bond value;
- Not applying the appropriate forward zero rates for the resulting credit quality at the end of the first year.

The credit migration component of EC is defined to be the 99.9% one-year VaR of the change in the value of the asset portfolio due to credit migration. T o determine the 99.9% VaR, we need the 0.1% percentile of the portfolio.

Based on the one-year transition matrix, the worst possible outcome for the A-rated bond is to get downgraded to credit rating BB with 1% probability and for the BB rated bond is to default with 10% probability.

The joint probability of this event since the bonds are uncorrelated is $10\% \times 1\% = 0.1\%$.

10. Continued

The value of the bonds can be calculated using the one-year forward zero curve. The value of a bond after one year is calculated as follows:

$$B_1 = PV\ (Coupons) + PV\ (Par\ Value\ at\ Maturity)$$

The value of the A-rated bond when downgraded to BB is

$$B_{1|A\to BB} = 60{,}000 + \frac{60{,}000}{1.054} + \frac{60{,}000}{1.0615^2} + \frac{1{,}060{,}000}{1.0695^3} = 1{,}036{,}638$$

where the discount rates are derived from the one-year forward zero curve for BB rated bond.

If the BB-rated bond defaults at the end of the first year, it would reduce the value of the bond to

$$B_{1|BB\to Default} = Par\ Value \times Bond\ Recovery\ Rate = 1{,}000{,}000 \times 40\% = 400{,}000$$

The portfolio value of the two bonds is $1{,}036{,}638 + 400{,}0000 = 1{,}436{,}638$.

Since the credit EC is defined to be the change in portfolio value, we need to quantify the value of the portfolio if neither of the bonds' ratings changes.

If the rating of the A-rated bond does not change (remains A-rated), the value of the bond at the end of the first year is calculated as

$$B_{1|A\to A} = 60{,}000 + \frac{60{,}000}{1.0465} + \frac{60{,}000}{1.0535^2} + \frac{1{,}060{,}000}{1.0575^3} = 1{,}067{,}718$$

If the rating of the BB-rated bond does not change (remains BB-rated), the value of the bond is calculated as

$$B_{1|BB\to BB} = 80{,}000 + \frac{80{,}000}{1.0545} + \frac{80{,}000}{1.0615^2} + \frac{1{,}080{,}000}{1.0695^3} = 1{,}109{,}703$$

The portfolio value of the two bonds is $1{,}067{,}718 + 1{,}109{,}703 = 2{,}177{,}421$.

Therefore, the credit migration component of EC, defined to be the 99.9% one-year VaR is $2{,}177{,}421 - 1{,}436{,}638 = \mathbf{740{,}783}$.

10. Continued

(c)

(i) Calculate the expected value of the CDS's net payoff amount for MMIC at the end of each year.

Commentary on Question:
Most of the students did well on this part of the question. There were some instances where students calculated every combination of credit quality changes (entire two-year transition matrix) which can be time consuming without noticing that only two instances would lead to a default at the end of the second year.

MMIC would receive a payment from the CDS if the BB-rated bond defaults at the end of the first year or second year. If default occurs, the CDS pays the face value of the bond in exchange of the recovery value. The net payoff is

$$1{,}000{,}000 - (1{,}000{,}000 \times 40\%) = 600{,}000.$$

The probability of the BB-rated bond to default is 10% at the end of the first year; therefore, the expected value of the CDS's net payoff is

$$600{,}000 \times 10\% = \mathbf{60{,}000}.$$

The BB-rated bond can only default at the end of the second year if:

- The bond remains BB-rated at the end of the first year and defaults at the end of the second year. The probability associated with this is

$$\Pr(BB_1|BB_0) \times \Pr(Default_2|BB_1) = 74\% \times 10\% = 0.74\%.$$

- The bond migrates to BBB-rated at the end of the first year and defaults at the end of the second year. The probability associated with this is

$$\Pr(BBB_1|BB_0) \times \Pr(Default_2|BBB_1) = 12\% \times 3\% = 0.36\%.$$

None of the other credit quality change combinations would lead to default for the currently BB-rated bond. Therefore, the expected value of the CDS's net payoff at the end of the second year is

$$600{,}000 \times (7.4\% + 0.36\%) = \mathbf{46{,}560}.$$

10. Continued

(ii) Calculate the reduction in the credit migration risk EC at the end of the first year that would be gained from purchasing the CDS.

Commentary on Question:
The CDS may change the worst outcome as the net payoff for the BB-rated bond to default was 600,000. Very few students verified whether the BB-rated bond defaulting continued to be the worst outcome. Students may have guessed the reduction in the credit migration risk EC as 600,000 as the market value of bond was greater than the 1,000,000 payoff from the CDS.

As determined earlier, the 99.9% one-year VaR of the change in the value of the asset portfolio due to credit migration occurred when the A-rated bond is downgraded to credit rating BB and for the BB rated bond is to default.

The value of the A-rated bond that is downgraded to BB at the end of the first year is

$$B_{1|A\to BB} = 1{,}036{,}638 \qquad \textit{as determined in part } (b).$$

With the CDS, the value of the BB-rated bond defaulting is now the payoff from the CDS of 1,000,000.

The portfolio value of the two bonds is
$1{,}036{,}638 + 1{,}000{,}000 = 2{,}036{,}638$.

However, with the CDS swap, this outcome may not be the 99.9% one-year VaR of the change in the value of the asset portfolio. We need to test the worst scenario without the currently BB-rated bond defaulting: the currently A-rated bond migrating to BB rating and the BB-rated bond remaining BB at the end of the first year.

$$B_{1|A\to BB} = 1{,}036{,}638 \qquad \textit{as determined in part } (b)$$

And,

$$B_{1|BB\to BB} = 1{,}109{,}703 \qquad \textit{as determined in part } (b)$$

The portfolio value of the two bonds is
$1{,}036{,}638 + 1{,}109{,}703 = 2{,}146{,}341$.

10. Continued

Since the portfolio value of the bond continues to be the worst when the currently BB-rated bond defaults, the 99.9% VaR of the change in the value of the asset portfolio continues to occur when the BB-rated bond defaults.

Therefore, the credit migration component of EC, defined to be the 99.9% one-year VaR is $2{,}177{,}421 - 2{,}036{,}638 = 140{,}783$.

Consequently, the reduction in EC is $740{,}783 - 140{,}783 = \mathbf{600{,}000}$.

(d) Determine the mark-to-market value of the CDS at time 0 using a discount rate of 4.50% for each year.

Commentary on Question:
Students did not perform well on this section which may have been due to significant time spent on part (b) and (c)(ii) calculating bond values or probabilities that were not necessary.

From part (c)(i), the expected payoff of the CDS swap is $60{,}000$ at the end of the first year and $46{,}560$ at the end of the second year.

The probability of the CDS counterparty defaulting is 10% and the collateral is forfeited to MMIC should this occur. Therefore, the mark-to-market value of the CDS at the end of the first year is

$$60{,}000 \times 90\% + 60{,}000 \times [(12\% \times 1{,}000{,}000) \times (1 + 3\%)] \times 10\%$$

$$= 54{,}742.$$

The probability of the CDS counterparty defaulting at the end of the second year is 15% and the collateral is forfeited to MMIC should this occur. Therefore, the mark-to-market value of the CDS at the end of the second year is

$$46{,}560 \times 85\% + 46{,}560 \times [(12\% \times 1{,}000{,}000) \times (1 + 3\%)^2] \times 15\%$$

$$= 40{,}465.$$

The mark-to-market value of the CDS at time 0 using a discount rate of 4.50% is

$$\frac{54{,}742}{1.045} + \frac{40{,}465}{1.045^2} = \mathbf{88{,}439}.$$

11. Learning Objectives:

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

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.

(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.

(3c) Define and evaluate model and parameter risk.

(4c) Demonstrate means for reducing risk without transferring it (internal hedges).

(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.

Sources:

Tillman

Hardy Chapter 12

11. Continued

Commentary on Question:
This question aimed to test candidates' understanding of types of risks faced by Hamsik by offering GMMB and GAO options, how these risks could be quantified and how Hamsik could manage these risks. In general, candidates performed poorly on this question. Candidates answered parts (a) and (f) well. A majority of candidates had difficulty defining the option payouts; specifically the GAO payout. Candidates were also not consistent in applying the payout function throughout; there were cases where they would apply the BS formula to value the options but did not consistently carry out the method through their answer.

Solution:

(a) Briefly describe the options granted:

(i) By Hamsik to the policyholder;

Commentary on Question:
Overall, candidates performed well on part (i) and were able to identify options Hamsik had granted the policy holder. In most cases candidates did not identify options the policy holder had granted Hamsik.

<u>Options granted by Hamsik to the policyholder:</u>

- The guaranteed minimum credited rate is an interest rate floor of 3% on funds in the general account.
- The GMMB is a put option on the value of funds in the general account.
- The GAO is a call option on future annuity payments.
- Transferring funds from the general account to the separate account without a market value adjustment is a put option on bond prices.

(ii) By the policyholder to Hamsik.

Commentary on Question:
Candidates performed poorly on this question.

<u>Options granted by policyholder to Hamsik:</u>

- Right to increase M&E fees is a put option on the overall performance of the contract.
- Right to convert from fixed to floating rate on general account funds in a declining interest rate environment is a swaption on interest rates.

(b) Provide a formulaic expression for the projected random payout amount of the following options:

(i) GMMB option

11. Continued

Commentary on Question:
The majority of candidates answered this correctly. Candidates often left out the survival factor on the payout function. It was common to see the payout incorrectly defined as the either the greater of the AV or the option payout; the payout is the difference between the two which Hamsik is required to pay. There were candidates which interpreted this question to ask for the value of the options and applied the BS formulas. Candidates could have earned additional points if more details were given in defining each of the components in the payout functions.

GMMB option payout:
Define the following terms as:

- F(20) is policyholder account value at maturity
- G is guarantee amount and is equal to the sum of all premiums paid
- ${}_{20}p_x^{\tau}$ is the inforce factor or the probability that the policy is still in force at maturity and is defined as:
  - w_{x+t} is the annualized lapse rate in year t
  - q_{x+t} is the annualized mortality rate in year t
  - ${}_{20}p_x^{\tau}$ equals $_{t=1}\Pi^{20}\ [(1 - w_{x+t})(1 - q_{x+t})]$

- The projected payout function of the GMMB option is:
  - $_{20}p_x^{\tau}$**max(G - F(20), 0) or**
  - $_{20}p_x^{\tau}$**max(G - F(20))+**

(ii) GAO option

Commentary on Question:
Candidates performed poorly and demonstrated a lack of knowledge on the GAO. Candidates often left out the survival factor on the payout function. It was common to see the payout incorrectly defined as the either the greater of the AV or the option payout; the payout is the difference between the two which Hamsik is required to pay. There were candidates which interpreted this question to ask for the value of the options and applied the BS formulas. Candidates could have earned additional points if more details were given in defining each of the components in the payout functions.

GAO option payout:
Define the following terms:

- The same terms for the GMMB apply for the GAO except for G.
- g is guaranteed annuitization rate at issue
  - 15 year term certain = 9.75 based on long term rate of 7.5%
  - Therefore g = 1/9.75 = 0.1026

11. Continued

- a(20) is the annuity factor, or the market price of 1 per year payable immediately under the terms of the annuity, at maturity
- The projected payout function of the GAO option is:
  - $_{20}p_x^{\tau} F(20)\max(g*a(20) - 1, 0)$ or
  - $_{20}p_x^{\tau} F(20)\max(g*a(20) - 1)+$

(c) For each expression in part (b):

(i) Rate the components as high, medium or low in terms of their relative impact on the projected payout of the option.

Commentary on Question:
Candidates' performance was contingent on the preceding section. Most answers correctly identified driving factors for the GMMB option. Candidates could have earned additional points if more details were given in their explanations as well as greater understanding of the GAO option.

	GMMB Option - Payout		**GAO Option - Payout**	
Component	**Relative Rating**	**Explanation**	**Relative Rating**	**Explanation**
F(20): AV @ Maturity	High	For the GMMB option, the value of the option increase by the same amount as a decrease in the AV at maturity once the option is in the money.	High	For the GAO, although the account value at maturity [F(20)] does not determine whether a payout will occur, the value of the option is directly proportional to F(20).
Interest Rates	Low	For the GMMB option, the value of the option is impacted by interest rates only to the extent interest rates affecting the credited rate on the general account.	High	The annuitization rate (g) and thus the value of the GAO option will change dramatically with relatively small changes in rates.
Mortality	Low	The mortality assumption impacts the inforce factor which will affect the size of the projected payout but not whether the payout will occur. Mortality assumptions are generally small so significant miss-estimation of rates will not have a material impact on the inforce factor, especially compared to lapse assumptions.	Low	In addition to the rationale as GMMB, the GAO provides a term-certain immediate annuity, so the mortality assumption does not impact the value of the annuity only interest rates.
Lapses	Medium	The lapse assumption impacts the inforce factor which will affect the size of the projected payout but not whether the payout will occur. Lapses rates are typically the main contributor to the inforce factor and changes to lapse rates will have a large impact on the inforce factor.	Medium	Same rationale as GMMB.

11. Continued

(ii) Determine the direction for each of these components that would increase the projected payout of the option.

	GMMB Option – Payout		GAO Option - Payout	
Component	**Impact on Payout**	**Explanation**	**Impact on Payout**	**Explanation**
F(20): AV @ Maturity	Decrease	For GMMB, an increase in F(20), account value at maturity, decreases the projected payoff of the option, since GMMB is an equity put option.	Increase	For GAO, an increase in F(20), account value at maturity, increases the projected payoff of the option, since the projected payoff is proportional to F(20).
Interest Rates	Decrease	For GMMB, a decrease in interest rates increases the payoff of the option, to the extent lower interest rates translate into lower account value at maturity.	Decrease	For GAO, a decrease in interest rates increases the projected payoff of the option, since the annuity factor increases as rates decrease.
Mortality/Lapse	Increase	Changes in mortality and lapse assumption change the inforce factor in the same direction. The projected payoffs of the two options are both proportional to the inforce factor; fewer decrements translate into a higher inforce factor. By this reasoning, for both GMMB and GAO, decreases in either mortality or lapse rates increase the projected payoff of the option.	Increase	Same rationale as GMMB.

(d) Complete the table.

Commentary on Question:
Candidates did not perform well on this section; there was confusion in how to determine the investment strategy. A few candidates interpreted this to mean how it relates to the BS formula rather than using the option payout function that was defined in preceding sections. Candidate answers for GMMB were better than the GAO investment strategy.

Define/calculate the following terms:

- F(0) = S(0) = 1000 for each scenario
- F(20) = S(20)(1 - m)20, where m is annual M&E charge and is equal to 0.01
  - F(20) = S(20)(1 - 0.01)20 = 0.8179S(20)
- For GMMB, guaranteed benefit G = cumulative premiums = 1,000
- For GAO, guaranteed annuitization rate = 1/9.75 = 0.1026
- Inforce factor, ${}_{20}p_x^{\tau}$, at end of 20 years is $(1 - 0.03)^{20} = 0.5438$
- Bonds earn 7% for 20 years, so investment of 1 in risk-free bonds results in cash flow at maturity of $(1.07)^{20} = 3.8697$

11. Continued

Scenario 1:
The investment of 1 in underlying fund results in cash flow at maturity of 10,000/1,000 = 10

The account value at maturity, F(20) = 0.8179S(20) = 0.8719*10,000 = 8,179.07

GMMB Investment Strategy:
Recall projected GMMB payoff is a multiple of:

$${}_{20}p_x^{\tau}\max(G - F(20), 0)$$
$$= 0.5438\max(1{,}000 - 8{,}179.07, 0) = 0$$

Since the projected payoff of GMMB is 0, no assets are needed for either investment strategy.

GAO Investment Strategy
The long term interest rate at maturity is 5%, so annuity factor or a(20) = 10.90.

Recall the projected payout of GAO option is:

$${}_{20}p_x^{\tau}\max(gF(20)a(20) - F(20), 0)$$
$$= 0.5438\max((0.1026)(8179.07)(10.90) - 8179.07, 0)$$
$$= 0.5438\max(967.82, 0) = 526.30$$

The initial investment required for:

- Investing in bonds = 536.30/3.8697
  = 136
- Investing in underlying funds = 526.30/10
  = 52.63

Scenario 2
The investment of 1 in underlying fund results in cash flow at maturity of 1,000/1,000 = 1

The account value at maturity, F(20) = 0.8179S(20) = 0.8719*1,000 = 817.91

GMMB Investment Strategy
Recall projected GMMB payoff is a multiple of:

$${}_{20}p_x^{\tau}\max(G - F(20), 0)$$
$$= 0.5438\max(1{,}000 - 817.91, 0) = 99.02$$

The initial investment required for:

- Investing in bonds = 99.02/3.8697
  = 25.59
- Investing in underlying funds = 99.02/1
  = 99.02

11. Continued

GAO Investment Strategy

The long term interest rate at maturity is 9%, so annuity factor or a(20) = 8.78.

Recall the projected payout of GAO option is:

$$_{20}p_x^{\tau}\max(gF(20)a(20) - F(20), 0)$$
$$= 0.5438\max((0.1026)(817.91)(8.78) - 817.91, 0)$$
$$= 0$$

Since the projected payoff of GAO is 0, no assets are needed for either investment strategy.

Completed table:

Scenario #	Option	Investment Strategy	$Investment Required
1	GMMB	Long-term Bonds	$0.00
		Underlying funds	$0.00
	GAO	Long-term Bonds	$136.00
		Underlying funds	$52.63
2	GMMB	Long-term Bonds	$25.59
		Underlying funds	$99.02
	GAO	Long-term Bonds	$0.00
		Underlying funds	$0.00

(e) Recommend a general investment strategy for each maturity option and explain your reasoning.

For GMMB, the projected payoff occurs when the underlying fund loses value which causes the account value to be less than the guarantee value. Therefore, for GMMB, recommend investing in risk-free bonds for better return when projected payoff occurs.

For GAO, the projected payoff is proportional to the underlying fund. Investing in risk-free bonds introduces basis risk between performance of bonds vs. performance of underlying funds. Investing in the underlying fund generally reduces this risk. Therefore, for GAO, recommend investing in underlying fund as it will better track projected payoff.

11. Continued

(f) Suggest improvements in the analysis in part (d) regarding the decrement assumption

The decrement assumptions can be improved by:

- Incorporating a lapse assumption which would vary dynamically in response to in-the-moneyness of the option. The reason being that policyholders have less incentive to lapse when the policy in the money.

Separate assumption for mortality and lapses; lapse rates should not be tied to mortality. The current assumption of a constant 3% implies that as mortality increases, lapses are assumed to decrease.

12. Learning Objectives:

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:

(5e) Compare and contrast various regulatory/industry frameworks: Basle II, Sarbanes-Oxley Act, OSFI Supervisory Framework, OSFI Standard of Sound Financial and Business Practices, UK FSA guidelines and COSO.

Sources:

Crouhy, Ch. 2, The New Regulatory and Corporate Environment

Crouhy, Ch. 3, Structuring and Managing the Risk Management Function in a Bank

FE-C129-07: Principles for the Management of Interest Rate Risk

FE-C134-07: Supervisory Framework - 1999 and Beyond (OSFI - Canadian)

FE-C172-09: Enterprise Risk Management - Integrated Framework: Executive Summary, COSO, September 2004.

Commentary on Question:

This seven point focus question required candidates to know key principles/aspects of the Basle (II) OSFI, COSO and G-30 risk management frameworks, and then apply them to three scenarios of risk management practices.

When assessing the scenarios, candidates should have noted the deficiency in each one, apply and briefly discuss the applicable principles, followed by an effective correction action. Thus, the Cognitive Skills tested were mixed between Retrieval and Comprehensive.

Performance on this question was mixed. Since these concepts were tested in a prior exam, some candidates did very well. Some candidates did poorly, randomly listing many irrelevant principles in the frameworks without consideration to the scenarios mentioned in the question. Some candidates did not attempt this question, perhaps because of poor time management or fatigue, as this was the last question in the exam.

Solution:

(a) For Case 1

(i) Identify concept(s) from the g-30 framework which apply.

Principle 1—The Role of Senior Management

- Ensure risk controlled consistent with the risk management and capital policies
- Approve procedures and controls to implement these policies

12. Continued

Principle 16—Professional Expertise
- Should be undertaken by professionals with experience, skills and degrees of specialization

(ii) Identify concept(s) from the Basle framework which apply.

Principle 2—Senior Management's Responsibilities
- Manage the structure of the business and the level of risk
- Establish appropriate policies and procedures to control and limit these risks
- Aggregate information as well as sufficient supporting details should be reviewed regularly by senior management
- Ensure that resources/expertise are available for evaluation and controlling risk

(iii) Describe how the case is deficient relative to these frameworks and propose one corrective action.

Deficiency: The small size (4 members) of the risk management team and the expertise of the staff.

Corrective Action: The CRO should have adequate staff and resources in place to control risk. This can be accomplished by expanding the number of staff members as well as including more experienced staff with specialized skills.

(b) For Case 2:

(i) Identify concept(s) from the COSO framework which apply to this case.

Principle 4—Risk Assessment
- Analyze, considering likelihood and impact, as a basis for determining how risks should be managed

(ii) Identify concept(s) from the OSFI framework which apply.

Principle 2
- Exercise sound judgment in identifying and evaluating the risks is central to the effectiveness of the framework

12. Continued

(iii) Identify concept(s) from the Basle framework which apply.

Principle 5—Risk Management In New Products
- Identify the risks in new products and/or activities
- Ensure the products are subjected to adequate procedures and controls before being introduced
- Major hedging or risk management initiatives should be approved in advance

(iv) Describe how the case is deficient relative to these frameworks and propose two corrective actions.

Deficiency: Approval of risk management initiatives *after* launching the new product.

Corrective Action: This Canadian bank should make sure all risks are identified, analyzed and evaluated before the product is released. This bank should also ensure adequate controls and risk management techniques are in place before releasing the product.

(c) For Case 3:

(i) Identify concept(s) from the COSO framework which apply to this case.

Principle 8—Monitoring
- The entirety of ERM is monitored and modifications made as necessary

(ii) Identify concept(s) from the Basle framework which apply to this case.

Principle 10—Internal Controls
- Must have an adequate system of internal controls over their risk management process
- Have regular independent reviews and evaluations of the effectiveness of the system
- Ensure appropriate revisions or enhancements to internal controls are made
- Results of these reviews should be available to supervisory authorities

12. Continued

(iii) Describe how the case is deficient relative to these frameworks and propose one corrective action

Deficiency: Reviewing the internal controls on an ad hoc basis with long periods of time between reviews (3 years is too long).

Corrective Action: ERM should be reviewed more often, and it should be updated as needed. Also, this company should have regular independent reviews; changes made as needed, and shore the reviews with authorities.