AFE Complete Illustrative Solutions
Spring 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:

(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.

(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.

Sources:

Tiller, Life, Health and Annuity Reinsurance, 3rd Edition, 2005, Ch. 5, "Advanced Methods of Reinsurance"

FE-C155-09: Babbel & Fabozzi, Investment Management for Insurers, 1999, Ch.1, "Risk Management by Insurers: an analysis of the Process," Babbel & Santomero

Atkinson & Dallas, Life Insurance Products and Finance, FE-C169-09: Ch. 3, Pricing Assumptions

Commentary on Question:

This question is designed to determine whether the candidate understands the relative importance of different types of risks as related to product lines, reinsurance agreements, and an interest rate swap strategy. The candidate needs to understand the basic concepts of each risk and is challenged to identify subtle differences between groups.
Some candidates reached the maximum in sections (b) and (c). Most people acquired the minimum adequate knowledge expectations.
The high/medium/low categorization has some gray areas. Candidates can receive full credit for categorizing the risk differently if reasonable justification is provided.
The best candidates distinguished themselves by providing strong justifications and responding with Zoolander-specific information.

1. Continued

Solution:

(a) For each product line below, rate the importance of each paradigm risk as either "high" or "low" and justify your rating.

(i) Zoolander's GIC line

Actuarial Risk – High – GICs contain crediting guarantees which are developed by the actuarial department.
Systemic Risk – High – GICs have a high interest rate risk which comes from an asset duration mismatch relative to the liability and direct link to the market.
Credit Risk – High – Zoolander's GICs have assets invested in lower quality bonds, private placements, and non-investment grade bonds.
Liquidity Risk – High – A combination of put covenants and assets invested in classes like real estate and private placements makes access to needed assets difficult.
Operational Risk – High – Zoolander has no stated internal controls or Risk Management, plus the personnel working with GICs are inexperienced.
Legal Risk – High – GICs have complicated controls, in addition, corporate clients could default or regulations may change.

(ii) Zoolander's Term line

Actuarial Risk – High – Lower margins in term pricing means higher sensitivity to pricing assumptions, especially mortality and lapses.
Systemic Risk – Low – Term insurance has little asset-related risk.
Credit Risk – Low – Term insurance has little asset-related risk.
Liquidity Risk – High – If there are more claims than expected, the illiquid assets backing the claims may not be assessed in a timely manner.
Operational Risk – Low – Term has a well-established underwriting group as well as a straight-forward operation.
Legal Risk – Low – Term has well defined regulations and contracts with no known issues currently.

(b) Regarding the Term product line, describe the change in each of the six paradigm risks were Zoolander to enter into each of the following reinsurance arrangements: (Note: the status of Rose Re in this deal was not specified. Equal credit could be earned by assuming either the new reinsurance was a replacement of Rose Re or was an addition to Rose Re.)

1. Continued

(i) Amethyst Re

Actuarial Risk – Reduced – The primary Term risk is misjudging mortality.
Systemic Risk – Reduced – Reduced the already low market risk.
Credit Risk – Increased – Due to reinsurance counterparty risk.
Liquidity Risk – Reduced – Agreement would give excess claim protection.
Operational Risk – Increased – The reinsurer is new to the market.
Legal Risk – Increased – The reinsurer is new to the market.

(ii) Aquamarine Re

Actuarial Risk – Reduced – Zoolander holds less liability and resultant reserve.
Systemic Risk – Reduced – Zoolander holds less liability and resultant reserve.
Credit Risk – Increased – Due to reinsurance counterparty risk.
Liquidity Risk – Reduced – Zoolander holds less liability and resultant reserve.
Operational Risk – Increased – Processing transactions between Zoolander and Aquamarine Re.
Legal Risk – Increased – Processing transactions between Zoo and Aqua Re.

(iii) Emerald Re

Actuarial Risk – Reduced – Agreement shares liabilities and premiums.
Systemic Risk – Reduced – Zoolander holds less liability and resultant reserve.
Credit Risk – Increased – Due to reinsurance counterparty risk (and B+ rating).
Liquidity Risk – Reduced – Agreement shares liabilities and premiums.
Operational Risk – Increased – The reinsurer is new to the market and 3 principles from failing Rose Re added to reinsurer may be a liability.
Legal Risk – Increased – Reinsurer has flexibility in contract terms and conditions.

1. Continued

(c) Describe the change in each of the six paradigm risks were Zoolander to manage the duration mismatch for the GIC line by using the interest rate swaps rather than by buying and selling bonds.

Actuarial Risk – Reduced – Interest Rate Swap (IRS) has less risk of not earning guaranteed crediting rate due to varying interest rates than GICs.
Systemic Risk – Reduced – With IRS, when interest rates change, the net asset return changes the same way as the liability.
Credit Risk – Increased – Due to counterparty risk.
Liquidity Risk – Reduced – With IRS, there is less need to sell assets since there is a much better asset/liability interest rate sensitivity match than with GICs.
Operational Risk – Increased – IRS contracts require expertise in execution.
Legal Risk – Increased – IRS contracts require expertise in execution.

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.

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.

(4p) Define liquidity risk.

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

(4r) 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:

Atkinson & Dallas, Life Insurance products and finance

FE-C151-08: chapter 13 (Sections 13.1-13.4), Annuity and Investment Products

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

"Liquidity Risk Measurement," CIA Education Note:
http;//www.actuaries/ca/members/publications/1996/9626e.pdf

Commentary on Question:

The question was designed to test the candidates' understanding of the liquidity risks inherent in certain product offerings.
On recommendation-type questions, candidates should provide additional details to supplement the high-level recommendation.
Candidates did well on the calculation and discussing General American's sequence of events. Candidates could have done better in parts (d), (e), and (f) had they expanded on their recommendations.

2. Continued

Solution:

(a) Identify five considerations specific to Zoolander's institutional GIC business when assessing liquidity risk.

Commentary on Question:
Candidates did not consider the implication of having a large concentration of institutional investors on their GIC business and how it would affect their liquidity risk. Candidates mostly focused on the investment of assets and certain product designs.

- Zoolander sells GIC primarily to institutional clients who have specific investment quality requirement.
- Institutional investors will have larger account balances involved with surrender resulting in concentration risk.
- Institutional investors have greater sophistication and are typically influenced by knowledgeable consultants and brokers.
- Ratings downgrade may entitle institutional investors to cash-out at book-value.
- Investments in high-yielding and private placement bonds would expose Zoolander to liquidity risk on surrender.

(b) Calculate Zoolander's Liquidity Ratio under the going concern scenario and under the panic scenario. Assess the degree of the liquidity threat to which Zoolander is currently exposed based on your results.

Commentary on Question:
In general, candidates performed well on this question. The common mistake included calculating a different liquid asset value for the two scenarios, and not including the cash-flow from operations in the liquid asset value.

Liquidity Ratio = Liquid Assets / Projected Demand Liabilities (PDL)

$$Liquid\ Assets = 1{,}000 + 5{,}100 + 750 + 0 + 100 + 36.2 + 3.8 + 40 = 7{,}030$$

<u>Under Going-Concern Scenario:</u>

$$PDL\ (GC) = (0 \times 0) + (4{,}700 \times 0) + (1{,}100 \times 0.10) + (3{,}350 \times 0.15) + (10 \times 0.07) + (0 \times 0) = 613.2$$

$$Liquidity\ Ratio\ (GC) = \frac{7{,}030}{613.2} = 11.45$$

GC Ratio is 11.45, which is a A+ (Superior) score on Kelly's ratings, much greater than 1.

2. Continued

Under Panic Scenario

$$PDL\ (Panic) = (0 \times 0) + (4{,}700 \times 1) + (1{,}100 \times 0.9) + (3{,}350 \times 0.5) + (10 \times 0.1) + (0 \times 0) = 7{,}366$$

$$Liquidity\ Ratio\ (GC) = \frac{7{,}030}{7{,}366} = 0.95$$

Panic Liquidity Ratio = 0.95 is below 1, and "B (Troubled)" on Kelly's scale

If downgraded below investment grade, the panic scenario liquidity ratio indicates that Zoolander has insufficient liquid assets to back demand liabilities over a 3-month horizon.

(c) Describe how liquidity risk led to the General American crisis.

Commentary on Question:
Responses for this question focused primarily on the degree and exposure to risk as well as the sequence of events that resulted in the default of General American. However, the question also asked for management actions/inactions and financial/general consequences and these two items were not addressed very well.

Nature and Degree of Exposure to Liquidity Risk

- General American was a midsize US mutual company with approximately $22 billion in assets.
- When General American's 50% partner in institutional GIC business withdrew, General American was forced to recapture that business.
- Moody's responded to the recapture by lowering GA's rating from A2 to A3.

Sequence of Events

- The ratings downgrade triggered covenants in a substantial number of the funding rate agreements.
- General American's ratings-sensitive and institutional investors responded by demanding to cash in on $6 billion worth of business.
- A run-on-the-bank scenario ensued at General American with payouts required within a week.
- General American could not sell enough assets in time without incurring large losses as the bond market became illiquid.
- General American defaulted on its GIC obligations and sought state supervision.

2. Continued

- This prompted rating agencies to further downgrade General American to below investment grade, which prevented any further debt issuance.

Management Actions or Inactions

- General American's recapture of 3.5 billion GICs was expected to have only a modest impact on General American's risk-adjusted capitalization.
- A near-term mismatch in General American's asset/liability profile was not foreseen.
- There was no contingency plan for "disasters."
- A fire sale of the assets did not take place in order to protect the value of the company and other policyholders.
- Management saw it is a short-term liquidity problem, not an insolvency problem.

Financial Impacts and General Consequences

- An immediate liquidity shortfall at General American ensued.
- Without state protection, General American would have realized substantial capital losses under a forced liquidation of assets.
- General American defaulted on its obligations but wasn't insolvent.

(d) Assess similarities and differences between the General American crisis and Zoolander's situation were Zoolander to be downgraded to below-investment-grade.

Commentary on Question:
Candidates were able to identify certain similarities and differences. One common mistake was assuming Zoolander reinsured the GIC block.

Similarities:

- Zoolander has a large exposure to GIC product line (>53% book).
- GICs are mostly held by institutional investors who are likely obligated to surrender upon downgrade below investment-grade.
- Zoolander's GIC business is not well matched.
- Zoolander is exposed to liquidity risk if downgraded.

Differences:

- Zoolander does not reinsure their GIC business.
- Zoolander is not likely to have all GICs refundable within 7 days and it may have more time to raise funds.

(e) Recommend two product-based strategies that Zoolander should pursue to reduce its liquidity risk and explain how each strategy improves Zoolander's liquidity profile.

2. Continued

Commentary on Question:
Candidates were able to provide high-level recommendations but did not expand on them; hence, they did not achieve maximum credit.

Improve Surrender Protection

- Have meaningful surrender charges for surrender protection
- Introduce products with Market Value Adjustments (MVAs)
- Eliminate GICs with book value withdrawals
- Offer guarantees that can be achievable in light of liquidity concerns

Diversify Lines of Business

- Diversify product lines; reduce GIC business relative to other product lines (including reinsuring/divesting some of the block)
- Zoolander's GICs are concentrated with a few institutional, sophisticated, ratings-sensitive investors; hence, they should expand to non-institutional markets
- Diversify to different distribution channels

(f) Recommend two investment-based strategies that Zoolander should pursue to reduce its liquidity risk and explain how each strategy improves Zoolander's liquidity profile.

Commentary on Question:
Candidates were able to provide high-level recommendations but did not expand on them; hence, they did not achieve maximum credit. Candidates at times confused product-based strategies with investment-based strategies.

Improve duration/cash flow match in GIC book

- Manage duration gap between assets and liabilities
- Have a short term investment strategy which allows Zoolander to adjust quickly when rates change
- Match future asset/liability cash-flows

Improve liquidity in asset portfolio

- Increase the percentage of liquid assets relative to private placements, junk bonds etc
- Establish constraints on asset mix
- Develop a plan for a stress scenario/contingency plan
- Indentify order of sale of assets
- Setting up backup banking facilities

3. Learning Objectives:

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

Learning Outcomes:

(2b) Analyze a specific company financial situation by demonstrating advanced knowledge of balance sheet and income statement structures.

(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.

Sources:

"An Overview of Embedded Value," H. Mueller, Financial Reporter, Sept. 2003. http://www.soa.org/library/newsletters/financial-reporter/2003/november/frn-20030iss55-mueller.pdg

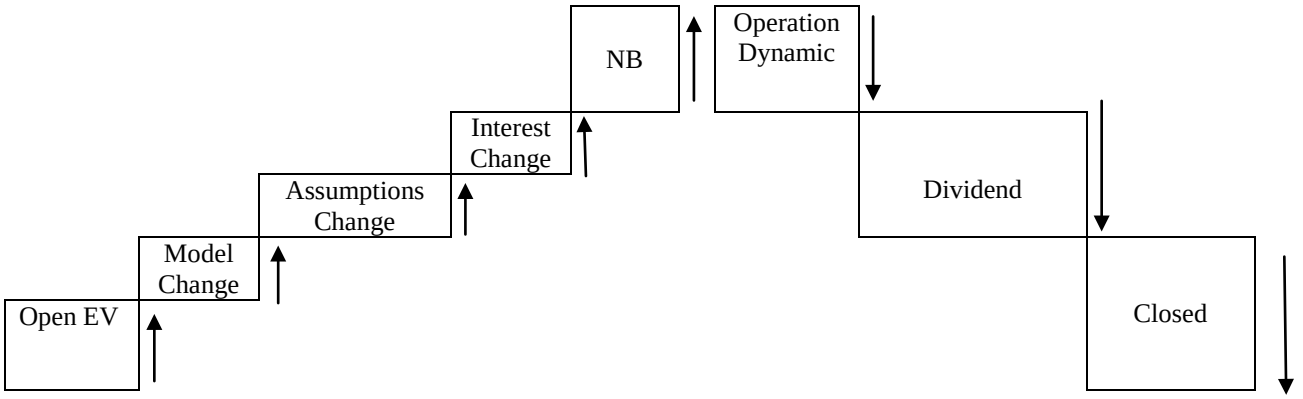
Case Study

Commentary on Question:

Candidates struggled with this question.

Solution:

(a) Identify the elements Zoolander must consider when rolling forward EV from one valuation date to the next.



Opening EV
+ / - Model Changes
+ / - Assumption Changes
+ / - Expected Return
+ / - New Business
+ / - Operating Variations
+ / - Shareholder Dividends
=Closing EV
*The driven factor (component) shown as figure above.

3. Continued

(b) Calculate the expected EV and Value of Inforce (VIF) of the Term Life block as of December 31, 2010.

VNB = 5% x $20mil = $1 mil

VIF_{2009} = $58.9 mil
EV_{2009} = $73.9 mil
ANW_{2009} = $15.0 mil

Chg. of Case of Cap. 2010 = PV Capital Release + PV After Tax Income on Capital – Regular Capital
= (11.0 + 2.6 – 15) mil
= -$1.4 mil

$ANW_{2010} = ANW_{2009}$ = $15.0 mil
$VIF_{2010} = VIF_{2009}$ + Chg in CoC_{2010} + VNB
=$58.9 mil - $1.4mil + $1.0 mil = $58.5 mil
$EV_{2010} = VIF_{2010} + ANW_{2010}$ = $58.5 mil + $15.0 mil = $73.5 mil

(c) Explain how EV is related to the company's stock price.

A firm's stock price multiplied by the share outstanding represents to market value and the EV is a component of the market value:

Other Value (e.g. Goodwill)
Value of future Business
$\left.\frac{\text{VIF}}{\text{ANW}}\right\}$ EV } Appraisal Value } Enterprise or Market Value(Stock Price)

(d) Describe the insights gained by Zoolander in computing EV.

Zoolander gains an appreciation of the factors contributing to the firm's value, including the cost, nature, and arrangement of capital, the effect and value of new business, and their relationship to the firm's overall enterprise value and its stock price.

EV provides a measure of transparency and is issued by agencies, equity analysts, etc.

Is a leading indicator
Can be used by to emphasis a division or business over another
Use realist assumptions

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.

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 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.
- Asses the overall corporate risk exposure arising from financial and non-financial risks.

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

Sources:

Hardy, Investment Guarantees:

- Ch 1. Investment Guarantees
- Ch. 8 Dynamic Hedging
- Ch. 10 emerging Cost analysis

Commentary on Question:

The question is designed to test candidates' understanding on the actuarial CTE approach and dynamic hedging for GMDB guarantees.

The question challenged candidates to solve a numerical question using the knowledge of the dynamic hedging and actuarial approach. It also asked candidates to use the results to make comparison and recommendation. Candidates score much better when each step is shown and the thought process is detailed. Fewer points are earned by only showing a final number.

Most candidates answered parts (a) and (e) well.

4. Continued

Candidates had more trouble with part (b) and (d).
For part (b), a good number of candidates missed the mortality portion in the calculation on GMDB guarantees. Regarding part (d), when comparing the dynamic hedging and current approach, both sides of the transaction should be considered.

Solution:

(a) Complete table of preliminary values:

Down Scenario: t=1 payout is 10, t=2 payout is 20
Up Scenario: t=1 payout is 0; t=2 payout is 0
${}_1p_{50} = 1 - q_{50} = 1 - 0.0035 = 0.9965$
${}_0p_{50}\, q_{50,0} = 1 \times 0.0035 = 0.0035$
${}_1p_{50}\, q_{50,1} = 0.9965 \times 0.0040 = 0.003986$

(b) Assume that the policy is dynamically hedged with annual rebalancing. Using Badger's option pricing data, complete table.

Use 1.03 or $e^{0.03}$ for interest accumulation

Hedge Cost(0) = $\square_1^2$ [$Stock_0(t) + Bond_0(t)$] ${}_{t-1}p_{50}\, q_{50,t-1}$
Hedge Cost(0) = [$Stock_0(1) + Bond_0(1)$] ${}_0p_{50}\, q_{50,0}$ + [$Stock_0(2) + Bond_0(2)$] ${}_1p_{50}\, q_{50,1}$
Hedge Cost(0) = [-40.129 + 46.587] (0.0035) + [-36.184 + 44.434] (0.003986)
Hedge Cost(0) = (6.458) (0.0035) + (8.250) (0.003986)
Hedge Cost(0) = 0.02260 + 0.03288 = 0.0555

<u>Down Scenario: t=1 $S_1 = 90$</u>

hedging error = $HE_1 = H(1) + {}_0p_{50}\, q_{50,0}\, (G-F_1)^+ - H(1^-)$

Cost of new 1-yr GMDB hedge:

$H(1) = (Stock_1(2) + Bond_1(2))\, {}_1p_{50}\, q_{50,1}$ = (-54.813 + 66.306) (0.003986) = (11.492)(0.003986) = 0.0458
req'd payout = ${}_0p_{50}\, q_{50,0}\, (100-90)+$ = 0.0035 (10) = 0.0350
$H(1^-) = [Stock_0(1) \times 90/100 + Bond_0(1) \times (1.03)]\, {}_0p_{50}\, q_{50,0} + [Stock_0(2) \times 90/100 + Bond_0(2) \times (1.03)]\, {}_1p_{50}\, q_{50,1}$
H(1⁻) = [(-40.129)(0.9) + (46.587)(1.03)] (0.0035) + [(-36.184)(0.9) + (44.434)(1.03)] (0.003986)
= [-36.1161 + 47.9846] (0.0035) + [-32.5656 + 45.7670] (0.003986)
= 11.8685 (0.0035) + 13.2014 (0.003986) = 0.0415 + 0.0526 = 0.0941

4. Continued

hedging error = $HE_1 = 0.0458 + 0.0350 - 0.0941 = -0.0133$
OR: hedging error using $H(1)^{+}{}_{0}p_{50}\, q_{50,0}\, (G\text{-}F_1)^{+} - H(1^{-})$
hedging error = 0.0458(0.0350) - 0.0941 = -0.0925

Down Scenario: t=2 $S_2 = 80$

hedging error = $HE_2 = 0 + {}_{1}p_{50}\, q_{50,1}\, (G\text{-}F_2)^{+} - H(2^{-})$ where H(2) = 0
req'd payout = ${}_{1}p_{50}\, q_{50,1}\, (100\text{-}80)+ = 0.003986\ (20) = 0.07972$
$H(2^{-}) = [\ Stock_1(2) \times 80/90 + Bond_1(2) \times (1.03)\ ]\ {}_{1}p_{50}\, q_{50,1} = [\ (-54.813)(0.89) + (66.306)(1.03)\ ]\ (0.003986)$
$= [\ -48.7836 + 68.2952\ ]\ (0.003986) = 19.5116\ (0.003986) = 0.0778$

hedging error = $HE_2 = 0 + 0.07972 - 0.0778 = 0.00192$
OR: hedging error using $H(2)^{+}{}_{1}p_{50}\, q_{51,0}\, (G\text{-}F_2)^{+} - H(2^{-})$
hedging error = 0 x 0.07972 - 0.0778 = -0.0778

Up Scenario: t=1 $S_1 = 110$

hedging error = $HE_1 = H(1) + {}_{0}p_{50}\, q_{50,0}\, (G\text{-}F_1)^{+} - H(1^{-})$

Cost of new 1-yr GMDB hedge:
$H(1) = (\ Stock_1(2) + Bond_1(2)\ )\ {}_{1}p_{50}\, q_{50,1} = (\ -25.713 + 29.041)\ (0.003986) = (3.328)(0.003986) = 0.0133$
req'd payout = ${}_{0}p_{50}\, q_{50,0}\, (100\text{-}110)+ = 0.0035\ (0) = 0$
$H(1^{-}) = [\ Stock_0(1) \times 110/100 + Bond_0(1) \times (1.03)\ ]\ {}_{0}p_{50}\, q_{50,0} + [\ Stock_0(2) \times 110/100 + Bond_0(2) \times (1.03)\ ]\ {}_{1}p_{50}\, q_{50,1}$
$H(1^{-}) = [\ (-40.129)(1.1) + (46.587)(1.03)\ ]\ (0.0035) + [\ (-36.184)(1.1) + (44.434)(1.03)\ ]\ (0.003986)$
$= [\ -44.1419 + 47.9846\ ]\ (0.0035) + [\ -39.8024 + 45.7670\ ]\ (0.003986)$
$= 3.8427(0.0035) + 5.9646(0.003986) = 0.01345 + 0.02377 = 0.0372$

hedging error = $HE_1 = 0.0133 + 0 - 0.0372 = -0.0239$
OR: hedging error using $H(1)^{+}{}_{0}p_{50}\, q_{50,0}\, (G\text{-}F_1)^{+} - H(1^{-})$
hedging error = 0.0133 x 0 - 0.0372 = -0.0372

Up Scenario: t=2 $S_2 = 120$

hedging error = $HE_2 = 0 + {}_{1}p_{50}\, q_{50,1}\, (G\text{-}F_2)^{+} - H(2^{-})$ where H(2) = 0
req'd payout = ${}_{1}p_{50}\, q_{50,1}\, (100\text{-}110)^{+} = 0.003986\ (0) = 0$
$H(2^{-}) = [\ Stock_1(2) \times 120/110 + Bond_1(2) \times (1.03)\ ]\ {}_{1}p_{50}\, q_{50,1} = [\ (-25.713)(1.0909) + (29.041)(1.03)\ ]\ (0.003986)$
$= [\ -28.0505 + 29.9122\ ]\ (0.003986) = 1.8617\ (0.003986) = 0.0074$

4. Continued

hedging error = $HE_2 = 0 + 0 - 0.0074 = -0.0074$
OR: hedging error using $H(2)^{+}{}_1p_{50}\, q_{51,0}\, (G\text{-}F_2)^{+} - H(2^{-})$
hedging error = 0 x 0 - 0.0074 = -0.0074

(c) Assume that the GMDB risk is managed initially using the actuarial approach (consistent with Zoolander's current risk management approach) using Badger's option pricing data where applicable.

t=0 S_0 =100
Initially, \$0.18 is invested in risk-free bonds.
After 1 yr, the investment earns risk-free rate and pays out DB gtees of (q = 0.0035) x $(G\text{-}S_1)^{+}$
Thus, Actuarial Approach Value (0) with 1-yr interest = $CTE_0(95)$ x 1.03 = 0.18 x 1.03 = 0.1854
Thus, Actuarial Approach Value (0) after mortality = 0.1854 - (0.0035 x 10) = 0.1854 - 0.0350 = 0.1504

Down Scenario: t=1 S_1 = 90
At t=1, req'd CTE(95) is 0.20, change is 0.02/0.18 which is greater than 10%, so triggers dynamic hedge
versus holding 0.1504 units of risk-free asset
req'd hedge : $BSP_1(2)\ {}_1p_{50}\ q_{50,1}$ = [-54.813 + 66.306] (0.003986) = -0.2185 + 0.2643 = 0.0458
versus holding (66.306 x 0.003986) = \$0.2643 bonds, therefore, buy \$0.1139 additional units of risk-free asset, and short index by amount (54.813 x 0.003986) = \$0.2185

Down Scenario: t=2 S_2 = 80
At maturity, t=2, the bond part of hedge earns risk-free rate: \$0.2643 x (1.03) = \$0.2722
At maturity, t=2, the stock part of hedge is: -\$80/90 x 0.2185 = -\$0.1942
At maturity, t=2, total portfolio value is \$0.2722 - \$0.1942 = \$0.0780
At maturity, t=2, the portfolio pays DB gtee of (0.003986) x $(G\text{-}S_2)^{+}$ = 0.003986 x 20 = 0.0797
Thus, Portfolio Value after mortality = \$0.0780 - (0.003986 x 20) = \$0.0780 - 0.0797 = -0.0017

Up Scenario: t=1 S_1 = 110
At t=1, req'd CTE(95) is 0.15, i.e., a decrease from issue level of 0.18, so no trigger for dynamic hedge
After 1 yr, the investment earns risk-free rate pays out a gtee death benefit = 0.0035 x $(G\text{-}S_1)^{+}$ = \$0
Thus, Actuarial Approach Value (0) with 1-yr interest = $CTE_0(95)$ x 1.03 = 0.18 x 1.03 = 0.1854

4. Continued

Thus, Actuarial Approach Value (0) after mortality = 0.1854 - (0.0035 x 0) = 0.1854
Thus, can release \$0.1854 - \$0.15 = \$0.0354 of risk-free bonds

Up Scenario: t=2 S_2 = 120
At maturity, the investment earns risk-free rate pays out a gtee death benefit = 0.003986 x $(G\text{-}S_2)^+$ = \$0
Thus, Actuarial Hedge Value (1) with 1-yr interest = $CTE_1(95)$ x 1.03 = 0.15 x 1.03 = \$0.1545
Thus, Actuarial Hedge Value (1) after mortality = 0.1545 - (0.003986 x 0) = \$0.1545

(d) Propose reasonable capital requirements for the dynamic hedging approach. Compare these to Zoolander's capital requirements under the current actuarial approach.

- For actuarial approach, capital requirements are reasonably CTE(95), invested in risk free bonds.
- The actuarial approach requires substantially more capital than dynamic hedge approach.
- Although capital requirements are generally higher for actuarial approach, the overall cost may be lower.
- Importantly, solvency capital requirements under actuarial approach are held in event of an unfavorable investment experience.
- If an investment experience is favorable, then the capital is not required and is released back to insurer.
- Only cost is carrying cost of capital for contract period.
- For dynamic hedging, capital requirements comprises the capital allocated to the hedge itself, plus an allowance for the additional costs that may be required to cover transaction costs and hedging error.
- Net costs = Transaction costs and hedging error less margin offset.
- Reasonably, a capital requirement might be CTE(95) for PV of projected net costs, discounted at risk-free rate.
- Total capital requirements using dynamic hedging are lower than for actuarial risk management.
- For dynamic hedge approach, only the unhedged liable reserve (covering hedge error and transaction costs) is available to company if experience is favorable.
- If guarantee ends up OTM, then hedge will expire worthless and none of hedge cost is returned to company (except hedging error).
- A dynamic-hedge approach to risk management is preferred to actuarial approach except at very low risk discount rates.

4. Continued

(e) Provide one advantage and one disadvantage for each of the following GMDB risk-management approaches:

(i) Dynamic hedging;

Advantage: lower capital requirements, decrease downside risk
Disadvantage: higher transaction costs, require frequent rebalancing, still expose to some downside risk

(ii) Actuarial using CTE(95);

Advantage: low/marginal transaction costs, no frequent rebalancing, capital can be released in favorable investment experience
Disadvantage: higher capital requirements than dynamic hedging, still expose to some downside risk

(iii) Badger's hybrid approach.

Advantage: lower transaction costs than dynamic hedging
Disadvantage: may be expensive to hedge if large market movement, increase model error

5. 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:

(2a) Explain basic account concepts used in producing financial statements:
- In insurance companies
- In other financial institutions
- In non-financial institutions

(2b) Analyze a specific company financial situation by demonstrating advanced knowledge of balance sheet and income statement structures.

(4a) Explain the rationale for managing risk and demonstrate the selection of the appropriate risk retention level.

(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.

Sources:

Doherty Chapters 7 and 8

Fridson Chapter 2

Hardy Chapter 9

Tiller Chapter 5

Commentary on Question:

The question tested candidates' understanding of the impact of a non-linear tax structure and risk on a firm's shareholders and bondholders, and their ability to apply this understanding to a business situation.

Solution:

(a) Calculate the funds needed (in addition to the premium) as of the beginning of the year to meet the total asset requirement.

Commentary on Question:

Candidates were required to use the CTE concept to determine the required capital.

5. Continued

CTE98 is the average of values beyond the 98th percentile of the loss distribution. In this case, there is only one value to consider: $2,625,000 payable at the end of the year. The funds will earn 5%.
So,

2,625,000 = (F + 400,000)* 1.05, which yields
F = 2,625,000/1.05 – 400,000 = 2,100,000

(b) Assuming MI uses 100% equity to provide the additional funds determined in part (a):

(i) Calculate the expected after-tax profit for the year. Show your work.

Commentary on Question:
Candidates were required to identify the elements of an income statement. Note that:

- The $2,100,000 which is financed by equity is not revenue; and
- Because of the non-linear tax schedule, it is best to analyze each benefit scenario separately.

	Scenario 1	Scenario 2	Scenario 3
Premium	400	400	400
Investment Inc	(2,100+400)*.05 = 125	125	125
Benefit	0	-525	-2,625
Pre-tax income	525	0	-2,100
Taxable income	525	0	-525 (floor)
Tax (TI * 40%)	210	0	-210*
After tax income	315	0	-1,890

Expected after tax income = 315 * .8 + 8 * .16 + (-1,890)* .06 = 176.4

*Note: Candidates may have inferred from the wording of the question that in Scenario 3, tax = 0 because the pre-tax income is less than -525. This answer was accepted.

(ii) Determine whether the expected ROE is sufficient to meet Board requirements.

Commentary on Question:
Most candidates applied the definition of ROE correctly, even if they determined its components incorrectly.

Expected ROE = (Expected After-tax income) / (Equity at BOY)
= 176.4 / 2,100 = 8.4%
This falls below the Board's 9% requirement.

5. Continued

(c) Explain why increased risk may be costly to shareholders.

Commentary on Question:
Most candidates identified at least one of the following.

Non-linear taxes.
Bankruptcy costs may be shared by shareholders.
Increased likelihood of bankruptcy will reduce the value of the firm.
Managers may act in their own interest, regardless of shareholders' interests.

(d) Assuming MI uses 85% equity and 15% one-year debt to provide for the additional required funds:

(i) Determine the minimum interest rate at which MI could issue such debt.

Commentary on Question:
This section introduced the issue of potential bankruptcy. If the firm sustains after-tax losses in excess of its equity, bankruptcy will occur.

When bankruptcy occurs, there are three effects:
1. Shareholders lose all their equity;
2. Bankruptcy costs are incurred and are borne by bondholders; and
3. Bondholders are only repaid the remaining value of the firm.

The additional funds of 2,100 will be funded as follows:
Equity = 85% * 2,100 = 1,785
Debt = 15% * 2,100 = 315
Given the analysis above, Scenario 3 is a bankruptcy scenario; the others are not.
In Scenario 3, the remaining value of the firm is
$2{,}100 - 1{,}890 = 210,$
and bondholders incur 21 in bankruptcy costs.
For bondholders to at least make the minimum 6% return, it is required that
$315 * 1.06 = 315 * (1 + R) * .96 + (210 - 21) * .04,$
which yields R = 7.92%

(ii) Calculate the expected after-tax profit assuming debt is issued at the rate determined in part (d)(i).

Commentary on Question:
Once again, each benefit scenario is analyzed separately.

5. Continued

	Scenario 1	Scenario 2	Scenario 3
Premium	400	400	400
Investment Inc	(2,100+400)*.05 = 125	125	125
Interest	315 * 7.92% = 24.9	24.9	24.9
Benefit	0	-525	-2,625
Pre-tax income	500.1	-24.9	-2,124.9
Taxable income	500.1	-24.9	-525 (floor)
Tax (TI * 40%)	200.0	-10	-210
After tax income	300.1	-14.9	-1,914.9

Expected after-tax income = 300.1 * .80 + (-14.9) * .16 + (-1,914.9) * .04
= 161.1

(iii) Determine whether the expected ROE is sufficient to meet Board expectations.

Expected ROE = 161.1 / 1,785 = 9.03%
This meets the Board's requirements.

(e) Explain why non-linear tax schedules can make risk costly to shareholders.

Commentary on Question:
About one-third of candidates were able to identify at least one of the following.

When the tax schedule is convex, increased volatility of earnings causes expected taxes to increase.
Increased taxes means reduced return to shareholders.
In a non-linear tax schedule, the effective tax rate varies with taxable earnings.

(f) Describe how reinsurance can be used to eliminate the tax inefficiency at MI.

Commentary on Question:
Most candidates who responded provided either or both of the following.

Reinsurance reduces the volatility in earnings.
Sofrito's ability to absorb greater losses can be used to their mutual gain.

(g) Sofrito has offered this reinsurance coverage at a cost of $250,000.

(i) Calculate the funds needed (in addition to the premium net of reinsurance cost) as of the beginning of the year to meet the reduced total asset requirement with reinsurance in place.

CTE98 is now 525,000.

5. Continued

To cover this potential liability, we will require:
525,000 = (F + 400 – 250) * 1.05
F = 525,000 / 1.05 – (400 – 250) = 350

(ii) Assuming MI uses 100% equity to provide the additional funds, determine whether the expected ROE is sufficient to meet Board requirements.

Commentary on Question:
In this case, Scenarios 2 and 3 are identical, with a combined probability of 20%.

	Scenario 1	Scenarios 2/3
Premium	400	400
Less: reins prem	-250	-250
Investment Income (350 + 400 – 250)*.05 =	25	25
Benefit	0	525
Pre-tax income	175	-350
Taxable income	175	-350
Tax (TI * 40%)	70	-140
After-tax income	105	-210

Expected after-tax income = 105 * .8 + (-210) * .2 = 42

ROE = 42 / 350 = 12.0%
Exceeds Board's requirement.

6. Learning Objectives:

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

Learning Outcomes:

(4g) Analyze funding and portfolio management strategies to control equity and interest rate risk, including key rate risks.

- Contrast modified duration and effective duration measures.
- Calculate effective duration and effective key-rate durations of a portfolio.
- Explain the concepts of immunization including modern refinements and practical limitations.

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

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

(4l) Define and evaluate spread risk as related to fixed income securities.

Sources:

FE-C128-07: (8FE-316-03), Ch. 22 of Life Insurance Accounting – ALM

FE-C129-07: (8E-707-04), Principals for the Management of Interest Rate Risk

FE0C130-07: Hedging with Derivatives in Traditional Insurance Products

FE-C127-07: Asset Liability Management for Insurers

FE-C156-09: Key Rate Durations: Measures of Interest Rate Risks

FE-C157-09: Long Term Economic and Market Trends and Their Implications for Asset-Liability Management of Insurance Companies

Commentary on Question:

Commentary listed beneath each question component.

Solution:

(a) List four key elements of a successful ALM program.

Commentary on Question:

There are six correct responses, but any four are all that are needed. Adding extra detail to each response would allow the candidate to score even more. Very few candidates did so.

1. Commitment from Senior Management
2. Clearly defined roles and responsibilities

6. Continued

3. Leverage the Cash Flow Testing platform
4. Appropriate risk metrics

(b) Describe the interest rate and credit risks of Condado's asset portfolio and the potential impacts to profitability.

Commentary on Question:
Adding extra explanation of the risks, especially as it applies to Condado's situation would improve the candidates score.
No candidates mentioned credit spread risks. Most mentioned default risk and the fact that Condado has too many high yield bonds. There were a lot of other things that could have been added about Condado's default risk, but few candidates did.

Interest Rate Risks
Maturity Mismatch Risk – Average asset maturity is just over five and liability maturity is over twenty
Yield Curve Risk
Optionality Risk
Basis Risk
Credit Risks

- Credit Spread Risks – Can't lock in today's spreads
- Default Risk – Many risky high yield bonds can default

7. 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:

"Actuarial Aspects of SOX 404," The Financial Reporter, Dec. 2004

Commentary on Question:

Commentary listed beneath each question component.

Solution:

(a) Identify and describe the four key risk areas used to characterize the "risk profile" of the actuarial financial reporting process under Sarbanes Oxley.

1. Data
   The process of gathering and interpreting data

2. Actuarial Valuation System
   Programs used to calculate reserves and other figures

3. Compilation Process
   Process of compiling reserves and other financial information for the financial statements

4. Management Review Process
   The way that management reviews the data, actuarial figures and financial statements

(b) Describe specific kinds of business risks related to its actuarial financial reporting process that PWL may encounter.

(c) Recommend adjustments to PWL's actuarial processes that may help to reduce the kinds of business risks identified in (b).

Commentary on Question:

Some writers recognized that it made sense to combine part (b) and part (c). They would list an issue they saw, then make a recommendation for how to correct it. This is how the model solution below has been developed.

7. Continued

Data used in reserve calculations is incomplete.

- Claims data cuts of mid-month, but the valuation date occurs at the end of the month. Two weeks of data is missing.
- Recommend moving the claims feed to the end of the month, at the same time as the reserve calculation.

Reserve modeling is inappropriate.

- Two different systems are being used for quarterly and year-end GAAP and DAC calculations. This could lead to large restatements at year-end.
- Recommend that PWL only use one system and model the reserves at least quarterly.

Actuary is customizing the commercial actuarial software with limited controls.

- Since there's no review, errors would likely go unchecked.
- Recommend peer review and sign-off for model changes.

Only one actuary is responsible for all the calculations.

- Again, errors will likely not be caught.
- What happens if they quit, or are out for a long period of time?
- Recommend hiring another actuary to peer review the process.

Process is too complicated.

- There are too many systems and too much manual work involved, which increases the risk of errors.
- Recommend automating the process as much as possible. For instance, making the information available to the accountant on the network so that emailing the data isn't necessary.

8. 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:

(3a) 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.
- Asses the overall corporate risk exposure arising from financial and non-financial risks.

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

Sources:

CSFB Copula Study Note, Chapters 2 and 4

Commentary on Question:

Commentary listed beneath each question component.

Solution:

(a) Describe the bottom-up and top-down approaches to modeling the aggregate credit default loss without the use of copulas and the difficulties each of these approaches presents.

Commentary on Question:

The bottom up approach was often answered by candidates on a per security approach.

Bottom-up approach

Model the default distribution of losses for each portfolio and determine the correlations between them. Correlations are difficult to determine due to quantity, data, methods and the need to specify more than pairs.

Top-down approach

Create a factor based loss distribution for each portfolio. Selecting the appropriate factors, their distributions and the appropriate factor model is difficult.

8. Continued

(b) Define "copula," and describe how copulas can simplify your modeling of the aggregate credit default loss.

Commentary on Question:
Most candidates understood the definition but were weak on the benefits.

A copula is a distribution function of a multivariate random variable with uniform marginals. A copula is a method for correlating random variables together, irrespective of their marginal distributions simplifying the distributions calculations. Copulas allow for the separation of marginal distributions from correlation

(c) Describe how you would determine $E[S]$, where $S = X + Y$.

Commentary on Question:
Most candidates did not demonstrate adequate knowledge on this section.

C(X, Y) is the cumulative multivariate distribution function for X, Y
Determine the multivariate density function c(X, Y) by differentiating C(X, Y) over both x and y
Determine cumulative distribution function F(S) by integrating c(X, Y) over the region bounded by x = -infinity to s - y and y = -infinity to s
Differentiate F(s) over s to obtain density function f(s) for S
Evaluate the integral over all s of s*f(s) to determine E[S]

(d)

(i) Explain upper and lower tail dependence.

Commentary on Question:
Most candidates understood some aspects of tail dependence, but many confused the details.

If a random variable tends to take on relatively low values whenever another variable has low values, they have lower tail dependence. Similarly, if a random variable tends to take on relatively high values whenever another variable has high values, they have upper tail dependence.

(ii) Applying the appropriate limits, determine the lower tail dependence for the following copula:

$$C(x, y) = xy/(x + y - xy)$$

8. Continued

Commentary on Question:
Many candidates did not provide an answer for this part. Candidates who understood the underlying theory were able to distinguish themselves.

Tail dependence does not depend on the marginal distributions of X and Y and is instead a property only of the copula.
Lower tail dependence measured by limit as $x \rightarrow 0$ of $C(x, x)/x$
Limit as $x \rightarrow 0$ of $[x^2/ (2x - x^2)]/x = ½$

(iii) State whether lower or upper tail dependence is more relevant to credit default risk, and explain why.

The asset return depends on sensitivity to one or more systematic (correlated) risks as well as one firm-specific (uncorrelated) risk.
If a bad state of the world (increased systematic risk) leads to default for a particular asset, other assets are more likely to default as well, assuming they have a similar sensitivity to systematic risk.
Therefore, credit default risk exhibits high lower tail dependence.
In a good state of the world, systematic risk has little impact and the asset return is mostly affected by uncorrelated firm-specific risk.
Independent or uncorrelated variables have no tail dependence.
As such, credit default risk exhibits low upper tail dependence.

9. 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) Explain the elements of risk governance, and demonstrate how governance issues are resolved through organizational structure.

Sources:

FE-C139-07: No assurance of Good governance: Observations on Corporate Governance in the U.S. Insurance sector.

Commentary on Question:

Commentary listed beneath each question component.

Solution:

(a) Describe the ideal Board governance framework that is applicable to the insurance sector using Moody's perspective.

Board members should be independent. They should have a good knowledge of the business and they should have a good committee structure organized effectively.

Board compensation must not align directors' interest too closely with management. Compensation should be aligned with shareholders interest.

Chief actuaries should report to board committees.

(b) Evaluate RVL relative to Moody's perspective on ideal Board governance, and recommend four changes which would help RVL improve its governance framework.

Commentary on Question:

Since this question was worth 5 points, 15 minutes of thinking and writing were allocated. We expected observations and comprehensive recommendations for each, including a full observation, evaluation and recommendation.

Independence:

Observation:

There are 5 members of management on the board, that's too many insiders.

Evaluation:

Thus they are not really independent.

9. Continued

Recommendation:

Replace enough members of management on the board by independent members so that the board can be considered independent.

Knowledge:

Observation:

20 members, out of 25, are from the manufacturing industry.

Evaluation:

They may lack knowledge of the insurance industry and of finance.

Recommendation:

The board should be changed to include more knowledgeable members.

Size:

Observation:

25 Board members.

Evaluation:

The board is too large. Smaller boards, 9 to 12 members, are more effective. Smaller boards allow more discussion and participation.

Recommendation:

The size of the board should be reduced.

Structure:

Observation:

The Chief Actuary doesn't present at committees meetings.
A Chief Risk Officer has been appointed.

Evaluation:

The Chief Actuary doesn't seem independent.
The CRO reporting to the board is strength for the company.

Recommendation:

The structure should be changed so that the actuary be independent and report to the board.

9. Continued

Compensation:

Observation:

The board is paid with stock options.

Evaluation:

This form of compensation aligns board interest with management, which is not appropriate. It also encourages a short term perspective.

Recommendation:

The compensation structure should be changed to promote a long-term perspective and align the board interest with shareholders interest.

10. 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:

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

Sources:

FE-C130-07: Hedging with Derivatives in Traditional Insurance Products

SOA Economic Capital for Life Insurance Companies

FE-C128-97: Asset/Liability Management

Commentary on Question:

Commentary listed beneath each question component.

Solution:

(a) Identify and describe three aspects of morbidity risk in the IDI product line that Hamsik should consider when modeling this risk.

Commentary on Question:

Candidates generally performed poorly on this section as their answers did not directly relate back to modeling morbidity risk within an EC model.

Any three of the following aspects of morbidity risk with explanations were acceptable answers:

1. Catastrophe Risk: For IDI, catastrophic claims experience could result from a natural or man-made disaster (e.g., a nuclear accident) resulting in a higher incidence/longer duration of disabilities. Given the high correlation normally witnessed between disability income claims and economic conditions, a depression-type scenario could be expected to lead to catastrophic claims incidence for IDI.
2. Volatility Risk: This refers to sources of volatility for morbidity risk; such as variations in the number of claims; variations in the size of claims; and variations in the duration of claims. The impact on capital due to volatility is generally significantly smaller than that due to other risks.
3. Mis-Estimation (Parameter) Risk: This is the risk that past experience is not necessarily a good guide to future experience. This could be caused by errors in collecting or analyzing the data, past random fluctuations or heterogeneous data.

10. Continued

4. Trend Risk: This risk relates to how future experience might evolve - for example, through medical advances. Trend risk would usually be expected to be a significant contributor to EC for IDI, although the specific factors that give rise to the risk would likely vary depending upon product design.

(b) Explain why using an industry morbidity table may be insufficient to assess Hamsik's morbidity risk exposure in its IDI product line.

Commentary on Question:
Most candidates identified that company specific experience could be very different than the industry; as well differences in underlying demographics and underwriting practices would not be reflected in the industry morbidity table.

The industry morbidity table may be insufficient to assess Hamsik's morbidity risk exposure in its IDI product line for the following reasons:

- Experience can vary by company.
- Underlying demographics of insured will impact experience; for example occupation, economic status, geographical location, access to medical care.
- Current economic environment is a factor, with poor economy correlating with poor morbidity experience.
- Company lapse experience will be anti-selective.
- Differences in benefit levels, benefit qualification requirements, elimination periods, etc. will all affect morbidity experience.
- Distribution will affect experience.

(c) The Chief Risk Officer (CRO) of Hamsik has observed that the fixed renewal premiums are a series of embedded call options on interest rates. As such, the CRO is considering entering into a series of forward starting interest rates swaps to hedge the risks associated with granting these options.

Commentary on Question:
Overall candidates did not demonstrate an adequate understanding of this section. Areas of improvement would be to identify that Hamsik would receive fixed payments to offset the embedded call option, the timing and length of the trade (payments would start in three years and although the question did not specify, the expectation is that the swap would be longer than 3 years) and the general mechanics of how to fund the floating payments for the IRS.

(i) Explain how Hamsik could use this offsetting derivatives strategy to hedge $100 million of IDI premium coming due in three years.

10. Continued

Hamsik is agreeing today, at point of policy issue, to sell to the policy holder a series of bonds yielding 6%. To offset the IDI embedded calls, Hamsik could use a forward starting IRS, where Hamsik would receive a fixed coupon (6%) on the notional amount and pay floating. If the fixed rate is greater than the floating rate, Hamsik would receive a payment from the swap counter party; this payment would equal the forward starting swap rate less the floating rate/LIBOR.
Note that while the forward starting swap rate would remain fixed for life of the swap, floating rate/LIBOR would change. Typically, the net payments would occur quarterly; in any given quarter, Hamsik will pay to or receive cash from the swap counter party.

(ii) Describe the trades at both time zero and at the end of three years.

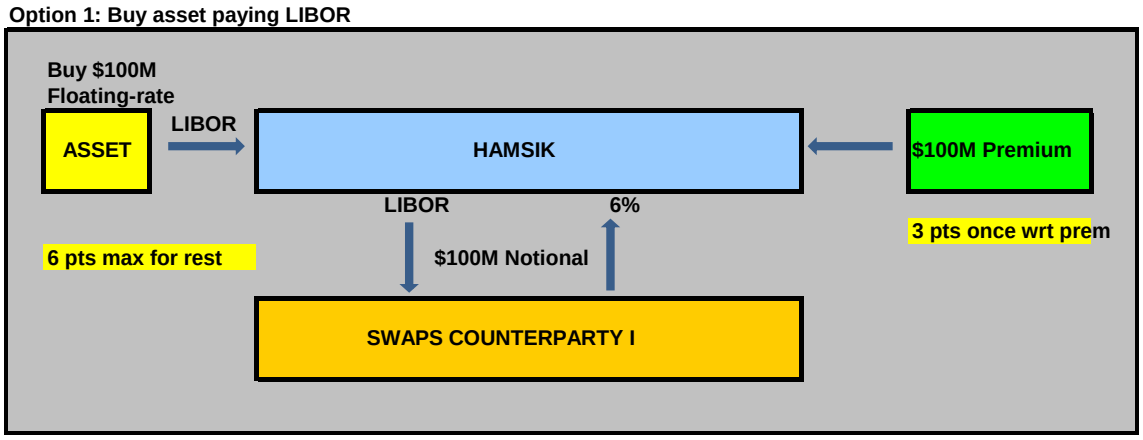
At time = 0:

- Hamsik would enter a 3-year forward starting swap with a notional amount of $100 M with a swap counterparty, receiving fixed and paying float/Libor.

At time = 3:

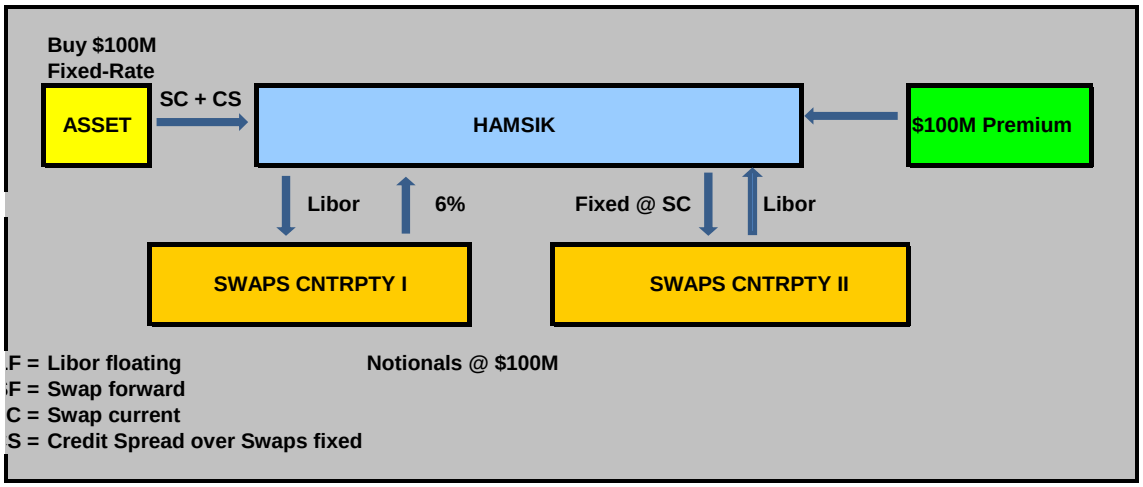
- Hamsik receives its $100M premium and has 2 options:

  i. The simplest is to buy a floating-rate asset paying LIBOR: Hamsik is receiving LIBOR from the asset and paying LIBOR to the swap counter party. These two items cancel out and Hamsik is left receiving the swap forward fixed rate.



10. Continued

ii. Enter into an offsetting swap and buy a fixed-rate credit instrument. The fixed-rate asset and 2 interest rate swaps net to Hamsik receiving current swap rate plus the credit spread.



(d) Identify two concerns that the CRO of Hamsik may have with the strategy described in part (c) above.

Commentary on Question:
Most candidates identified that CRO would be concerned about additional credit risk from the swap counter party. However credit risk would also arise from the assets purchased to fund the float payments. Also candidates could improve their explanation of how basis risk or hedge error would arise; mainly coming from an inability to lock the credit spreads assumed in pricing.

The CRO of Hamsik may have two concerns with the strategy described above:

1. The large counterparty risk exposure, a variant of credit risk. This risk exists when Hamsik first enters a forward starting swap agreement, when they enter the offsetting swap, and when they buy the credit instrument. As a result, Hamsik now has 3 times the credit exposure than if it had just bought the credit instrument. However, given that swap counter parties tend to be highly rated, the credit risk is probably less than 3 times.

2. A more critical concern is the inability to lock in today's credit spreads. Pricing yield consists of the swap plus the credit spread which is not constant and may experience large swings over time. A company that hedged their interest rate exposure using this strategy could still experience losses as credit spreads declined.

10. Continued

(e) Evaluate these options and their effectiveness in mitigating the interest rate risk.

(i) For new issues, re-price using a 1% interest rate assumption in place of the 6% assumption;

Repricing new issues is not immediately effective, as it does nothing to reduce interest rate risk exposure on the inforce block. However this would reduce over time if new business becomes a greater proportion of the inforce block. The repricing could impair the competitiveness of product and would need to be evaluated when using a 1% rate and its impact on sales.

(ii) Coinsurance of IDI inforce block.

Coinsurance is effective provided a reinsurer could be found to assume the business. This may be difficult as product is aggressively priced and is now in a low interest rate environment. Note that the coinsurance option mitigates all product risks, not just interest rate risk but it does introduce credit counter party risk. Coinsurance comes at a cost as Hamsik gives up some portion of the profits on the block in addition to offloading interest rate risk.

11. Learning Objectives:

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:

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

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

Sources:

Hardy, Investment Guarantees, Chapter 12

Commentary on Question:

The question was testing the understanding of managing risk using hedging strategies and then asking candidates to evaluate the effectiveness of the hedging strategy.
The cognitive level of this question was recall, solve, and analyze.
Overall, candidates performed well on this question. This question had 2 typos in the formulas provided but this did not seem to impact the quality of answers. Most performed well on the calculation in section (c) despite the typos.

Solution:

(a) Identify the similarities and differences in assessing capital requirements for the GMIB versus the GMMB using an actuarial approach.

Commentary on Question:

Candidates performed very poorly on this section. The main problem was that the question was not answered in reference to capital requirements. Many papers described GMIBs and GMMBs in general and did not address similarities and differences related to capital requirements.

Similarities

- Both use stochastic simulation to project the liabilities
- Liabilities are discounted back to the start of the projection period

Differences

- Good fund performance means higher GMIB liability but lower GMMB liability
- Invest the GMIB solvency capital in the same assets at the separate account
- Invest the GMMB solvency capital in risk-free bonds

11. Continued

(b) Assess the appropriateness of the 10% conversion rate.

Commentary on Question:
Overall this section was answered correctly. Most candidates identified the 10% conversion rate as being too high. Those who did not perform well on this section did not offer supporting detail as to why the conversion rate was too high.

- Long term yield is currently 4%
- Option is in-the-money when $a_{65}(t) > 1/g$
- Option ITM at 4%, $11.30 > 1/g = 10$
- Option is already ITM so use a lower conversion rate

(c) Complete the table of values below given a simulated random normal variate of 2.164 for $t = 1$.

Commentary on Question:
The majority of candidates performed very well on this section of the question despite the typos in the exam booklet. Many recognized the typo in the formula provided for H_0^a and stated what the formula should be and continued with the response. The intended formula was $H_t^a = F_t\, g\, a^d_{65}(t)F(d_1(t))$ and $H_t^a = F_t\, g\, a^d_{65}(d_1(t))\, F(t)$ was printed. Candidates were given credit for using either equation. Also, the squared term in the formula for H_0^F was different than found in Hardy Chapter 12. Credit was awarded for implementing either expression.

$\ln(1+i) = 0.07 + 0.97*(0.0392 - 0.07) + 0.004*2.164$
$i = 5\%$

$B(0,15) = 1.04^{-15} = 0.55526$
$B(1,15) = 1.05^{-14} = 0.50507$

$a_{65}(15)_{.05} = 10.38$ from table

$a^d_{65}(0) = 11.30*B(0,15) = 11.3* 0.55526 = 6.2744$
$a^d_{65}(1) = 11.30*B(1,15) = 10.38* 0.50507 = 5.2426$

$H_0^a = 100(0.1)(6.2744)(0.0104) = 0.6525$
$H_0^b = -100(0.1)(6.2744)(0.0104) = -0.6525$
$H_0^F = 100\{0.1(6.2744)(0.0104) - (0.0061)\} = 0.0425$
$H_0 = H_0^a + H_0^b + H_0^F = 0.0425$

11. Continued

$H_1^F = 110\{0.1(5.2426)(0.0004) - (0.002)\} = 0.00001$
$H_1 = H_1^a + H_1^b + H_1^F = 0.00001$

(d) Identify potential shortcomings with the dynamic hedging strategy described above and the associated assumptions. Recommend possible enhancements.

Commentary on Question:
Section (d) was poorly answered or not answered at all by most candidates. There were broad general answers given about interest rate models. The candidates did not address specific details supplied in the question stem about the hedging strategy rather broad improvements. The assumptions were rarely addressed.

Shortcomings
- Assuming discounted annuity process is lognormal may be inappropriate
- Long term yield modeled using AR(1) only
- Simplified interest rate model may produce large hedging errors
- No lapse assumptions
- Forward annuity is not a traded instrument

Enhancements
- More sophisticated modeling of term structure
- Add regime switching to current autoregressive interest rate model
- Incorporate lapse assumption will reduce risk capital required

(e) Describe a potential static replication approach that Arroz could employ to manage the GMIB risk.

Commentary on Question:
Many candidates were able to identify a swaption could be used as a static replication approach. Those papers scoring well in this section described the swaption in detail and commented on the differences from the GMIB liability.

- Static approach to replicate the annuity payments with readily available traded options.
- A swaption could be used to swap bond paying variable interest for a bond paying fixed rate.
- Swaption is not life contingent and introduces counterparty risk.

12. Learning Objectives:

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

Learning Outcomes:

(4s) Define strategic risk.

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

(4u) 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:

Damoradan, Strategic Risk-Taking, Chapter 9, 10 and 11

Commentary on Question:

Commentary listed beneath each component question.

Solution:

(a) Describe five considerations companies should take into account when deciding whether to hedge risk or manage risk.

Commentary on Question:

Part (a) is a simple recall question directly from the source material. Most candidates listed 5 considerations, but few went into the details to explain why they are important in deciding whether to hedge or manage risk.
The question asks for 5 considerations and any 5 of the below would be sufficient to get full credits.

1. Value of Risk
   Risk is a danger (Hedging). Risk is a danger and an opportunity (Management).

2. Objective
   To protect against the downside of risk (Hedging). To exploit the upside created by uncertainty (Management).

3. Functional Emphasis
   Financial (Hedging). Strategic, stretching across all functions (Management).

12. Continued

4. Process
   Product oriented. Primarily focused on the use of derivatives and insurance to hedge against risks (Hedging). Process oriented. Identify key risk dimensions and try to develop better ways of handling and taking advantage of these risks than the competition (Management).

5. Measure of Success
   Reduce volatility in earnings, cash flows or value (Hedging). Higher value (Management).

6. Type of Real Option
   Put option (Insurance against bad outcomes) (Hedging). Call option (Taking advantage of high volatility to create good outcomes) (Management).

7. Primary Effect on Value
   Lower discount rate (Hedging). Higher and more sustainable excess returns (Management).

8. Likely Makes Sense For
   Closely held and private firms or publicly traded firms with high financial leverage and substantial distress costs (Hedging). Firms in volatile businesses with significant potential for excess returns (if successful) (Management).

(b) Explain the advantages and disadvantages of managing versus hedging WG's exposure to pulpwood price volatility.

Commentary on Question:
This part tests the comprehensive skills of the candidates. Most candidates did well on this part and showed their understanding of risk (hedge) and opportunity (manage). The candidates who scored well not only considered advantages and disadvantages of hedging versus managing, but explained how they were applied to pulpwood price risk.

The Case for Managing:
- By managing the risk and not hedging, Wier Green can exploit the upside created by the uncertainty of the pulpwood risk.
- Managing the risk and hedging could lead to higher value.
- Diversified investors could hedge pulpwood price risk more efficiently than the firm by holding a diversified portfolio.
- Not hedging represents a strategic call option (taking advantage of the volatility of the underlying risk to create good outcomes).
- Not hedging could lead to higher and more sustainable excess returns.

12. Continued

The Case for Hedging:

- Pulpwood price risk is a danger and not necessarily an opportunity.
- Hedging would protect against the downside risk from pulpwood price fluctuations.
- Reduce volatility in earnings, cash flows or value.
- Hedging represents a real put option (insurance against bad outcomes).
- Hedging could lead to a lower discount rate, which is beneficial to the firm in discounted cash flow valuation model → greater value.

(c) Evaluate the CFO's rationale for the acquisition from the perspective of WG's shareholders.

Commentary on Question:
This part tests the analytical skills.
Part (c) asks the candidates to evaluate the CFO's rationale from the shareholders' perspectives. A lot of candidates missed that they have to answer from the shareholders' perspective, as specified in the question: it would be much cheaper for shareholders to diversify their portfolio than to have the company do it and also the acquisition was over-priced. For instance, a lot of candidates realized the acquisition was over-priced, but they still considered this a good idea and justified the acquisition from the CFO's perspectives.
Also, a lot of candidates just regurgitated the question, and did not go into the details to explain why the acquisition was not a good idea.

- Investors in Wier Green are faced with the same risk to pulpwood prices as does the firm.
- Hedging will add value only if the cost of hedging is lower to the firm than it is to investors.
- Wier Green investors can hedge the risk exposure to pulpwood prices by holding a diversified portfolio at a much lower cost than Wier Green's acquisition.
- By paying a premium to acquire TreeToppler, the costly acquisition could have an adverse impact on the financial strength of the total company.
- The significant fluctuations in pulpwood prices could be an outlier and the acquisition could be viewed as an over-compensatory act.
- Making the acquisition after significant pulpwood price fluctuations (assuming pulpwood prices are cyclical) means that WG loses out on the upside gain when pulpwood prices goes through a potential correction.
- The costs of the acquisition itself actually decreased value in the firm that would not have occurred had the firm let its shareholders hedge the risk themselves (e.g. buying TreeToppler's or a similar company's stock).

12. Continued

(d) WG is considering modernizing its production process by investing heavily in a new and costlier technology.

(i) Describe the five steps of the process through which this disruptive technology can displace currently prevalent technology.

Commentary on Question:
This question is a list-type question. However, many candidates put down general 5-step processes that did not answer the question.

Step 1: New and disruptive technology is introduced, which is often significantly worse than the dominant, prevailing technology.

- In Wier Green's case, the large investment made into this technology would lead to a more expensive product when these costs are passed to the customers.

Step 2: New technology attracts fringe or new customers who are not being served by current technology by offering cheaper, simpler, or more convenient product.

- In Wier Green's case, the product is more environmentally friendly, which can appeal to some niche customers.

Step 3: Most profitable customers stay with incumbent firms who conclude that investing in the new technology does not make financial sense.

Step 4: New technology improves until it meets or beats standards set for established technology.

- In Wier Green's case, production efficiencies with the new technology could eventually lead to competitive prices with the existing technology, but also being more environmentally friendly.

Step 5: New technology becomes the dominant technology and established firms are left behind.
Examples include:

- The disk drive business
- The growth of University of Phoenix online

12. Continued

(ii) Explain the strategic implications for WG of investing in the new technology.

Commentary on Question:
This part tests how well the candidate utilized their reading material and applied it in WG. Most candidates did well on this part and were able to identify current trends in manufacturing ("greener technology") to WG's strategy.

- New technology is much less reliant on pulpwood in paper production and hence acts as an implicit hedge against pulpwood prices in that it reduces the firm's exposure to pulpwood price risk.
- Competitive advantage over competitors since this is a "greener" technology; it would appeal more to niche customers who are environmentally focused.
- "Greener" technology could improve reputation value of the firm.
- "Greener" technology is implicitly a marketing point and could lead to more sales.
- In the long term, if industry as a whole moves towards "greener" technology, Wier Green would be ahead of its competitors and would achieve production efficiencies and savings by the time competitors begin to adopt the new technology.

13. Learning Objectives:

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:

(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.

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

Sources:

Crouhy, Ch. 15 Model Risk

FE-C145-07: DFCA Handbook

Economic Capital for Life Insurance Companies

FE-C127-09: Asset Liability Management for Insurers

Commentary on Question:

This question tests the candidate's ability to not only understand model risks, how models vary by application, but also the actual application of an EC model itself. In order to score well, candidates needed to be able to correctly identify issues with the existing cash flow testing model, and have a good understand of products in order to appropriately conduct stress scenarios.

Solution:

(a) Describe four ways to mitigate model risk.

Any four of the following:

- Vetting
- Benchmark modeling
- Check results and stress test
- Listen to risk management function if they raise concerns rather than just trusting the answer that looks good/avoid Tinkerbell Syndrome
- Be aware of model risk: think through possibilities that would occur with the failure of the model

13. Continued

- Estimate model risk quantitatively
- Reevaluate models periodically
- Build model risk management into overall risk management procedures

(b) Describe the changes that will need to be made to the cash flow testing models to create the Economic Capital model.

- Make allowance for stochastic variation in assumptions/Allowance for variation in assumptions by scenario different than just assumptions associated with interest rate sensitivity
- Stochastic or different stress scenarios than NY7 should be added, stress scenarios created for each of key risks
- Additional risk factor consideration besides just interest rate risk
- Deterministic adverse scenario creation for examining longer term risks outside of one-year period to calculate terminal liability value
- Possible stochastic on stochastic calculation capability needs developed

(c) Describe two advantages and two disadvantages of using stress scenarios for Economic Capital analysis.

Advantages
- Avoids stochastic-on-stochastic calculations
- Easily communicated

Disadvantages
- Scenarios have to be defined, rather than generated
- Stress tests do not provide insight into the likelihood of adverse tail event, merely quantifying impact

(d) For each of the four products, propose two significant stress scenarios for assessing JLA's exposure to risk.

Commentary on Question:
The keyword here was "significant." There are many factors affecting JLA's exposure, the candidate needed to pick scenarios which are significant to the products.

<u>For UL:</u>
Scenario 1: Interest rate scenario tests - NY 7, inverted yield curve test, random 200 interest rate scenarios
Justification: Universal Life contracts with guaranteed credited rate of 4% may not be profitable in scenarios where interest rates are very low.

13. Continued

Scenario 2: Alternative reinvestment strategies
Justification: Low interest rate environment and expected decline in investment income may lead to need for it for ULs with high guarantees.

For Term:
Scenario 1: Mortality increase
Justification: Term product has good mortality experience, but need to know what would happen if mortality worsened.

Scenario 2: Lapse shock
Justification: A lapse shock in the direction detrimental to the profitability of the term block (question does not specify whether the product is lapse-supported or not) should be performed to determine exposure to lapse risk.

For SPIA:
Scenario 1: Sudden or rapid increase in inflation
Justification: Inflation indexed immediate annuities lead to exposure in times of large jumps in inflation index.

Scenario 2: Longevity increase
Justification: Increased longevity would be detrimental to immediate annuities.

For VA:
Scenario 1: Equity Shock scenario
Justification: Tests Variable Annuities to see impact since there is no hedge

Scenario 2: Equity Shock + Mortality increase
Justification: Tests the GMDB component of VAs specifically.

14. 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:

Commentary listed beneath each component question.

Solution:

(a) For Case 1:

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

Commentary on Question:

It was common for candidates to cite Principle 3: Separation of Duties. The reason this does not apply to this case is that full separation of risk management duties can be achieved while having the CFO approving the strategies, which will still violate Principle 1. Another common but not necessarily correct statement from candidates is that the job of approving risk management strategies should be given to a Chief Risk Officer because the CFO is presumably not qualified to make those judgments.

Principle 1: Board of Directors' Responsibilities

- The BoD should approve strategies and policies.
- The BoD should ensure the senior management monitors and controls these risks

Principle 2: Senior Management's Responsibilities

- Establish appropriate policies and procedures to control and limit these risks.

14. Continued

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

Risk Management Control Function: Board of Directors
- BoD reviews and approves procedural controls.
- BoD reviews and approves policies and procedures.

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

The Board of Directors should approve risk management strategies, not senior management.

(b) For Case 2:

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

Principle 11: Monitoring of Risk by Supervisory Authorities
- SA should obtain from banks sufficient and timely information to evaluate the level of risk.
- SA should take appropriate account of the range of maturities and currencies in each bank's portfolio.

(ii) Describe how the case is deficient relative to this framework and propose a corrective action.

The bank should report exposures in the original currencies separately.

(c) For Case 3:

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

Components of ERM #4: Risk Assessment
- Risks are analyzed, considering likelihood and impact, as a basis for determining how they should be managed.

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

Principle 6: Risk Measurement Systems
- Measurement systems should capture all material sources of risk.
- Measurement systems should assess the effect of changes consistent with the scope of their activities.

14. Continued

Principle 8: Stress Testing

- Banks should measure their vulnerability to loss under stressful market conditions.
- Banks should consider those results when establishing and reviewing the policies and limits for risk.
- The stress testing of assumptions used for illiquid instruments is particularly critical to achieving and understanding of the risk profile.

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

The illiquid instruments should be included in stress testing.