# AFE Complete Illustrative Solutions
# Spring 2010

**AFE Examination:**

*Overall, the pool of candidates performed very well on this exam relative to past sittings. While it's impossible to explain entirely the strong performance, we can speculate as to contributing factors. For instance, we think that perhaps the November 2009 exam's relatively challenging candidate performance provided our pool of candidates a good indication of what is expected from this examination in terms of depth of knowledge and the ability to apply it. Hence, we believe that this pool of candidates was perhaps better prepared in this regard.*

*Another contributing factor may be that some of the questions asked in our exam were fairly straight forward. Definitions and basic descriptions were asked in a number of questions, which have historically exhibited stronger performance in the past. Additionally, application of syllabus material was generally relegated to situations and circumstances that were extendable from the subject material.*

*Finally, changes in the committee infrastructure regarding exam review resulted in a closer inspection to question interpretation and exam points allocated to each question. We believe that these enhancements resulted in better time management by the candidates.*

# Question 1

**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:**

(4s) Define strategic risk.

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

(5d) Explain the elements of risk governance, and demonstrate how governance issues are resolved through organizational structure.

## 1. Continued

**Sources:**
Damoradan Ch. 11, Strategic Risk Management

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

ERM Specialty Guide, SOA 2006

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

**General Commentary on Question:**
The five point question covered enterprise risk management at the corporate level and challenged the candidate to indentify certain risk management issues within the case study.

The Cognitive Skills tested were Retrieval for part (a) by asking for definitions and descriptions of strategic risk and the strategic risk process, respectively. Part (b) tested a mix of Comprehension and Knowledge Utilization skills in analyzing Zoolander's strategic risk issues.

The candidate is required to list key elements related to ERM in part A of the question, and then relate case study specifics to ERM principles in part B of the question.

Candidates typically struggled with the definition of strategic risk; however, most candidates could provide a partial or full listing of the key steps of the strategic risk management process. Most candidates were also able to indentify at least some of the short comings and recommendations, but credit was only given for the first three in each category. Some candidates failed to achieve full credit by supplying shortcomings without corresponding recommendations.

**Solution:**

(a)

(i) Define strategic risk.

Strategic Risk - risks from damage to reputation, competition, demographic trends, technological innovation, capital availability, or regulatory trends.

## 1. Continued

(ii) Describe the strategic risk management process.

Strategic Risk Process

- Economic Capital
- Risk adjusted product pricing
- Capital Budgeting
- Risk adjusted performance measurement (RAPM)

(b) For each of the following, provide three shortcomings specific to Zoolander and recommend an action to address each shortcoming:

(i) Corporate Governance

Shortcoming

- The board is made up of mostly employees / insiders.
- The board is too small.
- The company ERM leader report reports ineffectively.

Recommendation

- Add independent members to the board.
- Raise the board size from 5 to 9-12.
- Have ERM leader report through CFO or to board.

(ii) Reward / Punishment mechanisms

Shortcoming

- CEO sets his own salary.
- Stock awards vest immediately.
- No apparent punishment mechanisms in place.

**1. Continued**

Recommendation

- Remove CEO from compensation board or add independent members to comp board.
- Delay vesting of stock awards.
- Put specific punishment mechanisms in place.

(iii) Risk Management Culture

Shortcoming

- CEO wants to disband ERM committee.
- No active role by senior management in enforcing policies / procedures.
- Difference in opinions not tolerated, encouraged or reconciled.

Recommendation

- Keep ERM committee in place.
- Senior management must be involved in reinforcement of risk management culture.
- Board and senior management must be more open minded and set the proper tone from the top.

# Question 2

**Learning Objectives:**

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

**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.

**Sources:**

An Overview of Embedded Value, H. Mueller, Sept 2003, p. 23-26

FE-C162-09 - EVA & Strategy, Stern Stewart & Co., April 2000, p. 4

**General Commentary on Question:**

- Nine point integrated Case Study question tested Embedded Value (EV) principles and the use of EV results

- This question tested candidates on multiple Cognitive Skill levels mostly varying by subpart. Parts (a) and (b) required Retrieval skills from the student in asking for definitions and descriptions of EV and its components. The rest of the question mixed Comprehension and Analysis cognitive skills by requiring candidates to identify EV components, apply/calculate EV for a Term Life block using information in the Case Study, interpret the results in terms of an acquisition offer on the block, and then determine how changes in EV inputs would change the answer.

- Candidates did well on parts (a), (d), and (c)(ii). Very few got part (c)(i) completely correct as the Cost of Capital calculation tripped up most people, but most got partial points. Part (e) was the weakest area of performance as few candidates could interpret how changes in EV inputs would impact the final EV result.

- General comment: It was surprising how inconsistent candidates would be across the different parts of the question. Some would be able to calculate Cost of Capital which was one of the more difficult parts of the question, but not be able to understand how it would change if inputs changed in part (d). Others would not be able to identify parts of EV but be able to calculate it.

## 2. Continued

**Solution:**

**Commentary on Question:**
This is a straightforward question. Most candidates did well but didn't include the adjustments to ANW or that VIF is reduced for the cost of holding capital.

(a) Define and describe the two major elements of EV.

EV = ANW + VIF
ANW: Adjusted Net Worth

- Equals statutory capital & surplus, adjusted for certain items

VIF: Value of Inforce

- Equals PV of future after-tax profits on existing business, less cost of holding capital

**Commentary on Question:**
This is a straightforward question. Most candidates did fairly well, but many confused risk neutral valuation with adjusting for risks through the discount rate.

(b) Describe the Risk Discount Rate (RDR) used in the EV calculation. Identify two methods which may be used to determine the RDR.

RDR is the risk-adjusted discount rate used in EV to calculate VIF

- should reflect riskiness of business producing the profits

Method 1: Risk Free Rate + Risk Premium

Method 2: Weighted Average Cost of Capital (WACC)

**Commentary on Question:**
Most candidates got partial points on part (i) but very few got the Cost of Capital calculation correct. Most candidates got part (ii) correct regardless of their answer to part (i), although a few were confused and argued to accept any offer if EV > 0.

(c) Assuming no IMR or AVR is attributed to the term life block and that the shareholder equity for each line of business equals the statutory required surplus (all free surplus is allocated to "Corporate"):

(i.) Calculate the EV of Zoolander's term life block using the projections provided by Sam Otter and Zoolander's balance sheet. Show your work.

EV = ANW + VIF
ANW = Regulatory Capital & Surplus = 15

## 2. Continued

VIF = PV After-Tax Profits less Cost of Capital
PV After-Tax Profits = 60.3
CoC = PV Capital Release + PV AT Income on Capital – Required Capital
= 11 + 2.6 – 15 = 1.4
VIF = 60.3 – 1.4 = 58.9
EV = 15 + 58.9 = 73.9M

(ii.) Based solely on the results in (i), recommend whether to accept or reject Purchaser Life's offer.

Since EV = 73.9M > 65M offer from Purchaser Life, reject offer

**Commentary on Question:**
Many candidates did very well on this part. Particularly, it seemed the candidates who did poorly on other parts of the question did very well here, as they could make a long list of things that would cause EV differences and sometimes seem to revert to a list of why two models would produce different results. Difference in assumptions and discount rates were the most popular answers.

(d) Explain why Purchaser Life may calculate a different EV amount than Zoolander.

- Different Risk Discount Rate (RDR) due to different view on riskiness of business, or may require a different rate of return on the business
- Different assumptions used to project future profits in VIF
  - mortality, expenses, lapses
- Purchaser Life may hold different level of capital than Zoolander
- Purchaser Life may gain diversification benefits from the block when combined with its existing business (synergies)

## 2. Continued

**Commentary on Question:**
Many candidates struggled with this section offering explanations that were irrelevant, contradictory or just wrong. In part (i) several candidates confused cost of capital in terms of the discount rate with cost of capital that is a drag on EV. In part (ii) several candidates assumed an increase in the assumed pre-tax asset yield would change the Risk Discount Rate as well, or that it would change the Adjusted Net Worth (ANW).

(e) Zoolander recently completed a review of the assumptions for the term life block of business. Determine the direction and relative magnitude of the impact that each of the following assumption changes will have on the EV of the term life block. Explain your answers.

(i) Capital requirements on the block should be 20% lower than currently assumed.

Impact: Increase EV
Magnitude: Small
Reason: The decrease in capital can be distributed immediately, so the decrease in ANW is exactly offset by the increase in PV Capital Released. Since less capital is held going forward, lower cost of holding capital in the future so higher VIF, which increases EV. Since change in capital is only 3M, it is relatively small compared to total EV.

(ii) Pre-tax asset yield should be 0.25% higher than currently assumed.

Impact: Increase EV
Magnitude: Small
Reason: Higher pre-tax asset yield increases projected investment income in the future, which increases VIF. Impact will be small since value of block is insensitive to the asset yields projected, as stated in the Case Study.

# Question 3

**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:**

(4i) Demonstrate how derivatives may be used to manage equity risk.

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

**Sources:**

Hardy Ch. 8

FE-C167-09: Hedging the Bet: Variable Annuity "Bells and Whistles", Moody's October 2005

FE-C158-09: Variable Product Hedging Practical Considerations

**General Commentary on Question:**

This 10 point focused Case Study question primarily tested the candidates knowledge regarding variable annuities with guarantees and the hedging thereof.

This question tests multiple Cognitive Skill levels mostly varying by subpart. Part (b) of the question was worth two points and required mostly Knowledge Utilization cognitive skills in requiring the student to recommend and describe appropriate risk mitigation techniques. Part (d) of the question was worth two points and utilized a mix of Retrieval and Comprehension cognitive skills in asking the candidate to compare Case Study statements and source information. The rest of the question required a mix of Comprehension and Analysis cognitive skills in asking the student to understand the VA product and guarantees and calculate the option value of the product guarantee.

Most candidates were able to successfully answer at least part of this question with most candidates earning points on several parts.

For part (a), the key distinction was to note that tail risk resides in such a benefit design.

For part (b), most candidates were able to state a recommendation, however not all advantages and disadvantages given were consistent with the recommendation.

Most candidates attempted the calculation section of this question in part (c) and earned at least some partial credit. The calculations were straightforward and the formulas were given in part (i).

## 3. Continued

A majority of candidates did not fully attempt to answer part (d). Most candidates struggled with recalling the study note source material that covered the best practices of modeling GMXB products.

**Solution:**

(a) Evaluate Lyon's claim.

Past returns are not a guarantee of future performance. While the liability may only be in the money a small percentage of the time, it can be very costly to the company when it is. Even if deaths and negative market returns are not correlated, benefit payments will occur when market has a downturn and the payments can be large if the downtown is sharp.

**Commentary on Question:**
Other recommendations such as reinsurance, actuarial approach/self insurance and securitization were accepted with corresponding advantages and disadvantages.

(b) Recommend a risk mitigation approach, 2 advantages and 2 disadvantages.

One recommendation is dynamic hedging to reduce the financial risk to Zoolander from the VA Plus line of business.

**Advantages:**
Transfers market risk to derivative counterparties.
More stable earnings stream than unhedged company.

**Disadvantages:**
Derivatives can be expensive to purchase and market volatility may lead to excessive rebalancing costs.
Zoolander does not currently have sufficient expertise or systems to implement a program.

(c)

(i) Calculate *BSP(10)* for ZooEquity500 fund.

From case study concerning ZooEquity500
sigma = 25%
$m$ = 1.25%
$G$ = (1.02)^10 = 1.219
$r$ = 6%

## 3. Continued

**Calculate *d1***

$d1 = [1\text{n}((1-0.0125)^{10}/(1.02)^{10}) + (0.06 + 0.25^2/2)(10)]/[0.25*\sqrt{10}]$

$d1 = (-0.32382 + 0.9125)/0.79057$

$d1 = 0.74464$

$N(-d1) = 0.228$ [N represents the standar normal cumulative distribution]

**Calculate *d2***

$d2 = 0.74464 - 0.25*\sqrt{10}$

$d2 = 0.74464 - 0.79057$

$d2 = -0.046$

$N(-de) = 0.518$

**Calculate *BSP(10)***

$BSP(10) = (1.02)^{10} * \exp(-0.6*10) * N(-d2) - (1-0.0125)^{10} * N(-d1)$

$BSP(10) = 0.34675 - 0.20127$

$BSP(10) = 0.145$

**Commentary on Question:**
Some candidates tried to calculate a combined GMAB and GMDB joint benefit in part (c)(ii) instead of just the GMAB benefit, making the formulas much more complicated.

(ii) Calculate the hedge cost for the GMAB survival benefit.

GMAB survival hedge cost $= BSP(10) *_{10} p_x + BSP(20) *_{20} p_x + BSP(30) *_{30} p_x$

GMAB survival hedge cost $= 0.033*0.35 + 0.018*0.25 + 0.007*0.05$

GMAB survival hedge cost $= 0.0164$

(d) Evaluate these recommendations:

(i) Group policies with similar characteristics together

Policies with similar characteristics should not be grouped for dynamic hedging. Many input variables have non-linear impacts on valuations. While it may limit the amount of data and run time needed, it won't be as accurate.

## 3. Continued

(ii) Vary random scenarios by policy to ensure faster convergence

This is a good recommendation as varying random scenarios by policy can increase convergence. It has the effect of increasing your sample size.

(iii) Use static policyholder behavior assumptions to increase accuracy and speed

It is not a good idea to use static policyholder behavior assumptions, dynamic assumptions should be used. Customer behavior will impact the value of the guarantees we are trying to model. As the option becomes more valuable to the client, we should assume persistency will increase. Speed may increase, but loss of accuracy of option value will occur.

# Question 4

**Learning Objectives:**

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

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

6. The candidate will understand the structure of ERM process in an entity and be able to demonstrate best practices in enterprise management.

**Learning Outcomes:**

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

(4v) Define operational risk.

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

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

**Sources:**

Managing Operational Risk, Risk Management Ch. 13, Crouhy

ERM Specialty Guide, SOA 2006

FE 137-07 Moody's Looks at Risk Management

FE 145-07 Dynamic Financial Conditional Analysis

FE-C104-07 Insurance Op Risk: The Big Unknown, Shay & Longley-Cook

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

**General Commentary on Question:**

This six point integrated Case Study question was designed to test the candidate's comprehension of how operational decisions change the risk profile of a company.

This question tested on various Cognitive Skill levels varying mostly by subpart. Parts (a) and (b) were worth three points in aggregate and used mostly Retrieval type cognitive skills as these were mostly list-type questions asking for definitions and listing a risk assessment framework. The rest of the question required a mix of Comprehension and Analysis cognitive skills in requiring the candidate to understand various risks to Zoolander and their resultant impact.

## 4. Continued

Simple definitions were required for Part (a) so candidates generally did well.

Part (b) was a list-type question but candidates were too general in their responses. Most candidates received some points but few answered the question fully.

Both Part (c) and (d) were weighted higher because analysis was required. In Part (c)(i), some candidates responded with what the outcome would be if a rating downgrade occurred instead of explaining why the likelihood increased. Most students did well however as any reasonable answer that was supported by the case study was accepted. In section (ii), students provided fewer examples than section (i) and they were often too general in their responses. Partial credit was given where appropriate.

In Part (d), most students only provided 2-3 potential impacts where more where needed to fully answer the question.

**Solution:**

(a) Define operational risk, operational strategic risk and operational failure risk**.**

- Operational risk – risk of direct or indirect loss from failed internal processes, people or systems or from external events
- Operational strategic risk – arises from an inappropriate strategy from external environmental factors such as political, taxation, regulation or competition
- Operational failure risk – arises from failure in normal course of operating a business such as people, process and technology which should be accounted

*[Note – Candidates received credit for relevant additional details provided for each risk]*

(b) List and explain the steps of the general risk framework that Zoolander should use to create a complete risk assessment report.

- Categorize losses due to operational failures in people, process and technology and external dependencies
- Examine connectivity and interdependencies across risk categories
- Sources that drives risk categories falls under change, complexity and complacency
- Assess the net likelihood of operational failure within one year for each risk

## 4. Continued

- Assess the severity for each exposure
- Combine likelihood and severity into overall risk assessment
- Define cause and effect of losses
- Develop a risk summary report

*[Note – Candidates received partial credit for referencing other measurements or risk calculation techniques.]*

(c) Explain why the likelihood for each of the following risks is higher now than in the past.

(i) Risk of rating agency downgrade

- Received informal warnings from regulators and rating agencies
- Currently A- with negative implication which is rare for two consecutive years
- Only one reinsurer for term and reinsurer is deteriorating financially
- Quick liquidity and current liquidity ratios trended down over the past four years
- Risk management culture  weak due to limited focus on internal controls and processes

*[Note – Candidates received partial credit for other issues identified that are supported by case study material.]*

(ii) Modeling risk relating to the hedge fund initiative

- Hedge fund initiative peer review includes a straightforward interest rate swap for potentially complex strategies
- "Rules of thumb" used to estimate credit-risk exposure instead of modeling risk
- Model builder reviewed and tested his own model
- Validation of model limited to a particular type of derivative

## 4. Continued

- Model is from wound-down company

(d) Describe the potential impact to Zoolander of a rating agency downgrade.

- "Run on the bank" may occur due to GIC rating provision
- Potential reduction in future new business or increased lapses of current business
- Reduction in brand value and increased reputational risk
- Capital and other financing costs may increase
- Reduction in stock price

*[Note – Candidates received partial credit for other issues identified that are supported by case study material.]*

# Question 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:**

(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.

(4b) Demonstrate means for transferring risk to a third party and analyze the costs and benefits of doing so.

(4d) Evaluate the performance of risk transference activities.

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

**Sources:**

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

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

"Fair Value – Financial Economics Perspective," by Babbel, Gold and Merrill NAAJ
"Fair Valuation of Insurance Liabilities: Principles and Methods," AAA Monograph, September 2002

**General Commentary on Question:**

This 14 point integrated question tested candidates' ability to understand and calculate a fair value of a liability and their ability to develop a basic balance sheet and income statement. It also tested the candidates' understanding of how considerations such as the limited downside risk of equity holders, non-linearity of taxes, deadweight loss in the event of financial distress, and declining marginal utility can influence the incentives of different parties to accept and manage risk.

## 5. Continued

This question tested different cognitive skills based mainly on the question subparts. There were roughly two points worth of mixed Retrieval and Comprehension type questions part (b). There was about a point worth of Knowledge Utilization type questions part (e), whereby the candidate is asked to make a recommendation based on results in other parts of the question. The rest of the question is spread between Comprehension and Analysis (more of the latter), whereby the candidate is requested to construct financial statements and perform other financial statement-based calculations and analyses.

The primary challenge of this question for the candidate is to apply what should be familiar concepts to an unfamiliar situation. Candidates who attempted each portion of the question were usually able to begin setting up the problem to at least earn partial credit.

However, many candidates incorporated errors into the formulas used, and few were able to complete the calculations accurately. In particular, most candidates failed to consider some of the revenue and expense items that are required to complete part (d), and many candidates completed part (a) using a traditional discounted cash flow method rather than the risk-neutral approach that was requested. Finally, some students showed confusion between a balance sheet and an income statement in parts (c) and (d).

**Solution:**

**Commentary on Question:**
Most students understood the concept of calculating a net present value of risky cash flows, but only a minority attempted to calculate the fair value using the martingale approach requested. Applying the traditional risk-adjusted discount rate was more common. Those that did attempt the martingale approach often showed adequate knowledge with the appropriate formulas.

(a) Calculate the fair value of the insurance liability Safari has sold to its customers as of January 1, 2010 using the risk-neutral (martingale) approach. Show your work.

Normal Lions: 75% probability > 0.1% mortality 1,000 * 100,000 * 0.1% = $100,000 claims
Hungry Lions: 25% probability > 0.5% mortality 1,000 * 100,000 * 0.5% = $500,000 claims

## 5. Continued

With risk-neutral approach

$S_u$ = normal claims

$S_d$ = hungry claims

$\pi$ = risk - neutral probability = $p - \lambda * \sqrt{p(1-p)} = .75 - .02\sqrt{.75(.25)} = 74.13\%$

$p$ = real - world probability

$\lambda$ = market price of risk

$$FV = \frac{S_u\pi + S_d(1-\pi)}{1+r_f} = \frac{100,000 * .7413 + 500,000 * .2587}{1.04} = \$195,638.56$$

**Commentary on Question:**
Students performed fairly well on this question. Many were able to identify the appropriate methods and associated formulae. Many candidates lost points by failing to present the formulas. Other common missteps included describing market values and simulations as ways of calculating fair value in this context.

(b) Describe two alternate methods which can be used to calculate the fair value of the insurance liability. Explain how the results might differ from the current risk neutral method when using either of these alternate methods.

Alternate methods of calculating fair value:

1) Discount cash flows using real-world probabilities and a risk-adjusted discount rate

$$FV = \frac{S_u p + S_d(1-p)}{1+r_f+\lambda\sigma}$$

$\sigma$ = standard deviation of claims distribution

2) Adjust cash flows by a certainty equivalent and discount using real-world probabilities and a risk free rate

$$FV = \frac{S_u p + S_d(1-p) - Z}{1+r_f}$$

All methods will yield the same result, which can be used to determine the value of the certainty equivalent, Z.

## 5. Continued

**Commentary on Question:**
Common mistakes on this question included calculating an income statement rather than a balance sheet, and failing to include the future operating costs as a liability. Still, most candidates received substantial credit for this question.

(c) Assume that both the life insurance liability and a reserve for the tour operating costs are calculated with the risk neutral (martingale) approach to fair value. Construct the balance sheet for Safari as of January 1, 2010 ignoring taxes, showing assets, liabilities and surplus: (i) without reinsurance, (ii) with reinsurance. Show your work.

(i) Balance Sheet as of 12/31/2010 without reinsurance

Assets

| | |
|---|---|
| $150,000 | Starting Assets |
| $1,000,000 | Revenue from tours |
| $1,150,000 | |

Liabilities

| | |
|---|---|
| $195,639 | FV of insurance liability (from a) |
| $697,116 | Reserve for operating costs |
| $892,754 | |

Surplus = Assets – Liabilities
= $257,246

(ii) Balance Sheet as of 12/31/2010 with reinsurance

Assets

| | |
|---|---|
| $150,000 | Starting Assets |
| $1,000,000 | Revenue from tours |
| ($200,000) | Paid to reinsurer |
| $950,000 | |

Liabilities

| | |
|---|---|
| $19,564 | FV of insurance liability after 90% ceded |
| $697,116 | Reserve for operating costs |
| $716,679 | |

Surplus = Assets – Liabilities
= $233,321

## 5. Continued

**Commentary on Question:**
Most students accurately began to calculate an income statement under each scenario. However, many forgot to include the expenses or revenues such as investment income, taxes, or the reinsurance payments. In addition, many students did not realize that the loss to shareholders was limited to their starting equity value. Some students also did not understand that the loss to tourists is the amount of their death claims that would go unpaid. The number of calculations necessary to complete this question also likely contributed to its difficulty.

(d) Tourist loss is defined to be uncollected death benefits. Fill in the values for the table below by computing the gain or loss for the shareholders and the tourists. Show your work.

Sum cash flows under each scenario

| | Without Reinsurance | | With Reinsurance | |
|---|---|---|---|---|
| | Normal Lions | Hungry Lions | Normal Lions | Hungry Lions |
| Tour revenue | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 |
| Payment to reinsurer | 0 | 0 | 200,000 | 200,000 |
| Claims | 100,000*1,000*0.1%= 100,000 | 100,000*1,000*0.5% =500,000 | 100,000*1,000*0.1% *10%=10,000 | 100,000*1,000*0.1% *10%=50,000 |
| Investment income | 1,150,000*5% =57,500 | 1,150,000*5% =57,500 | 950,000*5% =47,500 | 950,000*5% =47,500 |
| Operating Costs | 725,000 | 725,000 | 725,000 | 725,000 |
| EBIT (subtotal) | 232,500 | (167,500) | 112,500 | 72,500 |
| Taxes = max(0, 25%*(EBIT-25,000)) | 51,875 | 0 | 21,875 | 11,875 |
| Net income | 180,625 | (167,500) | 90,625 | 60,625 |
| Shareholder G/L= max(starting assets, NI) | 180,625 | (150,000) | 90,625 | 60,625 |
| Bankruptcy Costs | 0 | 10,000 | 0 | 0 |
| Claim pay shortfall= Shareholder G/L-NI+ bankruptcy costs | 0 | 27,500 | 0 | 0 |

## 5. Continued

**Commentary on Question:**
Most candidates understood that an expected value calculation across the scenarios calculated in part (d) was the correct approach to this question. However, very few fully described the implications of the tourists and shareholders conflict of interest.

(e) Based upon your calculations above, determine if conflict exists between the shareholders and the tourists regarding whether Safari should enter into the reinsurance agreement.

Compare expected G/L for shareholders and tourists calculated in (d) both with and without reinsurance.

Shareholders expected gain without reinsurance:

$$.75*180,625+0.25*(-150,000)=\$97,969$$

Shareholders expected gain with reinsurance:

$$0.75*90,625+0.25*60,625=\$83,125$$

Shareholders will opt not to reinsure.

Tourist expected loss with reinsurance:

$$0.75*0+0.25*27,500=\$6,875$$

Tourist expected loss with reinsurance:

$$0.75*0+0.25*0=\$0$$

Tourists can only experiences losses without the reinsurance so they will prefer if Safari reinsures. However, since it is in the incentives of the Safari shareholders not to reinsure the tourists will assume the reinsurance is foregone, and they will not be willing to pay as much for the tour.

## 5. Continued

**Commentary on Question:**
Most candidates approached this problem correctly by calculating the expected CEO utility. The only common mistake was students calculating the utility of the expected wealth rather than the expected utility. The former will not capture the implications of decreasing marginal utility on risk incentives.

(f) The CEO of Safari owns 40% of the outstanding company shares and has no other assets. She seeks to maximize her expected utility and has the following utility function: U(wealth) = wealth^1/2. Determine whether the CEO favors the reinsurance agreement. Show your work.

$$\text{CEO wealth} = 40\% \text{ of ending equity} = 40\% * (150,000 + \frac{G}{L} \text{ to shareholders})$$

$$\text{CEO utility} = \sqrt{\text{CEO Wealth}}$$

Compare CEO utility across each scenario

| | Without Reinsurance | | With Reinsurance | |
|---|---|---|---|---|
| | Normal Lions | Hungry Lions | Normal Lions | Hungry Lions |
| CEO Wealth | $330,625 | $0 | $240,625 | $210,625 |
| CEO Utility | 364 | 0 | 310 | 290 |
| Expected Utility | $.75*364+.25*0=273$ | | $.75*310+.25*290=305$ | |

Due to risk aversion, CEO will prefer to reinsure.

# Question 6

**Learning Objectives:**

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

**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.

**Sources:**

FE-C143-07: Dynamic Financial Models of Property-Casualty Insurers

**General Commentary on Question:**

This eight point focus question tested Dynamic Financial Analysis (DFA) and Dynamic Financial Models (DFM). The Cognitive Skills tested varied by subpart, but this question used more Retrieval type skills compared to other questions. Roughly one half of this question fell into the Retrieval type question, where the candidate was asked to describe various attributes of DFA and DFM. The rest of the question fell into the Analysis cognitive skill category, where the candidate was asked to apply the DFA/DFM theory to private mortgage insurance (PMI) specifically.

This proved to be a very challenging question for most of the candidates, illustrated by several candidates skipping this question entirely. Numerous candidates were able to do well on a single section, but very few did well on all sections.

## 6. Continued

There were two sources from which candidates pulled their answers. Part (b) asked for the "primary considerations" of DFM model design, identified in study note FE-C143-07. Several candidates wrote about the "Other Considerations" or listed the five components of the DFA report from the study note FE-C127-07, "Asset Liability Management for Insurers." Candidates who correctly identified the primary factors for model design received full credit; those who submitted either non-primary considerations or components of the report, received partial credit.

There were a couple of question parts where the candidate was asked to apply theory by recommending a course of action or describing how a situation should be viewed in light of the theory. There were many candidates who were able to retrieve the theory part (i), but weren't able to apply it effectively as requested part (ii). These candidates did not receive full credit unless he/she made a specific recommendation for or against a particular course of action, which shows a higher level of cognitive understanding and is an integral part of the question.

**Solution:**

**Commentary on Question:**
There were two possible definitions to use for dynamic financial analysis; nearly all candidates used the definition from the study note FE-C127-07. Candidates did very well on the definition but struggled with the key points in part (ii).

(a) For insurance applications:

(i) Describe Dynamic Financial Analysis

DFA is the process of assessing the entire financial condition of the company over time, taking into account interrelationships between the risk factors & the dynamic nature of risks.

(ii) Describe how using a DFM may help you accomplish your objective.

- Illustrates link between strategies and results.
- Reflects the interplay of assets and liabilities and the resultant risks to income and cash flows.
- Models help identify problems early.
- Models distinguish between short and long term problems.

## 6. Continued

**Commentary on Question:**
Part (b) was by far where candidates performed the best. As described above, candidates mixed the considerations between two sources. Candidates who listed the four primary considerations of model design received full credit; alternate answers regarding non-primary considerations and/or components of the report received only partial credit. Candidates who based their answers on FE-C127-07 typically performed worse on part (ii) as well.

(b) Regarding DFM design:

(i) Describe the 4 primary DFM model design considerations;

Stochastic vs. Deterministic
- Important to model variable interaction
- If certain variables exhibit random behavior, incorporate the stochastic features in the model

Time Horizon
- The length of modeling period critical for existing business runoff and new business
- The time intervals are important

Feedback Loops / Adapting to Change
- Reflects automatic decisions already built into the model

Relationship with external environment
- Constraints are rating agencies and regulations

(ii) For each, recommend & justify approach to modeling PMI

Stochastic vs. Deterministic
- Defaults are a function of unemployment
- Location parameters are integral to the default assumption
- Recommend using stochastic scenarios because the future is uncertain

Time Horizon
- 95% of PMI policies closed in 10 years so I would recommend 10 years for existing business
- May consider additional 5 years for new business

Feedback Loops / Adapting to Change
- May need to change the premium rates in the future if Harbourside has poor experience

## 6. Continued

Relationship with external environment

- Constraint - Harbourside invested in Treasuries and high grade corporate bonds

**Commentary on Question:**
Overall, candidates performed worst on part (c). Most candidates did fairly well acknowledging that the model or assumptions may be wrong, but they weren't able to talk about scenarios, defaults, unemployment or model change. The stem of the question was intended to provide sufficient information for candidates to recognize what was being asked of them here. Generally, candidates who performed poorly on parts (a) and (b) also performed poorly on part (c).

(c)

(i) Describe three potential modeling dangers/pitfalls for Dynamic Financial Analysis.

1. The range of scenarios may not reflect the user's intent of the model.
   - Scenarios link model parameters to the assumptions.
   - May need to stress test additional scenarios.
   - Scenarios determined by management or regulators.

2. The model may be incomplete or incorrectly specified for its intended purpose.
   - Validate the model to actual historical results.
   - Reconcile the differences between the model and actuals.
   - A good model will reproduce the historical actuals.

3. The model may become obsolete if it's not adaptable to change.
   - New insurance products or new regulatory / tax laws are examples of change.

(ii) For each of these, describe the implication for modeling Harbourside's PMI business.

1. Harbourside's model purpose is for internal reasons.
   - Need to understand the potential PMI earnings in the future due to uncertainty.
   - Recent mortgage meltdown after 2007 was not captured by scenarios.

## 6. Continued

2. Unemployment must be tied to the economic scenarios.
   - Were default rates predicted well based on mortgages, unemployment, and location?
   - Are mortgage refinancing and prepayments reasonable with historical experience?
   - The model may need to be adjusted as experience emerges.

3. Harbourside's model purpose is for internal reasons.
   - Need to understand the potential PMI earnings in the future.

# Question 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:**

Crouhy Ch. 2, The New Regulatory and Corporate Environment

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.

**General Commentary on Question:**

This eight 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 four scenarios of risk management practices. When assessing the scenarios, candidates should have noted the deficiency in each one and apply and briefly discuss the applicable principles. Thus, the Cognitive Skills tested were mixed between Comprehension and Analysis.

Performance on this question was poor, perhaps because of poor time management or fatigue, as this was the last question in the morning session. Many candidates did not match the principles to the frameworks as the question asked. Additional credit was given if the candidate recommended corrections to the deficiencies.

**Solution:**

(i) Scenario 1: The Board meets once every 12 months.

The deficiency is the infrequency of Board meetings; the Board should meet more frequently.

(a) COSO - Principle 7 : information and communication

- Relevant information is identified, captured and communicated in a form and timeframe that enable people to carry out their responsibilities

## 7. Continued

(b) Basle (II) - Principle 1 : Board of Directors' responsibilities
- Should be informed regularly of the risk exposure
- Understand and assess the performance of senior management regularly
- Periodically re-evaluate IRRM strategies and policies

(c) OSFI –
- Review and approve policies and procedures for the institution's major activities
- Review and approve strategic and business plans

(ii) Scenario 2: Summary reports (including supporting detail) are compiled quarterly and presented to the CIO.

The deficiency is that the reports are only reviewed by the CIO; the reports should be reviewed by all senior management, especially the Chief Risk Officer (CRO).

(a) Basle (II) - Principle 2 : Senior management's responsibilities
- Aggregate information as well as sufficient supporting detail should be reviewed regularly by senior management
- Manage the structure of the business and the level of risk
- Ensure that resources/expertise are available for evaluating and controlling risk

(b) OSFI - Report the results of risk monitoring to management

(c) COSO - Principle 7 : information and communication
- Relevant information is identified, captured, and communicated in a form and timeframe that enable people to carry out their responsibilities
- Risks are analyzed, considering likelihood and impact, as a basis for determining how they should be managed

(iii) Scenario 3: The Board defines appropriate limits on risk taking for a large multiline insurance company.

The deficiency here is that the Board should not be defining the risk limits for the company; senior management should *define* the limits, and the Board should *approve* the limits.

(a) Basle (II) - Principle 1 : Board of Directors' responsibilities
- Approve risk management strategies and policies
- Ensure that senior management monitors and controls these risks

## 7. Continued

(b) Basle (II) - Principle 2 : Senior management's responsibilities
- Establish appropriate policies and procedures to control and limit these risks
- Manage the structure of the business and the level of risk

(c) OSFI –
- Review and approve organizational and procedural controls
- Review and approve policies and procedures for the institution's major activities

(d) G-30 – Principle 1: The role of senior management
- Ensure risk controlled consistent with the risk management and capital policies

(iv) Scenario 4: A bank measures its credit risk on the largest 90% of its derivative holdings, and ignores netting arrangements.

There are two deficiencies in this scenario: the bank should use all derivative holdings when measuring its credit risk and should recognize netting arrangements.

(a) G-30 - 10. Measuring credit exposure
- For each derivative transaction based on both current and potential credit exposure

(b) G-30 - 11. Aggregating credit exposures
- All credit exposures to a counterparty, should be aggregated, taking into consideration enforceable netting arrangements

(c) COSO – Principle 4 : risk assessment
- Risks analyzed, considering likelihood and impact, as a basis for determining how they should be managed

(d) OSFI – Principle 2
- Exercise of sound judgment in identifying and evaluating risks is central to the effectiveness of the framework

(e) Basle (II) - Principle 6 : risk measurement systems
- Capture all material sources of risk
- Basle (II) also notes that netting arrangements should be recognized

# Question 8

**Learning Objectives:**

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

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:**

(1b) Identify & analyze insurance risks faced by an entity, including but not limited to: mortality, morbidity, catastrophe and product risks and embedded options.

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

**Sources:**

FE-C124-07: Performance Measurement Using Transfer Pricing, by M. Wallace

FE-C151-08: Atkinson 13.1 - 13.4, Annuity and Investment Products

**General Commentary on Question:**

This 10 point integrated question tested the candidate's ability to apply the Transfer Pricing concept to a practical situation involving a Single Premium Deferred Annuity (SPDA) block.

The Cognitive Skills tested varied across question subparts. The one point part (a) question was mostly a Retrieval type of question, where the student was asked for a list describing benefits of Transfer Pricing. The four point Part (b) was a mix of Comprehension and Analysis type questions, whereby the candidate was asked to perform a Transfer Pricing analysis on the SPDA block. The five point part (c) was an Analysis type question, whereby the candidate was asked to assess the impact on Transfer Pricing results of five separate scenarios involving the SPDA block.

**Solution:**

**Commentary on Question:**

Candidates did fairly well on this part of the question. Some students mentioned bonuses and compensation.

(a) List 5 benefits of Transfer Pricing for performance measurement and attribution.

- Improved measurement of product profitability which can lead to improved pricing

## 8. Continued

- Improved measurement asset portfolio performance on a risk adjusted basis leading to better investment decisions
- Provides viable investment alternative when returns on actual assets don't match benchmark performance over time
- Permits separate measurement of residual A/L mismatch impact
- Allows for improved risk management

**Commentary on Question:**
Candidates did well on part (i) but were weak on interpreting and stating implications of the results. Students did not pick up on the opportunity to improve ALM and credit results by adding duration and/or spread.

(b)

(i) Use Transfer Pricing to allocate income for the SPDA across I, II and III.

Total Income = Product Income + ALM Income + Credit & Security Selection Income

Product Income = Benchmark #1 - Payment on Liabilities

Income from Interest Rate Risk = Benchmark #2 - Benchmark #1
= ALM income
Income from Credit Risk & Security Selection = Inv Income - Benchmark #2

Income Benchmark #1 = Benchmark #1 rate x Reserves
= 5% x 100 million = 5 million

Income Benchmark #2 = Benchmark #2 rate x Reserves
= 6% x 100 million = 6 million

Income from Credit Risk and Security Selection
= 7 million – 6 million = 1 million

Income from Interest Rate Risk = 6 mil – 5 mil = 1 mil

Product Income = Total income – ALM income – Credit & Security Selection Income
= 1.95 mil – 1 mil – 1 mil = -0.05 mil

## 8. Continued

Alternative Calculation:
Payment on Liabilities = Investment Income - Pre-Tax Income
= 7 million – 1.95 million = 5.05 million

Product Income = 5 million – 5.05 million = -0.05 million

(ii) Identify the conclusions that can be drawn about sources of profit.

- The predominant source of SPDA profit comes from the asset side (2M vs. 50K)
- SPDA is predominantly a spread product, thus the asset side is very important
- ALM Income may come from longer assets than liabilities or higher actual asset portfolio convexity than that of the benchmark
- Income from Credit Risk/Security may come from portfolio assets with credit spreads larger than the benchmark's
- Product Income mostly drives off of crediting rate strategy and expense management

**Commentary on Question:**
The key to part (c) is to analyze the impact on the benchmarks and the resulting effect on the three transfer pricing measures. Candidate responses seemed to focus on risk instead of profit. For instance, many said things like "Interest Rate Risk increased," which doesn't answer the question. They should have said whether the Income from Interest Rate Risk increased, and they should have described how the change in Benchmarks caused the income to increase.

(c) Olympic is considering each of the following independent actions analyze the transfer pricing implications.

**Commentary on Question:**
Candidates were able to identify the increased return volatility and Credit risk / security selection income for Olympic, but had a harder time with the ALM and product income.

I. Non-investment grade securities

- BENCHMARK #2 will increase to include non-investment grade bonds which have higher risk.

## 8. Continued

- Non-investment grade securities will have lower default rates in "good credit" years, so will provide enhanced returns relative to investment grade bonds.

- Benchmark 1 is not affected.

- Income for total SPDA and Credit Risk/Selection are expected to increase in "good credit" years, decrease in "poor credit' years with the riskier assets.

- Income from Interest Rate Risk should increase since BENCHMARK #2 is increasing.

- Product Income is not affected since Liability Payments and BENCHMARK #1 are not changing.

**Commentary on Question:**
Candidates were able to identify the decreased return volatility and Credit / security selection income for Olympic, but had a harder time with the ALM and product income.

II. Hedging interest rate risks

- BENCHMARK #2 will probably decrease due to hedging cost.

- BENCHMARK #1 doesn't change.

- Income for total SPDA and Credit/Selection is expected to decrease in non-severe interest environment years due to net hedge cost and remain somewhat flat for severe years due to hedge payoffs.

- During harsh economic environments, hedging will also help meet Min Guarantee Crediting Rate.

- Product Income is not affected since Liability Payments and BENCHMARK #1 are not changing.

- Income due to Interest Rate Risk will decrease since BENCHMARK #2 has decreased.

## 8. Continued

**Commentary on Question:**
Candidates often confused decrease in credit spreads due to asset selection with increasing crediting rate.

III. Increasing the Crediting Rate which lowers credit spread

- Higher crediting rate means, higher reserves, higher benefits paid out and probably increased persistency, potentially acting as an offset to benefit earnings.

- Total SPDA income and Product Income - it is unclear whether the increased investment income from better persistency will overcome the resultant increased reserves.

- Higher persistency translates into a longer duration for the liabilities resulting in BENCHMARK #1 change (and will probably be increased assuming a positive yield curve), to maintain equality in sensitivity to interest rate changes.

- BENCHMARK #2 should remain unchanged.

- Income rate due to Interest Rate Risk should decrease since BENCHMARK #1 is increasing.

- Income due to Credit Risk/Selection should increase since better persistency means more assets invested.

**Commentary on Question:**
Candidates most often picked up on the change in persistency; however they did not translate that into a change in Benchmark #1.

IV. Layoffs and Increased Efficiency

- Expenses are reduced and total SPDA income increases. However benchmarks do not change.

- Product Income increases since expense in Liability Payments will decrease.

- Income due to Interest Rate Risk should not change because benchmarks are not changing.

- Income due to credit risk/selection should not change since investment income and BENCHMARK #2 will not change.

## 8. Continued

**Commentary on Question:**
Candidates mostly did well on the initial impact on decreased expenses and increased income. Unfortunately some thought the improvements needed to be allocated.

V. Reduce Surrender Charge period for New Business

- Total SPDA income will probably decrease due to decreased persistency, which means smaller asset base and will probably reduce duration of liabilities.

- BENCHMARK #1 will need to be adjusted to assets with lower duration to match liabilities. It probably will decrease, assuming positively sloped yield curve.

- BENCHMARK #2 won't change.

- Product Income will decrease due to BENCHMARK #1 decrease.

- Income due to Interest Rate Risk will probably increase due to BENCHMARK #1 decrease.

- Income due to Credit Risk/Selection may decrease due to lower persistency.

# Question 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.

**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.

(1d) Identify and analyze strategic risks faced by an entity including but not limited to:

- Product sustainability risk
- Distribution sustainability risk
- Consumer preferences and demographics
- Geopolitical risk
- Competitor risk
- External relations risk
- Legislative/Regulatory risk
- Reputation risk
- Sovereign risk

(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.

## 9. Continued

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

FE-C164-09: CSFB Credit Portfolio Modeling Handbook
Ch. 2, "The Default/No-Default World and Factor Models"
Ch. 4 "Demystifying copulas"

FE-C160-09: "Moody's Looks at Terrorism Risk in the U. S. Life Insurance Industry," February 2006.

**General Commentary on Question:**
Question 9 was a 17 point integrated question that challenged students to apply the 1-factor Gaussian copula to terrorist events instead of bond credit losses as was illustrated in source FE-C164-09. In addition, underwriting criteria and methods from source FE-C169-09 were tested. Lastly, details on the Terrorism Study Note FE-C160-09 were highlighted.

The cognitive skills tested varied from part to part. Approximately three points were attributed to Retrieval type questions (parts (a), (b) and (c)). Roughly three points were attributed to Knowledge Utilization type questions, whereby candidates were required to suggest latent variables for use in the Gaussian copula model (part (e)) and were required to recommend actions to take to manage specified risks (part (f)). The rest of the exam points were spread between Comprehension and Analysis type questions, whereby the candidates were expected to calculate Value at Risk (VaR) losses for specified risks and model. In addition to this, the candidate had to understand and apply the attributes of this model in part (e).

Although students often didn't make it all the way through the 1-factor Gaussian copula, many made it partially through. Common errors included not knowing V, not calculating the denominator correctly or forgetting to weight the results by the exposure.

In parts (a) and (b), the most common error included discussing different pricing assumptions rather than underwriting methods and criteria.

In general, students performed well on parts (c) and (f).

## 9. Continued

**Solution:**

(a) Contrast underwriting for group term contracts with typical individual life underwriting.

- When selling to large groups of insureds, especially employee groups, it is common to use a streamlined approach to underwriting.
- Group contracts can be either guarantee issue or simplified issue.
- There is a reduced opportunity for anti-selection in group context as compared to individual insurance.
- Guaranteed Issue underwriting has less rigorous underwriting requirements, but COI is higher.
- Simplified Issue similar to Guaranteed Issue but includes some medical questions.

(b) Propose underwriting criteria that Wigan should use when issuing group term contracts.

- Death benefit should be multiple of salary or an objective formula.
- Minimum hours worked per week to be eligible for coverage.
- Require minimum number of employees to elect coverage.
- New employees eligible upon hire will require full underwriting if initially decline coverage and seek coverage later.
- Major issues can be more fully underwritten, minor issues usually passed on.
- Choose simplified issue with a short questionnaire.
- Require a period with no medical leave or absences.

## 9. Continued

(c) Identify seven factors that would affect the lapse rate assumption for Wigan's individual UL policies.

For each of these factors, explain whether and how it would apply for the Wigan group term contracts.

- Manner in which policy is sold
  - Higher lapse will characterize individuals who were pressured to buy.
  - Since the group clients have expressed interest (i.e. not pressured by Wigan), lapse is less likely.

- Perceived Value
  - If customer perceives policy to be a "good deal", lapse rate will tend to be low.
  - This is the same for individual and group business.

- Degree of Understanding
  - Individual policy persistency improves when benefits of policy are understood.
  - For a group product, the decision to purchase will be made by HR or executives i.e. the decision makers are well-equipped to make informed decision.

- Ability to pay
  - Corporate clients who are financially distressed will pose higher lapse risk.
  - However, as premium is paid in full at BOY, not an issue, employer pays the premium.

- Distribution/agent attitude
  - Individual policy persistency affected by agent "churning" or commission structures (chargebacks, level versus heaped).
  - Not an issue for group term as premium is non-refundable; employer decision to lapse/switch carriers is a big undertaking.

- Customer commitment
  - For an individual, if the policy is part of a financial plan or broader objectives, persistency is increased.
  - Same is true for group term, if benefit is offered as part of a well thought out benefits package, it will likely be maintained.

## 9. Continued

- Ease of premium payments
  - For individuals, automatic payment options increase persistency.
  - Not as relevant here as premium is annual, corporate function and paid in full beginning of year.

Evaluate the relative importance of the lapse assumption of Wigan's individual UL policies compared to the group term contracts.

- Lapse Rates are very important for individual life.
- Lapse Rates are not important for this group term product.
- For individual, lapse rates determine the period and policies over which expenses are spread.
- For individual, lapse rates reflect customer satisfaction/company reputation.
- For group, there aren't large upfront costs that need to be recouped.

(d) Calculate the 97.5% VAR loss for terrorism-related losses for this portfolio of group term contracts using a one factor Gaussian copula model.

$$P(Z < \zeta \,|V) = \Phi[\zeta - \alpha V) / SQRT(1-\alpha^2)]$$

| Client Name | Location | Employee Count | Total Exposure | Prob of loss | Inverse Normal | Alpha | Alpha x V |
|---|---|---|---|---|---|---|---|
| Walcott | Capital City | 400 | 450 | 0.01% | -3.72 | 0.5 | 0.5 x (1.96) |
| Denilson | Beaverton | 120 | 400 | 0.005% | -3.89 | 0.2 | 0.2 x (1.96) |
| Hamsik | Capital City | 200 | 300 | 0.01% | -3.72 | 0.5 | 0.5 x (1.96) |
| Lavezzi | Capital City | 150 | 275 | 0.01% | -3.72 | 0.5 | 0.5 x (1.96) |
| Inter | Ruviano | 50 | 270 | 0.005% | -3.89 | 0.2 | 0.2 x (1.96) |

## 9. Continued

| Client Name | Numerator (inverse N - $\alpha$V) | Denominator $(1-\alpha^2)^{.5}$ | x = Num / Denom | Phi (x) (nearest value) | Weighted by Exposure |
|---|---|---|---|---|---|
| Walcott | (2.74) | 0.866 | (3.164) | 0.068% | 0.306 |
| Denilson | (3.50) | 0.980 | (3.570) | 0.010% | 0.040 |
| Hamsik | (2.74) | 0.866 | (3.164) | 0.068% | 0.204 |
| Lavezzi | (2.74) | 0.866 | (3.164) | 0.068% | 0.187 |
| Inter | (3.50) | 0.980 | (3.570) | 0.010% | 0.027 |

Sum of Phi ($x$) weighted by exposure = 0.764 million

(e) Explain what the $\alpha$ values imply about the underlying risk of loss.

- The high alpha value for Capital City locations suggests a high correlation between potential terrorist events in this city and the common factor V.
- Capital City is more likely to be the center of a terrorist event if in fact there is an event.
- The low alpha values for cities outside of Capital City indicate less correlation between potential terrorist events in these locations and common factor V.

Justify your decision to not use the Archimedian copula model.

- Archimedian copula is characterized by latent variable defining correlation / distribution.
- Cannot have any two exposures more or less correlated than any other two exposures.
- This seems inappropriate for Wigan given the relationship between geographical location and terror risk.
- Can be difficult to use (with more latent variables).

Describe the advantages and disadvantages of using a student-t copula.

- T copula has stochastic volatility unlike Gaussian, which has static volatility (advantage) - works well for modeling assets.
- This is helpful in modeling financial events which has "bursty" behaviour (high and low periods of volatility).

## 9. Continued

- T copula exhibits tail dependence (advantage).
- Benefits offset by increased complexity.

Suggest two potential latent variables.

- Homeland security threat level
- Premiums for stand-alone terror coverage

Both of these describe the state of the world relating to potential for terror events.

(f) Recommend actions that Wigan can undertake to manage the exposure to potential catastrophic losses on its group term portfolio due to terrorist acts.

- Collect exposure data to allow for monitoring and assessment of risk
- Define concentration limits
- Map larger exposures by geographic region
- Manage exposure through highly rated counterparties
- Greater use of mortality reinsurance
- Enforce lower limits on group policies

# Question 10

**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) Explain the challenges and limits of economic capital calculations and explain how economic capital may differ from external requirements of rating agencies and regulators.

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

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

**Sources:**

Crouhy, Galai, & Mark, *Risk Management*, 2001, Ch. 5, "Measuring Market Risk: The VaR Approach

Crouhy, Galai, & Mark, *Risk Management*, 2001, Ch. 6, "Measuring Market Risk: Extensions of the VaR Approach and Testing the Models

**General Commentary on Question:**

This question was valued at 12 exam points and tested the candidates' knowledge of market risk and their ability to apply such risk metrics as Value at Risk (VaR) and Incremental VaR (IVaR) to assess this risk.

This question tested a variety of cognitive skill levels. Four points were mixed between the Retrieval and Comprehension varieties (parts (a) and (c)). These parts had the candidate identify and describe the applicable market risks for the given portfolio and explain how different VaR methods result in different results. Another exam point was of the Knowledge Utilization category in that the candidate was asked to make a recommendation part (d). The rest of the marks were mixed between Comprehension and Analysis in that the candidate was requested to calculate VaR and IVaR using given information in the stem.

## 10. Continued

**Solution:**

**Commentary on Question:**
Students who scored well on this section described (not just listed) each source of market risk and identified which stocks in the portfolio contributed to each type of market risk.

The four types of market risk are listed in the model solution in the order of student performance (best to worst).

(a) Identify and describe four major sources of market risk associated with this portfolio.

Market Risk - Risk that changes in financial market prices and rates will reduce the value of a security or a portfolio.

Types of Market Risk

- Interest Rate Risk: Risk the value of a fixed-income security will fall as a result of a change in market interest rates. (EMB)

- Commodity Price Risk: Generic and specific components. The concentration of supply can magnify price volatility and fluctuations in market liquidity often exacerbate price volatility. (GSG)

- Foreign Exchange Risk: Includes imperfect correlations in the movement of currency prices and fluctuations in international interest rates. (EMB, VNQ)

- Equity Price Risk: Includes sensitivity to changes in the level of broad stock market indices & volatility that is firm specific. (All)

**Commentary on Question:**
It was very evident which students knew how to calculate VaR using the variance-covariance method. Many students failed to understand the relationship between the generic VaR formula (see (b)(ii) below) and the variance-covariance method VaR calculation. Students who did not successfully apply the variance-covariance method but identified the correct confidence level and displayed knowledge of how to convert 1-day VaR to 10-day VaR received partial credit.

## 10. Continued

(b)

(i) Using the variance-covariance method calculate the 10 day VAR of the portfolio at a 99% confidence level.

Monthly Projections

| 1Ω1* | Per Stock Weight (w) | Variance ($1\Omega1 * w^2$) |
|---|---|---|
| 0.0027 | 1/3 | 0.0300% |

*1Ω1 denotes the sum of the elements in the variance covariance matrix

$$VaR_V(10;99) = \sqrt{10} VaR_V(1;99) = 2.33\ \sqrt{10}\ \sigma_V V$$

| 99% Confidence | 10 Day^.5 | Standard Deviation | Portfolio Value | VaR |
|---|---|---|---|---|
| 2.33 | 3.16 | 1.73% | 1,000,000,000 | $127,468,250 |

Yearly Projections

| 1Ω1 | Per Stock Weight (w) | Variance ($1\Omega1 * w^2$) |
|---|---|---|
| 0.0115 | 1/3 | 0.1278% |

$$VaR_V(10;99) = \sqrt{10} VaR_V(1;99) = 2.33\ \sqrt{10}\ \sigma_V V$$

| 99% Confidence | 10 Day^.5 | Standard Deviation | Portfolio Value | VaR |
|---|---|---|---|---|
| 2.33 | 3.16 | 3.57% | 1,000,000,000 | $263,041,418 |

**Commentary on Question:**
The question stem provided the necessary components to calculate VaR using the historical simulation method by applying the generic VaR formula. The most common mistakes students made were to calculate the Absolute VaR (worst case loss at the 99 percent confidence interval) or use the historical standard deviation (provided in the stem, but not used for the historical simulation method).

(ii) Using the historical simulation method calculate the 10 day VAR of the portfolio at a 99% confidence level.

| Mean | 1%tile | Mean-1%tile | Portfolio Value | 1 Day VaR | 10 Day^.5 | VaR |
|---|---|---|---|---|---|---|
| -0.12% | -10.65% | 10.53% | 1,000,000,000 | 105,300,000 | 3.16 | $332,987,838 |

*VaR* = Expected profit/loss
Worst case loss at the 99 percent confidence level

## 10. Continued

**Commentary on Question:**
Top performing students outlined key differences between the variance-covariance method and the historical simulation method.

(c) Explain why the VaR amounts computed above differ.

Variance – Covariance

- Parametric VaR - Assume returns have an analytic density function. Projection data is used to estimate the parameters of the assumed distribution function.
- Does not cope well with "fat tail" distributions - actual data appears to have extreme outcomes / cover period of high volatility.
- Difference due to variance in experience over different time periods (one month, one year and 200 trading days).

Historical Simulation

- Non-parametric VaR - Derived from a distribution that is constructed using historical data.
- Short data set may lead to biased and imprecise estimation of VaR.
- Complete dependence on a particular historical data set.
- Fat tails and other extreme events are captured as long as they are in the data set.

## 10. Continued

**Commentary on Question:**
Students performed very poorly on this section. Typically, students recommended an amount of capital but failed to identify key considerations. Unsupported recommendations received little to no credit.

(d) Recommend the amount of capital to be held by Banaca Napoli and identify the considerations taken in arriving at your recommendations.

Traditional Method (10 day VaR computed using the variance-covariance method at a 99% confidence interval based on the yearly projection information)

| Variance – Covariance | | 2010 / 200x |
|---|---|---|
| 2007 | $57,700,000 | 456% |
| 2008 | $76,600,000 | 343% |
| 2009 | $67,600,000 | 389% |
| 2010 | $263,041,418 | |

Non-Traditional Methods

| | |
|---|---|
| Monthly Projections | $127,468,250 |
| Historical Simulations | $332,987,838 |

Recommendation:

- The traditional method and the historical simulation method are both indicative of stress scenarios.

- When using monthly projections (based on historical data) in the traditional method, calculated VaR is less indicative of a stress scenario.

- Hold capital half way in between the traditional method using monthly projections and annual projections.

## 10. Continued

**Commentary on Question:**
A majority of students knew the IVaR formula, but did not know how to calculate VaR using the variance-covariance method.

(e) Determine which stock to remove using 10-day IVaR at a 99% confidence level.

Yearly Projections

| | 1Ω1* | Per Stock Weight (w) | Variance ($1\Omega1 * w^2$) |
|---|---|---|---|
| Remove GSG | 0.0079 | 1/2 | 0.1975% |
| Remove VNQ | 0.0046 | 1/2 | 0.1150% |
| Remove EMB | 0.0043 | 1/2 | 0.1075% |

*1Ω1 denotes the sum of the elements in the variance covariance matrix

$$VaR_V(10;99) = \sqrt{10} VaR_V(1;99) = 2.33\ \sqrt{10}\ \sigma_V V$$

| | 99% Confidence | 10 Day^.5 | Standard Deviation | Portfolio Value | VaR (with) | VaR (without) | IVAR |
|---|---|---|---|---|---|---|---|
| Remove GSG | 2.33 | 3.16 | 4.44% | 1 Billion | $263,041,418 | $327,143,948 | $64,102,530 |
| Remove VNQ | 2.33 | 3.16 | 3.39% | 1Billion | $263,041,418 | $249,778,826 | $13,262,593 |
| Remove EMB | 2.33 | 3.16 | 3.28% | 1 Billion | $263,041,418 | $241,673,908 | $21,367,510 |

Decision: Remove EMB
Note that Incremental VaR (IVaR) = VaR With the position less VaR without position

# Question 11

**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.

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:**

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

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

**Sources:**

Application of Coherent Risk Measures to Capital Requirements in Insurance, Artzner, NAAJ, Vol 3, No 2

Hardy, *Investment Guarantees*, 2003 -- Ch. 9, Risk Measures

**General Commentary on Question:**

This 11 point integrated question tested for recognition and understanding of various axioms related to risk measures and the ability to explain the meaning of these axioms. The question tested the ability to apply the axioms to a given risk measure by mathematically demonstrating whether the given risk measure met each of the axioms. In addition, the question also tested the concept of coherence as it relates to risk measures, by requiring the candidate to apply the coherence concept to a specified risk measure.

The Cognitive Skills tested were a mix between Comprehension and Analysis. Parts (a) and (b) were worth five points together and were mostly Comprehension type questions, whereby the candidate was asked to identify and explain the listed axioms. The one point Part (d) was also a Comprehension type question, in that the candidate mostly needed to know the definition of Coherence to get much of the credit. The five point Part (c) fell into the Analysis category, whereby the candidate had to mathematically apply the axioms to a specified risk measure.

In general, candidates did quite well on this question. Candidates demonstrated a strong understanding of the Translation Invariance, Positive Homogeneity, Monotonicity and Subadditivity Axioms; most candidates were able to give good explanations of the meanings of these axioms and were able to apply these axioms to the given risk measure. The Relevance and Conservatism Axioms were not as well understood by some of the candidates, as many struggled to explain and apply these axioms.

## 11. Continued

The Hardy source uses a slightly different framework for risk measures than does the Artzner source, resulting in some of the axioms being stated in a slightly different manner; Hardy also has a slightly different definition of coherence. Full credit was awarded for answers referencing either source. Where applicable, solutions from both perspectives are included.

**Solution:**

**Commentary on Question:**
In general, candidates did well on this part and were able to distinguish the various axioms.

(a) The following mathematical axioms have been proposed in relation to a risk measure $\rho(X)$, where X represents a loss random variable, and $\alpha$ and $\lambda$ represent real numbers.

(A) $\rho(X) = \rho(\max(X,0))$

(B) $\rho(\lambda X) = \lambda\rho(X)$, for $\lambda \geq 0$

(C) $\rho(X_1 + X_2) \leq \rho(X_1) + \rho(X_2)$

(D) If $\Pr[X > 0] \neq 0$, then $\rho(X) > 0$

(E) $\rho(X + \alpha) = \rho(X) + \alpha$

(F) If $X_1$ is always $\leq X_2$, then $\rho(X_1) \leq \rho(X_2)$

Associate each axiom (i) through (vi) below with the appropriate mathematical expression (A) through (F) above.

(i) Translation Invariance Axiom

(ii) Positive Homogeneity Axiom

(iii) Monotonicity Axiom

(iv) Relevance Axiom

(v) Conservatism Axiom

(vi) Subadditivity Axiom

## 11. Continued

(i) E
(ii) B
(iii) F
(iv) D
(v) A
(vi) C

**Commentary on Question:**
While most candidates understood the meaning of the Translation Invariance, Positive Homogeneity, Monotonicity and Subadditivity Axioms, some candidates struggled to explain these axioms clearly in the context of a risk measure (i.e., some candidates simply put the mathematical expressions into words without explicitly mentioning the meaning of the variables and quantities in the expressions). The Relevance and Conservatism Axioms were the most frequently misunderstood axioms. Some candidates explained Relevance as pertaining to a situation where a loss random variable *always* showed a loss (as opposed to *ever* showing a loss). Many candidates misinterpreted the Conservatism Axiom as flooring the risk measure at 0, rather than flooring the argument to the risk measure at 0. Also, some candidates confused the Conservatism Axiom with the idea that the risk measure should be bounded above by the maximum loss.

(b) Explain briefly in words the meaning of each of the axioms above, in the context of a risk measure used to determine capital adequacy.

Translation Invariance Axiom: This axiom means that adding a known certain (fixed) amount of loss $\alpha$ to a loss random variable $X$ increases the risk by exactly that amount. (Or equivalently, adding a fixed cash position $\alpha$ to the position $X$ reduces the amount of capital needed by $\alpha$.)

Positive Homogeneity Axiom: This axiom means that scaling the loss random variable $X$ by a fixed multiple $\lambda$ scales the risk proportionately. (Equivalently, scaling the position $X$ by a fixed multiple $\lambda$ scales the capital required proportionately.) One implication/interpretation of this is that the units we use should not affect the total risk measure -- e.g., moving from measuring in $ to measuring in $000s. It also implies that we can neither create nor eliminate risk by combining/dividing risks that are perfectly correlated.

Monotonicity Axiom: Under this axiom we require that if one loss is always greater than another -- i.e., in any state of the world -- then that ordering should be reflected in the ordering of their respective risk measures. (Equivalently, if in all cases, a position $X$ is greater than a position $Y$, then $X$ is ``less risky", i.e., should have a lower value for the risk measure than $Y$.)

## 11. Continued

Relevance Axiom: Under this axiom we require that any possibility of a loss (or negative outcome) should be reflected in a positive risk measure, even if the bulk of the distribution lies on the profit side.

Conservatism Axiom: Under this axiom we require that profits (i.e., positive outcomes) should not be taken into consideration in measuring risk, only losses (negative outcomes).

Subadditivity Axiom: Under this axiom we require that combining risks does not increase the overall measure of total risk; it will not be less risky to treat any two risks separately than it is to treat them together, and potentially benefit from diversification. Combining multiple risks could possibly decrease (but could not increase) their combined risk. Likewise, we cannot decrease overall risk by dividing a risk among, say, subsidiaries of the same corporation.

**Commentary on Question:**
In general, candidates did very well with the demonstration of the Translation Invariance and Positive Homogeneity Axioms. The proofs of these axioms relied on basic properties of the expectation and standard deviation operators. Most candidates were also able to demonstrate the Subadditivity Axiom and the (failure of the) Monotonicity Axiom, at least in principle. The Subadditivity Axiom required reasoning about the standard deviation of a sum of two random variables, whereas the Monotonicity Axiom required construction of a counterexample, or the ability to explain why this property fails for the given risk measure. Many candidates struggled with the Relevance and Conservatism axioms, neither of which were met by the given risk measure.

(iii) Determine whether each of the axioms above is satisfied by the standard deviation principle: $\rho(X) = \mathrm{E}[X] + \beta\sigma[X], \beta > 0$

Translation Invariance: This property does indeed hold for this risk measure, so we want to show that $\rho(X+\alpha) = \rho(X) + \alpha$ .

$$\begin{aligned}\rho(X+\alpha) &= \mathrm{E}[X+\alpha] + \beta\alpha[X+\alpha] \\ &= \mathrm{E}[X] + \alpha + \beta\alpha[X] \\ &= \mathrm{E}[X] + \beta\alpha[X] + \alpha \\ &= \rho(X) + \alpha,\end{aligned}$$

so this property does indeed hold.

## 11. Continued

Positive Homogeneity: This property does indeed hold for this risk measure, so we want to show that $\rho(\lambda X) = \lambda\rho(X),$ for $\lambda \geq 0.$

$$\begin{aligned}
&\rho(\lambda X) = \mathrm{E}[\lambda X] + \beta\alpha[\lambda X] \\
&= \lambda\mathrm{E}[X] + \beta\lambda\alpha[X] \\
&= \lambda(\mathrm{E}[X] + \beta\alpha) \\
&= \lambda\rho(X),
\end{aligned}$$

so this property does indeed hold for any $\lambda \geq 0.$

Monotonicity: This property DOES NOT hold for the standard deviation risk measure given. Consider the following counterexample:

Let $X_1 = \{5, 9\}$ each with probability ½ and let $X_2 \equiv 10.$
Note that $X_1$ is always $\leq X_2$. Then $\rho(X_2) = \mathrm{E}[X_2] + \beta\sigma[X_2] = 10 + \beta \bullet 0 = 10$ and $\rho(X_1) = \mathrm{E}[X_1] + \beta\sigma[X_1] = 7 + \beta\alpha[X_1].$ Since $\sigma[X_1] > 0$, then for a sufficiently large value of $\beta$, we will have $\beta\sigma[X_1] > 3$ so that $\rho(X_1) = 7 + \beta\sigma[X_1] > 10.$ Thus, this property does not hold.

Relevance: This property DOES NOT hold for this risk measure. Consider the following counterexample:

Let $X = \{-9, 1\}$ each with probability ½. Then $\Pr[X > 0] \neq 0.$ $\mathrm{E}[X] = -4$, and $\sigma[X] > 0$, so for some sufficiently small $\beta$, we will have $\rho(X) < 0.$ Thus, this property does not hold.

Conservatism: This property DOES NOT hold for this risk measure. Consider the following counterexample:

If $X$ is any loss random variable that takes both positive and negative values with positive probabilities, then $\mathrm{E}[\max(X, 0)] > \mathrm{E}[X]$, whereas $\sigma(X, 0) < \sigma(X)$, so that there exists some positive value of $\beta$ which makes $\rho(X) \neq \rho(\max(X, 0))$. Thus, this property does not hold.

## 11. Continued

Subadditivity: This property does indeed hold for this risk measure, so we want to show that $\rho(X_1 + X_2) \le \rho(X_1) + (X_2)$:

$$\begin{aligned}\rho(X_1 + X_2) &= \mathrm{E}[X_1 + X_2] + \beta\sigma[X_1 + X_2]\rho \\ &= \mathrm{E}[X_1] + \mathrm{E}[X_2] + \beta\sigma[X_1 + X_2] \\ &\le \mathrm{E}[X_1] + \mathrm{E}[X_2] + \beta(\sigma[X_1] + \sigma[X_2]) \\ &= (\mathrm{E}[X_1] + \beta\sigma[X_1]) + (\mathrm{E}[X_2] + \beta\sigma[X_2] \\ &= \rho(X_1) + \rho(X_2),\end{aligned}$$

so this property does indeed hold.

We can see that $\sigma[X_1 + X_2] \le \sigma[X_1] + \sigma[X_2]$ as follows:

$$\begin{aligned}(\sigma[X_1] + \sigma[X_2])^2 &= (\sigma[X_1])^2 + (\sigma[X_2])^2 + 2(\sigma[X_1]\sigma[X_2) \\ &\ge (\sigma[X_1]^2 + (\sigma[X_2])^2 + 2\sigma[X_1]\sigma[X_2]\rho_{12} \qquad (\text{since } \rho_{12} \le 1) \\ &= Var(X_1 + X_2) \\ &= (\sigma[X_1 + X_2])^2\end{aligned}$$

so that $\sigma[X_1 + X_2] \le \sigma[X_1] + \sigma[X_2]$.

**Commentary on Question:**
Candidates did a good job of identifying the requirements for a coherent risk measure and applying them to the standard deviation principle. Candidates were generally able to use the determinations made in the previous parts (even if that work was incorrect) to make an appropriate conclusion regarding the coherence of the given risk measure. As the definition of coherence varied slightly between the Hardy and Artzner sources, full credit was given for either answer.

(iv) State with reasons whether the standard deviation principle is coherent.

(Using the definition of coherence given in Artzner:)

A risk measure is coherent if it has the properties of Positive Homogeneity, Translation Invariance, Subadditivity and Monotonicity. While the standard deviation principle has the first three of these properties (as shown in the previous part), it is not Monotonic, and hence is not coherent.

(Using the definition of coherence given in Hardy:)

## 11. Continued

A risk measure to be coherent if it is bounded above by the maximum loss, bounded below by the mean, Scalar multiplicative and additive and Subadditive. It has been shown above that the standard deviation measure is Scalar multiplicative and additive (in the Translation Invariance and Positive Homogeneity portions of the previous part), and also is Subadditive. It is clear that the standard deviation measure is bounded below by the mean. However, this measure is NOT bounded above by the maximum loss. For a sufficiently large value of $\beta$ (and positive standard deviation), the standard deviation term will cause the measure to be greater than the maximum value of $X$. Thus, this measure is NOT bounded above by the maximum, and hence is not coherent.

# Question 12

**Learning Objectives:**

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

**Learning Outcomes:**

(2a) Explain basic accounting concepts used to produce financial statements in insurance companies, other financial institutions, and non-financial institutions.

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

**Sources:**

Fridson, Alvarez Financial Statement Analysis: A Practitioners Guide, Ch 13

Crouhy, Risk Management, Ch 7, p302-303

**General Commentary on Question:**

This 10 point focus question was a relatively straightforward one testing the candidate's understanding of financial ratios, how to calculate them, and how to use them to analyze a company's financial strength.

The Cognitive Skill levels tested varied by question subpart. The four point part (a) tested mixed Comprehension and Analysis cognitive skills in requiring the student to calculate a financial ratio based on specified changes to the financial statements. The four point part (b) tested cognitive skills ranging from Retrieval (subparts (i) and (iii)) to Analysis cognitive skills in subpart (ii). The final two point part of the question tested Knowledge Utilization cognitive skills by requiring the candidate to recommend and justify a capital structure based on their analysis in the prior question parts.

**Solution:**

**Commentary on Question:**

In general, candidates did not include enough detail in the calculation of the components of ROE in part (a). Candidates generally calculated ROE based on beginning-of-period equity, rather than end-of-period, which meant they did not take into account retained earnings.

Candidates did not demonstrate a thorough understanding of the relationships among Retained Earnings, Net Income and Dividends in the calculation of ROE. The numerator in ROE is *Net Income*, which is calculated before dividends*;* the denominator is *Retained Earnings* which is the amount retained after payment of dividends.

## 12. Continued

Many candidates did not use appropriate terminology to distinguish between the income from operations and net income. The latter reflects deduction of interest expenses and tax.

(a) Calculate the impact on ROE resulting from the proposed change in capital structure. Show your work.

ROE = Net Income / Total Equity
Total Equity = End of Year (EOY) Equity = Beginning Equity + Retained Earnings

Average Equity (average of BOY and EOY Equity) received full credit as well.

Interest Expense
*Current Structure:* Interest Expense = 1 (given)
*New Structure:* Interest Expense = current Interest Expense + (New bond rate) x (New bond issues)
New bond issues = amount required to increase debt from 20% to 50% of capital, or 30% of capital
New bond issues = 30% x 100 = 30
New bond rate = 7% (given)
Interest Expense = 1 + (7% x 30) = 3.1

Pre-Tax Income = Operating Income - Interest Expense
Operating Income = Sales - Operating Expenses
Operating Income = 100 - 80 = 20
Operating Income is same in both capital structures.
*Current Structure:* Pre-Tax Income = 20 - 1 = 19
*New Structure:* Pre-Tax Income = 20 - 3.1 = 16.9

Income Taxes = Tax Rate x Pre-Tax Income
*Current Structure*: Income Taxes = 30% x 19 = 5.70
*New Structure:* Income Taxes = 30% x 16.9 = 5.07

Net Income = Pre-Tax Income - Income Taxes
*Current Structure:* Net Income = 19 - 5.7 = 13.3
*New Structure:* Net Income = 16.9 - 5.07 = 11.83

Dividends = Dividend Rate x Net Income
*Current Structure:* Dividends = 25% x 13.3 = 3.325
*New Structure:* Dividends = 25% x 11.83 = 2.9575

## 12. Continued

Retained Earnings = Net Income - Dividends
*Current Structure:* Retained Earnings = 13.3 - 3.325 = 9.975
*New Structure:* Retained Earnings = 11.83 - 2.9575 = 8.8725

Final Equity = Beginning Equity + Retained Earnings
*Current Structure:* Final Equity = 80 + 9.975 = 89.975
*New Structure:* Final Equity = 50 + 8.8725 = 58.8725

Return on Equity = Net Income / Total Equity
*Current Structure:* ROE = 13.3 / 89.975 = 14.78%
*New Structure:* ROE = 11.83 / 58.8725 = 20.09%

ROE will increase in new capital structure.

**Commentary on Question:**
Parts (i) and (ii) required knowledge of specific ratios relating to credit rating. Thus, credit was only given for ratios affected by the increase in debt and ratios demonstrating the impact on the credit rating. Credit was given for appropriate ratios from both the Fridson and Crouhy sources.

(b) You are concerned that the proposed change in capital structure will impact TelCo's credit quality and ability to issue future debt at reasonable costs.

(i) Identify three additional financial ratios that you would consider in determining the effect of the change in capital structure on TelCo's credit standing.

Income statement ratios
Net Margin = Net Income / Sales
Fixed Charge Coverage = (Net Income + Income Taxes + Interest Expense) / Interest Expense

Income statement & balance sheet ratios
Return on Total Capital = (Net Income + Income Taxes + Interest Expense) / (Total Debt + Total Equity)
Funds from operation / Total debt = Net Income / Total Debt
Total Debt / Capitalization = Total Debt / (Total Debt + Total Equity)

## 12. Continued

(ii) Calculate the impact of the proposed change in capital structure on these ratios. Interpret your results.

Net Margin = Net Income / Sales
*Current Structure:* Net Margin = 13.3 / 100 = 13.3%
*New Structure:* Net Margin = 11.83 / 100 = 11.83%

Net Margin reflects the lower income due to debt servicing for the new (more-highly-leveraged) scenario, thereby resulting in a lower ratio value for the new structure. This ratio reflects management's control of the profitability of the enterprise.

Fixed Charge Coverage = (Net Income + Income Taxes + Interest Expense) / Interest Expense
*Current Structure:* Fixed Charge Coverage = (13.3 + 5.7 + 1) / 1 = 20
*New Structure:* Fixed Charge Coverage = (11.83 + 5.07 +3.1) / 3.1 = 6.45

Fixed Charge Coverage demonstrates that company's ability to meet the interest payments through its earnings. The lower value of the ratio for the new structure indicates that increasing the debt reduces the company's capacity to cover the higher debt servicing cost.

Return on Total Capital = (Net Income + Income Taxes + Interest Expense) / (Total Debt + Total Equity)
*Current Structure:* Return on Total Capital = ( 13.3 + 5.7 + 1) / (20 + 89.975) = 18.19%
*New Structure:* Return on Total Capital = (11.83 + 5.07 +3.1) / (50 + 58.8725) = 18.37%

Return on Total Capital will equalize the difference in capital structures. This comparison avoids distortion of using only ROE as the measure for this new structure, because it takes Retained Earnings into consideration. Total Capital declines slightly, even though ROE has increased.

Funds from operation / Total debt = Net Income / Total Debt
*Current Structure:* Funds from operation / Total debt = 13.3 / 20 = 66.5%
*New Structure:* Funds from operation / Total debt = 11.83 / 50 =23.66%

The lower ratio for the new structure indicates that TelCo will have a harder time carrying the increased debt.

## 12. Continued

Total Debt / Capitalization = Total Debt / (Total Debt + Total Equity)
*Current Structure:* Total Debt / (Total Debt + Total Equity) = 20 / (20 + 80) = 20%
*New Structure:* Total Debt / (Total Debt + Total Equity) = 50 / (50 + 50) = 50%

The higher ratio for the new structure reflects the more highly-leveraged scenario, which may indicate that the company has taken on more debt than it can handle.

**Commentary on Question:**
Candidates performed poorly on part (iii), not recognizing that comparative ratio analyses measure a company against its peers, either comparing companies within an industry, or companies with similar ratings across industries.

(iii) Identify and describe two Comparative Ratio Analyses that you can use to evaluate your company's competitive credit position.

TelCo's ratios should be compared with companies in an industry peer group. The specificity in this market reduces the comparison to a small number of similar companies in the same industry. Ratios must be examined and averaged over a set of years to avoid unrepresentative fluctuations in a single year. The ratios are interrelated for a given company, which allows the analysis to be limited to only a few ratios.

TelCo's ratios should also be compared within a ratings peer group – that is, other companies (across industries) with the same credit rating. The limitation here is that rating agencies (Moody's and Standard & Poor's) consider factors beyond the financial statements, so the comparisons may not be as useful.

## 12. Continued

**Commentary on Question:**
Most candidates identified the negative effect of the proposed new capital structure, but they did not relate it to the ratios identified in part (b) and the calculation in part (a). Candidates did recognize that it would be inappropriate to recommend the new structure because although it increased ROE as desired, it weakened the company's position overall.

(c) Recommend whether to adopt the proposed capital structure based solely on your analysis in part (a) and (b) above. Justify your recommendation.

If the goal is to increase the ROE without considering other financial burdens, the new structure should be adopted.

However, while shareholders appreciate the increased ROE, increasing the debt burden deteriorates the financial position of the company. The change in the net margin and fixed charge coverage ratios with the proposed capital structure indicate that the company's overall position will be weakened. Thus, adopting this new structure is not recommended.