AFE Complete Illustrative Solutions
Fall 2009

AFE Examination:

Overall, this exam proved to be very challenging for many of the candidates. More questions than usual were set in varied contexts and required a broader understanding of the basics and an ability to apply concepts to new situations. This was not intended to be a departure from previous exams but a continuation of a prior goal of testing higher cognitive skills. The examinations should reward those who have a deeper understanding of the material and can apply knowledge rather than allowing "memorization without understanding" to be a viable passing strategy.

Despite the challenging questions, candidates were able to demonstrate a considerable amount of knowledge even when they did not get the final answer exactly correct. Misinterpreting a term or assumption would not greatly impair a candidate's score as long as from that point forward the thought process or the calculation was reasonable.

A grader cannot ascertain why a question has been skipped. However, it appeared that some candidates ran out of time before answering the final question of each session. As a candidate, it is important to manage your time properly. The rule of thumb is 3 minutes per point. The committee members are very aware of this rule when constructing the exam. So when you see a 5 point question, the expectation is that you will think through the problem, compose your answer and review your response within 15 minutes. If you are spending more time than that, then you are using time that should be allocated to a different question.

1. Learning Objective:

1 b) Identify and describe insurance risks faced by an entity.

Source: Tilman, Ch. 16 Understanding Options Embedded in Insurers' Balance Sheets

Comments: This question tests the candidate's ability to recognize embedded options within each product line. In order to score well, candidates needed to identify the embedded options in every line, and be able to state what kind of an option it is (call/put/floor etc).

In general, it appeared that many candidates were not well-prepared to apply the concepts in the syllabus to practical situations. Memorizing lists without understanding how to apply them would not have been sufficient preparation for the understanding that the candidate was expected to demonstrate during the exam.

1. Continued

(a)(i) *Candidates did very well here.*

VA Line
- right to deposit additional premiums
- call on the value of future benefit payments
- GMIB: put option
- GMDB: short an equity put option

Disability
- ROP rider: returns premiums less claims every 10 years
- Multiple put options on paid premiums less claims
- call on the value of future benefit payments
- guaranteed renewable

Term
- call on the value of future benefit payments
- option to renew a policy at guaranteed premiums; company cannot change the premium rates, or can only change rate after lengthy uncertain approval process
- product provides benefit for a guaranteed level premium of 10, 15, 20, 30 yrs.

GIC
- put on value of policy: option to surrender
- interest rate floor: guaranteed minimum return

(a)(ii) *Most candidates talked about lapse, which is a policyholder behavior. Candidates also need to identify how EACH option would be exercised under what scenarios, i.e. low interest rate environment*

VA Line
- right to deposit additional premiums - in low interest rate environments, policyholder may make more deposits than anticipated because it is difficult to find other types of better yielding investments
- policyholders would transfer from risky funds to less risky funds, or vice versa
- GMIB: features allow policyholder to receive a level of guaranteed cash under adverse economic scenarios
- GMDB: policyholder must suffer loss before receiving benefit

1. Continued

Disability

- ROP rider: healthier policyholders would purchase this to get premiums returned every 10 years.
- Anti-selection

Term

- selective lapsation: healthy policyholders will lapse if competitors' renewal premiums are more competitive
- unhealthy ones will stay on the books.

GIC

- when interest rate environment is favorable, policyholder may surrender if they can find other investments providing better return than the GIC contract. May also deposit large sums if they cannot find better investments
- in a low interest rate environment, the contract is in the money. Surrenders will be lower than expected.
- Surrenders can also happen if Zoolander was downgraded

(a)(iii) *The question asked about product features that could be changed. Candidates should also state <u>how</u> the options could be made less generous.*

VA Line

- change GMDB to lesser of a voluntary annual reset of the fund level at the anniversary date and a return of cumulative premium accumulated at 5% per annum upon death from larger of the two. This makes the benefit less generous, if fund performance poor

- Policyholder may turn to competitors who offer the larger of the two benefits.

- Change the premium accumulation factor from 5% to a lower interest rate, say 3%
- Policyholder will prefer competitors who offer a higher than 3% factor.
- Unlikely in today's environment

- Could reduce annual reset to less frequent depending on competitor's features

- Introduce MVAs as fixed accounts within VAs
- If only MVAs were available as options, policyholder will prefer something without the market value adjustment
- May turn to competitor with non-MVA options

1. Continued

Disability
- reduce % premiums returned at the end of every 10 years
- healthy people are less likely to purchase this to anti-select

- increase premiums
- policyholders would prefer another company's rates that are lower

Term
- non guaranteed rates for the initial period followed by guaranteed rate scale
- this reduces competitiveness of the product. Policyholders will prefer competitor's product if rates were guaranteed for the initial period

GIC
- longer surrender charge period or higher surrender charges to reduce surrenders
- reduces competitiveness. May have to change target market to customers with longer investment horizons

- lowering guaranteed rate
- reduces competitiveness.

Part (b) tests the candidate's ability to recognize embedded options from the perspective of the company. It appeared that candidates were not used to considering options from the company's view. Candidates did not do well on Part (b) relative to Part (a). Some candidates repeated the answers in part (a). Some confused a call with a put.

(b)(i)

VA Line
- right to receive future mortality & expense risk fees and/or surrender charges whose value increase with the market value of assets managed
- bond with equity call option

Disability
- Right to receive either the future premium or reserve if premiums are not paid
- Callable bond

Term
- callable bond: right to receive future premiums or reserve if future premiums are not paid.

1. Continued

GIC
- right to credit rates lower than market when market is up

(b)(ii)

VA
- Policyholder will exercise the reset when markets go up
- Increased market performance will increase assets under management, as a result increase fees to the company
- Falling values reduce mortality and expense charges and acquisition costs are not recovered

Disability
- Policyholder must pay premium to keep protection in force
- Failure to pay causes the accumulated assets of the policy being forfeited to the company
- Company receives the reserve or cash flow

Term
- Policyholder must pay premium to keep protection in force
- Failure to pay causes the accumulated assets of the policy being forfeited to the company
- Company receives the reserve or cash flow

GIC
- in rising rate environment, policyholder will surrender if crediting rates not raised
- in falling environment, policyholder will surrender if crediting rates were lower than what they could earn elsewhere

(b)(iii) *Many candidates did not put down anything for (b)(iii)*

VA
- Implement ceiling to which reset can be selected, or automatic reset
- Hurts competitive position. Policyholder will prefer voluntary reset

Disability
- increase rates: will hurt competitiveness

Term (same as disability)
- increase rates: will hurt competitiveness

GIC
- decrease credited rates to earn target spread: hurt competitiveness
- policyholders will try to find better investments elsewhere

2. *Many candidates attempted to rely on lists they had memorized, and/or generalities. It appeared that several candidates had not familiarized themselves with the case study prior to sitting for the exam, and thus were at a disadvantage when it came to applying the risks and the control functions to the actual case study.*

Some candidates appeared to be unfamiliar with the OSFI net risk approach and thus missed the concept of first aggregating the risks, then the control functions, then comparing these two aggregate assessments to determine the net risk.

In general, it appeared that candidates were not prepared to apply the concepts in the syllabus to practical situations. The case study is distributed to candidates in advance as a tool for practicing the transfer of the concepts from the syllabus to real-life situations.

One good method of preparing for the case study questions is to imagine yourself sitting in a board room being asked for help. What will the syllabus and case study material mean to you when the CEO or the Board is relying on you as the ERM expert? Well prepared candidates will have compared the case study to the syllabus, will find connections and will devise expectations regarding potential questions.

Learning Objective:

4 e) Describe 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)

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

(a) (i)

Credit Risk

- Financial Counterparty's inability or unwillingness to fully meet its contractual financial obligations
- High
- Credit risk of reinsurer becoming questionable

Insurance Risk

- Includes product design and pricing risk, underwriting and liability risk
- Low
- Experience mortality in line with what was priced

Operational Risk

- Arises from problems in the performance of business functions or processes
- Low
- Good underwriting

2. Continued

Liquidity Risk
- Arises from an institution's inability to meet its cash obligations without incurring unacceptable losses
- High
- Only a rough draft exists of previous attempt to deal with liquidity (Jay's memo

(a) (ii)

Internal Audit
- Independent function within the institution that assesses adherence to and effectiveness of operational and organizational controls
- Strong
- Regular quarterly report involves exception reporting and listing of audits projects (given to Board of Directors)

Senior Management
- Responsible for planning, directing, and controlling strategic direction and general operations
- Weak
- Legal/regulatory/rating agency obligations and warnings ignored by senior management (seeking forgiveness instead of permission)

Board of Directors
- Responsible for providing stewardship and management oversight for the institution
- Weak
- Only one independent member on Board

Operation Management
- Responsible for planning, directing and controlling day-to-day operations on an institution's business activities
- Strong
- Experienced and well-staffed underwriters

(b) Net risk is aggregate inherent risk mitigated by aggregate quality of risk management control functions

1. Determine aggregate rating of inherent risk/Determine aggregate level of inherent risk
   Combine rankings on all inherent risks using relative materiality/significance to give weights to each risk (low, moderate, high)
2. Determine aggregate rating of quality of risk management controls
   Combine rankings on all risk management controls using relative materiality/significance to weight each control (weak,moderate,strong)

2. Continued

3. Determine net risk by calculating the level of aggregate risk offset/mitigated by the aggregate quality of risk management control functions
   Follows chart below:

	Aggregate Inherent Risk		
Aggregate RM Controls	Low	Moderate	High
Strong	Low	Low	Moderate
Acceptable	Low	Moderate	High
Weak	Moderate	High	High

Definition Net risk is function of aggregate level of inherent risk offset by aggregate quality of risk management control functions
Level of risk mitigated by quality of risk management control functions

(c) Aggregate Net risk is moderate
Aggregate risk management control functions is Acceptable

Overall net risk is moderate.

Net Risk

	Inherent Risk		Risk Management Controls
Credit Risk	Moderate to High	Operation Management	Strong
Insurance Risk	Low to Moderate	Internal Audit	Strong
Operational Risk	Low to Moderate	Board of Directors	Weak
Liquidity Risk	Moderate to High	Senior Management	Weak
Aggregate:	Moderate	Aggregate:	Acceptable

Net Risk: Based on the Aggregate answers above, look up answer in above chart: Based on above analysis of Moderate Inherent risk and Acceptable Risk Management Controls, would get moderate overall risk level

(d) Best Practices:
- Policies
  - Have an operational risk policy
  - Retention limits for mortality
- Methodologies
  - Use RAROC to evaluate term product's profitability
  - Calculate VaR/CTE measure of mortality or operational risk
- Infrastructure
  - Risk Management Information System in place
  - People who are knowledgeable and have good judgment for evaluating risks

2. Continued

(e) Best Practices needed at Zoolander:

Policies

Zoolander needs an operational risk policy (it has none)

Methodologies

Zoolander can start measuring RAROC and using that to evaluate the term product's profitability (it doesn't do so currently)

Infrastructure

Zoolander should get a Risk Management Information System (doesn't do so currently)

3. Learning Objectives:

3. Risk Management

a. Explain the rationale for managing risk and for the selection of the appropriate risk retention level.

b. Identify and describe means for transferring risk to a third party, and identify the costs and benefits of doing so.

d. Describe how the performance of risk transference activities may be evaluated.

4. Enterprise Risk Management Framework

f. Understand the perspectives of regulators, rating agencies, stock analysts, and company stakeholders and describe how they evaluate the risks and the risk management of an organization.

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

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

"An Overview of Embedded Value," H. Mueller, Financial Reporter, Sept. 2003.

(a) Describe risk management techniques (3 points)

Candidates tended to do best in this section. Some candidates wasted time by dumping a list of all risk approaches instead of focusing only on the risks applicable to Zoolander's Term Insurance.

C1

- Reduce: reduce exposure to below investment grade fixed income assets
- Reduce: hedge risk by purchasing credit derivatives
- Transfer: purchase interest rate swaps
- Transfer: coinsurance
- Manage: explore alternative assets and investment choices

C2

- Reduce: tighten underwriting standards
- Reduce: increase price by adding additional provisions for risk
- Transfer: reinsurance
- Transfer: securitize cash flows

3. Continued

- Manage: create internal hedges by selling products exposed to longevity risk (e.g. payout annuity)

C3
Stating that there is not much C3 risk in the term block would be a sufficient answer for C3. Or a candidate could state the following:

- Reduce: duration matching
- Reduce: cash flow matching
- Transfer: coinsurance
- Transfer: purchase interest rate swaps
- Manage: active manage asset portfolio

(b)(i) Reinsurer: Aquamarine Re

Candidates did fairly well on this section.

Compare contrast reserve credits

Quota Share Coinsurance
Quota share percentage is applied to all premiums, claims, surrenders, and reserves

Since Aquamarine is not licensed nor admitted in Zoolander's state of domicile, Zoolander may find it difficult to get a reinsurance credit

Modified Coinsurance
Ceding company maintains reserves and the assets backing the reserves. Mod-co reserve adjustment
Eliminates reserve credit problem, since Aquamarine Re is not licensed in Zoolander's state of domicile

Funds Withheld Coinsurance

Lessens Zoolander's insolvency risk compared to quota-share coinsurance
May still result in reserve credit problem but the problem is alleviated because Zoolander holds assets.

(b)(ii) Reinsurer: Turquoise Re: Compare contrast reserve credits (1 point)

Quota Share Coinsurance: Since Turquoise is authorized in Zoolander's state of domicile, Zoolander may find it easy to get a reinsurance credit.

3. Continued

Modified Coinsurance: Allows Zoolander to maintain control of their investment policy and since Turquoise Re is authorized in Zoolander's state of domicile, there is no reserve credit problem.

Funds Withheld Coinsurance: Lessens Zoolander's insolvency compared to quota-share coinsurance
There is no reserve credit problem for ceding to Turquoise Re.

(c) IEA and Impact on Surplus

Some candidates did very well here but the majority were able to only answer a very small portion of the section.

Present Value of Future Profits (PVFP)

- after-tax
  Cost of Required Capital (CoC)
- equals the present value of future release in required capital plus the after tax net investment income on assets backing required capital less required capital on valuation date

- VIF involves projection of cash flows using best estimate assumptions

Initial Expense Allowance, effect on Zoolander's surplus

$$PVFP = 60.3$$

$$CoC = 11.0 + 2.6 - 4\% * 453.6$$

$$= -4.6$$

$$VIF = PVFP + COC = 55.7$$

Effect on Surplus = VIF*0.65 + 4%*PVFP = 38.62
This is because the reserve stays with Zoolander but additional capital is ceded

(d) practices to monitor reinsurance program

Most candidates did not score well on this section. Part (d) was worth 3 points which is about 9 minutes of work. It did not appear that many candidates allocated enough time to this section.

Objective selection process of reinsurer based on counterparty risk and cost of coverage

Maintain awareness of degree to which insurance risk retention strategy is reliant on third parties willing to reinsure risks

3. Continued

Regular/detailed internal audits of accuracy, completeness, and timeliness of reinsurance settlements

Monitor aggregate reinsurance usage in context of view of total risk profile of insurer

Set limits on amount of insurance held by geographic region, industry, or political region and dispersion of sizes instead of just by retention limit for individuals
Evaluate reinsurer's ability to pay/timeliness of payments under extreme events

Manage concentration of risks spread among reinsurers
Acceptance criteria based on credit analysis
Monitoring market intelligence relating to cedents
Maintenance of close relationship with reinsurers
Appropriate use of letters of credit and collateralization
Due diligence of reinsurer financial strength
Reinsurance gain/loss analysis
Set standards for reinsurance treaty terms and authority limits for accepting changes to those terms

Set limits on amount of reinsurance ceded to individual reinsurers and process to handle violations to those limits
Evaluate fallout of more than one reinsurer failing
Evaluate fallout of significant inward losses combined with one reinsurer failing

Allow underwriting compliance review and audit by reinsurer

Plans for access to liquidity, plans for dealing with failure of reinsurer to pay/availability of reinsurance

Look at risk tolerance (retention level) based on priorities between stockholders, policyholders, and regulators/rating agencies

4. Learning Objectives:

3. Risk Management

s. Define operational risk

t. Describe methods for managing this risk, both pre-event and post-event

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

4. Enterprise Risk Management Framework

e. Describe 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, Galai, & Mark, Risk Management, 2001,• Ch.13, Managing Operational Risk

FE-C170-09: Why COSO Is Flawed, by A. Samed-Khan

Candidates generally scored more poorly on the Case Study questions than the rest of the exam. This question was not an exception. Candidate could improve scores by making more references to the Case Study.

(a) Describe sources of operational risk for Zoolander's Derivative Trading Operation

Candidates did decently on this part, but more reference to John Badger and the Zoolander operations would have boosted the scores.

Operation risk can be due to inadequacy or failure of people, systems or processes.

People

- Sales relationship with the derivative counterparty
- Insufficient Number of Skilled People
  - John Badger is experienced and skilled
  - Remainder of staff appears untrained, no extra capacity
  - Too much reliance on one expert
  - High risk due to errors or fraud.

Systems

- Model risks of deploying John's model due to bad data
- Model risks due to bad model
  - Some concern that isn't fully tested

4. Continued

- No independent testing
- Risk due to system limitations.

Process

- Badger in charge of both trading and administration.
- No procedures on credit exposure
- Lack of formal processes, validating mark to market and settlement.
- Mismatch between the derivative and the actual risk need
  - Hedge fund opportunity isn't really matched up with any existing Zoolander risks
- Errors on derivative reports could lead to excessive risk assumption
  - No real mention of any reporting with John Badger's hedge fund strategy
- Concerns regarding documentation
- System limitations

(b) Explain why COSO framework is insufficient

Most candidates did very well on this section. The COSO note was well understood and answers were very well organized with some candidates earning very high marks on this section.

COSO is highly subjective, overly simplistic and conceptually flawed.
COSO is resource dependent, Zoolander only has Bill Buck as sole ERM resource.
Implementation usually results in huge catalogue of risks.
Business Managers might not be the best source of risk information, which means John Badger would likely be interviewed for the sources of derivative trading risk.
Risk is measured as likelihood × impact.
Phantom risk is high probability and high impact, not realistic
COSO framework puts too much emphasis on these phantom risks.
Real risks are those where the probability is low but the impact on the firm is high.

(c) With respect to the derivatives operation, outline to what extent:

Most candidates struggled with applying Barings Bank to Zoolander. If an answer was provided, it usually focused on generic concerns and not many specific examples that relate to Zoolander.

(i) **It reflects lessons learned from Barings Bank**

- Management should fully understand the business they manage
  - Concern Peter Fish does not understand the complex derivatives
- Establish clear responsibility for each business activity
  - John Badger seems to have responsibility for all aspects of derivative trading (one man show)
- Put relevant controls in place, also include independent controls
- Resolve significant weaknesses quickly
  - Does not appear that Peter Fish has any interest in resolving weaknesses

4. Continued

(ii) **Group of 30 recommendations**

Answers varied. When attempted, most written answers earned some marking points. Only a few candidates were able to list several of the recommendations in succession.

- Measure current exposure using market value
  - John Badger's hedge fund model marks to market daily…good
- Aggregate all exposures with consideration of netting agreements
  - Minimal staff, rules of thumb instead of modeling
- Calculate exposures regularly and compare to credit limits
  - Not inforce at Zoolander
- Credit risk management should have clear and independent authority
- Use one master agreement
  - Zoolander starts every deal fresh
- Assess both benefits and costs of credit enhancements
  - Considered a waste of money at Zoolander

(iii) **Six Guiding Principles**

Nearly all candidates struggled with this question. Most papers did not attempt an answer. A few papers were able to list and define a couple of the principles.

1. Objectivity – the risk is measured using standard criteria
2. Consistency – same risk profiles will result in the same reported risks
   - Probably not there yet at Zoolander, ERM operation is fairly new
3. Relevance – reported risks is actionable
4. Transparency – all material risks are reported
5. Firm-wide – risk can be aggregated across the entire organization
   - Derivatives operation is small and centralized at Zoolander
6. Completeness – all material risks are identified and captured

5. Learning Objectives:

4. Risk Management - General

d. Evaluate the performance of risk transference activities.

4. Risk Management - Asset Liability Management

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

Sources: Hardy, Investment Guarantees, 2003, Chapter 8 and 9
Crouhy, Galai, & Mark, Risk Management, 2001, Chapter 5

Question Description
This question required the candidate to create a static delta hedge portfolio and compare the gain/loss to investing solely in a stock portfolio or a bond portfolio. This question then had the candidate recalculate the value of the static delta hedge portfolio if they rebalanced the portfolio after 6 months.

Generally, candidates did poorly on this question. The question was designed to test the understanding of the basic dynamics of hedging without requiring too much mathematics or formula memorization.

(a) *Candidates were able to calculate the hedge cost at time 0 but some missed calculating the hedge value at time 1. The hedge value at time 1 is needed to calculate the payout in Part (ii).*

(a)(i) Static delta hedge:
Short stock = $St\,\Psi t = -50\,\Phi[-d_1] = -50\,(0.3709) = -18.545$
Long bond $= 50e^{-0.03}\Phi[-d_2] = 50e^{-0.03}(0.5872) = 28.492$
$H(0) = -18.545 + 28.492 = 9.947$

At \$75 $H(1) = 28.492\,e^{0.03} - 75\,(0.3709) = 1.54$
At \$25 $H(1) = 28.492\,e^{0.03} - 25\,(0.3709) = 20.09$

90% VaR and invest in Stock:
Invest \$22 in BrewCo shares = \$22/\$50 = 0.44 shares
At \$75: Stock value = \$75 (0.44) = \$33
At \$25: Stock value = \$25 (0.44) = \$11

90% VaR and invest in Bond:
Invest \$22 in Treasury bonds
At \$75: Bond value = $\$22\,e^{0.03}$ =\$22.67
At \$25: Bond value = \$22.67

5. Continued

(a)(ii) *Many candidates did not realize that they had to borrow the $22 for the stock and bond portfolios. This results in an up front cost of $12.05 (=22 – 9.95) which needs to be deducted from the payout of these portfolios.*

Net position = value of hedge portfolio – payment of guarantee

Static delta hedge:
At $75: net position = 1.54 – 0 = 1.54
At $25: net position = 20.09 – 25 = – 4.91

90% VaR and invest in Stock:
You receive $9.95 but invest $22 for an initial cost of – 12.05
At $75: net position = $33 – $12.05 – 0 = $20.95
At $25: net position = $11 – $12.05 – $25 = – $26.05

90% VaR and invest in Bond:
You receive $9.95 but invest $22 for an initial cost of – 12.05
At $75: net position = $22.67 – $12.05 – 0 = $10.62
At $25: net position = $22.67 – $12.05 – $25 = – $14.38

(b) *Most candidates based their answers using the variance of results of the 3 portfolios. Other candidates based their ranking based on minimizing the loss when the stock declines. Both methods lead to the same ranking order.*

Ranking of Strategies
#1 = Static Delta Hedge
#2 = Actuarial hedge invested in treasury bonds
#3 = Actuarial hedge invested in BrewCo stock

The delta hedge is the most efficient as it assumes no additional capital is required because it is all paid by the $9.95 received from Antonio. The total loss is less than $5 even if the stock halves in value.

The treasury approach is next with a maximum potential loss of $14.38 when the stock value drops.

By investing in the underlying stock doesn't make sense because hedge portfolio is worth more when the guarantee doesn't payoff and vice versa.

5. Continued

(c)(i) *Most candidates stopped after calculating the hedge error at time 0.5. An example of this question can be found in the Hardy text book on page 144-146.*

At $t = 0$
from part (a): stock position = – 18.545 and bond position =28.492 for $BSP_0 = 9.948$

At $t = 0.5$
old hedge brought forward:

$$H(0.5)^{-} = Y_0\, e^{0.03(0.5)} + S_{0.5}\Psi_0 = 28.492e^{0.03(0.5)} + 75(-0.3709) = 1.1055$$

new hedge:

$$\begin{aligned} H(0.5) &= Y_{0.5} + S_{0.5}\Psi_{0.5} = 50e^{-0.03(0.5)}\Phi[-d_2] + -75\Phi[-d_1] \\ &= 49.2556(0.1876) - 75(0.1010) \\ &= 9.240 - 7.575 \\ &= 1.665 \end{aligned}$$

New hedge has stock position = – 7.575 and bond position of 9.24.

Hedging error $= H(0.5) - H(0.5)^{-} = 1.665 - 1.1055 = 0.56$ loss

At $t = 1$
old hedge brought forward:

$$9.24e^{0.03(0.5)} - 7.575(90/75) = 9.38 - 9.09 = 0.29$$

Hedging error $= 0 - 0.29 = -0.29$ gain

Total Hedging error = error at $t = 0.5$ + error at $t = 1$ = 0.56 – 0.29 = 0.27 loss

(c)(ii) *Very few candidates demonstrated that they understood that hedging against a decline in the stock will lose money when the stock increases.*

The hedge was quite effective since we are effectively replicating the guarantee payoff using the Black-Scholes-Merton formula.

We only lost 0.27 indicating that the hedge was effective.

We lost money because the stock price increased and we were short in the stock.

We would have had a small gain if the stock price had decreased.

We only rebalanced discretely. The gain/loss would be smaller if we rebalanced more frequently and there were no transaction costs.

6. Learning Objective:

3f. Risk Management and Asset Liability Management

- Describe how derivatives, synthetic securities, and financial contracting may be used to manage interest rate risk , including key rate risks.
- Contrast modified duration and effective duration measures.
- Calculate effective duration and effective key-rate durations of a portfolio.
- Explain the concepts of immunization including modern refinements and practical limitations.

Sources: Listed Below

Grader Comments: The performance on the question was below average. Five of the points were very straightforward applications of interest rate risk. The calculation was a little trickier; however many candidates did poorly throughout this question. Maybe, the poor results are due to fatigue or poor time management since this was the last question of the morning.

The concept in part (a) had been asked on a very recent exam. So it was surprising that candidates did not perform better, especially in part (a) ii.

(a) Qualitatively evaluate the impact on each of the following when market interest rates spike upwards after a long period of low interest rates.

Key Text: FE-C128-07: Asset/ Liability Management, IASA Handbook, page 8-9

Impact of interest rate spike: Values of existing fixed income assets are reduced because the interest rates they pay are lower than those available in the new interest rate environment.

(i) Long-dated maturities assets are more sensitive to changes in market interest rates and would suffer proportionately larger declines in value.
Book value liability values remain fixed.
Disintermediation - Savvy sales agents, acting in the interests of their clients, instigate surrenders of the original policies and placement with the new insurers. The original insurer is forced to liquidate assets at depressed values to fund the surrender values of departing policyholders, causing a financial loss.

(ii) Policy considerations
A "high" renewal rate acts to dampen current surrender activity, but at the cost of increasing policy account values and ultimate maturity values.
A "low" renewal rate accelerates surrender activity, but at commensurately lower values (perhaps further reduced by surrender charges).

6. Continued

Market value adjustments or surrender charges impact level of surrenders. Insurers must balance the need for acceptable profit margins and the necessity of maintaining SPDA marketplace credibility by establishing a record of attractive renewal rates.

Candidates did well on part (b).

(b) Sweet Life is currently managing SPDA by immunization.
- (i) Evaluate strengths and weaknesses.
- (ii) Calculate the third key rate duration.

Key Text: FE-C128-07: Asset/ Liability Management, IASA Handbook, page 8-9
Key Text: FE-C156-09 Key Rate Durations: Measures of Interest Rate Risks FET-119-07, Pages 5-6

(i) Immunization

Strengths: Immunize surplus against adverse fluctuations (eliminate interest rate risk) by matching durations of assets and liabilities. If durations are matched, a change in the level of interest rates is expected to have the same percentage impact on the values of both assets and liabilities.

Weaknesses: Requires continuous rebalancing of asset portfolio to re-establish the duration match. Impractical, costly. It is a measure only of the change in (asset or liability) economic value attributable to small changes in interest rates. Assumes parallel shifts in the yield curve (rates at all maturities change by equal amounts)

Asset	Proportion	Market/Book Ratio	D(1)	D(2)	D(3)
A	20%	96%	0.1	0.3	0.4
B	40%	120%	0.2	0.5	0.15
C	40%	82%	2	1.8	1.2
Assets	100%	100%	0.9	0.98	0.62
Liabilities	100%	100%	0.7	0.8	1
	Change in Key Rate	100	100	0	0

6. Continued

(ii) Key Rate Duration Calculations

$$0.7 + 0.8 + 1 = 2.5$$

$$0.2*0.1 + 0.4*0.2 + 0.4*2 = 0.9$$
$$0.2*0.3 + 0.4*0.5 + 0.4*1.8 = 0.98$$
$$2.5 - 0.98 - 9 = 0.62$$

$$(0.62 - 0.2*0.4 - 0.4*1.2)/0.4 = 0.15$$

Relatively few candidates did part (c) well.

(c) (4 pts) A sudden 100 bps increase in the Short rate occurred immediately after the immunization rebalancing. The Mid and Long rates remained unchanged.

Immediately following the interest rate spike, 30% of policyholders surrendered their contract at book value forcing Sweet Life to sell their assets.

Sweet Life disinvests assets pro-rata across asset classes to satisfy its obligations.

(i) Demonstrate that without the deal, the MV Assets is less than the target of 99.5% of BV Liabilities.

(ii) Calculate the minimum amount of Class C assets that Sweet Life should exchange with the government to maintain its desired target.

		Before Spike		After Spike	
Asset	Proportion	Market/Book Ratio	D(1)	Market/Book Ratio	Actual Assets
A	20%	96%	0.1	95.9%	19.98
B	40%	120%	0.2	119.8%	39.92
C	40%	82%	2.0	80.4%	39.20
MV Assets	100%		0.9		

(i)

	Before	After
MVA	100.00	99.100
BVL	100.00	100.000
MVA/BVL	100.0%	0.991

6. Continued

(ii)

	Value	How calculated
Surrender Amount	30.00	(30% * Book Value before surrender)
BLV after surrender	70.00	100 – 30
MVA at 99.5%	69.65	99.5% * 70 (desired target)
MVA before surrender	99.65	69.65 + 30 (desired target)
C Assets needed	39.75	99.65 – 19.98 – 39.92
Amount from government	5.71	$(40/0.82 - x) * 80.4\% + x * 90\% = 39.75$

Those that attempted part (d) did fairly well. However, being the last section on the last question of the morning seems to have caused many omits.

(d) Define each of the following approaches and describe advantages of incorporating each to manage the interest rate risks associated with SPDA.

Key Text: FE-C128-07: Asset/ Liability Management, IASA Handbook, page 20-24

(i) Option Pricing: Contingent cash flows must be projected for a large number of economic scenarios
Capital market assumptions required must be mathematically consistent with those implied by observed capital market prices (arbitrage-free interest rates)

Pros: Captures the cost of embedded options

(ii) Dynamic Hedging: Capital requirement is used to construct a replicating portfolio that mirrors the liabilities' equity market sensitivities (the "Greeks")

Pros: high likelihood of being effective i.e. hedged portfolio obligations will be met. Not required to mimic the cash flow pattern of the liabilities

(iii) Optimization Techniques: Aims to find "optimal" values for certain variables. Examples - minimize a particular risk measure, max some return

Pros: Can quickly and exhaustively evaluate the universe of feasible strategy alternatives. It can overcome unwieldy dimensionality that is typical of ALM projects due to complex dependencies.

7. Learning Objective:

5e. Describe how ERM is able to contribute to shareholder value creation.

Source: FE-C117-07: *Integrated Risk Managemen*t, Doherty, Chapter 7

Candidates did fairly well on this. They were able to show that they understood how incentives impact behaviors.

(a) Describe how incentive compensation can affect risk management decisions.

- Corporate decisions are typically made not by a firm's owners but by employed managers
- Managers may choose to adopt risk management decisions in own interest and not in the best interests of shareholders
- For most managers, employment income is a major source of wealth, risk in employment income is important
- Under Flat salary, manager is indifferent to any risk management decisions, assuming job security is not tied to any particular decision. Implementing the best strategy may affect job security / performance evaluations
- Under Incentive compensation (% of earnings), manager has direct monetary interest in the decision which favors shareholders. Manager will want to reduce their own risk and secure any efficiency gains from hedging
- Under Stock options plan, option is only worth money if the stock price > exercise price, manager has incentive not to hedge because it lowers value of their options. Manager would always want greater volatility

(b) Demonstrate whether senior management would be motivated to implement the stock value hedge under each of the three compensation schemes.

Flat salary

$U = 250,000^{0.5} = 500$

Manager should be indifferent by the purchase of the hedge

One might suppose that board of directors would give the senior management a better performance evaluation if the hedge is purchased because it aligns with company's interest

Salary + Stock option

Probability: Utility (unhedged)

$1/3 : (160,000 + 25,000 \times (100 - 88))^{0.5} = 678.23$

$1/3 : (160,000 + 25,000 \times (90 - 88))^{0.5} = 458.26$

$1/3 : (160,000 + \max(0, \quad 25,000 \times (80 - 88)))^{0.5} = 400.00$

Expected: 512.16

7. Continued

Many candidates were unable to apply the idea of utility. They incorrectly assumed that a positively sloping utility function won't impact the results. Or else they took the utility of the average of the outcomes instead of calculating the average of the utility of outcomes.

Utility (hedged): $(160,000 + \max(0, 25,000 \times (82 - 88)))^{0.5} = 400.00$

Manager would choose not to hedge:

Salary + Stock
Probability: Utility (unhedged)
$1/3 : (175,000 + 1000 \times 100)^{0.5} = 524.40$
$1/3 : (175,000 + 1000 \times 90)^{0.5} = 514.78$
$1/3 : (175,000 + 1000 \times 80)^{0.5} = 504.98$
Expected: 514.72

Utility (hedged): $(175,000 + 1000 \times 88)^{0.5} = 512.83$

Manager may choose to hedge since expectation difference is immaterial

(c) Compare and contrast each of the three compensation structures.

Flat salary
- Senior management is not really rewarded or penalized for their decisions, no direct money interest
- Hence their interests may or may not coincide with shareholders
- Company is forgoing potential efficiency gains from incentive compensation
- In current economic environment, one might suppose that their job security / good performance evaluation is sufficient enough

Salary + Stock options
- Has call options on stock, hence no downside risk on employment income, still has base salary
- Affects risk management decision because hedging would lower value of their options
- Since we assume the senior management is self-interested, this compensation scheme does not align with company's interest

7. Continued

Salary + Stocks

- Directly relates to value (both upside and downside)
- In a competitive labor market, incentive compensation would typically be higher than flat salary (risk premium)

- Because employment income typically is a large portion of manager's wealth, this risk significantly reduces manager's utility
- Incentive compensation is typically higher to compensate for the inherent risk
- Induce higher effort from manager but more costly because of the risk imposed on managers

(d) *Responses in (d) could vary. There is not one absolute correct answer because one could argue that hedging is not in the best interest of the company. No matter what recommendation is made, the recommendation must be justified. One recommendation would be:*

Recommend the compensation structure that best aligns with XYZ shareholder interests.

- Salary + Stocks (Incentive Compensation)
- Directly relates to value (both upside and downside)
- Flat salary or stock options either do not motivate managers or are one-sided
- The risk of a "bad" outcome (low stock price) is reflected in the manager's compensation
- If profit risk is hedged, incentive compensation becomes riskless and thus the level of compensation can be lowered
- Performance-related earnings induce higher effort but also are more costly because of the risk imposed on managers

Most managers are risk-aversed because their employment income is typically a large portion of their wealth

Senior management may secure hedge and lock in any efficiency gains
This risk premium is the cost of ensuring the interest of the manager and company are aligned

8. Learning Objective:

5: Enterprise Risk Management Process

a. Explain the ERM process steps to be followed once the ERM framework is in place:

- Risk identification
  - i. Defining and categorizing risk
  - ii. Qualitative risk assessments
- Risk quantification
  - i. Scenario development / types of scenarios
  - ii. Individual risk quantification, including inherent vs. residual exposures
  - iii. Quantifying enterprise risk exposure, including correlations of risks
- Risk management
  - i. Defining risk appetite
  - ii. Managing enterprise risk exposure towards risk appetite

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

Candidates did not do very well on this question. Few demonstrated a familiarity with the subject matter.

Candidates were able to pick up some points in part (a).

(a) Describe the "silo"-based approach to capital required by US regulation applicable to financial conglomerates. Identify and explain three major limitations of this approach.

- largely based around single business line on the notion that financial institutions or their business lines can be classified as banks, insurance companies, or securities firm
- that means separate regulatory treatment of banks, insurers and securities firm
- limitations
  - inconsistent treatment
    - silo approach is inconsistent and may lead to different treatment of similar risk types depending on where the risk is booked
  - aggregation
    - silo approach ignores aggregation because it fails to take account of risk concentrations or diversification across different operating subsidiaries / legal boundaries

8. Continued

- incompleteness
  - silo approach is incomplete because it ignores the capital requirements of unlicensed subsidiaries

(b) and (c) were each worth only one point. Candidates were able to demonstrate a bit of knowledge on this topic.

(b) For each of a Bank, P&C company and a Life company complete the following table to characterize each of the identified risks using the following scale.

An appropriate filling of the table would be as follows. Some variation in the exact values is allowed without penalty.

	Bank	P&C Co.	Life Co.
Market	1	1	2
Credit	2	0	0
Insurance	0	2	0
ALM	1	0	1
Operating	1	0	1

(c) Describe the three-level, "building block approach" that could be used to aggregate risks in a financial conglomerate.

- Level I
  - Aggregates the standalone risks within a single risk factor in an individual business line
- Level II
  - Aggregates risk across different risk factors within a single business line
- Level III
  - Aggregates risk across different business lines such as banking and insurance

Part d was worth 5 points. So candidates should have spent about 15 minutes on this section. Most did not have much to say about this topic.

(d) For each of the acquisition targets considered in isolation, qualitatively access the impact of CGB's risk at each of the following levels of risk aggregation.

8. Continued

	Dutch P&C	US Life
Level I Diversification	This will be maximum level diversification benefit for Dutch P&C Number of positions is quite large especially global company will have a large number of policies and has a large number of positions in its diversified investment portfolio	This will be maximum level diversification benefit for US Life Portfolio of USLIfeCo's liability risks are also concentrated geographically, decreasing the potential diversification of benefit
Level II Diversification	Level II diversification benefit lower for Level I for Dutch P&C Dutch P&C have relatively higher diversification benefit due to P&C liabilities being relatively uncorrelated to other risk types	Level II diversification benefit lower for Level I for US Life Expected Level II benefits lower for US Life than Dutch P&C. ALM/Market risk account for a large portion of US Life capital
Level III Diversification	Benefits at Level III are smaller than Level II and Level I for Dutch P&C Biggest diversification benefits stems from combining risks of equal size. Credit risk, dominant in bank is uncorrelated with catastrophic risk in P&C	Benefits at Level III are smaller than Level II and Level I for US Life CGB would not benefit much from the small scale of US Life relative to CGB

(e) Using the standalone economic capital estimates, complete the table below. Show your work.

Candidates did not take the total, given correlation matrix and line it up with the corresponding capital values from the two companies. Partial credit was given for partially correct set-ups

Calculating the total risk in a company is a key concept underlying ERM. Understanding covariance of risks requires a basic application of statistics and the application of the correlation matrix. The term diversification benefit ratio was not explicitly defined in the text. So the solution to any ratio dealing with diversification was accepted.

	Combined Entity Economic Capital	Diversification Benefit Ratio
CGB and Dutch P&C	$60.2 million	14.3%
CGB and US Life	$43.29 million	3.8%

8. Continued

CGB and Dutch P&C

$$\text{DB} = 1 - \frac{60.2}{38+32} = 14.3\%$$

CGB and US Life

EC_T is equal to the square root of the following:

$$|25 \;\; 10 \;\; 15 \;\; 1 \;\; 5 \;\; 3 \;\; 1| \begin{vmatrix} 1.00 & 0.30 & 0.45 & 0.90 & 0.30 & 0.40 & 0.00 \\ 0.30 & 1.00 & 0.15 & 0.30 & 0.80 & 0.10 & 0.00 \\ 0.45 & 0.15 & 1.00 & 0.40 & 0.10 & 0.50 & 0.10 \\ 0.90 & 0.30 & 0.40 & 1.00 & 0.20 & 0.15 & 0.00 \\ 0.30 & 0.80 & 0.10 & 0.20 & 1.00 & 0.15 & 0.00 \\ 0.40 & 0.10 & 0.50 & 0.15 & 0.15 & 1.00 & 0.15 \\ 0.00 & 0.00 & 0.10 & 0.00 & 0.00 & 0.15 & 1.00 \end{vmatrix} \begin{vmatrix} 25 \\ 10 \\ 15 \\ 1 \\ 5 \\ 3 \\ 1 \end{vmatrix}$$

$$EC_T = (1873.8)^{(0.5)} = 43.29$$

$$DB = 1 - \frac{43.29}{38+7} = 3.8\%$$

(f) Recommend and justify the most beneficial acquisition to CGB.

Some candidates were able to get part (f) even without part (e) by using information in the question stem. To get full points one must give a reasonable justification.

Acquire Dutch P&C.

Justification

- Higher diversification benefit ratio
- Dutch P&C is of larger size and closer in scale to CGB
- Dutch P&C is geographically diversified

9. Learning Objectives:

2. Value, Accounting Measures, and Risk Quantification

c. Describe economic measures of value (e.g. EVA; embedded value) and their uses in corporate decision-making process.

Sources: "Fair Valuation of Insurance Liabilities: Principles and Methods," AAA Monograph, September
FASB Summary of FAS 157

Candidates found this to be more difficult than most of the questions on the exam. Many were unable to demonstrate concepts relating to fair value.

(a) The three fair value principles that would apply to ABC's GMAB benefit are summarized as:

Principle 1. If there is no risk in the product, then discount the cash flows at a risk free rate.

Principle 2. If there is risk in the product, then present valuing the cash flows should include an adjustment for risk. This can be reflected in three different ways when there is no market value for the instrument:
(i) Adjust the discount rate keeping in mind that raising the discount rate decreases the reserve while lowering the discount rate increases the reserves.
(ii) Use an option pricing technique to weigh results under various probabilistic scenarios.
(iii) Upward adjust the cash flows by using greater than expected cash flows.

Principle 3. Discount using all cash flows including costs associated with the cash flows.

Certainly the GMAB product has risk so Principle 1 would not be appropriate. Principles 2 and 3 could be used.

(b) Arguments for:
- The liability of a company is someone else's asset.
- The largest liability of many industries is publically traded debt.
- There is no compelling reason why other financial liabilities should be treated any differently than publically traded debt.
- Since the owner of a firm can walk away from ownership, the fair value of its liabilities should never exceed its assets which are valued using credit spread.

9. Continued

Arguments Against:

- If the liabilities of a firm are valued using a credit standing and the credit standing worsens, then the discount rate would increase and the value of the liabilities would decrease, which is counterintuitive.
- Insurance liabilities are not traded assets and so credit standing has no basis in its valuation.
- Insurance liabilities are different than regular financial liabilities in that insurers cannot exit them except through settlement with policyholders. To reflect credit standings would imply that a transaction could exist but in fact is illegal due to unfair trade practices.
- Insurance guarantee funds override the credit worthiness of an insurance company.
- Non adjusted liability values are more meaningful and useful to financial statement users.

(c) The hierarchy is:

1. Use market value when available.
2. If no market value available, then look for something similar and adjust for the difference, if you can.
3. If 1 or 2 not available, then go to basics and present value the cash flows adjusting for risk.

The GMAB rider has no market value and there really is no similar instrument you can look to for guidance on how to value. So, you need to go to the basics, hierarchy 3.

(d)(i) ABC Life has adopted FAS 157. The upshot of that requirement is that you must include in your valuation three items; (a) non performance risk, (b) illiquidity risk, and (c) risk in the model being used to value the liability.

The table gives us discounted values at 2%, 4%, and 6%. We are told that the risk free rate is 4%. We are also told that the only surrender is the uncertainty, so illiquidity is not an issue here. And we have Best Estimate and 10% plus or minus adjustments due to modeling the surrender effect.

The first problem is how to reflect the nonperformance risk? Ordinarily this is done by adding the credit default swap spread to the risk free rate to give us 6%. But, we also know that increasing the discount rate will decrease the reserve. This is a disadvantage of adding the credit spread.

9. Continued

We really don't know whether adding 10%, subtracting 10%, or just using Best Estimate produces the largest reserve. So, we need to test to find that maximum reserve in the 6% column.

At Best Estimate and 6% the reserve = 90 – 46 = 44.
At 110% of Best Estimate the reserve = 77 – 41 = 36 using the 6% column.
At 90% the reserve = 113 – 51 = 62.
Therefore, we want to use the 90% values at 6%.

(d)(ii) MVM refers to risk uncertainty in the valuation model, which would be the reserve with the risk margin less the reserve without the risk margin. Using the 6% column the reserve without the risk margin would be 90 – 46 = 44. Therefore, the MVM would be 62 – 44, or 18. Note, this includes nonperformance margin. Alternatively, you could compute the MVM using the 4% column and removing the nonperformance component in which case the MVM is 20, (125 – 55) – (100 – 50).

(d)(iii) The present value of the nonperformance risk is reflected in the differential between the 4% and 6% discount rates. So, we have three rows to choose from. Using Best Estimate the differential would be |(90 – 46) – (100 – 50)| = 6. At the 110% row we have |(77 – 41) – (85 – 45)| = 4. At the 90% row we have |(113 – 51) – (125 – 55)| = 8. Since we didn't use the 110% values, the accepted answers were 6 and 8.

(e)(i) Since the GMAB matures on January 1, 2010 you basically have one year to value and since the rider is in the money the cash flows now look more like a zero coupon bond. Thus, we could consider using methods 1 or 2. On the other hand even though only one year remains, there could be some lapses which might affect the reserve and thus the continuation of method 3 would certainly be reasonable.

(e)(ii) Many factors could contribute to the reserve difference between January 1, 2008 and January 1, 2009:

- You used a different method.
- The risk rate changed
- The CDS spread changed but note that the net change in the two discount rates was zero.
- You changed assumptions with regard to the surrender rates
- There actually were deaths even though you assumed none.
- The surrenders were different than you expected.

10. Learning Objectives:

5. Enterprise Risk Management Process

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

f. Explain how risk metrics can be incorporated into the risk monitoring function as part of an ERM framework.

g. Describe means for managing risks and measures for evaluating their effectiveness.

Sources: Crouhy, Galai, & Mark, *Risk Management*, 2001, Ch. 14, Capital Allocation and Performance Measurement
• FE-C124-07: Performance Measurement Using Transfer Pricing

The candidates as a group performed best on questions 10 and 11.

(a) Choose three from:
- relates the return on capital provided by a transaction/business line/product to the riskiness of the investment
- provides economic basis from which to measure all the relevant risk types and risk positions consistently
- RAROC promotes consistent, fair, and reasonable risk-adjusted performance measures
- provides managers with the info needed to make trade-off between risk and reward more efficient
- RAROC approach accepted as best-practice standard during late 1990's by the financial industry and its regulators

(b)
- in a financial institution it is the cushion that provides protection against various risks inherent in the business, capital adequacy
- provide confidence to claimholders
- absorb unexpected losses up to a certain level of confidence
- set at a confidence level that is less than 100% (too costly), say 99%, meaning that there remains a probability of 1% that actual losses will exceed the amt of eco capital
- the determination of eco capital, and its allocation to various business units, is a strategic decision process that affects the risk/return performance of the bus units and the company as a whole

- it influences dramatically the way that capital is allocated/reallocated among the various activities and projects

10. Continued

(c)

- RAROC = (Revenues – Expenses + Return on Eco Capital +/– Transfer Prices – Realized Losses)/(Eco Capital)
- RAROC(Product A) = (450–200+(0.05×(1000)) – 25 –100)/1000
- RAROC(Product A) = (250+(0.05×(1000)) –125)/1000 = (250+50–125)/1000=175/1000=17.5%
- RAROC(Product B) = (175–50+(0.05×(500)) – 12 –65)/500
- RAROC(Product B) = (125+(0.05×(500)) – 77)/(500) = (125+25–77)/500=73/500=14.6%
- RAROC(Product C) = (40–15+(0.05×(100)) – 3 –15)/100
- RAROC(Product C) = (25+(0.05×100) –18)/100 = (25+5–18)/100 = 12/100 = 12%
- Product A beats, Product B is close to meeting, and Product C fails to meet the 15% hurdle rate
- Product A can be said to add value to ELF; Products B and C are destroying s/h value
- Product A is outperforming Product B is outperforming Product C on a RAROC basis

(d)

(i) Improved Profitability Analysis
- Better Product Profitability Measurement both between products and between pricing and actual

(ii) Benchmarking of Asset Performance
- Helps establish well-defined risk-adjusted targets for investments and facilitates measuring actual asset performance on a risk-adjusted basis
- Compares performance of assets that match liability risk characteristics with actual assets
- Provides viable investment alternative if return on assets doesn't match benchmark portfolio over time, invest in benchmark

(iii) Isolation of A/L Risks
- Can concentrate all ALM risk in one unit should result in more coordinated approach to managing this risk
- Separate measurement of the impact from residual mismatching of A/L should promote better risk management decisions

(e)

- Define Benchmark #1 as a benchmark based on generic assets that have the same duration and convexity as the liabilities and have credit or claims paying risk of the liabilities

10. Continued

- Define Benchmark #2 as a benchmark based on generic assets that have the same duration, convexity and credit quality as the assets that will be used in the actual investment portfolio
- Product Performance = Benchmark #1 – Actual Returns of the Liabilities

- ALM Performance = Benchmark #2 – Benchmark #1
- Asset Performance = Return on Actual Assets – Benchmark #2

(f)

(i) Product A
- Assets 16.5% – Liabilities 15.5% = Marked to Market Return of 1.0%

(ii) Product B
- Assets 14.9% – Liabilities 14.5% = Marked to Market Return of 0.4%

(iii) Product C
- Assets 12.5% – Liabilities 14.0% = Marked to Market Return of –1.5%

(i) Product Performance
- Product A: A1 – Actual Returns of Liabilities = 14.5% – 15.5% = –1.0%
- Product B: B1 – Actual Returns of Liabilities = 14.0% – 14.5% = –0.5%
- Product C: C1 – Actual Returns of Liabilities = 13.0% – 14.0% = –1.0%

(ii) ALM Performance
- Product A: A2 – A1 = 15.0% – 14.5% = 0.5%
- Product B: B2 – B1 = 13.9% – 14.0% = –0.1%
- Product C: C2 – C1 = 11.0% – 13.0% = –2.0%

(iii) Asset Performance
- Product A: Return on Actual Assets – A2 = 16.5% – 15.0% = 1.5%
- Product B: Return on Actual Assets – B2 = 14.9% – 13.9% = 1.0%
- Product C: Return on Actual Assets – C2 = 12.5% – 11.0% = 1.5%

(g)

- Products B and C are not meeting the RAROC hurdle rate

(i) Strengths & weaknesses
- FTP analysis indicates that both products are mispriced and have product management issues
- Investment ops is the key source of performance, including BBB asset management

- Mixed performance from ALM, – 2% return from mismatching Product C the cause of an overall negative performance for the product, B almost breaks even at – 0.01%

10. Continued

(ii) Management actions

- Review product pricing & management on products B & C
- No large duration bets on Product C
- Consider BBB asset investment given success for Product A

11. Learning Objective:

2(e) - Define risk metrics to quantify major type of risk exposure in the context of an integrated risk management process

Source: Crouhy Ch.5 - Measuring Market Risk: The VaR Approach

As mentioned in 10. Candidates did well on this question. Since the label in the table said only "volatility", two sets of answers were acceptable – the results from assuming "volatility" meant "variance" and from assuming "volatility" was "standard deviation".

(a) Demonstrate that the company is currently not in compliance with the internal limit

Planned income for change for VA at 99% = 279.15 = Planned income × Volatility × I(X)
(A) = 300*0.4*2.33= 279.60

LTC Change in Net income at 99% = 100*0.2*2.33 (B) = 46.60
DI Change in Net Income at 99% = 80* 0.1 *2.33 (C) = 18.64
Total net income with diversification
$= (A^2 + B^2 + C^2 + 2*A*B*Cov(A,B) + 2*A*C*COV(A,C) + 2*BC*Cov(B,C))^{0.5} =$
$(279.60^2 + 46.60^2 + 18.64^2 + 2*279.60*46.60*0.25 + 2*279.60*18.64*0.4 + 2$
$*46.60*18.64*0.75) = 304.44$
Internal minimum capital: 2 * 304.44 = 608.88 > 500
The company fails to achieve its requirement

(b) Determine which of the two lines K-Life should sell to maximize expected annual income and comply with the limit. Show your work

Methodology 1 to calculate answer

Volatility of net income for VA and LTC =
[(Planned income × volatility^2 + planned income × vol^2 + 2 × cov (A,B) × planned income × planned income * volatility × volatility)]$^{0.5}$ = 126.49

Total Net income at 99% for VA and LTC = Net income for Va + LTC – change in net income at 99% = 300 + 100 – 2.33*126.49 = 105.28

Volatility of net income for VA and DI = [(Planned income × volatility^2 + planned income × volatility^2 + 2 × cov (A,c) × planned income × planned income * volatility × volatility)]$^{0.5}$ = 123.42

11. Continued

Total Net income at 99% for VA and DI = Net income for Va + DI – change in net income at 99% = 300+80 – 2.33*123.42 = 92.44

Sell DI line since the net income at the total net income at the 99% is lower than the net income with VA and DI

Methodology 2 to calculate answer
VA Change in Net income at 99% =300 * 0.4 *2.33 = Planned income x Volatility × I(X) (A) = 279.60
LTC Change in Net income at 99% = 100*0.2*2.33 (B) = 46.60
DI Change in Net Income at 99% = 80* 0.1 *2.32 (C) = 18.64

VA and LTC Change in NET income at 99% = Change in NI for VA and LTC

$$= (A^2 + B^2 + 2 \times \text{Cov}(A,B) * A * B)^{0.5}$$

$$= (279.60^2 + 46.60^2 + 2 * 0.25 * 279.60 * 46.60)^{0.5} = 294.72$$

VA and DI Change in NET income at 99% = Change in NI for VA and DI

$$= (A^2 + C^2 + 2 \times Cov(A,C) * A * C)^{0.5} = (279.60^2 + 18.64^2 + 2 * 0.4 * 279.60 * 18.64)^{0,5}$$

$$= 287.56$$

Total 1-year net income at 99% for VA and LTC = VA + LTC net income – change in net income $= 300 + 100 - 294.72 = 105.28$

Total 1-year net income at 99% for VA and DI = VA + DI net income – change in net income = 300 + 80 – 287.56= 92.44

Sell DI line since the net income at the total net income at the 99% is lower than the net income with VA and DI

Internal minimum capital: 2 * 294.72 or 2 * 287.56 > 500 – still fails due to VA requirements
VA limit on capital: 2 * 279.6 = 559.2 – only negative correlation would help

(c)(i) Evaluate appropriateness of the Var-Covar methodology to assess tail risk

- Results are highly depending on the volatility and correlation any change in those will materially affect the results
- Only one results is produced no confidence interval produced, this is misleading since there is a range of results
- One of the key problems is the assumed normality of returns, which is not appropriate for more complex product

11. Continued

- Another problem is that the methodology assumes multivariate distribution this may not cope well with fat tails
- Information assume market conditions are normal, this may not capture all the interactions that could make results worse
- Overall the variance-covariance approach obtain results quickly and is easy to use, however additional information should be produced before final decision is taken.

(c)(ii) Compare the Monte Carlo Simulation and Historical Simulation approach against the Variance-Covariance approach in calculating VaR.

- Monte Carlo Simulation comparing to analytic VAR-COV approach
- Can choose any analytic multivariate distribution for the risks factors
- Only limitations is the ability to estimate parameters
- Flexible and allows to choose distribution with fat tails and skewness
- Historical Simulation Approach comparing to analytic VAR-COV approach
- No need to make any assumptions about the distribution of VAR
- No need to estimate parameters (Volatilities, correlations)
- Use empirical distribution generated from historical realized events over specific time period
- Fat tail distributions and extreme events captured only if happened in the data set studied
- Nonparametric and does not depend on any assumptions about distribution of risk factors

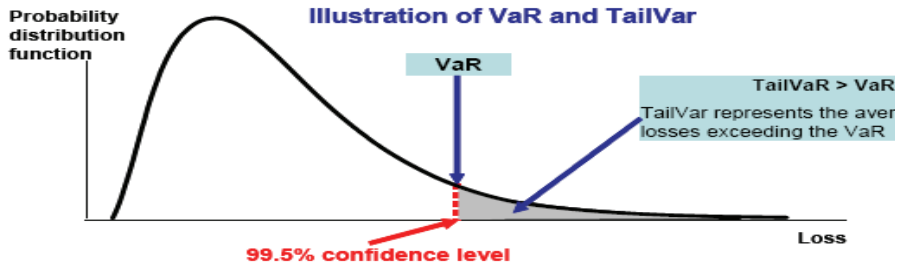
(c)(iii) Recommend an approach to improve K-Life's tail risk analysis

Would recommend Monte Carlo approach with distribution selected reflecting fat tail.
Justification - Variance-Covariance Approach assume risk factors log-normally distributed therefore would ignore fat tail
Justification - Historical Approach use historical realization of risk factors to create empirical distribution, if no fat tail event, then does not create fat tail
Justification - Monte Carlo Approach is implemented by choosing any analytic multivariate distribution therefore can select distribution with fat tail

(d) Demonstrate graphically the difference between VaR and CTE and describe advantages

Candidates did very well in this section.

11. Continued



- Axis Name - Probability of distribution function AND Axis Name – Loss
- Selecting a confidence interval
- Curve shown
- Showing VAR
- Showing TVAR /CTE
- Brief explanation of VAR and CTE, CTE/TVAR > VAR average of losses exceeding VAR
- CTE is coherent risk measure
- Extension of VAR, average of values above VAR
- Advantage: Provide better indication of potential magnitude of loss in tails

(e) Describe three additional extensions to K-Life's current VaR approach. Provide one advantage for each extension

Source: Crouhy Ch.6 - Measuring Market Risk: Extensions of the VaR approach

Incremental VAR

- measure the impact of adding of eliminating a line of business/product to total net income
- Can be positive is positively correlated and add to overall risk to net income
- Advantage: can look at the impact of specific line of business on the overall company

Delta VAR

- measure the risk contribution of asset/product to overall risk of portfolio
- Total VAR is sum of all Delta VAR
- Once most significant delta VAR are identified can find optimal hedge strategy
- Advantage: can identify where to spend resource to decrease risk

11. Continued

Stress test

- Use to analyze extreme events that lie outside normal conditions
- for example, high correlation, high volatility
- can be use for longer time horizons
- Advantage: can incorporate additional risks (like liquidity risk)
- Advantage: can run specific scenario without having specific assumptions/conditions

Scenario analysis

- Use to determine the size not the frequency of potential loss
- Would consist of extreme changes in the value of a risk factor
- Advantage: Help identify the vulnerability of portfolio to extreme events

12. Learning Objectives:

3. Risk Management

c. Identify and describe means for reducing risk without transferring it (internal hedges)

d. Describe how the performance of risk transference activities may be evaluated.

Sources: FE-C117-07: *Integrated Risk Managemen*t, Doherty.

Comments on the question: This question illustrates the advantages of hedging at an enterprise level in an idealized simplify situation. It required application rather than just memorization. Generally, candidates who spent time on this question showed understanding of the concept in a non-insurance setting. However, since this was the last question in the afternoon some candidates did not make a good effort on this one. Better time management – not spending more than 3 minutes on a point – may have improved some of these scores.

(a) Explain why the CFO's hedging goal and recommended hedge method are not optimal for WithBothHands:

- Having both subsidiaries fully hedge independently would be redundant
- Sugarfactory and Candy Co. are natural (or internal) hedges against one another for WithBothHands
- Only the net exposure should be hedged at the parent company level as it achieves the same degree of risk mitigation as having each subsidiary fully hedge. The expected profits of WithBothHands would be higher since it avoids the additional transaction costs of purchasing hedges that already have natural offsets.
- By hedging only the incremental exposure, you save the cost of 10 hedge units (you buy 5 units instead of buying 10 and selling 5)

(b) Describe and recommend the optimal hedge position to mitigate the risk of WithBothHands's total exposure to sugar prices

- The unhedged profit of WithBothHands is $\Pi W = \Pi S + \Pi C$
  $= (20 + 10P + S) + (100 – 5P + C)$
  $= 120 + 5P + S + C$
- Therefore, to be fully hedged against the price of sugar, WithBothHands only needs to buy 5 units of the hedge at the parent company level and have both Sugarfactory Inc. and Candy Co. be unhedged.

12. Continued

Points were also given either of these two recommendations.

- Have Sugarfactory buy 5 units of the hedge and have Candy Co. be unhedged
- Have Candy Co. buy 5 units of the hedge and have Sugarfactory be unhedged

(c) Calculate the increase in profit and reduction in risk that WithBothHands could achieve by adopting your recommendation compared to WithBothHands' current method and the CFO recommendation

STATUS QUO

- To be fully hedged against the price of sugar, Sugarfactory Inc. would buy 10 units of the hedge, with a total transaction cost of 10.
  $\Pi S = 20 + 10P + 10H + S - 10$
  $\Pi C = 100 - 5P + C$
  Thus, $\Pi W = \Pi S + \Pi C = 110 + 5P + 10H + S + C$
  $E(\Pi W) = 110 + 5\times E(P) + 10\times E[E(P) - P] + E(S) + E(C)$
  $= 110 + 5\times 10 + 10\times 0 + 0 + 0$
  $= 160$
  $Var(\Pi W) = 52\times Var(P) + 102\times Var[E(P) - P] + Var[S] + Var[C] + 2\times Corr[5P, 10H]\times 5\times \sigma(P)\times 10\times \sigma(E(P) - P)$
  $= 25\times 52 + 100\times 52 + 52 + 102 + 2\times(-1)\times 5\times 5\times 10\times 5$
  $= 750$
  $\sigma(W) = 7500.5 = 27$

PROPOSED

- As illustrated in part (b), WithBothHands only needs to buy 5 units of the hedge at the parent company level, and have both Sugarfactory Inc. and Candy Co. be unhedged.
  Thus, with the hedge, $\Pi W = 120 + 5P + 5H + S + C - 5$
  $E(\Pi W) = 115 + 5\times E(P) + 5\times E[E(P) - P] + E(S) + E(C)$
  $= 115 + 5\times 10 + 5\times 0 + 0 + 0$
  $= 165$
  $Var(\Pi W) = 52\times Var(P) + 52\times Var[E(P) - P] + Var(S) + Var[C] + 2\times Corr[5P, 5H]\times 5\times \sigma(P)\times 5\times \sigma(E(P) - P)$
  $= 25\times 52 + 25\times 52 + 52 + 102 + 2\times(-1)\times 5\times 5\times 5\times 5$
  $= 125$
  $\sigma(W) = 1250.5 = 11$

12. Continued

CFO Recommendation

- To be fully hedged against the price of sugar, Sugarfactory Inc. would buy 10 units of the hedge, and Candy will sell 5 units

$\Pi S = 20 + 10P + 10H + S - 10$

$\Pi C = 100 - 5P - 5H + C - 5$

Thus, $\Pi W = \Pi S + \Pi C = 105 + 5P + 5H + S + C$

$E(\Pi W) = 105 + 5 \times E(P) + 5 \times E[E(P) - P] + E(S) + E(C)$

$= 105 + 5 \times 10 + 10 \times 0 + 0 + 0$

$= 155$

$Var(\Pi W) = 52 \times Var(P) + 52 \times Var[E(P) - P] + Var(S) + Var[C] + 2 \times Corr[5P, 5H] \times 5 \times \sigma(P) \times 5 \times \sigma(E(P) - P)$

$= 25 \times 52 + 25 \times 52 + 52 + 102 + 2 \times (-1) \times 5 \times 5 \times 5 \times 5$

$= 125$

$\sigma(W) = 1250.5 = 11$

Therefore, by adopting an integrated risk management approach to hedging, WithBothHands would increase its expected profits by 5 and reduce its risk.