ILA LRM Model Solutions
Spring 2015

1. Learning Objectives:

1. The candidate will demonstrate an understanding of the principles of Risk Management.

Learning Outcomes:

(1a) Define and evaluate risk.

(1b) Evaluate the role of risk management within an insurance company

Sources:

LRM-102-14 Insurance Criteria, Refining the Focus of Insurer Enterprise Risk Management Criteria, page 1-2

ERM Specialty Guide, May 2006 – Chapters 1 – 6, page 26

Commentary on Question:

Most candidates didn't see outsourcing as a risk transfer/sharing mechanism and instead most thought that outsourcing increased risk.

Solution:

(a) Evaluate ABC's Risk Control Process.

Commentary on Question:

For part a), to get maximum points, the candidate not only needs to list the risk control process steps, but to also comment on how ABC's operation fits into the risk control process framework.

Risk Control Process Evaluation:

1. Identifying the risks: lapse risk is monitored, and the company is attempting to manage underwriting, claims, and investment plus their associated expenses via outsourcing. However, mortality risk is a possible exposure, and guarantee risk has been dismissed as part of the asset management outsourcing.
2. Risk evaluation: some key risks may be improperly evaluated such as their segregated fund guarantee exposure.
3. Monitor the risks: lapse risk is monitored on a reasonably frequent timeframe with in an appropriate environment, but should extend monitoring to include mortality exposure.

1. Continued

4. Risk limits: no explicit limits are set, but outsourcing limits exposure to key risk areas. No risk-appetite stated.
5. Risk avoidance: some risks are mitigated via outsourcing arrangements
6. Offsetting risks: there are no offsetting mortality/lapse risks in the block and no hedging of the segregated fund guarantee. Both T-100 and segregated fund guarantees are often lapse supported.
7. Transferring risks: mortality risk is accepted but not monitored, and without such monitoring and analysis, the company cannot easily evaluate its retained risk and whether reinsurance is a suitable risk transfer option. While the segregated fund guarantee assets may be managed externally, the underlying guarantee hedging strategy needs to be evaluated by ABC.
8. New Product Review: limited evidence of a rigorous process for evaluating new product initiatives; basic signaling from capital management area in terms of business capacity without proper risk assessment.

(b) You have been asked to investigate ABC's Enterprise Risk Management (ERM) Quality Classification:

(i) (2 *points*) Propose which of the ERM Quality Classifications is currently appropriate for ABC. Justify your answer.

(ii) (*2 points*) Explain how ABC could improve its ERM Quality Classification, if possible.

Commentary on Question:
Most candidates evaluated ABC's ERM quality as "weak", and as long as appropriate justification specific to ABC was provided, both "weak" and "adequate" were considered to be acceptable classifications.

(i) "Adequate" classification:

1. There are 4 classifications: weak, adequate, strong, and excellent insurer ERM programs. ABC's ERM program is "adequate".
2. ABC has a fully functioning risk control system in place for major risks; an Experience Monitoring team tracks lapse experience, which providing yearly revisions to pricing and valuation assumptions.
3. Unusual losses outside risk tolerances not expected unless a rapid and major change occurs in the environment related to their major risks.
4. However, ABC's strategy is classical and silo-based, and lacks clear vision of overall risk profile and a robust process for identifying and preparing for emerging risk; possible examples could include mortality and guarantee risk.

1. Continued

(ii) Ways to improve on "adequate" classification:

1. Fully identify, measure and manage risk exposure for new business pricing;
2. Implement hedging to control risk exposure of existing segregated fund products;
3. Create vision of overall risk profile;
4. Establish overall risk tolerance;
5. Build process for developing risk limits from overall risk tolerance that is tied to risk-adjusted returns for the various alternatives;
6. Optimize for risk-adjusted returns;
7. Create robust process to identify and prepare for emerging risk

(i) "Weak" classification:

1. There are 4 classifications:, weak, adequate, strong, and excellent insurer ERM programs. ABC's ERM program is "weak".
2. Risk control is incomplete for one or more major risks; ABC hasn't fully identified, measured, or managed all major risk exposures.
3. ABC appears to be incapable of consistently controlling all major risks with a limited and selective approach to risk management

(ii) Ways to improve on "weak" classification:

1. Have a fully functioning risk control systems in place for all – not just some – major risks;
2. Fully identify, measure and manage risk exposure for new business pricing;
3. Implement hedging to control risk exposure of existing segregated fund products;
4. Create vision of overall risk profile, create an ERM department, and create a cross-risk view for the entire company;
5. Establish overall risk tolerance;
6. Build process for developing risk limits from overall risk tolerance that is tied to risk-adjusted returns for the various alternatives;
7. Begin to make decisions based on risk-adjusted returns;
8. Create a process to prepare for emerging risk

2. Learning Objectives:

4. The candidate will demonstrate an understanding of the principles of modeling, cash flow testing and asset-liability matching, and perform related calculations.

Sources:
ERM-111-12: Key Rate Durations- Measures of Interest Rate Risks, page 2-3, page 14

Commentary on Question:
This question tests candidates' knowledge of practical ALM applications, as well as a candidates' ability to justify a statement of agreement/disagreement with supporting evidence.

In general, candidate performance was roughly equivalent between parts (a) and (b). See the individual sections below to determine where candidates did well and where candidates had trouble.

Solution:

(a) One of your analysts proposes that matching effective duration of XYZ Life's assets and liabilities is sufficient to manage interest rate risk exposure. XYZ Life's liability portfolio behaves like an option-embedded bond. State whether you agree or disagree with your analyst's proposal. Justify your answer.

Commentary on Question:
To receive full credit on part a), a well-prepared candidate should 1) explicitly disagree with the analyst's proposal, and 2) justify the answer by both explaining the shortcomings of the proposal and proposing an alternative.

Common mistakes in part a included the following:

- *Many candidates only disagreed and explained the shortcomings of effective duration, but did not provide additional justification by providing a superior alternative; this approach received partial credit.*

- *A small yet significant number of candidates explained the shortcomings of effective duration and/or proposed alternatives, but failed to state whether or not they agreed or disagreed with the proposal. While it is likely that these candidates would disagree, the question specifically asks for agreement or disagreement. Clear disagreement should be stated to receive credit for that portion of the question.*

2. Continued

I disagree with the analyst's proposal.

Effective duration is a measure of the change in security value to an infinitesimal parallel shift of the spot curve. It is often inadequate in measuring interest rate exposure.

Key rate duration (KRD) has several advantages over effective duration:

- It can identify the price sensitivity of an option-embedded bond to each segment of the spot yield curve.
- While effective duration is the total risk exposure, the KRD measures the component part of the effective duration.
- KRD recognizes that yield curve movement is driven by multiple market factors, and is applicable over a broad range of yield curve movements.
- KRD can be used to easily create a replicating portfolio of a bond with embedded options using just zero coupon bonds.

(b)

(i) (*1 point*) Calculate the key rate duration of the bond index.

(ii) (2 *points*) Construct a portfolio of zero-coupon bonds from the above bond index to replicate this product's liabilities.

Commentary on Question:
The calculation portion of this question was straightforward; most candidates either fully knew the calculations or knew none at all. Approximately half of all candidates correctly answered part (i), while less than half correctly answered part (ii).

Common mistakes in part b included the following:

- *Many candidates incorrectly calculated the key rate duration of the bond index as an average of the sum of the individual key rate durations (3.25 / 6) = 0.54.*

- *The product's liability duration of 20 years was extra information that was not needed to answer the question. Some candidates constructed arbitrary portfolios of zero-coupon bonds such that the asset portfolio duration was 20 years; this approach did not receive any credit.*

2. Continued

(i) The key rate duration of the bond index is the sum of the individual key rate durations:

KRD = (0.05 + 0.2 + 0.7 + 1.0 + 0.7 + 0.5) = 3.25

(ii) W(i) = Weight for the ith key rate
= D(i)/T(i), where D(i) is the duration and T() is the term of the ith key rate

W(0) + W(1) + …+ W(6) = 1
VW(0) + VW(1) + …+ VW(6) = V

One must invest VW(i) in the zero-coupon bond on the term of ith key rate, and hold VW(0) cash

Portfolio duration = W(i) * T(i)

Thus, one must purchase:
100 million * 0.05/0.25 = 20 (million)
100 million * 0.2/1 = 20
100 million * 0.7/2 = 35
100 million * 1.0/5 = 20
100 million * 0.7/10 = 7
100 million * 0.6/30 = 2

Total = 20 + 20 + 35 + 20 + 7 + 2 = 104 million

The sum of the total investment is $104 million, so one must short 4 million in cash.

3. Learning Objectives:

1. The candidate will demonstrate an understanding of the principles of Risk Management.

Learning Outcomes:

(1b) Evaluate the role of risk management within an insurance company

(1d) Describe how risk management techniques may be used to manage capital deployed by insurers and how they impact strategic decision making.

Sources:

Financial Enterprise Risk Management, pages 7-8

Risk Appetite: Linkage with Strategic Planning, pages 29-36

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Describe the role of the central risk function (CRF) in each of the following models of risk management:

(i) Three Lines of Defence

(ii) Offence and Defence

(iii) Policy and Policing

(iv) Partnership

Commentary on Question:

Overall, candidates did very well in this section. As part of the answer, candidates needed to build on simply stating where the central risk function fit in each model. To receive full credit, the role and activities of the central risk function had to be discussed and any key advantages/disadvantages of the model needed to be identified.

(i) Three Lines of Defense – This model classifies an organization into three lines, each having its own role in risk management. It explains the responsibilities well, but is not very clear on the degree of interaction between the different lines.

a. The first level is taken on by the business units. They conduct the day to day management for the company which includes pricing and sales.
b. The second level is the central risk function. They have independent ongoing oversight of the day to day line with varying degrees of intervention.

3. Continued

c. The last level is audit which oversees both the first two levels, but on a less frequent basis

(ii) Offense and Defense – In this model, the first and second lines are set up in opposition. The first-line business units try to take as much risk as possible as part of their day to day activities while the second-line central risk function tries to reduce risk as much as possible to minimize losses. The results of this approach are rarely optimal. It would be better for each side to consider both risk management and maximizing the effectiveness of the risk budget.

(iii) Policy and Policing Model – The central risk function sets risk management policies and then monitors that the other areas in the company comply with these policies. This model helps avoid the confrontation that can occur in the offence and defense model but also lead to a CRF that is too detached.

(iv) Partnership Model – The central risk function works together with the first-line business units, with each working together to maximize returns while also taking on an appropriate risk. Frequently, this involves embedding risk professionals in the first-line business units to ensure communication occurs on a day to day basis. This model is considered a good way for the two levels to work together, however, it can hinder the CRF's ability to give an independent risk management assessment.

(b) Calculate the risk-adjusted return on capital (RAROC) for 2014 new business for each of the following:

(i) UL-SG product

(ii) VA product

(iii) LFW's combined insurance portfolio

Commentary on Question:
Again, candidates did fairly well with this section. To receive full credit, the candidate needed to do the following:

1) *Provide the proper full formula for RAROC*
2) *Show the calculation of the pieces of RAROC for UL-SG, VA, and the combined insurance portfolio*
3) *Arrive at the correct final RAROC values*

3. Continued

Partial points were given for each section if the general RAROC formula was followed but if one of the pieces were calculated incorrectly. Common errors included the exclusion of the investment income on capital piece and/or the incorrect use of 2014 premium in the calculation of the present value of underwriting profit.

RAROC = (PV(Underwriting Profit) + PV(Investment Income on Capital)) / (PV(Required Capital)) * (1 – tax rate)

Tax rate is given as 0% for the (1-tax rate) piece can be ignored.

Profit Margin = PV(Underwriting Profit) / PV(Premium) therefore:
PV(Underwriting Profit) = PV(Premium) * Profit Margin

PV(Investment Income on Capital) = Interest Rate * PV(Required Capital)
PV(Investment Income on Capital) = .04 * PV(Required Capital)

(i) UL-SG
   a. PV(Underwriting Profit) = 250 * .08 = 20
   b. PV(Investment Income on Capital) = 125 * .04 = 5
   c. RAROC = (20 + 5) / 125 = .20

(ii) VA
   a. PV(Underwriting Profit) = 100 * .12 = 12
   b. PV(Investment Income on Capital) = 80 * .04 = 3.2
   c. RAROC = (12 + 3.2) / 80 = .19

(iii) Combined Insurance Portfolio - No diversification benefit means that the products can simply be summed for the RAROC pieces.
   a. PV(Underwriting Profit) = 20 + 12
   b. PV(Investment Income on Capital) = 5 + 3.2
   c. RAROC = (32 + 8.2) / (125+80) = .1961

(c) Propose a revised new business plan which maximizes RAROC while satisfying the following requirements:

- Hold 225% of minimum required capital for each product
- Increase 2016 expected sales by at least 5% for each product

Commentary on Question:
The candidates had more difficulty with this section of Question 3. The most common issue for candidates who attempted part c is that they only addressed a small part of the problem and failed to provide a complete answer.

3. Continued

In order to receive full credit, the following had to be completed:

1) *The current business plan had to be evaluated to understand what capital was available for a revised business plan. This involved comparing the current capital levels to the $135 million of available capital.*
2) *The candidate needed to identify that maximizing sales of UL-SG would maximize RAROC*
3) *Both sales and required capital levels needed to be calculated for the two product lines. The candidate needed to clearly show that these followed the requirements stated in the question.*
4) *The revised RAROC should have been calculated*

Partial credit was given for answers that incorporated some, but not all, of the pieces above.

Partial credit was also given to candidates who provided a plan for UL-SG and Variable Annuity sales/required capital which fit all of the restrictions but did not maximize RAROC.

LFW has $135M in available capital currently. The company has a minimum required capital ratio of 225%. This means that they have a level of current available capital of $135M/2.25 = $60M. The current business plan for 2016 has $28M + $25M = $53M of minimum required capital which leaves an available $7M of current minimum required for increases in sales.

The most efficient way to maximize RAROC in this scenario is to target the UL-SG product as it has a higher RAROC on an identical level in the present value of required capital. Therefore, the plan should target the minimum amount of VA sales which would be $50M * 1.05 = $52.5 (5% increase is required for both products). This increases the minimum required capital for VA to $25 * 1.05 = $26.25. This leaves $60M - $26.25M = $33.75 for UL-SG which represents a 20.5% increase. This leaves sales at $100M * 1.205 = $120.5M.

Ultimately, this leaves a total minimum required capital which fits within the $60M requirement as $26.25 + $33.75 ≤ $60M. Both products increased by at least 5%, fulfilling that requirement as well.

New RAROC will then be a weighted average of the two products based on total capital requirements.

RAROC = (60 * 225% * 1.205 *25% + 60 * 225% * 1.05 * 15%) / (60 * 225% * 1.205 + 60 * 225% * 1.05) = 20.34%

4. Learning Objectives:

3. The candidate will demonstrate an understanding of important risk measurement techniques along with their uses and limitations, and be able to perform risk measurement calculations.

Learning Outcomes:

(3a) Analyze and evaluate risk measures & estimators (e.g., Value-At-Risk, Conditional Tail Expectations, etc.)

Sources:

ERM - 102 - 12 Value-At-Risk: Evolution, Deficiencies and Alternatives - Vozian 2010 (also FE-C181-11)

Chapter 33 The New Corporate Finance - Value at Risk - Uses and Abuses - Chew 2001

VAR: Seductive But Dangerous, Beder 1995

Commentary on Question:

This question tested the candidates' understanding of the VaR risk measure, its limitations and properties. Candidates were required to demonstrate the their understanding of different ways to estimate VaR (e.g. historical simulation and Monte Carlo) and recognize the pros and cons as well as the factors that influence the model parameters. In addition, the candidate is expected to demonstrate that VaR should not be used as a standalone measure of risk but in combination with other measures of risk. Candidates received full credit if they were able to demonstrate these concepts clearly.

Solution:

(a) The Chief Actuary has reviewed these results and made the following statements:

(i) "Portfolio B is our riskiest portfolio since it has a higher VaR."

(ii) "The 95% VaR of the combined portfolios is 24; this is the number on which we should base our risk analysis."

Critique these statements.

Commentary on Question:

This question tested the candidates' knowledge of the VaR as a risk measure and its limitations. In addition, candidates were tested on the relationship between individual VaR and portfolio VaR. Most candidates understood the concept of VaR and it's limitations a risk measurement tool. Candidates also had a general understanding that VaR is not sub-additive. Candidates did not get full marks if they stated the VaR is not sub-additive but then was unable to illustrate this in the context of the question.

4. Continued

(i) The chief actuary's comment is not necessarily correct because while portfolio B has the highest VaR, VaR does not indicate tail risks. For example, although portfolio B has a higher VaR, portfolio A has a scenario that produces the highest loss (scenario 3 has a value of -20). You could argue that portfolio A is actually riskier.

(ii) The chief actuary's statement is not necessarily correct. I am assuming that he just summed the individual VaR's of each portfolio. This is incorrect since VaR is not sub-additive. Therefore, depending on the correlation between both portfolios, aggregating the portfolios could result VaR being higher or lower than 24.

(b) Explain why Luck Life's VaR might be different than Chance Mutual's.

Commentary on Question:
Most candidates understood and were able to list some of the major reasons (correlation assumptions, data, etc.) why Luck Life might have a different VaR than Chance Mutual. Candidates only needed to list a majority of the reasons to get full credits.

1. **Time Horizon**: Luck Life and Chance Mutual may have used different time horizons for their VaR calculations, which would likely cause different results.
2. **Data**: Despite using the same VaR method, the two companies may have used different data sets, which could lead to different results.
3. **Outliers**: The two companies may treat outliers differently.
4. **Assumptions**: The two companies may also have used different correlation assumptions.
5. **Public vs Private**: The type of company may influence the time horizon selected since both types of companies have different risk tolerances. For example, a public company has lower risk tolerance and may select a horizon with more stable history.

(c)

(i) (*1 point*) List the motivating factors that may influence the choice of time horizon.

(ii) (2.5 *points*) The Chief Actuary states *"For all future VaR calculations, we should use the historical simulation method because historical data is the best data available. We should also use a 1 day time horizon because it will always result in a bigger VaR."*

Critique this statement.

4. Continued

Commentary on Question:
Most candidates were not able list the most of motivating factors that influenced the choice of time horizon. However, most candidates were able to identify the major limitations of historical simulation. Once a candidate demonstrated understanding of the concept most of the credits were awarded.

(i) Timing of employee performance evaluation
Key management decision making (e.g., asset purchase)
Major reporting event (e.g., board meeting or required disclosure)
Regulatory examination

(ii)

- Historical data is not necessarily the best data to use for a VaR calculation as history must repeat itself in order to predict the future
- The 100 day historical simulation is a relative short period of historical observation
- A 1 day time horizon does not always result in a larger VaR; VaR usually increases with increasing time horizons
- Luck may want to consider using a different model for VaR, such as a Monte Carlo simulation which is not dependent on the horizon of the data.
- Since it is an insurance company with long-term liabilities, it may be more appropriate to use longer time horizons.

5. Learning Objectives:

2. The candidate will demonstrate an understanding of the various sources of risks faced by an insurer.

Learning Outcomes:

(2a) Identify, categorize and evaluate potential sources of risk in products including but not limited to mortality, morbidity, and lapse.

(2b) Identify, categorize and evaluate potential sources of risk in investments including but not limited to credit risk, liquidity, equity-based exposure and asset-liability matching.

(2c) Describe and evaluate the other risks an insurance company faces including operational, marketplace and expense risks.

Sources:

Case Study

ILA-C 116-07 – mapping of life insurance risks pp 1-7

ILA – 124 10 – Insurance Criteria p 29

Sweeting chapter 7 pp 99-100, 105-110

Risk Appetite: Linkage with Strategic planning

Commentary on Question:

Most candidates did poorly on section b). It appears many viewed the question much like c) and focused on product changes, not the processes that could be used to mitigate the risk (risk sources, tolerances, ERM, and investment strategies).

Solution:

(a) Explain new product, investment and business risks that would be introduced to Simple Life if they agree to the broker's proposal.

Commentary on Question:

The focus of this part is on the risks of the new venture – product, investment and business. The first paragraph includes major considerations. The second paragraph is an example of many secondary considerations that would have less impact – there were many possible alternatives here to receive full credit.

Simple life currently sells to males and this product is to females - so they have no experience on which to base future results for their assumptions.
There is further risk from the inadequate pricing that stems from random fluctuation in claims.

5. Continued

Underwriting these large face amounts will cause considerable strain and there is a risk that Simple life will not have sufficient capital.
Simple life is already struggling to meet investment requirement, this higher minimum may not be supportable without weakening of the quality of the fixed assets.

Since this is a new market the policyholder behavior may be different.
New broker relationship will need more attention.
Admin systems is already strained and this new product will need additional changes and monitoring of sales practices.
The volume of sales could lead to a concentration of risk in the UL line of business.
Small blocks with high face/premiums could lead to a lumpy risk profile.

(b) Identify changes Simple Life should make to their risk management processes if the broker meets their sales objective.

Commentary on Question:
This part of the question is to focus on the risk management function – ERM – and how to ensure that it will control the risks mentioned above in a. The first paragraph includes major considerations. The second paragraph is an example of many secondary considerations that would have less impact – there were many possible alternatives here to receive full credit.

Risk tolerance, appetite for each category, as well as risk limits needs to be reviewed with the new opportunity.
Review of the measures to track risk exposures – new business volume, market share, persistency EV of new business.
New initial needs to be reviewed to see if it fits in with the company's capability and strategic plans.

Over-reliance on one distribution channel may be an uncomfortable exposure.
Very large policy sizes could create more volatility.
Concentration of risk in new product – could also be a diversification benefit.
Increased pressure on asset returns could lower the credit quality of the investment portfolio. May need to define a new investment strategy to support this product.
A sound practice should also design a full control process, including ongoing post-implementation process to monitor performance.

5. Continued

(c) Recommend changes to the broker's proposal to reduce the risk for Simple Life.

Commentary on Question:
This part is asking for changes to the product proposal so that the risks stated above in a) are reduced.

This product needs adjust the compensation levels and product guarantees to fit into the same pricing/profit framework as current UL.
Simple Life should consider limiting sales volumes, and/or limiting the size of policies.
Should also restrict replacement of broker's existing business with this new product.