ILA LRM Model Solutions
Fall 2015

1. Learning Objectives:

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

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

Learning Outcomes:

(1a) Define and evaluate risk.

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

(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.

Sources:

CIA: Dynamic Capital Adequacy Testing (DCAT) Education Note, November 2007 (pages 4 - 33)

A New Approach for Managing Operational Risk - SoA Research 2008

LRM-100-14 The Theory of Risk Capital in Financial Firms - Chew

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Describe the goals of stress testing as discussed in the CIA DCAT Educational Note.

Commentary on Question:

For part a), most candidates were able to identify the goals, but to get full credit, they were also required to define them as per the DCAT Educational Note. Some candidates referenced broader stress testing goals not specific to DCAT.

1. Continued

i. Risk Identification – stress testing may be included in risk management activities, ranging from risk mitigation at a detailed or portfolio level.
ii. Complementary risk perspective – stress testing can complement other techniques and provide a perspective on complex risks and simultaneous shocks
iii. Supporting capital management – stress testing can help identify compounding events or changes in market condition that would impact the financial health of the institution
iv. Liquidity management – stress testing is a central tool to controlling funding liquidity risks

(b) Describe reverse stress testing.

Commentary on Question:
Most candidates understood that reverse stress testing involved testing to what degree risk factors would need to change to arrive at a particular result, but they were required to identify the threshold as turning surplus negative and assess if the degree of change was plausible to get full credit.

Reverse stress testing involves determining how far risk factors have to change in order to drive an insurer's surplus negative during the forecast period and then evaluating if that degree of change is plausible.

(c) Assuming interest rates decrease by 2.5%:

(i) Calculate the change in surplus using modified duration.

(ii) Calculate the change in asset duration which results in zero surplus using modified duration.

Commentary on Question:
Most candidates fared well on this question and correctly calculated both parts.

Some candidates missed the final step of subtracting the result from the initial data (i.e. they identified that surplus became -250, but not that it was a drop in surplus of 750).

In part b), a number of candidates did not consider that the initial surplus was positive rather than zero, and calculated a higher change in asset duration than necessary.

1. Continued

(i)

Assets = 2000 Modified Duration of Assets = 7.5
Liabilities = 1500 Modified Duration of Liabilities = 30
Surplus = 500

Change in Assets $= -(2000 \times 7.5 \times -0.025) = +375$
Change in Liability $= -(1500 \times 30 \times -0.025) = +1125$

New Asset Value = 2000 + 375 = 2375
New Liability Value = 1500 + 1125 = 2625
New Surplus = 2375 – 2625 = –250

Change in Surplus = –250 – 500 = –750

(ii) Assume y is the minimum duration of the asset which will result in at least zero surplus:

$(2000 + -(2000 \times y \times -0.025)) - (1500 + 1125) \geq 0$
$50y - 625 \geq 0$
$50y \geq 625$
$y \geq 12.5$

If the interest rate drops 2.5%, the asset will at least equal the liability with a modified duration of at least 12.5, or 5 greater than it is currently.

(d) Calculate:

(i) Stand-alone risk capital

(ii) Diversification benefit

Commentary on Question:
Many candidates had difficulty with this section of Question 1. This section required an understanding of how lines of business which are not perfectly correlated have a risk at the portfolio level which is less than the sum of the stand-alone risks.

(i) **Stand-alone risk capital**:

Risk Capital $= 0.4 \times A \times \sigma \times \sqrt{T}$,
where A = assets allocated to the business;
σ = standard deviation of profits for the business; and
T = the horizon required for risk capital

1. Continued

Required capital for Business A = 0.4 × 4000 × 0.25 = 400
Required capital for Business B = 0.4 × 4000 × 0.5 = 800
Required capital for Business C = 0.4 × 2000 × 0.75 = 600

Stand Alone Risk Capital = 400 + 800 + 600 = 1800

(ii) **Diversification Benefit**:

Correlation Matrix:

	A	B	C
A	1	0.75	0
B	0.75	1	0
C	0	0	1

Variance of Portfolio = $\sum_{\substack{i\in(A,B,C)\\ j\in(A,B,C)}} w_i w_j \rho_{ij} \sigma_i \sigma_j$,
where w_i =*the weight of total assets from business i;*
ρ_{ij} = *correlation of profits between businesses i and j; and*
σ_i = *standard deviation of profits for business i*

The components of the sum are as follows, and total to 10.25%:

	i=A	i=B	i = C
j =A	1.0%	1.5%	0.0%
j = B	1.5%	4.0%	0.0%
j = C	0.0%	0.0%	2.25%

Standard Deviation of Portfolio = $\sqrt{10.25\%}$ = 32.02%
Risk Capital of Portfolio = 0.4 × 10000 × 0.3202 = 1281
Diversification Benefit = Stand-alone risk capital – Risk capital of portfolio
= 1800 – 1281
= 519

2. Learning Objectives:

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

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

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.

(4a) For an ALM model
- (i) Select appropriate assumptions and scenarios
- (ii) Model dynamic behavior of both assets and liabilities
- (iii) Model and explain various strategies, including hedging
- (iv) Analyze and evaluate results (including actual v. projected differences)
- (v) Recommend appropriate strategies

Sources:

LRM-105-14: Mapping of Life Insurance Risks

LRM-116-14: Life Insurance Forecasting and Liability Models

SOA – Society of Actuaries, 2002 Ch. 2 - Defining Asset-Liability Management

Commentary on Question:

This question contains two key parts. The first part tests the candidate's knowledge of applying modeling simplifications. The second part introduces a common scenario whereby a new product feature is being considered, and two aspects of a new product initiative need to be considered - insurance risk and investment/ALM strategy.

Solution:

(a) Describe two ways to validate modeling simplifications.

Commentary on Question:

Most candidates answered this section well.

2. Continued

Static validation - compares certain known and modeled values from the starting projection date of the model. It is a useful tool to evaluate aspects of the model such as its ability to model reserves, annualized premium, and face amounts.

Dynamic validation - compares trend in actual historical results with the model's projections for goodness of fit. It usually involves looking at many assumptions at once to observe how they interact. Ways of evaluating the quality of a model using dynamic validation including comparing historical changes in reserve with projected changes in reserve, and new sales for an open block model.

(b) Describe two types of trade-offs arising from modeling simplifications.

Commentary on Question:
To receive full credit for this section, candidates needed to identify and define known error and unknown error. Many candidates did not come up with these trade-offs.

Known error - the deviation between the model and a known quantity, such as the starting reserve in a static validation

Unknown error - the error arising from model simplifications that cannot be calculated because there is no data to validate against. An example might be future claims which cannot be validated until the point in time which is projected is reached.

(c)

(i) Calculate the age error for the 35-39 age band, using the number of policies for weighting purposes.

(ii) Calculate the average known error for the 35-39 age band.

(iii) Critique the analyst's approach to modeled age. Justify your answer.

Commentary on Question:
Most candidates correctly calculated the age error in part (i).
In part (ii), some candidates used weightings other than policy count, which was required for full credit. Many candidates did not apply the required formulas.

In part (iii), candidates were required to critique two key aspects of the modeling assumption – the width of the age bands and the modeled age for each. Full credit was given if both aspects were identified and addressed appropriately.

2. Continued

(i) Age error = difference in weighted average age vs modeled age in absolute terms
= (35 × 250 + 36 × 260 + 37 × 200 + 38 × 225 + 39 × 240) ÷ (250 + 260 + 200 + 225 + 240) – 37 = -0.047

The age error is therefore 0.047.

(ii) Static premium error = % deviation from modeled premium from base scenario in absolute terms
= modeled premium per policy × number of policies ÷ actual premium – 1
= (232000 ÷ 200) × (250 + 260 + 200 + 225 + 240) ÷ (275000 + 300000 + 232000 + 270000 + 300000) – 1 = -1.017%

The static premium error is therefore 1.017%

Static reserve error = % deviation from modeled reserve from base scenario in absolute terms
= modeled reserve per policy × number of policies ÷ actual reserve – 1
= (425000 ÷ 200) × (250 + 260 + 200 + 225 + 240) ÷ (500000 + 540000 + 425000 + 480000 + 525000) – 1 = 1.088%

The static reserve error is therefore 1.088%.

The average known error is the average of 1.017% and 1.088%, or 1.052%

(iii) With the exception of the 18-24 age band, the analyst has chosen to model on a quinquennial (i.e. every 5 years) basis and has chosen the midpoint age for every band.

While we have shown that for the 35-39 age band the age error is low, that is not guaranteed for all bands and something close to the weighted average might be the best choice for all age bands instead of the midpoint.

Similarly, the analyst may have chosen 5 year banding for simplicity's sake. However, given the wide range of inforce business mix in each cell, it may be prudent to reduce volatility in the cells with small percentages of business by modeling them with different age bands to reduce the volatility of the simplifying assumption made for them.

2. Continued

(d) The marketing area recommends adding a return of premium (ROP) rider to attract new sales. At the end of every ten year period, for an additional charge of 30% of base premium, 75% of cumulative gross premiums for that period are refunded.

(i) (*3 points*) Assess three risks mapped according to the Federal Reserve Risk categories for the proposed ROP rider.

(ii) (*1 point*) Recommend an asset liability management technique suitable for the ROP rider.

Commentary on Question:
To receive full credit for part (i), candidates were required to identify three risks and why they were relevant for the proposed product feature. Most candidates answered this part well, and could identify and explain at least two risks.

In part (ii), candidates were expected to identify that the specific 10-year timing of the ROP benefit would make asset segmentation and/or cash flow matching more appropriate techniques than duration matching. Full credit was given for an explanation of why either technique would be appropriate.

(i) *(five risks are provided below, but three were sufficient to receive full credit)*

Liquidity risk - as a ten year recurring ROP, each year of new business will likely have a spike in refunds made every ten years. At each of these periods, a significant amount of cash is required to make payments to policyholders

Operational risk - several applicable subcategories such as startup/strategic/business continuation risk - a new product requires significant resources to launch and involves all functional areas such as finance to set up accounting model, IT resources to handle the systems, valuation to determine what reserves need to be set up and maintained, and having enough data to appropriately estimate the cost of the feature for pricing.

Policyholder behaviour/lapse - ROP is usually lapse supported, meaning that based on the 10-year ROP, lapses for a given cohort of business with ROP will have lapses grade to a low level as the ROP matures, and potentially spike immediately after.

2. Continued

Morbidity - ROP business may have different/better morbidity experience since ROP offers more value if the policyholder perceives they are unlikely to need to claim and want the option to be refunded their premiums as a result.

Reserves - ROP usually produces high reserves so investment strategy and ability to meet investment income expectations is crucial in order to be able to meet targets on ROP benefit

(ii) Segmentation – the timing of ROP is fairly certain since it becomes payable at end of each ten year period, so it is reasonable to keep funds separate for completely different patterns of liabilities instead of pooling assets to back the base DI liabilities and the ROP benefit.

Cash flow matching – given the simplicity of the ROP liabilities, duration matching may not be effective because many portfolios could match duration while introducing liquidity risk if no cash is available when ROP benefits become due. It may be more appropriate to invest ROP premium in assets which mature at the appropriate time in the future when the benefit becomes payable.

3. Learning Objectives:

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

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

Learning Outcomes:

(1a) Define and evaluate risk.

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

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

Sources:

LRM-123-15: Enterprise Risk Management, S&P, May 2013

LRM-105-14: Mapping of Life Insurance Risks, AAA Report to NAIC (same as ERM - 401 - 12)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) List the possible overall ERM assessment scores and subfactor scores in the S&P methodology.

Commentary on Question:

Overall, candidates did well in this section. To receive full credit, candidates need to correctly list out all the possible ERM assessment scores, and all the possible subfactors scores.

Possible overall ERM assessment scores:

1 – Very strong
2 – Strong
3 – Adequate with strong risk control
4 – Adequate
5 – Weak

Possible subfactor scores:

- Positive
- Neutral
- Negative

3. Continued

(b) Describe sources of market risk which could emerge if the valuation group does not perform a timely review of the new Variable Annuity product structure.

Commentary on Question:
This section was intended to test that the candidate can demonstrate an understanding of the various sources of risks faced by an insurer.

To receive full credit, candidates need to list at least 4 market risks that could emerge if the valuation group does not perform a timely review of the new product, and be able to describe each of the risk listed.

Many candidates were only able to correctly list and describe one market risk. Many candidates just listed out the sources of market risk but did not provide a description.

- Interest Rate Risk: Risk of adverse interest rate fluctuations. Typically, this is an asset-side risk but may be a liability risk particularly for a life insurer.
- Basis Risk: Risk that yields on investments of varying credit quality, liquidity, and maturity do not move in the same direction and/or same magnitude as the liabilities backed by those investments.
- Reinvestment Risk: Risk that rates will fall causing cashflows from an investment, upon reinvestment to earn less than original underlying assets.
- Currency Risk: Risk that the domestic dollar rises in comparison with other foreign currencies resulting in the decreases in value of the foreign securities.
- Asset/Liability Matching Risk: Risk resulting from the impact of fluctuating interest and inflation rates on the values of assets and liabilities.
- Asset Market Value Risk: Risk that realizable value may be less than carrying value upon conversion to cash because of current market conditions.
- Political Risk: Risk to the value of invested assets associated with changes in government policies.

(c)

(i) Recommend scores for each subfactor.

(ii) Propose ways for Simple Life to improve their scores.

Justify your answer.

3. Continued

Commentary on Question:
This section was intended to test if the candidate can demonstrate an understanding of the principles of ERM, and be able to evaluate the role of risk management as a result of product changes and product development.

To receive full credit for each subfactor, candidates need to provide the appropriate subfactor score, and the reasons for it. Then, candidates need to be able to provide at least 2 ways to improve the scores based on Simple Life's situation.

In part (i), many candidates gave ERM scores (ie very strong, strong, adequate, adequate with strong risk control, adequate or weak) instead of subfactor scores (positive, neutral, negative). However, many candidates provided the appropriate rationale for their recommended score, receiving partial marks.

In part (ii), most candidates were able to provide at least 1 way to improve the score for each subfactor.

Risk Management Culture
Recommended score: Negative
Rationale:

- Incentive compensation is based on sales, not supportive of ERM
- Risk committee is being eliminated, which reduced Board participation in risk management
- Formal ERM framework has not yet been developed
- No formal risk appetite

Ways to Improve Score:

- Align incentive compensation to (risk-adjusted) profit
- Engage Board by retaining risk committee chaired by CRO accountable to the board

Risk Models
Recommended score: Neutral
Rationale:

- Economic capital model only captures interest risk, equity risk, credit risk, mortality risk. Policyholder behavior and operational risk are not included.
- Interaction captured via correlation factors rather than direct modeling

Ways to Improve Score:

- Models should reflect all material risk including interrelations in aggregation
- Company should establish comprehensive model risk policy

3. Continued

Emerging Risk Management
Recommended score: Neutral
Rationale:

- No consistent risk-assessment/pricing of new products or product changes
- No clear communication between product areas and investment areas to allow existing risk assessments to be adjusted for product changes
- Established process for credit risk, market risk, liquidity risk

OR
Recommended score: Negative
Rationale:

- Insurer's level of preparedness if those emerging risks materialize is low
- No evidence of monitoring regulation, the physical environment, the macroeconomic environment and medical developments
- Does not have formal pricing risk assessment completed before launch
- Does not have evidence of any emerging RM process, either formal or informal

Ways to Improve Score:

- Establish formal guidance on risk in product development procedures such as company position/statements on risk and requirement for risk identification, assessment and mitigation
- Perform scenario analysis to estimate the impact of possible adverse events on the insurer's reputation, liquidity, and overall financials (or monitor emerging trend)

4. Learning Objectives:

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

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:

(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.

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

(3b) Apply and analyze scenario and stress testing in managing risk including the calibration and setting of assumptions

Sources:

How Fair Value Measurement Changes RM Behavior in the Insurance Industry SoA-Rosner 2013

Gregory Credit Risk Ch 8 – Credit Exposure

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Describe the advantages and disadvantages of using hedging as a risk management strategy for VAs.

Commentary on Question:

Candidate did well on this part of the question. Most were able to identify the advantages and disadvantages of hedging as a risk management strategy for VAs.

Advantages:

- The economic risk of VA guarantees is too significant and VA hedging programs are highly effective at immunizing financial risks
- Hedging is nearly universal among variable annuity writers. For accumulation benefits and withdrawal benefits, companies largely hedge first-order price risk and interest rate risk
- Insurers having a sound hedging program in place can help gain a competitive advantage, which allows the company to use capital more efficiently and stabilize income

4. Continued

- Hedging can help improve ratings as rating agencies often do not want insurers to be exposed to stock market fluctuations

Disadvantages:

- Hedging requires a significant investment by the company (i.e. specific skills sets, processes, and models spanning multiple departments)
- Companies must exercise judgment when hedging with illiquid instruments
- Hedging can make accounting movements harder to interpret
- Companies currently require a significant amount of computing capacity to recalculate greeks daily

(b) Evaluate the appropriateness of using VaR to measure credit risk exposure. Justify your answer.

Commentary on Question:
Most candidates were able to identify VaR as an inappropriate measure of VA risk due to its short term nature, because it does not account for tail risk, and the fact that it does not satisfy subadditivity. However, to receive full credit, candidates were required to explain what those mean in the context of VAs.

VaR is not appropriate because measuring exposure has these unique additional complexities:

- Time horizon: market risk is short term vs. counterparty risk is long term. Therefore, exposure is path- dependent and needs to be defined over multiple time horizons until the end of contract obligation date. This has two implications: (1) the "ageing" of transactions must be considered, e.g. contractual payments, changes in cash flows, exercise decisions, callability, and, (2) the trend and the volatility of market variables is relevant.
- Risk mitigants: the use of netting and collaterals is common and they reduce future exposures. These risk mitigants do not exist for market risk due to its short-term nature.
- Application. VaR is a risk management approach whereas exposure must be defined for both risk management and pricing. This may require two completely different sets of calculations to evaluate exposure.

(c) Recommend ways DBM Life can manage risk related to money deposited into VAs.

Commentary on Question:
Most candidates were able to identify a broad technique for managing deposits, but specific examples relevant to VAs were required to receive full credit.

Ways to manage risks related to deposits into VAs:

- Reduce ratchets and rollups
- Rrestrict the types of funds available:

4. Continued

- Companies can more closely align the fund choices with tradable indices to limit basis risk in hedging programs.
- Adopt target volatility funds, or other similar designs intended to embed tail risk protection directly into the fund
- Reallocate assets across the entire account rather than within a single fund.
- Impose more restrictions in exposure to higher volatility funds.
- Set up fee structures in a way that they are either not tied to the account value or designed to be countercyclical to market movements
- Account for the cost of hedging in the pricing process and model it explicitly
- Take into account how policyholders may react to guarantees under different market conditions and eliminate any guarantees for which behavior is particularly difficult to predict, or which contain the potential for extreme tail risk

(d) Critique the new actuary's statement.

Commentary on Question:
Most candidates criticized reinsurance as a form of risk management tool. Few candidates noted that reinsurance allows VA writers to cede policyholder behavior risk, a key risks for VAs.

Reinsurance is a form of immunization where the company retains the business, but is indemnified by a reinsurer for all or a portion of the risks in the liabilities, replaced by counterparty credit risk of the reinsurer.

Advantages of reinsurance:

- Reinsurance transfers policyholder behavior risk
- Risk transfer to reinsurer allows companies to assume other risks.

Disadvantages (VAs are generally not reinsured due to the following):

- Hedging only immunizes financial risk, whereas reinsurance immunizes against policyholder behaviour as well. Reinsurers may decline to quote because of unpredictable policyholder behaviour, or will require additional compensation.
- The risks for variable annuities do not diversify away with increased exposure.
- Pricing gap exists between direct insurers and reinsurers; some direct insurers are willing to sell VA business at a loss in order to stay in the market while reinsurers may be unwilling to do so.
- The expertise required for VAs means most players are very large, and hence, the economies of scale obtained from reinsurance is not as necessary.

4. Continued

(e) Assess trends in the marketplace which may make reinsurance for VAs a more attractive risk management strategy in the future.

Commentary on Question:
To receive full credit for part (e), candidates needed to make four relevant links between reinsurance and practices surrounding VAs. Eight examples are provided below.

- Smaller companies may have a need to issue products with financial guarantees but may not be ready or have the skill set to perform hedging operations.
- Companies that are underweight on insurance risk (C-2) and overweight on financial risks may be able to gain Risk-Based Capital (RBC) efficiency by balancing the components of RBC.
- Companies tend to take full credit in statutory reporting for coinsurance arrangements, whereas hedging may not materially reduce AG43 and C3 Phase II requirements
- As companies gain a better understanding of the tail risks in the newer products, reinsurers may become more amenable to assuming this business.
- Once an active reinsurance marketplace exists, smaller companies may become willing to write business anticipating that they can obtain reinsurance, further improving the market.
- If interest rates rise, the reinsurance pricing (which is generally based on fair value) will become more in line with insurance company pricing.
- As it becomes more common to price business so that the MCVNB is always positive, direct writers will likely price their new business more in line with how reinsurers.
- New forms of reinsurance may be developed that limit the reinsurer's tail risk coming from policyholder behaviour. For income benefits, reinsurers may design treaties that pay over the life of the annuity. This might cause companies to account for their assets and liabilities on a more parallel basis.