ERM-GI Model Solutions
Fall 2015

1. Learning Objectives:

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

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

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

Learning Outcomes:

(1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.

(3d) Analyze risks that are not easily quantifiable, such as operational and liquidity risks.

(4j) Demonstrate risk management strategies for other key risks (for example, operational, strategic, legal, and insurance risks).

Sources:

ERM-702-12: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry

Commentary on Question:

The question tested candidates' understanding of unquantifiable risks, by identifying, by evaluating or measuring, and by managing them. Some candidates only listed and did not provide an adequate descriptions or explanations. Several candidates thought that group long-term disability has a cash surrender value. Some candidates did not respond in a manner that addresses what the CRO wanted and did not respond with "a rapid increase in interest rates" scenario in mind. Overall, candidates performed better in parts a & b than in parts c & d.

1. Continued

Solution:

(a) Describe ways to evaluate non-quantifiable risks, in general

Commentary on Question:
Marks were not given if the candidate only identified ways and did not describe them.

Consult with subject matter experts or make educated guesses on the potential size of the loss: direct and indirect costs

Consider likelihood of the loss: qualitative or quantitative
Example of qualitative: very likely, moderately likely, very unlikely
Example of quantitative: probability: less than 25%, between 25% and 75%, over 75%

Use a risk map – a two-dimensional chart with likelihood and impact on the axes.
Use a residual risk map – similar to above risk map but with the original risk mitigated.
Use risk timing – risk velocity is near-term, mid-term or long-term.

If data is unavailable or is limited, use industry, competitor, reinsurer or consulting company's data to measure against.

Use extreme value theory to try to quantify the risk.

(b) Describe the potential risks to your company under the following three risk categories if a rapid increase in interest rates occurs:

I. Product / Pricing

II. Liquidity

III. Operational

Commentary on Question:
Many candidates were able to address the risks for UL and FA but did not address the risk on the GLTD product; as a result, partial marks were given. Some candidates incorrectly stated that there was no impact on GLTD.

Partial marks for part b.II were given if the candidate only identified the increased lapses but did not discuss either of the asset or funding liquidity risk.

Many candidates struggled with b.III and left this part unanswered.

1. Continued

I. Product/Pricing

For UL and FA in the accumulation phase: under a "rapid increase in interest rates" environment

- The earned rates in a portfolio may lag significantly behind the rapidly rising interest resulting in the inability to provide higher crediting rates and rates, leading to higher lapses, as policyholders seek better returns elsewhere.
- W.r.t. new business, the company may be slow in raising the crediting rate and lose sales to competitors.

For GLTD:

- Under the low-interest rate environment, the company may have been one of the first few companies to raise rates and lose new sales and renewals to competitors. Under the rapidly rising interest rates environment, the company may not be able to react quickly to adjust the manual rates and state-file in time during the high-quoting seasons.

A smaller inforce block (due to lapses) would lead to higher unit costs leading to potential uncompetitive new business pricing.

II. Liquidity

- Higher lapses may require the sale of illiquid assets, depending on market performance.
- Higher lapses may affect liquidity ratio.

- The company may have increased asset liquidity risk, depending on the price-impact function and the size of the asset position. -->Forced liquidation of assets creates unfavourable price movements.
- The company may have increased funding liquidity risk, which arises when financing cannot be maintained owing to creditor and investor demands. --> Arises from the liability side of the balance sheet.

III. Operational

- Policy administration may not have the personnel to process higher than expected volume of surrendered/lapsed policies, and policy loan activity.

- Potential over-expense on staff not having enough work in underwriting, new business processing and claims departments for all products if there is a decline in new sales and renewals and product lines decrease in size. Potential over-hiring of temporary staff during high quoting season.

1. Continued

- Potential turnover in distribution due to the low new sales and renewal business.

- Increase model risk as the pricing actuaries change their model assumptions to respond to the market changes and changes to policyholder behaviour.

(c) Recommend a specific approach for measuring liquidity risk for each of the company's three products.

Commentary on Question:
Some candidates did not answer the question but responded with mitigants to liquidity risk.

I recommend performing a 12-month projection using the following lapse assumptions: e.g., best estimate lapse assumption, 1.25 x best estimate, 1.5 x best estimate, 2 x, etc.

I would shock my lapse assumptions and project liability and asset cash flows to calculate future profits/losses. Similar to a DCAT exercise, in which I would test the impact of higher than expected lapses on future income and required capital levels, with and without management action such as increasing crediting rates for UL and FA, and reducing premium rates for GLTD.

Alternatively, candidate recommends an approach that monitors the risk and/or sets up an early warning signal:

I.e., measure:
- surrender activity on a weekly basis and reporting to ALM for advance warning/trend reporting
- liquidity ratio of the assets supporting each product and the company as a whole
- persistency ratio of existing business, at any time for UL and FA
- persistency ratio of existing business at renewal time for GLTD

Unlike the UL and FA policyholders who can decide to lapse their policy at any time in the year, GLTD policyholders usually make their decision to lapse at the annual renewal of the policy.

- the closing percentages on quoted business, as new business premiums can be used to mitigate liquidity risk by investing in liquid assets

I recommend setting liquidity benchmarks by reference to the amount of investment assets to be held in highly liquid assets.

1. Continued

(d) Explain how you will monitor and report on the operational risks identified in part (b).

Commentary on Question:
Some candidates wrote answers more than what was asked by answering with all of part b in mind, instead of only with part b.III.

Some candidates described an operational risk management framework in general terms and received partial marks only, as they did not provide specific monitoring activities related to the operational risks as a result of "rapid increase rates."

Monitoring activities:

- Monitor the policyholder and broker inquiries on/requests for surrender, account values, etc.
- Monitor customer processing times. Conduct customer call satisfaction surveys.
- Monitor new sales activities and changes from before the mitigating actions were implemented.
- Monitor distribution calls and complaints on the higher premium rates, by product and by other categories, such as, region and distribution channel.
- Monitor employee turnover in distribution and sales support. Track historical number of openings versus current number, length of time position remains open.
- Monitor caseloads in policy administration, involving surrenders, and policy loans.
- Monitor caseloads in underwriting, new business processing and claims areas.

Reporting:
Report on a frequent basis (e.g., weekly) on key risk indicators to the operational committee or sub-committee and escalate issues to the risk management committee, senior leadership and/or the CRO.

2. **Learning Objectives:**

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

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

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

Learning Outcomes:

(1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.

(3a) Apply and construct risk metrics to quantify major types of risk exposure such as market risk, credit risk, liquidity risk, regulatory risk, etc., and tolerances in the context of an integrated risk management process.

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

(4d) Demonstrate how derivatives, synthetic securities, and financial contracting may be used to reduce risk or to assign it to the party most able to bear it.

(4e) Develop an appropriate choice of a risk mitigation strategy for a given situation (e.g., reinsurance, derivatives, financial contracting), which balances benefits with inherent costs, including exposure to credit risk, basis risk, moral hazard and other risks.

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

(4g) Demonstrate the use of tools and techniques for analyzing and managing credit and counterparty risk.

(4j) Demonstrate risk management strategies for other key risks (for example, operational, strategic, legal, and insurance risks).

Sources:

Sweeting, Ch. 16 Responses to Risk; Sweeting, Ch. 14 Quantifying particular risks

ERM-110-12: Derivatives: Practice and Principles, Recommendations 9-24 & Section III

ERM-124-15: Counterparty Credit Risk, Ch.2

2. Continued

Commentary on Question:
The goal of the question was to test the candidate's knowledge and understanding of liability equity risk exposures and possible approaches to hedging this exposure. The candidates were expected to apply the Black-Scholes put option formula to a liability option and analyze and choose from amongst various derivative solutions to mitigate the equity delta risk exposure.

See comment on each part.

Solution:

(a) Calculate delta, that is, the total exposure to the underlying S&P500 TR Index that needs to be hedged relative to the one-year ROP option written by Lily. Show your work.

Commentary on Question:
Generally this part was done well. Some candidates missed the 95% persistency expected at the end of the year.

$d_1 = [\ln(X_0/E) + (r + \sigma_x^2/2)] / \sigma_x$
$= [\ln(2100/2100) + (0.01 + 0.2^2/2)]/(0.2)$
$= [\ln(1) + (0.01 + 0.02)]/0.2$
$= [0 + 0.03]/0.2$
$= 0.15$

$\Phi(d_1) = \Phi(0.15) = 0.56$

$\Delta P = \Phi(d_1) - 1]$
$= [0.56 - 1]$
$= -0.44$

Delta exposure to hedge is $-0.44 * \$5{,}800{,}000 * 0.95$
$= -0.44 * \$5{,}510{,}000$
$= - \$2{,}424{,}400$

(b) You now consider alternative I to delta-hedge the equity risk exposure from LVA.

(i) Calculate the optimal hedge ratio to minimize the volatility of the S&P500 one-year futures hedge.

(ii) Determine the number of one-year S&P500 futures contracts that Lily should enter into to cover the delta risk exposure from LVA.

Show your work.

2. Continued

Commentary on Question:
Generally part (i) was done well. For part (ii), a good portion of candidates used the full premium of $5,800,000 as the exposure to hedge, instead of the delta exposure of $2,424,400 calculated in part (a).

(i) β_M
$= \rho_{F,M} * \sigma_M / \sigma_F$
$= 0.80\ (0.20/0.16)$
$= 0.80 \times 1.25$
$= 1$

(ii) Number of contracts N
= h x $delta exposure to hedge/$exposure per contract
= 1 x ($2,424,400)/($250*2100)
= 1 x ($2,424,400 / $525,000)
= 4.62

Thus 5 S&P500 futures contracts should be purchased.

(c) You now consider alternative II to delta-hedge the equity risk exposure from LVA.

(i) Calculate the theoretical cost of an S&P500 ATM put option.

(ii) Calculate the number of put options that Lily should purchase.

Show your work.

Commentary on Question:
This part was generally done well. As the contract size was not specified, full credit was given for any reasonable value used.

(i) d_1 (from (a)) = 0.15
$d_2 = 0.15 - 0.20 = -0.05$
$X_0 = 2100$
E = 2100

$P_0 = -2100 * \Phi(-0.15) + 2100 * e^{-0.01} * \Phi(0.05)$
$= -2100*(0.44) + 2100*(0.99)*(0.52)$
$= -924.00 + 1081.08$
$= 157.08$

2. Continued

(ii) Using a contract size of $100:
N = $5,510,000/($100 x 2100)
= 26.2

Thus 26 S&P put option contracts should be purchased

(d) Assume Lily purchases the put option from Magnolia Bank.

Calculate Lily's current counterparty risk exposure to Magnolia Bank under each of (i) and (ii):

(i) Assume no netting agreement is in place

(ii) Assume a cross-product netting agreement is in place

Show your work.

Commentary on Question:
This part was not done well by most candidates as they included most or all financial exposures. Only the market value of derivative instruments represent counterparty risk exposure and are relevant to netting agreements.

(i) No netting: is the sum of positive counterparty exposures
Positive exposure of $2,300 from put option only
Therefore, total MegaBank exposure is $2,300

(ii) Netting: is the sum of all counterparty exposures
- Put option +$2,300
- IRS -$50,903

Total MegaBank exposure with netting = Max(0, $2,300 - with $50,903)
= 0

(e) Compare and contrast the nature of the counterparty risk between the exchange-traded put option hedge and the OTC put option hedge with Magnolia Bank.

Commentary on Question:
This part was generally done well. Some candidates did not realize that the exchange-traded option does have a small degree of counterparty risk. Many candidates made points unrelated to counterparty risk that did not receive credit.

2. Continued

For the exchange-traded put option hedge, counter-party risk is reduced by the pooling of contracts – since each party has a contract directly with the exchange, the failure of a single counterparty does not directly affect the payment of any single option contract. The exchange underwriting the contracts protects itself from its counterparties through the use of margins. Lily will contract directly with the exchange as counterparty, and there is a low likelihood of a default of the exchange.

The OTC put option hedge with Magnolia Bank, the counterparty risk will be with Magnolia Bank. Risk would depend on the agreement set with Magnolia Bank, and the credit rating of the Bank. The counterparty risk in the option is one-sided, with Lily paying the option cost upfront, but Magnolia is not required to perform until the option is exercised. Lily is exposed to a default of Magnolia before the option is exercised.

(f)

(i) Identify the criteria you would use in evaluating a recommendation to pursue one of the three alternative hedging approaches.

(ii) Recommend one of the three alternative hedging approaches based on the criteria identified in (i). Justify your response.

Commentary on Question:
Part (i) was generally well answered. Full credit was given for any 3 relevant criteria. On part (ii), the responses varied. Credit was given for any of the three approaches chosen, as long as there were well-reasoned arguments relative to the listed criteria to support the choice.

(i) Hedge Effectiveness – consider the hedge effectiveness of the three alternatives with respect to the liability exposure.
Counterparty risk exposure – consider the degree of additional counterparty risk involved in each of the three alternatives
Operational risk of each of these hedge alternatives – what is the additional operation risk involved with the three alternatives, i.e. complexity, infrastructure, knowledge/sophistication required

2. Continued

(ii) I would recommend the Magnolia OTC put option, and for the following reasons:

Hedge Effectiveness: For the exchange-traded S&P500 futures contract or S&P500 put option, there will be basis risk to the extent that the All-American fund does not track the S&P500 fund. The whole number of contracts purchased may produce over- or under-hedging of the delta exposure. The OTC put from Magnolia may be customized to minimize basis risk by hedging the actual exposure of the All-American fund returns.
Counterparty risk: The exchange traded alternative would have significantly lower counterparty risk vs. the OTC option. However, Magnolia counterparty risk could be mitigated using collateral requirements and a netting agreement.

Operational risk: Lily Life is currently holding an interest rate swap with Magnolia Bank and thus there is already an established process in place to manage this position with this counterparty, thus new operational risk exposures would be minimized.

3. **Learning Objectives:**

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

2. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.

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

Learning Outcomes:

(1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.

(2a) Demonstrate how each of the financial and non-financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, and scenario analysis.

(2h) Construct approaches to modeling various risks and evaluate how an entity makes decisions about techniques to model, measure and aggregate risks including but not limited to stochastic processes.

(3a) Apply and construct risk metrics to quantify major types of risk exposure such as market risk, credit risk, liquidity risk, regulatory risk, etc., and tolerances in the context of an integrated risk management process.

(3b) Analyze and evaluate the properties of risk measures (e.g., Delta, volatility, duration, VaR, TVaR, etc.) and their limitations.

Sources:

Value-at- Risk, Third Edition, The New Benchmark for Managing Financial Risk, Jorion

Commentary on Question:

The purpose of this question was to test knowledge and understanding of common approaches used to forecast volatility and to determine their applicability for use in a delta-hedging program. Candidates were required to demonstrate thorough understanding of the approaches through both quantitative calculations and qualitative application.

3. Continued

Solution:

(a) Consider the observation that financial market volatility is predictable. Describe three implications for risk management assuming this is the case.

Commentary on Question:
Most candidates performed well on this part. However, a common misconception is that predictable volatility implies perfect knowledge of future market movements. Even if volatility were constant and known, it would not logically follow that market prices would be known. There is also some confusion about the meaning of the word predictable*. In this context it means that the distribution and parameters can be determined, not that the actual sample measurements are known in advance.*

Additionally, the answers should pertain to risk management. Common responses which were not accepted related purely to arbitrage opportunities.

A variety of responses were acceptable for full credit.

- There is a strong position correlation between market volatility and VaR. Increases in market volatility imply increases in VaR.
- Assets, such as derivatives, that depend directly on market volatility will change in value in a predictable way.
- Equilibrium asset prices will be affected by changes in volatility. Investors who can reliably predict changes in volatility should be able to control financial market risks better.

(b) Describe two features of empirical equity returns that are inconsistent with the assumption that returns are normally distributed.

Commentary on Question:
Candidates performed well on this part. The following list is not exhaustive and only two relevant points are required for full credit.

Compared to the normal distribution, distributions of empirical equity returns:

- are asymmetric
- exhibit fatter tails
- contain larger centers
- change over time
- exhibit volatility clustering
- exhibit autocorrelation
- may be regime-switching

3. Continued

(c) Calculate the daily σ_t^2 using the MA model with a 20-day window, given $\left(100 \times \sigma_{t-2}^2\right) = 0.8311\%$. Show your work.

Commentary on Question:
Most candidates either performed very well or very poorly on this part. Candidates who recognized how to apply the information provided in the stem to solve the problem generally received close to full credit.

$\sigma_t^2 = \frac{1}{M}\sum_{i=1}^{M} r_{t-i}^2$

The MA model specified has a 20-day window, therefore M = 20.

$\sigma_t^2 - \sigma_{t-2}^2 = \frac{1}{20}(r_{t-1}^2 + r_{t-2}^2 - r_{t-21}^2 - r_{t-22}^2)$

$\sigma_t^2 - .008311\% = \frac{1}{20}(.004339\% + .001241\% - .020378\% - .000143\%)$

$\sigma_t^2 = .007564\%$

(d)

(i) Calculate *h*, the long-run average, unconditional variance. Show your work.

(ii) Calculate the expected 1-month equity return variance at *t*, assuming the one-day variance h_t is equal to 0.008750%. Show your work.

Commentary on Question:
Performance on this part was split. In general, candidates performed better on subpart (i) than on subpart (ii).

In subpart (ii), the shortcut was accepted only if the candidate calculated the correct answer to subpart (i), thereby confirming that the long-term variance equals the given daily variance. Full credit was possible for subpart (ii) by using the longer formula (provided in the stem), regardless of whether the answer to subpart (i) was correct. Substantial partial credit was awarded in subpart (ii) for long method answers that went astray due to calculation error.

(i)

$$h = \frac{\alpha_0}{1-\alpha_0-\beta} = \frac{0.000049\%}{1-.0485-.9459} = .00875\%$$

3. Continued

(ii)

Short method:

Note that $h_t = h$. Therefore:

$E_{t-1}[r^2_{t,T}] = hn.$

$= .00875\% \times 20$

$= 0.175\%$

Long method:

$$E_{t-1}\left[r^2_{t,T}\right] = \frac{\alpha_0}{1-(\alpha_1+\beta)}\left[(n-1) - (\alpha_1+\beta)\frac{1-(\alpha_1+\beta)^{n-1}}{1-(\alpha_1+\beta)}\right] + \frac{1-(\alpha_1+\beta)^n}{1-(\alpha_1+\beta)}h_t$$

Substitute:

α_0	α_1	β	n	h_t
.000049%	.0485	.9459	20	.00875%

$$E_{t-1}\left[r^2_{t,T}\right] = 0.175\%$$

(e) Explain specifically how this market option price data can be used to provide a forecast of the 1-month volatility of the S&P 500 Index returns.

Commentary on Question:
Candidates generally performed well on this part. A variety of responses was acceptable for full credit. However, complete answers were required to make reference to the Black-Scholes option pricing model—either by name or by writing out the formula.

Given the market price of the 1-month put option, the implied volatility can be solved using the Black-Scholes equation. The volatility that produces the 1-month put option price when used in the Black-Scholes formula is the implied volatility of the S&P 500 Index.

(f) Recommend one of the three approaches below to forecast equity volatility, citing the advantages of your recommended approach and the disadvantages of each of the other two approaches:

I. The MA model

II. GARCH(1,1)

III. Use of market option prices

3. Continued

Commentary on Question:
The quality of responses to this part varied substantially. The candidate was expected to make a recommendation. Only minimal credit was possible for candidates who failed to do so. Credit was not awarded for any disadvantages cited for the recommended approach. Similarly, credit was not awarded for any advantages offered for the other two approaches.

The GARCH(1,1) is the best answer given that Rose Life uses delta-hedging to manage its risk. However, it was possible to receive full credit by recommending either the GARCH(1,1) approach or the use of market option prices. There were not enough advantages of the MA model to justify its recommendation, although partial credit was possible.

The GARCH (1,1) method is the best approach for Rose Life to make use of in its delta-hedging program. It provides a better fit to empirical data than the MA model and is commonly used in practice. It also accounts for serial dependency in volatility, which is observed in empirical data. Unlike the implied volatility from market option prices, GARCH (1,1) is also more relevant for internal hedging purposes, since it is not loaded for profit and contingencies like the implied volatilities.

The MA approach is not recommended because:

- It ignores the dynamic ordering of observations, assigning the same weight to recent and older observations within the moving observation window.
- There is no clear choice of the size of the moving window. While a larger window increases precision, it may miss underlying variation in volatility.
- There is a "ghosting" phenomenon which may lead to illogical plateaus in the data. There could be a large jump on the day a large return falls out of the observation window.

The use of market option prices is not recommended because:

- Quotes may not be available for the required time period, requiring the extrapolation of a volatility surface.
- Implied volatilities are loaded for profit and contingencies, which makes them more relevant for modeling the cost of market options rather than for use in an internal hedging program.
- Option-implied volatilities are based on risk-neutral distributions, rather than on real-world distributions. This could cause a systematic bias relative to actual volatility.

4. Learning Objectives:

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

5. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

(4i) Analyze the application of Asset Liability Management and Liability Driven Investment principles to Investment Policy and Asset Allocation.

(5c) Apply risk measures and demonstrate how to use them in capital assessment. Contrast regulatory, accounting, statutory and economic capital.

Sources:

ERM 112-12: Revisiting the Role of Insurance Company ALM within a Risk Management Framework

Commentary on Question:

This question tested the candidates' understanding of the ALM process and how to apply it to a Basic GIC product. Furthermore, candidates were asked to demonstrate understanding of how the ALM process would produce differing outcomes for two different product designs of a GIC product.

The question was divided into five parts, with parts (a) through (d) referring to the Basic GIC product only. Many candidates answered these parts as if both the Basic GIC and the GIC Plus were part of Begonia Life's portfolio. Portions of the candidates' responses that referred to the surrenderability feature of the GIC Plus product in these parts were not awarded credit.

Solution:

(a) Identify three Investment Objectives that would be important for this product. Justify your response.

Commentary on Question:

Full credit on part (a) required candidates to name three investment objectives and relate them back to the Basic GIC product. Overall, candidates performed well on this part. Partial credit was given for responses that were general and did not tie directly to the Basic GIC.

Target Spread – Profit on the Basic GIC comes from the spread between the asset earned rate and the fixed guaranteed rate. A target spread is needed to achieve the desired profitability level.

4. Continued

Duration Matching – The Basic GIC product has a fixed term of five years and is non-surrenderable, so liability cash flows are very predictable. Duration matching would limit volatility from interest rate changes.

Asset Quality Mix – A high quality portfolio is necessary to ensure the ability to meet the obligation at the end of each GIC's 5-year term.

(b) Consider the following asset classes:

I. Cash

II. Investment grade bonds or Treasuries with maturities less than 5 years

III. Investment grade bonds or Treasuries with maturities greater than 5 years

IV. Equities

Explain the role, if any, that each of the asset classes I through IV could play in your overall ALM strategy.

Commentary on Question:
Full credit on part (b) required an explanation of each of the four asset classes related to a portfolio of Basic GICs. Many candidates realized that a portfolio consisting primarily of asset classes II and III would be a good portfolio for the Basic GIC product. However, several candidates put too much emphasis on using equities to increase returns while not acknowledging the high level of risk that equities would bring to the portfolio.

I. Cash provides little return but has no risk and is very liquid. For an individual GIC, it is not needed because Basic GICs are non-surrenderable. For a block of GICs sold on different dates, holding some cash allows for more asset classes to match duration and provides liquidity for maturities.
II. Short-term investment grade bonds provide the same benefits as cash, but with higher yields and lower liquidity. They can be used to decrease duration of the portfolio if other longer-term instruments are used.
III. Long-term investment grade bonds can be used to increase portfolio yield and raise the duration of the portfolio. One strategy would be to use a combination of short-term and long-term investment grade bonds to maximize yield while matching the duration of the liability

4. Continued

IV. Equities could provide higher returns and diversification benefits, but given the volatility and risk of losses, they should represent a minimal portion of the portfolio if used at all.

(c) Explain how the size of the fixed spread may influence your Investment Objectives and Constraints in step 1 and your Asset Universe in step 2.

Commentary on Question:
Full credit on part (c) required candidates to address both the Objectives/Constraints and the Asset Universe steps in the ALM process. Many candidates answered only one of the two steps.

Investment Objectives and Constraints

- If the fixed spread increased, may need to consider relaxing constraints to allow for higher yielding assets.
- If the fixed spread decreased, may consider using stricter cash flow matching to lock in the desired profitability level.

Asset Universe

- A larger spread would likely expand the asset universe to include lower quality bonds or derivatives to increase yield.
- A smaller spread would likely narrow the asset universe to higher quality bonds to reduce risk and volatility while achieving the desired yield.

(d) Explain the implication of basing the Risk Measures in step 4 on the economic surplus amount instead of the regulatory surplus.

Commentary on Question:
The goal of part (d) was to focus on the impact to risk metrics of using economic surplus vs. regulatory surplus. Many candidates explained the difference between economic capital and regulatory capital but did not make any connection to risk metrics. These responses did not get full credit.

Statutory valuation of both assets and liabilities are relatively predictable and stable. Economic valuation will have more volatility due to marking assets to market and using a dynamic discount rate on liabilities.

For this reason, risk metrics based on economic surplus will tend to be more volatile, which may lead to a more conservative investment strategy. They should also provide a better measure of the true risk profile of the block of GICs.

4. Continued

(e) Explain how the following items will differ between Basic GIC and GIC Plus:

(i) Effective liability duration

(ii) Setting Investment Objectives and Constraints

(iii) Setting Asset Universe and Assumptions

(iv) Risk Measure based on an economic basis

Commentary on Question:
Candidates did very well on subpart (i). Most candidates received some credit for subparts (ii) and (iii), but many did not distinguish between the two enough to receive full credit. Subpart (iv) proved to be more of a challenge, as candidates had difficulty explaining how risk measures would differ between the Basic GIC and GIC Plus.

(i) The Basic GIC and GIC Plus have the same 5-year structure, but the GIC Plus has a surrender provision. Therefore, the GIC Plus will have a shorter effective liability duration.

(ii) Liability cash flows on the GIC Plus product are more variable, as they can occur as early as the end of year 2. Duration matching will be more difficult, so duration matching objectives may need to be relaxed on the GIC Plus to avoid frequent rebalancing.

(iii) For GIC Plus, one might consider adding derivatives to the asset portfolio that will pay out when interest rates rise and surrenders are more likely.

(iv) Risk measures will show increased risk on the GIC Plus product due to higher uncertainty around cash flows, whereas cash flows are locked in on the Basic GIC product.

5. Learning Objectives:

5. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

(5a) Describe the concepts of measures of value and capital requirements (for example, EVA, embedded value, economic capital, regulatory measures, and accounting measures) and demonstrate their uses in the risk management and corporate decision-making processes.

(5c) Apply risk measures and demonstrate how to use them in capital assessment. Contrast regulatory, accounting, statutory and economic capital.

Sources:

ERM-123-14: S&P Enterprise Risk Management Criteria (#1-71, 86-88)

ERM-501-12: Risk Based Capital – General Overview

Commentary on Question:

This question asked candidates to analyze and develop recommendations for real-life business situations involving ERM.

Solution:

(a) Describe three significant issues with Peony's risk management culture.

Commentary on Question:

Candidates generally did well on part (a). Credits were only given for answers related to risk management culture issues.

- The CEO wants to focus the ERM program on only the problem areas in the company (underwriting department). The risks are managed in complete silos on an annual basis or not managed at all.
- The CEO and the Board display a lack of understanding of the importance of ERM, and have insufficient active involvement in the ERM process.
- The CEO is concerned about increasing sales so everyone can have big bonuses this year, to the exclusion of risk concerns such as profitability and capital.
- The CEO believes that a strong RBC ratio is the only requirement for risks to be "financially covered".

(b) Outline the basic components of the ERM program you will design for Peony.

5. Continued

Commentary on Question
Candidates generally didn't perform well on part (b). They needed to demonstrate an understanding of how to develop an ERM program and apply it to Peony. Some candidates only listed key components without any brief explanation.

- The ERM function needs to be led by a well-qualified senior executive with risk management functions at the business level, and should be independent of the CEO.
- Active involvement from the Board, and strong buy-in from senior management and business units.
- Significant resources need to be committed to the day-to-day execution of the program.
- Develop methods to consistently identify, measure, and manage risk exposures and losses within chosen risk tolerances.
- Peony needs to aggregate and manage risk with an enterprise view, taking into consideration correlation and diversification.
- Need comprehensive and frequent risk reporting around all key areas of risk exposures.

(c) Explain to the CEO why Peony's strong RBC ratio may not translate into a strong S&P score.

Commentary on Question:
Candidates generally got most credits on part (c). But to receive full credit, candidates needed to discuss both RBC and components of the S&P scoring system.

- The RBC ratio provides a capital adequacy standard using a generic formula by primary insurance type.
- Although this formula requires companies to hold capital for most major risks, it does not solely fulfill the criteria of the major components of the S&P scoring system for a "strong" score.
- S&P ERM analysis is comprised of five subfactors:
  - Risk management culture
  - Risk controls
  - Emerging risk management
  - Risk models, and
  - Strategic risk management
- Peony received a "weak" score because the risk management culture and the risk controls subfactors were scored negative. For a "strong" score, the risk management culture, risk controls, and strategic risk management subfactors must be scored positive, with no subfactor scored negative.

5. Continued

(d) The CEO is reviewing Peony's RBC level. He asks you to provide information on four competitors. You research the RBC data from these companies and obtain the following:

Commentary on Question:
Candidates generally did well on part (d). Some candidates lost partial credits on NAIC action level.

Company #	Authorized Control Level ($)	Total Adjusted Capital ($)	RBC Ratio	NAIC Action Level
1	100	195	195%	Company Action Level
2	99	215	217%	No action
3	242	505	209%	No action
4	86	125	145%	Regulatory Action Level

(e) Companies 1 and 2 are considered peers of Peony. The CEO has proposed maintaining Peony's RBC ratio equal to the average RBC ratio of these two companies.

(i) Explain the positives and the negatives of maintaining Peony's RBC ratio at that level.

(ii) Assume you move forward with the CEO's proposal.

Propose three specific ways to lower Peony's RBC ratio to that level.

Commentary on Question:
Candidates generally did well on part (i). To receive full credit, candidates needed to discuss both positives and negatives.

Candidates did well on part (ii) if they knew the RBC formula well and tried to adjust the ratio from both the numerator and the denominator.

(i) The average RBC ratio of Companies 1 and 2 is 206%

Positives:
- The "no action" level does not require the company to take action.
- Frees up capital for new opportunities and future growth

5. Continued

Negatives:

- Peony is not considering risk vs. reward when determining what level of total adjusted capital to hold. Lowering the RBC ratio from 300% may force the company to take riskier investments and/or seek out riskier ventures without considering the additional risks associated with these opportunities. Poor strategic risk management may lead to a ratings downgrade.
- The average RBC ratio places Peony very close to the "Company Action Level" (150%-200%). If there is suddenly a strain on capital or surplus, Peony's RBC ratio may drop below 200%.
- Although the companies are considered peers of Peony, the other companies may have a different mix of products which result in different RBC ratios.
- Company 1 does not provide a good comparison since the company has a RBC ratio that falls into the "Company Action Level", which has a number of negative implications.

(ii) Lower the total adjusted capital:

- Seek alternative ways to utilize excess capital, such as new ventures, alternative investments (i.e. mortgage loans), acquisitions, and dividend payment, etc.

Increase the "Authorized Control Level" capital:

- Increase concentration in a single issuer (subject to concentration factor).
- Invest in riskier investments, such as junk bonds and/or riskier short and long term investments (increase potential for default and fluctuations in the fair value of assets).
- Seek rapid/excessive growth.

6. Learning Objectives:

2. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.

Learning Outcomes:

(2b) Evaluate how risks are correlated, and give examples of risks that are positively correlated and risks that are negatively correlated.

(2c) Analyze and evaluate risk aggregation techniques, including use of correlation, integrated risk distributions and copulas.

(2f) Analyze the importance of tails of distributions, tail correlations, and low frequency/high severity events.

Sources:

Study note – Aggregation of Risks and Allocation of Capital (Sections 4-7)

Study note – Measurement and Modeling of Dependences in Economic Capital (Ch 3-5)

Loss Models Ch. 10 Copula Models

Commentary on Question:

This question in general is testing candidates' ability to, first, analyze and evaluate risk aggregation techniques, including use of correlation, integrated risk distributions and copulas, and, secondly, analyze the importance of tails of distributions. In order to obtain the maximum points for this question, one would need to demonstrate the right calculation steps that lead to the given answers for Parts (a) and (b) and give four distinct advantages and/or disadvantages of the two models in Part (c). Many candidates attempted to work on Part (a) and to give a couple of reasons in Part (c). However, the general observation is that most of the candidates had not familiarized themselves with the topic of Copula models.

Solution:

(a)

(i) Demonstrate that the correlated uniform values using the Gaussian copula are $v_1 = 0.950,\ v_2 = 0.171$. Show your work.

(ii) Calculate the simulated total loss due to Equity and Credit risk factors using the correlated uniform values from (i). Show your work.

Commentary on Question:

*Most of the candidates attempted to work on Part (a) but skipped the first step of finding the independent normal random values and mistakenly used the independent uniform pseudorandom numbers as the **Z** in the matrix. Partial points were considered for matrix formation and for understanding the calculation result, i.e. not interpreting a loss as a gain.*

6. Continued

(i)

1. Turn u_1 and u_2 into independent normal random values, z_1 and z_2:
$z_1 = \Phi^{-1}(u_1 := 0.95)$ and $z_2 = \Phi^{-1}(u_2 := 0.08)$, where Φ is the standard normal cumulative distribution function.
==> $z_1 = 1.645$, $z_2 = -1.405$.

2. Calculate the corresponding **correlated standard normal values** by calculating $\boldsymbol{LxZ}$, where
$Z^t = (z_1, z_2) = (1.645, -1.405)$:
$\boldsymbol{L\ x\ Z} = \begin{bmatrix} 1 & 0 \\ 0.25 & 0.968 \end{bmatrix} \begin{pmatrix} 1.645 \\ -1.405 \end{pmatrix} = \begin{pmatrix} \mathbf{1.645} \\ \mathbf{-0.949} \end{pmatrix}$.

3. Calculate the correlated uniform values, v_1 and v_2 using the Gaussian copula:
$v_1 = \Phi(1.645) = 0.95$, $v_2 = \Phi(-0.949) = 0.171$.

(ii)

4. Calculate $F_1^{-1}(0.95)$ and $F_2^{-1}(0.171)$, where F_1 and F_2 are marginal loss distribution for Equity and Credit risk factor, respectively:
$F_1^{-1}(0.95)$ is the value x_1 such that Prob($Z_1 \leq x_1$) = 0.95, where Z_1 is a normal random variable with mean, 0, and standard deviation, 500.
$F_2^{-1}(0.171)$ is the value x_2 such that Prob($Z_2 \leq x_2$) = 0.171, where Z_2 is a normal random variable with mean, 0, and standard deviation, 1000.

$x_1/500 = 1.645$, so $x_1 = 500*1.645 = 822.43$. Likewise, $x_2/1000 = -0.949$, so $x_2 = -0.949*1000 = -949$.
The simulated total loss = $822.43 + (-949.2) = -126.81$.

(b)

(i) Demonstrate that the correlated uniform values using the *t*-copula are $v_1 = 0.972$, $v_2 = 0.071$. Show your work.

(ii) Calculate the simulated total loss due to Equity and Credit risk factors using the correlated uniform values from (i). Show your work.

Commentary on Question:
There were only a few candidates who were able to demonstrate calculations in Part (b) correctly or use the right steps that lead to the given answers. Points were considered for the alternative solution.

6. Continued

(i)

1. Step 1 is exactly the same as part (a).
Turn u_1 and u_2 into independent normal random values, z_1 and z_2:
$z_1 = \Phi^{-1}(u_1 := 0.95)$ and $z_2 = \Phi^{-1}(u_2 := 0.08)$, where Φ is the standard normal cumulative distribution function.
==> $z_1 = 1.645$, $z_2 = -1.405$.

2. Calculate the corresponding correlated t- values:
Divide the corresponding correlated standard normal values calculated in Step 2 of Part (a) by the square root of the simulated gamma value/degree of freedom.
$(1.645, -0.949) / (0.325/2)^{\wedge(1/2)} = (4.081, -2.355)$.

3. Calculate the correlated uniform values, v_1 and v_2 using the given cumulative distribution function of the *t*-distribution with 2 degrees of freedom, $F_{t,2}(x) = \frac{1}{2} + \frac{x}{2\sqrt{2+x^2}}$:
$v_1 = F_{t,2}(4.081) = 0.972$, $v_2 = F_{t,2}(-2.355) = 0.071$.

(ii)

4. Calculate $F_1^{-1}(0.972)$ and $F_2^{-1}(0.071)$:
$F_1^{-1}(0.972) = 958.9$, $F_2^{-1}(0.071) = -1{,}465.7$.
The simulated total loss = $958.9 + (-1{,}465.7) = -506.76$.

Alternative solution using Source method (i.e. Normal Distribution):
3. $v_1 = \Phi(4.081) = 0.99998$, $v_2 = \Phi(-2.355) = 0.00927$.
4. $F_1^{-1}(0.99998) = 2{,}040$, $F_2^{-1}(0.00927) = -2{,}355$.
The simulated total loss = $2{,}040 + (-2{,}355) = -315$.

(c) Outline the advantages and disadvantages of the proposed *t*-copula over the standard Gaussian copula in this situation.

Commentary on Question:
Most of the candidates attempted to give a couple of reasons in Part (c), and therefore received partial points. Full points in Part (c) were given to candidates who were able to demonstrate their understanding about the Copula models by pointing out four correct and distinct advantages and disadvantages.

6. Continued

Gaussian Copula

- Advantages:
  - Relatively easy to understand and mathematically tractable.
  - Correlation (or dependency) parameters easy to estimate and interpret.
  - Easily extended to the multidimensional case.
  - Can be easily programmed to generate simulated output within an economic capital model.
  - Normal distribution is well known and understood.
- Disadvantages:
  - Gaussian Copula's tail dependencies in the limit are zero.
  - This limitation means that the Gaussian Copula is not suitable for modelling dependency with heavy tails.

t-Copula

- Advantages:
  - The t-copula has non-zero tail dependency, upper and lower.
- Disadvantages:
  - It requires a degree of freedom ("df") parameter.
  - t-Copula is symmetrical and its left and right tail dependencies are equal.
    - This is not a perfect solution given that economic capital modeling is predominantly concerned with only one side of the distribution.
  - Some limitations exist when modeling more than two risks.
  - t-distribution is less well known.

7. Learning Objectives:

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

Learning Outcomes:

(4a) Demonstrate and analyze applicability of risk optimization techniques and the impact of an ERM strategy on an organization's value. Analyze the risk and return trade-offs that result from changes in the organization's risk profile.

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

Sources:

Risk Appetite: Linkage with Strategic Planning;

ERM-114-13 Introduction to Reinsurance

Commentary on Question:

This question was intended to test the candidate on his or her understanding of the components of a Risk Appetite Statement, as well as ability to apply different types of reinsurance to blocks of business.

Solution:

(a)

(i) Evaluate items I to IV in the bank's RAS with respect to their applicability to PIC and, where necessary, explain how they should be modified for PIC's RAS.

(ii) Identify two additional items that would be important for PIC to include in its RAS.

Commentary on Question:

Candidates appeared to struggle with part (i). Candidates did well on part (ii).

Many candidates evaluated the bank's RAS with respect to using it for any insurance company, but not specifically for PIC. Depending on the level of detail, partial credit was given.

Some candidates indicated whether the items in the bank's RAS were applicable, but didn't explain why or why not. No points were given in this case.
For part (ii) additional solutions other than the one shown below were accepted. For full credit the candidate had to identify items relevant to PIC, not just general items that could be included in any RAS

7. Continued

(i) *Be the top Bank on the island with a Moody's rating of at least Aa1*

- Too vague – what does top mean?
- The capital required to maintain Aa1 rating may not be initially feasible for PIC. What was PIC's rating prior to being acquired?

Have an average customer satisfaction rating of at least 90%.

- How is this rating determined? PB only serviced the community on the island, while PIC may be servicing clients elsewhere in the world. Can this same method be used for PIC?
- A bank may be valued for its person-to-person interactions, while an insurance company would more likely be valued based on the speed of its claims-paying, or its financial strength. The statement should identify clearly how an insurance company is valued

Annually grow overall client base by 5% while retaining 95% of present clients

- What is the PIC's client turnover level? Is the overall client base % so high that this type of measure isn't valuable?
- If this is a valuable measure, then proposed RAS should be back-tested to see if the limits would have been crossed in prior years.

Meet all withdrawal requests upon demand for all events

- What products does PIC have that have a cash value? (the products listed: term life, car insurance, critical illness and disability would generally not have a cash value.)
- Consider changing this to have liquidity able to meet a 1 in 200 year event

(ii)

- An overall annual profit / loss
  - "Risk appetite helps prevent default by preserving capital position" There should be a quantitative measure for the capital / equity PIC is willing to put at risk.

- A level of surplus required
  - What level of surplus is needed for PIC to handle an extreme event with a probability of x%?
  - This will be important in maintaining the required rating level.

7. Continued

(b) Recommend the most appropriate type of reinsurance from the list above for each of blocks I and II, based on the objective of mitigating earnings volatility. Justify your answer.

Commentary on Question:
Candidates appeared to struggle with this question.

Many candidates would recommend a type of reinsurance without providing details to why it was the most appropriate type of reinsurance.

Points were awarded only if the type of reinsurance recommended was a viable option.

Solutions other than one shown below were accepted if the choice recommended was viable, and the answer showed that the candidate had a clear understanding of the types of reinsurance.

Critical Insurance

- Recommend: Excess of Loss, on entire block of business.
- This is a closed block with a known NAR that is small. PIC can set the priority (fixed chosen quantity) at a level within PIC's risk tolerance and link the coverage to a fixed dollar amount per calendar year in relation to annual earnings.
- NOT Catastrophic excess of loss. Insuring against a tail event is an effective way to mitigate volatility. I would instead say, cat events usually do not lead to CI claims. CI claims relate to cancer, dread disease, etc. and not to cat events (9/11, earthquake, etc.)
- NOT treaty proportional quota share. PIC is not concerned with any individual claim on this small exposure to CI business as exposure to any one life is limited to $50K so cession of individual policies is not the best approach. They are concerned with overall deterioration of block resulting in multiple claims at once.
- Automatic / facultative is not really relevant here as the business is already inforce; auto/fac would apply to new risks being underwritten and individually assessed by the reinsurer.

7. Continued

20 year term insurance

- Recommend: Automatic (treaty) proportional quota share reinsurance.
- Automatic, not facultative, because we don't want to be sending each application to the reinsurer for their approval if this can be avoided (typically required for only very large policies / impaired lives which does not appear to be PIC market)
- NOT excess of loss, as this is a growing business and reinsurer's liability would not grow proportionately with PIC.

8. **Learning Objectives:**

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

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

Learning Outcomes:

(1c) Identify and assess the potential impact of risks faced by an entity, including but not limited to market risk, currency risk, credit risk, counterparty risk, spread risk, liquidity risk, interest rate risk, equity risk, hazard/insurance risk, inflationary risk, environmental risk, pricing risk, product risk, operational risk, project risk and strategic risk.

(4c) Demonstrate means for reducing risk without transferring it.

(4j) Demonstrate risk management strategies for other key risks (for example, operational, strategic, legal, and insurance risks).

Sources:

Financial Enterprise Risk Management, Sweeting, 2011 Ch. 16 Responses to Risk

Commentary on Question:

This question required candidates to apply their understanding of People Risk to the scenario presented. Credit was given only for risks categorized as People Risk in the source (Sweeting Ch. 16). No credit was given for risks included in other categories in this source (e.g. Crime Risk, Bias, Operational Risks), even if the answers were relevant and otherwise correct.

The intent was to have risks related to the divestiture project discussed only in part (b), and risks related to the VA business in general discussed only in part (a). But credit was given for appropriate answers that were included in the opposite place. However, if answers were repeated in both parts, credit was only given once.

Greater credit was given if risks were appropriately labeled, e.g. as Agency, Employment-related, etc. Moral Hazard and Adverse Selection were both accepted as appropriate labels for policyholder behavior risk in part(a).

Solution:

(a)

(i) Identify and analyze People Risk associated with the VA product.

(ii) Propose means for reducing such risk.

8. Continued

Commentary on Question:
Full credit could be attained for a correct answer that focused just on Adverse Selection related to policyholder investment options. Credit was also given for other types of People Risk discussed in the context of the VA business (e.g. employment-related risks, adverse selection related to longevity risk, etc.).

(i) The main people risk here is Adverse Selection. Policyholders can purposely choose very risky investments, because there are no investment restrictions, and will get very high returns if markets returns are favorable. But if market returns are unfavorable, the policyholder is protected by the investment guarantees and Fuchsia will incur the losses.

(ii) To reduce this risk, Fuchsia could re-design its VA product and make these changes:

- place restrictions on riskier investment options
- charge higher fees for riskier investments to create a disincentive for policyholders' choosing them
- reduce or eliminate the guarantees

(b)

(i) Identify and analyze two types of People Risk related to the divestiture project.

(ii) Propose means for reducing such risks.

Commentary on Question:
The best answers focused on Mr. A as the project leader, i.e. his incentives and fitness for the assignment. Partial credit was also given for answers that focused on the external consultants or other project team members.

(i) Two types of People Risk related to the project:

1. Agency Risk. Mr. A is promised a large bonus if the project is completed by year-end. So he may act in his own self-interest, not in Fuchsia's best interest. He might try to rush the project, without proper due diligence, in order to get the bonus, and the deal may not be as favorable to Fuchsia as it otherwise could have been.

2. Employment-related Risk. There is a risk that Mr. A is not the right person to lead the project. His background is in securities and sales. He does not have direct experience with VA products or with mergers & divestitures. This could result in mis-evaluation of the deal or in making bad decisions.

8. Continued

(ii) To reduce these risks:

1. Agency Risk: Redesign Mr. A's bonus package to better align his interests with Fuchsia's interest. For example, the bonus could be linked to the sales price of the divestiture or some other measure of value to the company, instead of simply to the timing of the deal.

2. Employment-related Risk. Instead of Mr. A, Fuchsia could pick a team leader that has experience in the VA business and/or experience with mergers & divestitures. Good recruitment techniques (e.g. interviews, checking references, use of head-hunters) should be used to ensure that the project leader has the right skills and background. Additional training could be also given to the project leader and others on the team to help prepare them for this project.

9. **Learning Objectives:**

2. The candidate will understand the concepts of risk modeling and be able to evaluate and understand the importance of risk models.

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

5. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

(2a) Demonstrate how each of the financial and non-financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, and scenario analysis.

(2b) Evaluate how risks are correlated, and give examples of risks that are positively correlated and risks that are negatively correlated.

(2c) Analyze and evaluate risk aggregation techniques, including use of correlation, integrated risk distributions and copulas.

(2h) Construct approaches to modeling various risks and evaluate how an entity makes decisions about techniques to model, measure and aggregate risks including but not limited to stochastic processes.

(3a) Apply and construct risk metrics to quantify major types of risk exposure such as market risk, credit risk, liquidity risk, regulatory risk, etc., and tolerances in the context of an integrated risk management process.

(3c) Analyze quantitative financial data and insurance data (including asset prices, credit spreads and defaults, interest rates, incidence, causes and losses) using modern statistical methods. Construct measures from the data and contrast the methods with respect to scope, coverage and application.

9. Continued

(5a) Describe the concepts of measures of value and capital requirements (for example, EVA, embedded value, economic capital, regulatory measures, and accounting measures) and demonstrate their uses in the risk management and corporate decision-making processes.

(5c) Apply risk measures and demonstrate how to use them in capital assessment. Contrast regulatory, accounting, statutory and economic capital.

(5d) Propose techniques for allocating/appropriating the cost of risks/capital/hedge strategy to business units in order to gauge performance (risk adjusted performance measures).

Sources:
CIA Research Paper 21204 "Considerations on the Quantification of Variability in P&C Insurance Policy Liabilities"

ERM-119-14 Aggregation of Risks and Allocation of Capital (Milliman) (Core Source)

ERM-710-14 Allocation of Capital in the Insurance Industry

Commentary on Question:
Part a of this question simply requires the recall of facts from the CIA Research Paper regarding the Panning method. Parts b –d test the candidate's understanding of how the Panning method works. The overall objective was to take a Personal Liability loss triangle and estimate the variance of this triangle so as to determine a 99% confidence interval, or VaR, at the extreme end. Having computed the VaR for the Personal Liability block and given the VaRs for the other two lines, the candidate is asked to compute the combined 99% VaR for all three lines both marginally and in total. This is identified as the Risk Capital for the purchase. Finally, we ask the candidate to take the information computed and assess the impact of the proposed purchase on the Risk profile of the company.

Solution:
(a) Identify and explain four potential advantages of using Panning's approach to measure loss reserve uncertainty in this situation.

1. Simplicity – Can be implemented on a spreadsheet and applied to universally available data(i.e. can get basic data from NAIC and use simple tool for analysis)
2. Accurate method – since it addresses and avoids a no. of pitfalls in statistical estimation and also meets a Monte Carlo test of its precision; i.e. not sacrificing accuracy working with data available and simple tools

9. Continued

3. The resulting estimates are comparable across different lines of business and different firms, i.e. can compare these results to Pryde's current Personal Auto results as well as other lines
4. The measure of Loss Reserve Uncertainty (LRU) is scalable so that it is applicable to reserves that have been estimated in different ways. i.e. again, can compare to Pryde's other lines even if use different reserving method from current insurer

(b)

(i) Calculate the missing fitted value for (DY1, AY5).

(ii) Calculate the missing $\boldsymbol{b_1}$ for DY3.

(iii) Calculate the missing $\boldsymbol{b_0}$ for DY6.

(iv) For DY2, you have derived the following variance-covariance matrix:

Commentary on Question:
Candidates needed to understand that the data is already fitted and so we are testing the candidate's understanding of how the fitting is actually computed.

(i) The missing fitted value for (DY1, AY5) is derived from the regression equation $\hat{Y} = b_0 + b_1X$, where X is (DY0, AY5) which is the value 8280; b_0 is 7685 and b_1 is 0.31. Thus missing value is therefore 10251.8, or 10252 rounded.

(ii) The missing $\mathbf{b_1}$ for DY3: Using AY6, $3739=2825+ (b_1 * 6528)$; $b_1 =0.14$

(iii) The missing $\mathbf{b_0}$ for DY6: Using AY3, $1188 = b_0 +0.31*8352$; $b_0 =-1401$

(iv) The missing standard deviation is the square root of the sum of squares from the variance-covariance matrix which is provided. The values in the matrix sum to (171,021.3 + 16,415.4 + 16,415.4 + 172,536.6) = 376,388.7.The square root of 376,388.7 = 613.5 or 614 rounded.

9. Continued

(c)

(i) Calculate the total unpaid losses.

(ii) Calculate the total standard deviation.

(iii) Calculate Panning's coefficient of variation.

(iv) Calculate VaR (99%).

Show your work.

(i) The total unpaid losses : need to sum the totals of all DYs:

	DY1	DY2	DY3	DY4	DY5	DY6	DY7	DY8	DY9
Unpaid Losses	9962	12106	11397	8118	6699	5682	4704	0	0

Total = 58,688

(ii) The total standard deviation (note that since we are using incremental losses, DY's are independent) is the square root of the sum of the $\mathbf{se}_{\mathbf{est}}$'s that are given below the "Fitted Values" table in the stem, plus the student's derived or assumed value for the missing $\mathbf{se}_{\mathbf{est}}$: Total SD = sqrt{760^2 +614^2 + 839^2 + 503^2 + 416^2 +294^2 + 344^2} = sqrt{2,289,354} = 1,513.06 or 1,513 rounded

(iii) Panning's coefficient of variation equals the ratio of Total Standard Deviation to Total Unpaid Losses, or 1513/58,688= 2.58%.

(iv) VaR(99%) : α=2.326 ; σ = total standard deviation (ii above) = 1513 ; so VaR = $\alpha\sigma$ =(2.326*1513) = 3,519 rounded. We also accepted a calculation as follows: VaR = $\alpha\alpha + \mu$ = 3,519 + 58,688 (mean equals total unpaid losses from i above) = 62,207 as per source.

(d)

(i) Calculate the current combined portfolio VaR for Pryde's PA and PP business units.

(ii) Calculate the Discrete Marginal Contribution of adding the excluded business to each of the Current Line combined portfolios.

(iii) Calculate the Scaled Marginal Contribution of adding the excluded business to each of the Current Line combined portfolios.

9. Continued

(i) In order to compute the combined portfolio VaR for the PA and PP business units one needs to use this covariance matrix formula

$$[11{,}258 \quad 7{,}792] \begin{bmatrix} 1 & .4 \\ .4 & 1. \end{bmatrix} \begin{bmatrix} 11{,}258 \\ 7{,}792 \end{bmatrix}$$

This will result in a value of 14,374*11,258 + 12,295*7,792 = 257,635,696
We then want to take the square root for a final value of 16,051

(ii) The discrete marginal contribution of adding the excluded business to each of the current line combinations is derived by subtracting the VaR of the current line combos from the total VaR for all three lines of 16,745:
a. (PA&PP): 16,745 – 16,051 = 694;
b. (PA&Pl): 16,745 – 12,449 = 4,296;
c. (PP&PL): 16,745 – 8,223 = 8,522

(iii) The scaled marginal contributions are derived by multiplying the discrete marginals by the ratio of the combined VaR of 16,745 and the sum of the marginals = (694+4,296+8522) = 13,512, or 16,745/13,512 = 1.239 factor:

Current Lines	Business Excluded	VaR of Current Lines	Discrete Marginal Contribution	Scaled Marginal Contribution
PA&PP	PL	16,051	694	860
PA&PL	PP	12,449	4,296	5,324
PP&PL	PA	8,223	8,522	10,561
Risk Capital for PA, PP & PL			13,512	16,745

(e) Assess the impact on Pryde's personal lines risk profile of the potential PL block acquisition using your preliminary analysis.

From (c)iv we see that the potential PL acquisition would add a standalone VaR or risk capital amount of $3,519, but the difference in total Capital of the 3 businesses is only 16,745 which is only a 694 increase in capital over the current personal lines of 16,051.

The diversification benefit increases from 3,009 (19,050 – 16,051) to 5,824 ((19,050+3,519) - 16,745)

9. Continued

This indicates that the PL block is not perfectly correlated with either the PA or the PP blocks

10. Learning Objectives:

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

5. The candidate will understand the concept of economic capital, risk measures in capital assessment and techniques to allocate the cost of risks within business units.

Learning Outcomes:

(3c) Analyze quantitative financial data and insurance data (including asset prices, credit spreads and defaults, interest rates, incidence, causes and losses) using modern statistical methods. Construct measures from the data and contrast the methods with respect to scope, coverage and application.

(5c) Apply risk measures and demonstrate how to use them in capital assessment. Contrast regulatory, accounting, statutory and economic capital.

Sources:

Regulatory Capital Standards for P&C Insurers under the U.S., Canadian, and Proposed Solvency II Formulas

Solvency II Reserving Risk and Risk Margins: Thinking Differently

Commentary on Question:

The goal of this question was to test candidates' understanding of capital requirements for the United States and Solvency II and differences in the two regimes.

Solution:

(a) You are given the following data as of 12/31/14 for Pryde:

Liability Item	U.S. Statutory Value	Solvency II Value
Losses and loss adjustment expense reserves	$1,987,000	$1,738,000

Provide possible reasons for the differences between the U.S. valuation of liabilities and the Solvency II valuation of liabilities.

Commentary on Question:

This question was meant to test candidates' understanding of general insurance valuation fundamentals in the U.S. and for Solvency II.

10. Continued

A. U.S. Valuation generally uses undiscounted reserves except for those reserves reflecting fixed and reasonably determinable payments.
B. U.S. Valuation requires establishing a premium deficiency reserve if anticipated losses, loss and expense reserves, and maintenance expenses exceed recorded unearned premium reserves and contingency reserves.
C. U.S. Valuation allows for loading reserves for conservatism, which Pryde may have implemented.
D. For Solvency II, liabilities would be marked to market wherever possible.
    1 If this is not possible, mark to model approaches should be used.
    2 Liabilities are assessed at their current exit value, which is the value at which they could be transferred or settled between knowledgeable willing parties in an arm's length transaction.
        a. The current exit value is determined using the Best Estimate Liability approach and a cost of capital risk margin (CCM).
        b. The CCM is the present value of future capital needs for run off of the business.
        c. The BEL is the probability weighted average of future liability cash flows discounted at the interest risk free rate.

(b) Pryde has been challenged by adverse loss reserve development in recent years. It is concerned about how this will translate into a Solvency II environment.

Compare and contrast reserving risk under the traditional actuarial view and Solvency II.

Commentary on Question:
This question further tested knowledge of valuation concepts in the U.S. and in Solvency II.

A. The traditional actuarial view of reserving risk considers variability of outstanding liabilities over their lifetime
    1 Analytical formula based approaches provide a standard deviation (SD) of the outstanding liabilities over their lifetime.
    2 Simulation-based approaches (e.g., bootstrapping) provide full predictive distributions.
B. Under Solvency II, the basic risk profile is the profit/loss on reserves held over a one-year period. This is called the claims development result (CDR) or the runoff result.
    1 On an undiscounted basis, CDR is defined as the opening expected undiscounted reserves, less claims paid (plus expenses) in the year, less closing expected undiscounted reserves after one year.
    2 Traditional actuarial view looks at the difference between the opening expected ultimate cost of claims and the actual ultimate cost of claims after all liabilities have been extinguished.

10. Continued

C. Direct Contrasts
   1 Solvency II - One year view of reserving for risk is less than the traditional actuarial view's perspective of ultimate cost of claims.
   2 Solvency II - discounted basis vs Traditional actuarial non-discounted basis.

(c) Lyon is concerned about capital levels for a foreign-based P&C insurer relative to what is required for Pryde in the U.S. Pryde's surplus is about 350% of the RBC Authorized Control Level (ACL) whereas the Solvency II Solvency Capital Requirement (SCR) is $937,000.

(i) Compute Pryde's RBC ACL as of 12/31/2014. Show your work.

(ii) Describe in detail the methodology used to compute U.S. Statutory RBC.

(iii) Describe in detail the methodology used to compute SCR under Solvency II.

Commentary on Question:
This question was meant to test candidates' understanding of regulatory surplus fundamentals in the U.S. and for Solvency II and is a recall question. Candidates received full credit on this answer if they were to recall the main points of each method.

(i) The company was holding a total amount of surplus equal to 3.5 times the ACL, any excess being dividended up to the holding company. The total surplus was $809,647 in the case study as of 12/31/2014. Thus, the ACL $231,327, $809,647/3.5.

(ii) Methodology used to compute U.S. Statutory RBC is as follows:
   a. Total RBC after covariance = R0 + square root of (R_1^2 + $R2^2$ + $R3^2$ + $R4^2$ + $R5^2$), where:
      R0 = asset risk – subsidiary risk
      R1 = asset risk – fixed income
      R2 = asset risk – equity
      R3 = asset/credit risk – recoverables, reinsurance
      R4 = underwriting risk – reserves
      R5 = underwriting risk – net written premium
   b. The Authorized Control Level RBC is defined as 0.5 x Total RBC after covariance.
   c. Generally, the RBC formula determines regulatory capital for a given risk by applying an RBC factor to an exposure amount obtained from the annual statement.
   d. Formulas for underwriting risk and net premium risk combine company experience and industry experience.

10. Continued

e. Calculation of U.S. RBC ratio is determined by comparing the insurance company's Total Adjusted Capital (TAC) to the ACL RBC
   1 If the RBC ratio falls below one of five predefined levels, a certain regulatory "action level" will be triggered.
   2 If RBC ratio falls below 70%, the state insurance commissioner should seize control of the insurer.
   3 RBC level is calculated and reported annually.

(iii) Describe in detail the methodology used to compute SCR under Solvency II.

a. Establishes two levels of capital requirements:
   1 Minimum Capital Requirement (MCR) – if available capital falls below this threshold, the insurer's license will be revoked.
   2 Solvency Capital Requirement (SCR) – The target level of capital below which the regulator will take corrective action to restore the financial health of the insurer.
b. SCR may be calculated using the prescribed standard model or a company's internal model subject to supervisory approval.
   1 The balance sheet is projected one year into the future with both old and new business under the Solvency II framework.
   2 Over the one-year horizon, assumed changes in the asset and liability risk factors are modeled and their impact on the economic balance sheet is measured.
   3 SCR corresponds to the 99.5% VaR of the change in economic surplus over the one year horizon.
c. SCR standard formula is divided into the life and non-life underwriting market, counterparty default and operational risk modules which are each further divided into component sub-risks.
d. Solvency II standard formula applies a combination of stress tests, scenarios, and factor-based capital charges to determine the solvency capital requirements for the individual risks in the formula.
   1 The formula uses correlation matrices to aggregate component risks within each major risk-module and across the major risk-modules.
   2 In addition to benefits of diversification captured in the SCR formula, the standard formula also allows for reduced capital requirements for risk management techniques such as reinsurance and capital market hedging programs.

(d) Pryde's CEO has told Lyon's Board that he believes the work done by Hawthorne can be used to determine Solvency II capital.

Explain whether he is correct.

10. Continued

Commentary on Question:
This question further tested candidates' understanding of Solvency II concepts along with their ability to apply them to an example from the case study.

a. Hawthorne has collaborated with Pryde to develop an EC model using 99.4% Value-at-Risk (VaR), which was used as a base for an internal EC model using 99% VaR to set capital.
b. Solvency II requires that mark-to-market be used first, if available. If not available, then mark-to-model approaches (i.e., based on market input) can be used.
c. Solvency II regulatory capital requirement is based on either a prescribed standard model or a company's internal model subject to supervisory approval.
    1 If the standard model is used, there is little benefit from the work done by Pryde/Hawthorne to calculate the Solvency II capital requirement.
    2 Assuming Pryde's model is consistent with one that would be approved, then it would need to change its VaR level to 99.5%. This change should require minimal effort.