# ERM-GI Model Solutions
# Spring 2014

## 1. 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.

**Learning Outcomes:**

(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.

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

**Sources:**

ERM-102-12: Value-at-Risk: Evolution, Deficiencies and Alternatives

Value-at-Risk: The New Benchmark for Managing Financial Risk, Jorion, 3rd Edition

- Ch. 5, Computing VaR
- Ch. 19, Operational Risk Management

ASOP 23: Data Quality

**Commentary on Question:**

*In answering this question, candidates are expected to analyze and evaluate the applications of risk measures to operational risk and to recognize their limitations. Candidates should also demonstrate a good understanding of the challenges in dealing with high-severity / low-frequency risks.*

**Solution:**

(a) Identify which shortcomings of VaR affect its use when determining EC for operational risk. Explain your answer.

## 1. Continued

**Commentary on Question:**
*From ERM 102-12, there are 6 shortcomings of VaR given, but not all shortcomings are specific to this situation. The three shortcomings discussed in the response below are considered the most relevant. Candidates who discussed other shortcomings, either from the list of six or from other sources, could receive some credit, if the answer was explained well and relevant to the question asked. Most candidates did reasonably well on this part.*

Coherency, subadditivity, and tail risk – If op risks occur, they are low frequency but high severity events, which are not captured well with VaR; VaR does not reflect the magnitude of these extreme losses because it's a threshold value, a point estimate.

Normal distribution –With op risk, we are interested in both high frequency/low severity and low frequency/high severity losses; a normal distribution may not appropriately capture the low frequency/high severity events.

Data and observation period – Assumes the past can predict the future. A shorter period of data may allow quick adaptation to current events, while a longer period of data can capture more varied markets and more extreme events. In this case, the Bank's past experience with this risk may be irrelevant, as new controls have been put into place, which would presumably affect outcomes. In addition, obtaining the data may be very difficult, and will rely on the Bank's abilities to collect this data internally or to access external sources of data.

(b) You are tasked with assessing whether the data used for these EC calculations is compliant with ASOP 23. List three considerations the team should apply from the ASOP when selecting data. Explain the challenges involved in calculating EC for operational risk with the current data

**Commentary on Question**:
*The candidates in majority did well on part (i) and received some credit in part (ii). Higher scores are given to candidates who provided thorough and well-rounded explanations for the challenges Bayou faces.*

*As the question was testing knowledge of the ASOP, candidates did not receive credit in (i) for general considerations if not part of the ASOP. The answers shown below for (ii) are more complete than would be expected on the exam. Three relevant, well-explained challenges would be sufficient for full credit.*

## 1. Continued

(i) List three considerations the team should apply from the ASOP when selecting data.

Any three of the following:
1. Appropriateness of the data
2. Reasonableness and comprehensiveness of the data elements
3. Known, material limitations of the data
4. Cost and feasibility of obtaining alternative data
5. Benefits vs. time and cost of alternative data
6. Sampling methods used

(ii) Explain the challenges involved in calculating EC for operational risk with the current data.

1. The appropriate frequency of observations for the VaR calculation needs to be determined, e.g. monthly, quarterly, or annual, etc. It depends on the number of internal events that the Bank has that can be qualified as relevant data for op risk. Considerations also need to be given as to the number of competitors to be included in the survey data and the time period to be covered by the survey data.

2. Determination needs to be made on the use of the internal data from occurrences prior to the internal control changes, i.e., should any of the older data also be included? To keep a good mix of internal data and survey data, the answer might also depend on how current the collectible survey data is.

3. A fundamental consideration for using historical data prior to the internal control changes is to understand if the changes to the internal controls made the data on prior internal events not applicable. These events might not have been measured and recorded consistently over time. Similarly, considerations need to be given on the appropriateness of the survey data for the firm as the surveyed competitors might not have similar internal controls.

4. Furthermore, the Bank's records on the internal events might not be complete. It's possible that qualified internal events might not have been recorded prior to the full institution of the new internal controls. On the other hand, competitors might not be willing to report all events or include all data in the survey.

(c) Explain how estimation error affects how these estimates of VaR are interpreted.

## 1. Continued

**Commentary on Question**:
*This question tests candidates' ability to make sound judgment about the VaR results.*

- Providing a confidence band with the VaR estimate conveys more information than the VaR estimate alone.
- A VaR with a smaller confidence band is more precise than one with a larger confidence band.
- Both of these statistics are attempting to measure the same thing, but the first is providing far less information, as the 95% confidence band covers $160 - $260 million, while the second band is much tighter, covering only $240 - $260 million. The estimation error makes the first measure less reliable than the second.

(d) The team uses the quantile approach to calculate the estimation error in the operational risk component of VaR.

(i) Explain an alternative approach for calculating the estimation error.

(ii) Explain the advantages and disadvantages of these two approaches.

(iii) Recommend to the CRO whether the alternative approach should be used instead of the quantile approach. Justify your response.

**Commentary on Question**:
*The intended response to (i) was the parametric approach, as shown in the response below. The grading took account of the fact that candidates suggested a wide variety of approaches that could be alternatives to the quantile approach. Credit was given to candidates who discussed the parametric approach in general, or chose a specific type of the parametric approach as their selection, or used a variation of a nonparametric approach in their answers. Therefore, a good answer could be quite different from the model solution. However, candidates needed to demonstrate a good level of knowledge in their choices and reasoning to receive good scores.*

*Similarly, although the quantile approach is the preferred answer for part (iii) in the model solution, credit was given for other recommendations that were supported by good explanations.*

(i) Parametric Approach – When the underlying distribution is known, we can determine the distributions of the estimated mean and variance. We can use these results to construct confidence bands for the point estimates.

## 1. Continued

In these cases, as the sample size increases, the precision of the estimate also increases.

(ii) Parametric Approach

- Pro: Inherently more precise than quantile approach as the sample standard deviation contains more information than the sample quantile.
- Con: May be difficult to determine the proper distribution in order to apply this method.

Quantile Approach [Non-parametric]

- Pro: Standard error can be estimated by bootstrapping the data when the underlying distribution is unknown.
- Con: Has substantial estimation errors relative to parametric approach (i.e. much larger confidence bands), especially for high confidence levels / rare events.

(iii) The parametric approach is inherently more precise than the quantile approach (the sample standard deviation contains more information than the sample quantile), but it can be difficult to determine the proper distribution in order to apply this method.

The quantile approach allows the standard error to be estimated without making an assumption about the underlying distribution. Since we cannot be sure what the underlying distribution is in this case, the quantile approach is more appropriate. However, it will give large estimation errors, which produces an imprecise range.

## 2. 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:**

(2d) Apply and analyze scenario and stress testing in the risk measurement process.

(2e) Evaluate the theory and applications of extreme value theory in the measuring and modeling of risk.

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

**Sources:**

Value-at- Risk: The New Benchmark for Managing Financial Risk, Jorion, 3rd Edition

- Ch. 14 Stress Testing
- Ch. 5 Computing VaR

Modeling Tail Behaviour with Extreme Value Theory, Risk Management, Sept 2009

Financial Enterprise Risk Management, Sweeting, 2011, Ch. 12 Extreme Value Theory

**Commentary on Question:**

*This question was designed to test the candidate's understanding of Extreme Value Theory (EVT) concepts and the strengths, weaknesses and limitations of EVT models. Candidates were also expected to be able to apply EVT to a specific situation.*

**Solution:**

(a) Define Extreme Value Theory (EVT) and explain its purpose in statistics and modeling.

**Commentary on Question**:

*Candidates did well on this portion of the question and showed a good understanding of EVT and its focus on creating a distribution of tail events that is separate from the rest of the underlying distribution.*

EVT is a technique used to model the distribution of tail risks above a certain threshold, using historical data to infer information about the tail.

EVT is used to model low frequency / high severity events, or 'black swan' events, where other distributions typically do not adequately capture the risk in the tails.

## 2. Continued

(b) You have been asked to recommend a threshold level based on the table above in order to fit an EVT distribution.

(i) Explain the tradeoffs, in general, of choosing among the possible threshold levels.

(ii) Recommend a threshold level for Biersch. Justify your choice.

**Commentary on Question**:
*Candidates did well on this portion of the question and understood the balancing act between choosing a threshold that is too high, which limits data points used to calibrate parameters, and choosing one that is too low which potentially leads to including non-tail events. Note that the actual recommendation of a specific threshold was secondary to the explanation of the thought process followed by the candidate.*

(i) Choosing a threshold level is a balancing act. Choosing a threshold that is too high will ensure you are focusing on extreme events, but it will limit the amount of data available to calibrate the model, which will potentially increase parameter estimation error. Choosing a threshold that is too low will increase the amount of data available to calibrate the model, but it may include data points which are not truly extreme and therefore are not appropriate to include in the EVT analysis.

(ii) I recommend using a threshold of $910 million, as the scale and shape parameters stabilize at this point. While they are also stable at higher thresholds, $910 million allows for more data points available to calibrate the model.

(c)

(i) Demonstrate that the CRO's calculation of the 16% probability is correct based on the selection of the $910 million threshold. Show your calculations.

(ii) Explain whether or not the 16% probability that losses will exceed $1 billion at least once over the next 30 years is reasonable.

(iii) Explain the limitations of the current modeling framework, assumptions and data.

**Commentary on Question**:
*The purpose of this question was to allow candidates to demonstrate their familiarity with EVT and use of the GPD. Candidates struggled with c(i) and c(ii), perhaps because the specific formula for the GPD was not provided.*

## 2. Continued

*However, there were several ways to analyze the reasonableness of the CRO's 16% probability and grading points were generally awarded for responses which provided a clear explanation and supporting logic, rather than requiring a specific response.*

*Candidates did well on c(iii) and showed a general understanding of the limitations of the EVT modeling framework, the underlying data used for EVT and the challenges of applying EVT in a real world setting.*

(i) The CRO's calculation was derived using the following approach.

$G(x) = 1- (1+ x/\beta\gamma)^{(-\gamma)}$ if $\gamma \neq 0$;
$1 - G(x) = 1 - (1 - (1 + (1 -.91)/(.03*10))^{(-10)}) = 0.07254$
1 Year Unconditional Prob ($\geq$ 1 bil) = Percentile * (1 – G(x))
= 0.08 * 0.07254 = 0.0058
30 Year Prob ($\geq$ 1 bil) = 1 - (1 - 0.0058)^30 = 0.16021

*While the 16% can be reconciled using the formulation provided above, there are alternate responses that could have been arrived at which did not reconcile to the 16%, either due to using different units (e.g., millions) for the loss amounts or due to using a different approach. Grading points were awarded for demonstrating familiarity with the GPD and use of the associated parameters regardless of whether the 16% result was obtained.*

(ii) The historical probability of an annual loss greater than \$910m is 8% based on the model data in the table, so the probability of a loss greater than \$1 billion can be estimated to be lower than 8% (perhaps 6%). The 16% probability quoted by the CRO is unreasonable vs. the 6% - 8% because the P(loss > 1 billion) are on two different time periods, the 16% being over a 30 year period versus the table showing an 8% probability of a loss exceeding \$910M in any given year.

P[annual loss > \$910 million in a given year]
= 1 – P[annual loss does not exceed \$910 million in a given year]
= 1 - 0.08 = 92%
Then, assuming independence,
P[Annual loss does not exceed \$910M in each of 30 years] = $1 – 92\%^{30}$ = 91.8%
Therefore the 16% probability appears to be understated based on the historical data.

## 2. Continued

(iii)

- The amount of data used to calibrate the EVT distribution is limited
- The selection of the threshold is subjective but it impacts the results
- Historical data may not be indicative of future events
- Model assumes all events are independent and identically distributed which may not hold true and ignores any potential correlations in the risk
- The data has been adjusted to fit company exposure and this adjustment process may impact the analysis

(d) Propose additional analyses to supplement the EVT analysis performed above.

**Commentary on Question**:
*Candidates performed well on (d) and provided a variety of quantitative and qualitative methods to supplement the EVT analysis.*

EVT should be supplemented with sensitivity testing and scenario analysis which would provide additional insights into the potential exposures that may not be included in the historical data or the EVT model calibration.

In addition, expanding the data set to include other relevant industry data may improve the model, and running stochastic simulations may provide other insights into the risk.

## 3. 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.

(2g) Analyze and evaluate model and parameter risk.

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

**Sources:**

ERM-101-12: Measurement and Modeling of Dependencies in Economic Capital

ERM-103-12: Basel Committee – Developments in Modeling Risk Aggregation

Value-at- Risk, The New Benchmark for Managing Financial Risk, Jorion, 3rd Edition, Ch. 5 Computing VaR

**Commentary on Question:**

*In general, candidates performed well on this question, demonstrating adequate knowledge of various risk aggregation techniques and concepts. The last part of the question is designed to be challenging, yet many candidates seemed to be well versed in the concept of tail dependency and mathematical derivation.*

**Solution:**

(a) Explain why the risks for these two LOB's may not perfectly offset each other.

**Commentary on Question**:

*The following list is more comprehensive than what is required for full credit. Most candidates were able to recognize the difference in underlying risk exposure as the main reason.*

- Underlying distribution of insured lives may differ in significant ways, e.g., attained age, gender mix, socio-economic and demographic composition, etc. Mortality risk is typically underwritten whereas longevity risk is typically not.

## 3. Continued

- Even if the insured lives are highly correlated, the size of the two portfolios appears to be different (at least as measured by expected cash outflows)
- Benefit provisions and contractual terms may limit the mortality/longevity risk exposure which may result in imperfect offsetting of risks.
- Catastrophe event usually impacts mortality, but less so longevity.

(b) Calculate the EC for the combined LOBs using the fixed diversification percentage method. Show your work.

**Commentary on Question**:
*While many candidates correctly applied the VaR formula and diversification method, some candidates failed to recognize the standard deviation given in the question is an absolute dollar amount, not a percentage, and thus erroneously included the [net expected cash outflow] as an extra multiplicative component.*

VaR(LOB A) = 20 million x 2.576 = 51.52 million

VaR(LOB B) = 16 million x 2.576 = 41.216 million

Total EC = (51.52 + 41.216) x (1 – 0.4) = 55.6416 million

(c) Calculate the correlation for mortality/longevity risk between LOBs from the simulation runs. Show your work.

**Commentary on Question**:
*Most candidates recalled the formula and applied it perfectly.*

Recall the Pearson correlation coefficient formula:
$\rho (X,Y) = Cov [X,Y] / \sqrt{Var(X) Var(Y)}$

$\rho = (E[ECF(LOB_A) \times ECF(LOB_B)] - E[ECF(LOB_A)] \times E[ECF(LOB_B)]) / (StdDev(LOB_A) \times StdDev(LOB_B))$
$= (11{,}860 – 100.8 \times 118.8) / (22.3 \times 16.3) = -0.316$

(d) Recalculate the EC for the combined LOBs based on the variance-covariance method. Show your work.

**Commentary on Question**:
*Many candidates used the matrix approach, but failed to set up the matrix correctly. If the matrix is set up correctly, the result is as shown here. A few candidates erroneously used the correlation factor as the fixed diversification factor.*

## 3. Continued

$$EC = \sqrt{VAR\left(LOB_A\right)^2 + VAR\left(LOB_B\right)^2 + 2 \times \rho \times VAR\left(LOB_A\right) VAR\left(LOB_B\right)}$$
$$= \sqrt{(51.52^2 + 41.216^2 + 2x(-0.316)x51.52x41.216)}$$
$$= 54.87$$

(e)

(i) Explain what the CRO means by his statement above.

(ii) Estimate $\theta$ using the values provided in the table above. Show your work.

(iii) Explain whether or not the Clayton copula is appropriate in this circumstance.

**Commentary on Question**:
*In (i) many candidates struggled to articulate the concept. While many candidates did recognize that the simple correlation factor cannot reflect the complex relationship, they failed to explain the shortcomings.*

*The application of the Clayton copula was the most challenging part of the question, as the source material does not directly illustrate application of copulas. Some candidates successfully derived the dependency formula, but few were able to use the tabulated values to estimate the parameter. Candidates received partial credit for demonstrating reasonable approaches to the problem.*

*Most of the answers in (iii) were simplistic without much "explanation" provided. The question was testing whether candidates understood the concepts of tail dependence as well as the practicalities of using copulas.*

(i)

- Correlation is simply a scalar measure of dependency. It cannot tell everything about the dependency structure of risks. In another words, correlation reduces the relationship to a single variable which may not effectively capture the nuance of this relationship.
- Correlation may not be static overtime
- Simulation runs may not produce the true correlation between two LOBs
- Correlation may not be an appropriate dependency measure for tail risk. EC is a measure of tail risk at VaR 99.5% in this case.
- There may be a different level of dependence for the same cohorts of business depending on the nature of the scenario being considered and the point in time being considered.

## 3. Continued

- Correlation is not invariant under monotonic transformation

(ii) The coefficient of lower tail dependence for the copula is defined to be:

$$\lim_{v\to 0}\frac{C(v,\,v)}{v}$$

For Clayton Copula:

$$Tail\ Dependency = \lim_{x\to 0}\frac{C(x,x)}{x} = \lim_{x\to 0}\frac{\left(x^{-\theta}+x^{-\theta}-1\right)^{-1/\theta}}{x}$$

$$= \lim_{x\to 0}\frac{\left(2x^{-\theta}-1\right)^{-1/\theta}}{x} = \lim_{x\to 0}\frac{\left(2x^{-\theta}-1\right)^{-1/\theta}}{\left(x^{-\theta}\right)^{-1/\theta}} = \lim_{x\to 0}\left[\frac{2x^{-\theta}-1}{x^{-\theta}}\right]^{-1/\theta}$$

$$= \lim_{x\to 0}\left[x^{\theta}\left(2x^{-\theta}-1\right)\right]^{-1/\theta} = \lim_{x\to 0}\left(2-x^{\theta}\right)^{-1/\theta} = 2^{-1/\theta}$$

Using Lower tail dependency to estimate the θ:
$2^{(-1/\theta)} = 0.79$ ==> $(-1/\theta)\ln 2 = \ln(0.79)$ $\theta = 2.94$

(iii)

- In evaluating the relationship between mortality and longevity, we would expect some level of dependence in the middle of the distribution reflecting that there is some relationship between mortality and longevity
- Heavier dependency would be expected at the tails as extreme events would more likely reduce the relevance of the differences in the underlying lives insured versus lives annuitized
- Clayton copula is relatively difficult to parameterize and simulate, but it is capable of modeling tail dependence.
- However, the coplua technique is very abstract and difficult to interpret, thus it has limitations in risk aggregation applications.

## 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 economic capital assessment and techniques to allocate the cost of risks within business units.

**Learning Outcomes:**

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

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

(4f) Develop an appropriate choice of hedging 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.

(5c) Explain the challenges and limits of economic capital calculations and explain how economic capital may differ from external requirements of rating agencies and regulators.

**Sources:**

ERM-114-13: Intro to Reinsurance – Wehrhahn

ERM-115-13: Creating an Understand of Special Purpose Vehicles – PWC

ERM-116-13: Risk Management and the Rating Process for Insurance Companies, AM Best

**Commentary on Question:**

*This question was testing candidates' understanding of Special Purpose Vehicles and reinsurance as ways to transfer risks.*

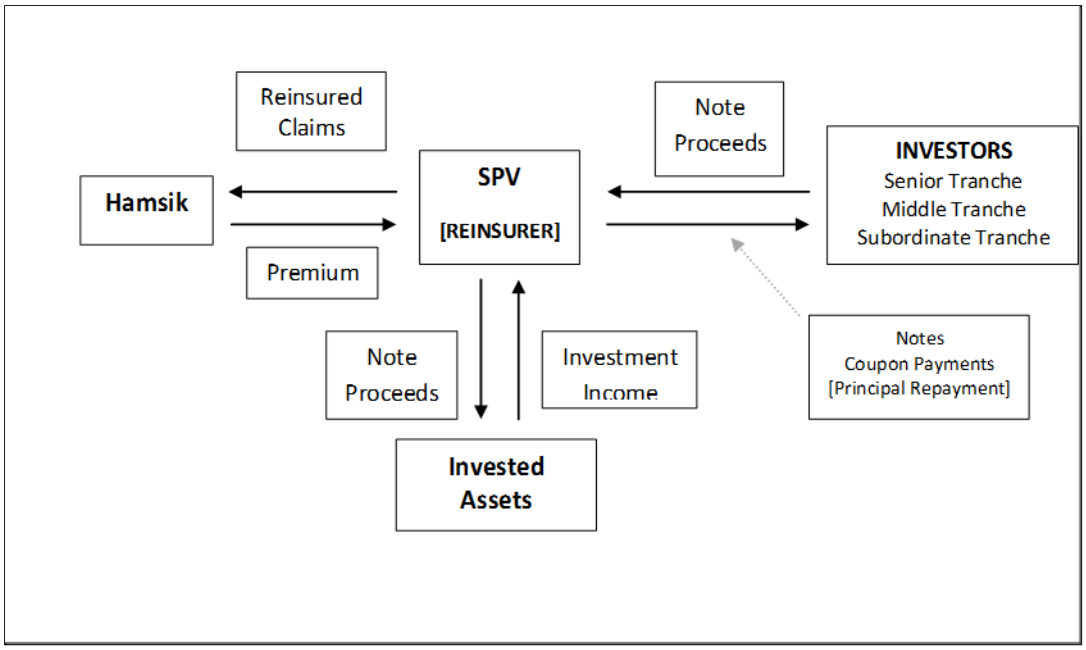
**Solution:**

(a) Draw a diagram that represents a possible structure for Hamsik's SPV. Label all entities and cash flows.

**Commentary on Question**:

*Most candidates received partial credit for identifying the key parties involved and for showing that the SPV acted as the intermediary. Candidates lost points for not clearly identifying the cash or asset flows between the parties. Many candidates simply labeled each item "cash flow" without describing what flows would be made.*

## 4. Continued




The diagram above is one example of a possible SPV structure. Other valid structures also received credit.

(b) Explain key provisions that impact how closely the SPV's coverage matches Hamsik's existing reinsurance agreement.

**Commentary on Question**:
*Candidates typically did not do well on this part of the question. Most either listed provisions without describing them or discussed only one or two provisions. Four well-explained provisions would be sufficient for full credit.*

Tranches: Define which tranche will fund the losses and at which annual loss amounts. This should not impact Hamsik. If the investments are fully funded Hamsik will collect on claims payments and will not have the counterparty risk that the company had under a reinsurance arrangement.

Length of term: Is this a one year investment or multiple years? One year is more typical of reinsurance arrangements, but it could be mutually beneficial to be over a longer horizon within the SPV.

## 4. Continued

Interest rate: What is the interest rate of the bond tranches? Are they zero coupon or do they pay out coupons? Introducing this investment to a broader market will generally lead to interest payments that are less than Hamsik's former reinsurance payments.

Issue amount of the bonds: Unlike the reinsurance arrangement, which pays based on Hamsik's losses, in the SPV arrangement if the losses are larger than the cumulative bond issue amount, Hamsik will not be able to recover all of its losses. However, the bonds are paid interest, so there's a balance that Hamsik has to find that sufficiently covers a reasonably likely set of loss scenarios without writing excessive debt.

Definition of what weather events are included: This can be mirrored from the current reinsurance agreement or could be either more specific or more general.

Are the losses indexed to an index or specific to Hamsik: If they are indexed, there could be mismatch risk to Hamsik.

(c)

(i) Explain the potential advantages for Hamsik if it sets up an SPV instead of continuing with its reinsurance agreement.

(ii) Explain the potential disadvantages for Hamsik if it sets up an SPV instead of continuing with its reinsurance agreement.

**Commentary on Question**:
*Similar to part (b), the most common reasons why candidates lost points were by providing lists but not explaining them, or by focusing extensively on one or two items. Full credit required explanation of approximately four advantages and four disadvantages, or eight items in total.*

(i) Greater diversification benefit for outside investors and gives them a new market to invest in, which increases investment demand and could lead to cheaper/more efficient ways to fund than reinsurance

Decreases counterparty credit risk since the SPV does not rely on a payment post crisis. With reinsurance Hamsik would rely on a reinsurer's ability/timeliness of payment.

Agreement could cover multiple years, while reinsurance is typically annually-renewable.

## 4. Continued

The SPV would be bankruptcy remote, which protects investors and Hamsik. If Hamsik encounters financial difficulties, it cannot access the funds in the SPV. If the underlying assets don't perform well, Hamsik is not liable for the shortfall.

Meets regulatory requirements for transferring assets and liabilities off balance sheet. With reinsurance, that may or may not be possible depending on the laws in the jurisdiction.

(ii) There may be no appetite in the marketplace for this type of security. They could incur the costs to set up the SPV and then be unable to sell the bonds for some reason, for example, particularly bad emerging weather making investors wary of investing in property insurance.

The market could dry up when the catastrophe bonds pay off, leaving Hamsik in search for a different risk transfer method. Hamsik would then have to retain the risk on its balance sheet or attempt to go back into the reinsurance market.

If Hamsik encounters financial difficulties, the funds in the SPV are isolated and can't be accessed by Hamsik.

The SPV and terms to the agreement would dictate when Hamsik could access the funds, which may not cover all situations during which it may need them.

Signaling effect - If the SPV's assets underperform, the market may draw conclusions about the balance sheet of Hamsik.

Regulatory scrutiny- in the past SPVs have been used to skirt requirements, so the regulators may be wary of this change. Hamsik's reputation may suffer if it uses the SPV.

Hamsik would lose any consultative help and insight that the reinsurer provides.

(d) State whether you expect the SPV to be viewed by A.M. Best as a positive or negative development for Hamsik's capitalization and operating performance. Explain your answer.

## 4. Continued

**Commentary on Question**:
*Candidates did relatively well on this part of the question. Either conclusion (positive or negative view by A.M. Best) could have received full credit if explained well.*

*Some candidates did not state an opinion on whether A.M. Best would view this as a positive or negative development, but rather put together a pros/cons list. Candidates doing this only received partial credit. When asked to take a position, candidates should do so. It is fine to show arguments for and against the position being taken, but the candidate should then balance the pros and cons and make a choice.*

The SPV may be viewed as more desirable than reinsurance because it addresses these two points:

- A.M. Best is concerned with Hamsik's dependence on third-party reinsurance
  - The SPV would reduce their credit exposure to Bourbon Re
  - The SPV would have access to a dedicated pool of funds in the event of a catastrophic weather event
- As Hamsik would offload the catastrophic weather risks to the SPV, Hamsik would not be financially responsible for losses above a certain threshold, thus helping it avoid material losses and avoid capital deterioration in these catastrophic situations.
  - Since the SPV is bankruptcy remote and is a separate legal entity, there is a layer of protection such that the SPV could not legally come after Hamsik's assets in the event of insolvency and Hamsik would not have to bail the SPV out.

(e) Explain key risk exposures not addressed by the SPV that A.M. Best would also consider in its rating opinion of Hamsik.

**Commentary on Question**:

*In this section, many candidates referenced risk exposures around the SPV (often just repeating answers to earlier parts of the question). This question part was asking for a more general discussion of other types of risks that Hamsik faces. It was testing knowledge of A.M. Best criteria and the ability to relate those criteria to Hamsik's specific situation. Four distinct risk exposures needed to be explained for full credit.*

- High geographic concentration in states prone to tornadoes (i.e. the Midwest)
- No product diversification to help offset risks in property line
- Agreement may not cover all types of property damage (hurricanes, earthquakes, etc.)

**4.** **Continued**

- Pricing and underwriting risks, which would lead to adverse loss reserve development and challenge operating results and capitalization
  - Selling products in different geographical locations not currently covered
  - Changing weather trends that could cause higher likelihood of disasters
  - Product design risks that allow policyholders to control various elements of the product.
- Are Hamsik's EC and Catastrophe models accurately modeling its catastrophic exposures and thus capital requirements?

## 5. 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 economic capital assessment and techniques to allocate the cost of risks within business units.

**Learning Outcomes:**

(4i) Analyze funding and portfolio management strategies to control equity and interest rate risk, including key rate risks. Explain the concepts of immunization including modern refinements and practical limitations. Contrast the various risk measures and be able to apply these risk measures to various entities.

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

(5e) 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:**

ERM-111-12: Key Rate Durations: Measures of Interest Rate Risks

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

**Commentary on Question:**

*Candidates should understand the Strategic Asset Allocation process and how it applies to risk management. Candidates should also understand the implications to the ALM process given different scenarios such as specific liability profiles and varying economic circumstances.*

**Solution:**

(a) Describe the processes and considerations involved in implementing each of the first four steps in the SAA framework above.

**Commentary on Question**:

*This question was relatively well done. Most candidates could describe the process and provide appropriate considerations for each step.*

Step 1: Objectives and Constraints: Objectives are generally a targeted yield, within some level of risk tolerance or duration mismatch limit. Objectives (and constraints) can be iteratively revisited depending on the risk or return metric decision in the later steps of the ALM process. Constraints can be set based on rating classes, type of assets, or asset concentrations.

## 5. Continued

Step 2: Asset Universe and Asset Assumptions: For the asset universe, allowable asset classes are established or available assets are identified. Asset assumptions could include default risk, correlations between assets or classes, etc.

Step 3: Liability CF and Replicating Portfolio: Consider the liability profile including best estimate liabilities, optionality or volatility of CFs, and term. Establish the key rate duration profile of the liabilities and where possible create a replicating portfolio of assets to match the KRD profile and other economic characteristics of the liabilities.

Step 4: Risk Measures: Establish a set of different risk metrics that will be used in the risk-return decision-making of setting the SAA. It is important to be a set, because a single risk metric doesn't give a complete picture. Examples include Surplus Volatility, Economic Capital or Required Capital.

(b) Explain how the attributes of the liabilities would influence each of the first four steps of the SAA process, for each of the three blocks of business.

**Commentary on Question**:
*Candidates did relatively well here. Many candidates however did not state any objectives or constraints when answering the question.*

GICs: The objective could be a spread over the guaranteed interest rate. For the asset universe, consider high quality fixed income/treasuries restricted to 5 year maturities. Allow for the assets to handle liquidity demands for surrenders (e.g., a percentage can be cash). Liabilities are medium term in nature and a replicating portfolio can be easily created. In terms of risk measures, the profitability may be sensitive to lapses, so a lapse sensitivity could suffice.

SPIA: The objective could be to duration match shorter term liability cash-flows, and then set a constraint on the return of the portfolio. For the asset universe, we have to consider the long term nature of liabilities, so consider the risk-return profile of long term fixed income. Also consider that there may not be available assets long enough to match certain durations so consider derivatives or Non-Fixed Income for total return matching. The liabilities are long term so a replicating portfolio may be difficult to construct. For a risk measure consider interest and longevity sensitivities and the implications to surplus drawdown.

Hurricane Insurance: We want to meet liquidity demands of the short-term liabilities, as well as capital demands. The asset universe could be short-term assets and liquid assets for the volatility of the liabilities. The liability profile is short-term, with low frequency / high severity events. Also, the events are likely seasonal. Since it is a catastrophic event, we may want to consider the tail of the distribution with a CTE metric.

## 5. Continued

(c) Mardi Gras has historically managed capital based on regulatory requirements, but is now considering using Economic Capital (EC).

Explain how this change in focus to EC could influence the SAA analysis.

**Commentary on Question**:
*This was the lowest scoring part of this question. Candidates often did not make any statements regarding the use of regulatory capital. Some candidates simply listed out all they could remember about Economic Capital without any application to the question. That is a waste of the candidate's time and does not score points since it is not answering the question asked.*

The Economic Capital measure is often tied to a VaR or CTE metric at a given confidence level of the total balance sheet requirement for solvency for a specific time period. Regulatory capital is often a formulaic/deterministic metric tied to surplus such as the case for RBC or MCCSR (Canada). For the asset universe, the impact of using different assets would change EC (as it values assets on a realistic basis) and regulatory capital (as it may use a factor approach on the asset class) differently. Since the sensitivities of regulatory capital and EC may be different, constraints could be different and threshold for risk measures could change. The metrics have no real effect on the existing liability CFs, but may influence new product decision making.

(d) Explain the implications to the first four steps of the SAA process if Mardi Gras managed these three blocks of business in aggregate, instead of separately.

**Commentary on Question**:
*This question could have been answered more fully. Most candidates did not give too much thought to a complete answer, and often just stated that there would be diversification without relating back to the steps.*

Objectives and Constraints: We may demand more return for risk because of diversification benefits, or the risk constraints may be lowered.

Asset universe: Needs to be expanded as compared to a single line of business. We now need to handle the volatility from hurricane insurance, the long duration of SPIA, and fixed income assets from the GIC.

Liability CF/Replicating Portfolio: Liability effects are aggregated, which would change the KRD profile and thus the replicating portfolio.

## 5. Continued

Risk Measures: Risk metrics are changed to reflect the new aggregate liability and should consider the diversification benefits. We may now want to use a common risk metric. Also the set of risk metrics should be used to understand and encompass all the risks backing all the products and considering if some risks may offset.

(e) Explain how the perspective gained from the economic crisis of 2007-2009 may have impacted Mardi Gras' analysis in the first four steps of the SAA process.

**Commentary on Question**:
*Some candidates did all right with this question, but many others did not. A lot of candidates did not think about how the asset universe might change. Some candidates also elected to expound on all they knew about the 2007-2009 crisis without real application to the question.*

As a result of the crisis the objectives and constraints may have become more defensive. For instance, there might now be more asset constraints and/or liquidity constraints.

The Asset Universe will likely change: Mardi Gras might have disallowed certain asset classes because of credit rating impacts, hedging instruments may have been introduced, and other assets may be deemed riskier than previously assumed (e.g., Credit default swaps) and are therefore no longer included.

For the liability CFs, Mardi Gras may have considered modifying certain liabilities (for example, lowering crediting rates or shortening guarantee periods), might be more careful about considering policyholder behavior changes, and changes might be made to future product designs.

For risk metrics, Mardi Gras may consider a greater array of risk metrics (such as EC, or RAROC) and consider changing the tolerance of risk metrics. The company may have introduced an extreme market scenario sensitivity.

## 6. Learning Objectives:

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

**Learning Outcomes:**

(1c) Identify and analyze risks faced by an entity, including but not limited to market risk, currency risk, credit 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

**Sources:**

ERM-107-12: Strategic Risk Management Practice, Andersen and Schroder, Ch. 7

**Commentary on Question:**

*The quality of answers varied widely. Many candidates did not recall the "Scenario Planning Approach" as detailed in the source, but used other material from the same reading. Partial credit was given for other reasonable strategic risk management approaches, if appropriately applied.*

*Candidates frequently did not answer the question as posed, in particular when asked to "explain" or "recommend". Some candidates did not focus on strategic risk in their answers, instead discussing a wider range of risks; this was a misuse of the time available as credit was only given for strategic risk responses.*

*As noted in the question, candidates had a choice of clients to focus on. The intent was to let candidates choose the industry they felt most comfortable assessing. The Las Vegas Casino Association was the entity chosen most often, and it is used in this model solution*

**Solution:**

(a)

(i) Identify the steps in the Scenario Planning Approach used in strategic risk management.

(ii) Apply the Scenario Planning Approach for the client you have chosen, showing your responses for each step in the process.

**Commentary on Question**:

*Scenario Planning Approach is described on pages 162-166, and there are five steps detailed. Many candidates were able to identify at least some of the steps.*

*Some candidates confused PESTEL or SWOT with the Scenario Planning Approach. Points could be received for applying PESTEL or SWOT, if the answer related to strategic risk management and development of scenarios.*

## 6. Continued

*Part (a)(i) was directly from the source material. Part (a) (ii) required the candidate to apply the approach and, by solving a problem, demonstrate understanding of fundamental strategic risk management ideas developed in the reading.*

*In part (a)(ii),at least two separate sources of strategic risk were necessary for full credit, and, in addition, the combination of themes in developing scenarios was necessary for full credit. There were candidates who detailed operational or financial risk sources in their responses rather than strategic.*

*The model response below is an example, and alternative answers also received credit.*

(i) Steps in Scenario Planning Approach:
Step 1 – Identify environmental risk factors
Step 2 – Elaborate major themes that characterize plausible alternative developments for future competitive market conditions
Step 3 – Elaborate on the major themes and describe some scenarios that arise as a consequence of different assumptions
Step 4 – Evaluate the consequences of key strategic risk factors within the alternative scenarios and assess capacity for corporate responsiveness
Step 5 – Formulate new strategic alternatives, if required, and evaluate them in the different scenarios.

(ii) Apply Scenario Planning Approach using the Las Vegas Casino Association:
Step 1 – Environmental risk factors:
1. Online gambling
2. Airline ticket prices

Step 2 – Elaborate major themes:
1. Online gambling becomes more popular so fewer gamblers visit LV casinos
2. Increasing ticket prices deter people from traveling to LV as a gambling or vacation destination

**6.** **Continued**

Step 3 – Elaborate on major themes and describe some scenarios:

| | | Online Gambling Popularity | |
|---|---|---|---|
| | | **Low** | **High** |
| **Airline ticket prices to LV** | **Low** | Status quo – people still traveling to Las Vegas | Online gambling becomes more popular – opportunity for LV casinos to form partnerships with online gambling sites |
| | **High** | Travel prices too costly so less visitors to LV – opportunity for LV casinos to develop relationships with smaller regional casinos; may result in losses to LV casinos | Travel costly and online gambling more popular – probable losses to LV casinos |

Step 4 – Evaluate consequences of key strategic risk factors within themes:

1. Current business model is based on gamblers' and other tourists' physical presence in LV, and this is too narrowly focused a market. Other opportunities include insurance for gambling websites, developing own gambling websites (or partnering), or developing relationships with local or regional casinos

Step 5 – Formulate strategic alternatives and evaluate them in different scenarios:

1. Market insurance product to online gambling sites or non-LV casinos; may provide significant revenue if websites or local casinos become much more popular
2. Develop alternative, non-gambling related products attracting a wider range of potential clients (make LV more than a gambling destination); should be profitable in any scenario but may require additional resources and expertise to develop

(b)

(i) Explain what should be considered when choosing participants for the environmental scanning task force.

(ii) Recommend one approach for your client's task force to take when scanning the environment.

(iii) Recommend two specific key risk indicators to be monitored.

**Commentary on Question:**
*Candidates were generally able to obtain at least partial credit for (b). Part (b)(i) is basically looking for diversity in the task force, but as the item requires candidates to "explain", for full credit the answer must include "why".*

## 6. Continued

*For part (b)(ii) candidates receive full credit only if they described and recommended one of the four possible approaches.*
*Part (b)(iii) looks for key risk indicators consistent with the answer to part (a). Often candidates would list KRIs but without explanation or sufficient specificity. Some candidates chose KRIs that could not reasonably be monitored.*

(i)

- Involve people who are observant and sensitive to changes in risk environment in order to recognize environmental changes early and allow for quicker reaction.
- Include a mix of people currently in casino industry at different levels (e.g., front line worker, manager, etc.) and different functions (e.g., marketing, finance, customer service, etc.) in order to have an understanding of different facets of the business and possible risk concerns.
- If possible include others with experience in industries that have experienced similar strategic threats, which could perhaps be a board member.

(ii)

- Undirected viewing is recommended for complex or volatile environments. This involves scanning many diverse sources of information without specific informational needs, and may be best to sense new trends and think about developments in unconventional ways.

(iii)

- Number of visitors to online casinos, to help determine if there is a movement away from casinos to online gambling
- Cost of airfare from selected cities to LV

## 7. 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 economic capital assessment and techniques to allocate the cost of risks within business units.

**Learning Outcomes:**

(4f) Develop an appropriate choice of hedging 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.

(5c) Explain the challenges and limits of economic capital calculations and explain how economic capital may differ from external requirements of rating agencies and regulators.

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

(5e) 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:**

ERM for Strategic Management – Status Report, Venter

Regulatory Capital Standards for Property and Casualty Insurers under US, Canadian and Proposed Solvency II (Standard) Formulas

**Commentary on Question:**

*The goal of the question was to test the candidate's understanding of economic capital and the ability to apply the information from the sources in the "real world" situation based on the case study.*

*For most sections of the question, the answers provided are more complete than what was needed for full credit.*

**Solution:**

(a) Describe four characteristics of the US statutory accounting system that decrease the likelihood of identifying a property and casualty insurer as financially troubled.

## 7. Continued

**Commentary on Question**:
*It was believed that this question would provide a challenge to candidates because it drew from material in more than one study note. There was a wide range of candidate scores indicating that some had difficulty while others understood what was being sought and fully addressed it. Four distinct responses were required for full credit.*

*Some candidates did not read the question carefully and thus did not answer the question that was asked.*

Statutory accounting has several characteristics that make it risk insensitive:

- A catastrophe risk charge is not included in the requirement for regulatory capital.
- An operational risk charge is not included in the requirement for regulatory capital.
- A risk charge for interest rate mismatch is not included in the requirement for regulatory capital.

Also, there is perceived to be opacity in Statutory accounting in the following ways:

- With lower prevailing interest rates the amount of available capital should decrease to reflect the reduced investment opportunities in the market. Therefore, since undiscounted claim liabilities are reported, the size of the implicit claim reserve valuation margin is decreased but the lesser margin is not recognized as a lower solvency buffer for regulatory capital purposes.
- An unearned premium reserve is simply an accounting construct and does not necessarily reflect the best estimate of expected claims with respect to the unexpired risks of existing policies.
- Inadequate premiums and reserves can generate lower capital charges than adequate levels of premiums and reserves for the lines of business.

(b) State two actions taken by Pryde that have decreased the likelihood that the company will become a financially troubled property and casualty insurer.

**Commentary on Question**:
*This was a straightforward question that should not have been difficult to answer because the information was in the case study. Most candidates received full credit for this part of the question. Two appropriate actions were needed for full credit.*

- Pryde has mitigated its catastrophe exposures using excess of loss reinsurance and catastrophe reinsurance.
- Pryde uses economic capital to assess its capital requirements.

## 7. Continued

- Pryde exited the specialty market line of business, a line that was not consistent with its target market. Since Pryde did not have experience or expertise in this line, exiting reduced the level of unknown risks.

(c) Describe three difficulties with using economic capital to determine capital adequacy.

**Commentary on Question**:
*This question was intended to test the candidates' fundamental understanding of economic capital. Most candidates were able to earn at least half of the points available although no one received full credit. Three items were needed for full credit. Possible answers are shown.*

- Need to set a target threshold, and the target selection is somewhat arbitrary.
- A risk measure must be chosen. Hawthorne's selection of VaR and TVaR as risk measures for Pryde impacts the level of capital.
- Level of capital is based on a single quantile from Pryde's probability distribution.
- Economic capital is beyond the capacity of Pryde's existing ERM models to quantify.
- Selection of distributional form impacts projected loss levels.
- Difficult to model remote probabilities in calculating Pryde's TVaR.

(d) Describe three issues with Hawthorne Consulting's method for allocating Pryde's total economic capital to lines of business.

**Commentary on Question**:
*This question was challenging because it required retrieving information from two different sources. However, the information being sought was straightforward and not difficult from a comprehension point of view. Few candidates scored well here, although most received at least half of the points allotted to this part of the question.*

Hawthorne Consulting allocated economic capital to Pryde's lines of business in proportion to marginal capital by line of business.

- Hawthorne used VaR to calculate total economic capital but used TVaR by line of business to allocate the capital to line of business. This mixed use of measures could result in inconsistent views of the capital requirements.
- A problem with proportional allocation is that it is not marginal, and so the risk-adjusted profit calculation does not maintain the financial principle of comparing marginal profits with marginal costs.

## 7. Continued

- Does not meet Tasche's requirement for suitable allocation. If capital is allocated by a risk measure in order to calculate risk-adjusted return by line, you would like to be able to conclude that growing a line with a higher-than-average return will increase the return for the whole company.
- Allocation is arbitrary since a risk measure and a distribution must be selected.
- Allocation is artificial because capital is not actually assigned to business units.

(e) Recommend an alternative to Hawthorne Consulting's method for allocating Pryde's total economic capital to lines of business. Justify your recommendation.

**Commentary on Question**:
*This part of the question was clearly the most challenging one for candidates because it required synthesizing an answer based on the information in the case study without reciting lists or applying formulas for a calculation. Few candidates scored more than 50% of the points allocated to this question, and a substantial minority received no credit.*

*The response shown is one example of an appropriate response. Other alternatives could also earn credit.*

Recommend capital consumption method. The steps in this method:
1. Calculate the cost to the company of bearing the risk of each line of business.
2. Subtract the result in 1. from line of business profits to obtain value added.
3. The cost of bearing the risk of a line of business is the value of the line of business' right to access the capital of the firm.

Justifications for the capital consumption approach include:
- It avoids the problem of artificial allocation.
- It avoids the problem of arbitrary allocation.

## 8. Learning Objectives:

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

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

**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.

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

(5e) 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:**

Regulatory Capital Standards for Property and Casualty Insurers under US, Canadian and Proposed Solvency II (Standard) Formulas

**Commentary on Question:**

*This question tested candidate understanding of the concept of diversification and whether candidates could recommend actions based on economic capital return results.*

**Solution:**

(a) Explain the justification for the reduction in EC from diversification.

**Commentary on Question**:

*Most candidates understood the reasons why diversification reduces EC needs.*

Diversification adjustments recognize that when risks are combined they have some degree of offset associated with them. Diversification benefits are based on the correlation of major risks -- if there is some degree of negative correlation between risks, then a reduction can be made.

(b) Assume Hawthorne's aggregate diversification benefit is applied uniformly to EC across all market niches. Determine the impact to returns on EC for each market niche if the diversification benefit is removed.

## 8. Continued

**Commentary on Question**:

*The case study capital allocation data was shown in section 5.16.1.*

*The case study noted that the marginal capital was used to allocate the overall Pryde capital and this was done on a proportional basis for each marginal niche requirement.*

*The case study also had a table showing the economic capital requirements by risk on a standalone basis and on a diversified basis. The total standalone EC requirement was $377.1m. The total diversified EC requirement was given as $262.2m.*

*The key to the solution was to recognize that the difference between the $377.1m and $262.2m was the diversification benefit and this difference needed to be added back to the Allocated EC Capital requirements for each niche in some fashion. The question asked that it be added uniformly. The correct answer was to add the difference in proportion to the Allocated EC Capital values for each niche. A few candidates simply took the difference and divided it by 4 and added to each niche. We gave credit for this approach though it resulted in very poor returns on the smaller niches.*

The total standalone EC given in the case study is $377.1 m and the diversified capital is $262.2 m, for a difference of $114.9 m. This has to be added back to the Allocated EC of the niches in proportion to the Allocated EC Capital, resulting in the following table:

| Niche | Re-Allocated EC | EC Profit | New Return | Delta |
|---|---|---|---|---|
| School District | 213,094 | 23,538 | 11.0% | -4.8% |
| Municipalities | 37,568 | 4,434 | 11.8% | -5.2% |
| Social Clubs | 81,986 | 14,798 | 18.0% | -7.9% |
| Personal Lines | 44,597 | 4,574 | 10.3% | -4.5% |
| Total | 377,245 | 47,344 | 12.5% | -5.5% |

(c) Recommend a course of action for Pryde given the 12% return on EC proposal.

## 8. Continued

**Commentary on Question**:
*This question did not have a single correct solution as many alternative responses could be appropriate. Therefore, points were awarded based on the reasonableness of the actions suggested and the depth of the analysis. For example, if the candidate simply said that only the Social Clubs exceeded 12% and the rest did not and thus the non performers should be shut down, this is correct but only partially so. Several possible responses are given below. Candidates did not need to provide such an extensive response for full credit*

The Social Club niche has a rate > 12% and the others do not. One course of action would be to stop selling the under-performing lines but this might be short sighted and rather extreme. In particular, two of the lines are below, but close to the 12% target. Another course of action might be to re-price the products so that the target return could be realized. Overall, the total return of all the niches is 12.5% and this may be acceptable.

Another action might be to look at returns over a number of years rather than just the one year given here.

Sometimes lines of business that underperform benefit the company in other ways such as increasing marketing opportunities. Therefore, a possible action could be to appeal to management to re-evaluate the 12% minimum requirement.

**9.** **Learning Objectives:**

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

**Learning Outcomes:**

(5c) Explain the challenges and limits of economic capital calculations and explain how economic capital may differ from external requirements of rating agencies and regulators.

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

**Sources:**

Regulatory Capital Standards for Property and Casualty Insurers under US, Canadian and Proposed Solvency II (Standard) Formulas

ERM-706-13: Solvency II Reserving Risk and Risk Margins

**Commentary on Question:**

*This question tested candidates' knowledge of US RBC and Solvency II requirements. It was a straightforward question based on study note material and information in the case study.*

**Solution:**

(a) Compare how the following non-life insurance risks are captured under the Solvency II regime and current US RBC.

(i) Operational Risk

(ii) Underwriting Risk

(iii) Catastrophic Risk

**Commentary on Question**:

*Answers to this set of questions generally gave insufficient detail, without much discussion about how RBC and Solvency II captured the risks. Only partial credit was given for such responses. Candidates did not need to provide the specific formulas in the requirements to receive full credit but needed to be able to explain in general terms how the risks were covered.*

## 9. Continued

(i) Operational Risk - Solvency II includes an explicit charge for operational risk while the U.S. formula does not.

The Solvency II Operational risk charge = min(0.3 × BSCR; max(0.038 × Earned Premium; 0.036 × TP)) where:

- BSCR is the Basic Solvency Capital Requirement, i.e., the sum of all the risk charges including diversification credits, and before adjustments for the risk reduction arising from future profit sharing and deferred taxes.
- Earned Premium is the total non-life earned premium (gross of reinsurance) in the year following the valuation date
- TP are the non-life Technical Provisions on the valuation date with a floor of zero.

(ii) Underwriting Risk - captured by both Solvency II and US RBC.
For RBC underwriting risk is captured in the New Premium Written component and in the reserve component.

- The NPW formula is based on the company loss ratio, industry loss ratio, and industry RBC loss ratio, a premium concentration factor, and an excess premium growth component.
- The Reserve formula is based on the company reserve development factor compared to the industry loss ratio, an adjustment for investments, and an adjustment for diversification.

For Solvency II the standard formula includes a module for premium risk and reserve risk and a module for catastrophic risk.
The components for Solvency II are based on volume by line of business, with capital reduction benefits for diversification by line of business and geographic region.
Solvency II gives a more complete result by including cat risk; the RBC approach relies more on industry comparisons.

(iii) Catastrophic Risk - captured by Solvency II by use of standard formula or company specific scenarios. Catastrophic risk is not included in RBC.

(b) Identify and describe the changes Pryde will need to make to its current EC model in order to calculate Solvency II capital.

**Commentary on Question**:
*Most candidates did not do well on this part of the question. Substantial credit could be obtained for commenting on the general requirements of Solvency II with respect to capital models. Additional credit was available for comments specific to Pryde based on information in the case study.*

## 9. Continued

Pryde will not have to make very many changes in order to compute Solvency II values. Pryde already uses a 99.4% VaR EC model. The Case Study does not say what the VaR period is, but for a P&C company a one year period is not unreasonable. Thus it has the building blocks in place to perform a Solvency II calculation.
Pryde will need to:

- Mark assets and liabilities to market if it did not do this as part of its own EC projection.
- Solvency II allows a company to use an internal model subject to Supervisory approval, so it will likely be acceptable to use Pryde's existing model, perhaps with modifications.
- The Pryde model has catastrophe, reserve and business plan (operational risk) components which are required Solvency II components.

The Pryde model does not seem to have any geographic diversification component whereas Solvency II does; so Pryde will need to do some modelling to determine the offset for this.