QFI IRM Model Solutions
Spring 2016

1. Learning Objectives:

3. Understand and be able to apply different approaches to risk measurement.

Learning Outcomes:

(3a) Evaluate a company's or a portfolio's exposures to various risks.

(3b) Explain the advantages and limitations of different risk metrics including value at risk.

Sources:

QFII-106-14 "Value-At-Risk: Evolution, Deficiencies and Alternatives" by Ecaterina Vozian, pp.46-50

QFII-107-14 "Chapter 14 of Value at Risk, Third Edition" by Philippe Jordon, pp.357-361,373-374

Commentary on Question:

The aim of this question was to test the candidate's knowledge and ability to apply concepts related to VaR. It posed progressively difficult questions beginning with the dissection of its definition to application in a setting that included reinsurance. Candidates were required to support a recommendation based on their VaR results.

Solution:

(a) Identify and explain if each statement on VaR is correct.

Commentary on Question:

Most candidates did well on this section. Some candidates noted that parts(ii) and (iii) should have been considered together. The question was a listing of all the items that were shown individually but the list was noted to be considered simultaneously. For those candidates, credit was given if the explanation was correct and appropriate understanding was demonstrated. Candidates who did not receive full credit usually made an error assuming VaR could be applied to all market conditions.

1. Continued

(i) VaR is an accurate measure of a loss.
INCORRECT – it is an estimate

(ii) VaR captures a firm's potential losses with a certain probability.
CORRECT – this is the intention and applicability of VaR

(iii) VaR captures a firm's potential losses during a certain period of time.
CORRECT – the time period needs to be specified and may not be consistent across the industry

(iv) VaR captures a firm's potential losses under any market condition.
INCORRECT – only applicable under normal conditions

(b)

(i) Calculate the VaR(95) after reinsurance under each arrangement.

(ii) Recommend a reinsurance arrangement based on the calculation in (i).

Commentary on Question:
Most candidates received partial credit for this section. Areas where candidates lost credit were not taking the full arrangement into account, including the reinsurance premium. Ignoring the reinsurance premium altered the ultimate cash outflow from entering a reinsurance arrangement to hedge VaR, resulting in an inaccurate conclusion. Nearly all candidates correctly chose the option based on the lowest VaR that resulted.

Opt	Loss Cvd (a)	Deductible + Premium (b)	Amount of loss not covered by Reinsurance (c)	VaR(95) (d) = (b) + (c)
A	$20m	=$6m + $4m =$10m	$30m-$20m=$10m	$10m + 10m = $20m
B	$24m	=$6m + $5m =$11m	$30m-$24m=$6m	$11m + $6m = $17m
C	$40m	=$5m + $7m =$12m	$0 ($30m-$30m)	$12m + $0m = $12m
D	$100m	=$5 + $15m =$20m	$0 ($30m-$30m)	$20m + $0m = $20m

The option based on the optimal (i.e., lowest) VaR(95) is Option C.

1. Continued

(c)

(i) Calculate the 95% CTE (before reinsurance).

(ii) Recommend a reinsurance arrangement based on the calculation in (i).

Commentary on Question:
Most candidates received nearly all credit on this section when attempted. Areas where candidates did not receive full credit were in part (ii), where candidates did not choose the option that best matched the 95% CTE level.

95% CTE = (40 + 65 + 100 + 175 + 180)/5 = 560/5 = $112m

Based on the $112m, option D is the best option that will cover the maximum amount of this loss.

(d) Explain any difference in your recommendation in b(ii) and c(ii).

Commentary on Question:
Most candidates performed well on this section and stated that the distribution was inappropriate for solely VaR analysis due to the tail risk.

The recommendations are different between part b) and part c). This is because VaR ignores tail risk, where CTE(95) is a more accurate estimate of the amount of the potential loss in this range. As the tail risk is substantial is this scenario, the conclusion from CTE(95) is superior to VaR. Option D would be the superior choice.

2. Learning Objectives:

1. The candidate will understand the needs and methods of governing investments.

Learning Outcomes:

(1a) Compare the interest of key stakeholders.

(1b) Explain principal versus agent conflict.

(1c) Identify sources of unethical conduct and explain the role of a fiduciary.

(1d) Describe governance mechanisms that attempt to address these conflicts.

(1g) Demonstrate understanding of how ethics relates to business decision-making, and relate ethics in business to personal ethics.

Sources:

Governance and Investment; Rajkumar and Dorfman, Strategic Management Ch 11

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) List four other key elements that should be defined in an investment policy framework.

Commentary on Question:

Candidates generally were able to get one or two of the other key elements but few were able to get all four

- Articulate fund/invesesment objectives
- Articulates investment horizon
- Sets risk tolerance of the fund
- Articulate asset allocation policy
- Articulate related policies and procedures

(b)

(i) Identify four key stakeholder segments to be considered in the framework and the interests and concerns of each segment.

(ii) Describe two examples of the agency problem among the stakeholders identified in (i).

2. Continued

Commentary on Question:
Candidate generally were able to provide most bust not all stakeholders. Candidates who performed well were able to identify that agency problems exist beyond the common shareholder/senior management example. In this example the shareholders are not affected by an agency problem.

(i)

- Plan participants/ Hosital employees/Doctors & Nurses - want their guarantees benefits
- Investment manager- want to earn fees from asset investments
- Stockholders – keep the costs low and maximize profit
- Plan administrators- Maximize returns on administration fees
- Plan Sponsor / the hospital- Minimize costs while ensuring strong returns so additional assets are not needed to support the fund

(ii)

- Agency Problem #1: The agents would be the Investment Manager and they are the ones who authority is delegated to, the principal would be the plan sponsor and they are the ones delegating the authority
  - The agents (investment manager) is looking to gain as much from their fees as possible, while the prinicpal or plan sponsor is looking to minimize fees and achieve a better funded status (e.g. better accumulation of pension assets relative to liabilities) for the pension plan.
  - Problems could arise if the investment managers promote high risk/high return assets because they have higher fees, that may not be in the principal's best interest
- Agency Problem #2: The agents would be the Plan Sponsor as they are the ones who authority is delegated to, the principal would be the plan participants as they are the ones delegating the authority
  - The agents (plan sponsor) is trying to manage costs in how the pension plan is run, while the plan participants would prefer richer benefits.
  - Problems could arise if the plan sponsor takes steps to reduce the generosity of the plan so that they can reduce their contributions to the plan and improve financials.

(c) Assess the doctor's proposal.

Commentary on Question:
Candidates could get credit for supporting either side, provide they gave supporting and non-conflicting reasons. Candidates generally receive post of the points provided they elaborated on their reasons.

2. Continued

Agree

- Some doctors would provide representation of the fund members
- Doctors would have a strong understanding of the organization
- Ok to add Doctors as long as conflicts of interest are clearly identified, assessed and managed
- Ok to add Doctors as long as additional board members have investment/asset management expertise
- Doctors could provide a diverse background
- Could act as inside directors because they have valuable knowledge about the company
- A robust selection process should be used to select the doctors

Disagree

- There may be a conflict of interest (doctors' interest could be different from other plan participants)
- Board members should have investment/asset management expertise to govern the fund
- Board members should have a strong understanding of fiduciary responsibility
- Need outside directors to provide objectivity to the monitoring and evaluating of processes
- The board of directors should be composed of a majority of outside directors who have no management responsibilites in the company and who are willing to hold top managers accountable
- A robust selection process should be used to select board members, not just any doctor at the company
- Board members should be independent thinking, which doctors at the company may not be

(d) Recommend six improvements or additions to the Investment Policy.

Commentary on Question:
Candidates generally performed well and were able to get most points.

- A clearly defined mission/objective should be mentioned
- Should have more regular meetings
- Transparency should be more explicity addressed, communicating to pension members regularly (more than "every few years")
- Should have a risk identification/tolerance policy in place
- Should have more guidance on cost control
- Should evaluate the fund relative to peers and industry best practices
- Should have clear linkage between mission, governance, management and results

2. Continued

(e) Explain how these areas may assist in turmoil markets.

Commentary on Question:
Candidates generally only got partial credit as few were able to relate the four areas to the specific pension funding pressures.

Strategic Asset Allocation:
- Disiplined rebalancing reduces risk to any one asset class
- Minimize exposure to high risk assets
- Diversification can lower exposure to any one asset class

Liquidity:
- Ensures liquid assets at all times
- Perpares for a volatile market
- Increased focus on ALM during times of stress

Quantitative Methodologies:
- Being mindful that methodologies with a normal return distribution may not accurately reflect volatile markets
- A variety of methodologies can help measure and mitigate tail risks or rare events
- Can be useful to provide different views of risk exposure

Sharing proper knowledge with shareholders:
- Makes it easier to formulate and select countermeasures to cope with market turmoil
- Helps keep all shareholders aware of the situation and asset strategy
- Less shareholder shock when things are not going as expected since they've been informed

(f)

(i) Identify the unethical behaviors present at LMN and explain four potential drivers of these unethical behaviors.

(ii) Recommend two ways to promote the consideration of ethical issues at LMN.

Commentary on Question:
Candidates performed well and generally received most or all available points

2. Continued

Unethical Behaviors:

- Self Dealing: When managers find a way to feather their own nests with corporate monies
- Information manipulation: managers use their control over corporate data to distort or hide information to enhance the competative position of the firm

Possible Causes:

- The manager may not have strong personal ethics
- They may not realize they are behaving unethically
- The organizational culture of the company may de-emphasize ethics
- Top level management may be putting pressure on the portfolio manager for strong performance
- There may be unethical leaders at the company

3. Learning Objectives:

1. The candidate will understand the needs and methods of governing investments.

2. The candidate will understand and be able to apply the components of an effective risk management system.

Learning Outcomes:

(1d) Describe governance mechanisms that attempt to address these conflicts.

(2b) Identify and describe the various kinds of risks, including market, credit, operational, etc.

(2c) Identify and describe various approaches for managing risks including risk budgeting, position limits, etc.

(2f) Examine examples of risk management failure.

Sources:

Marginn & Tuttle Chp 9

Sweeting Chp 7, 20

Doherty Chp 7

Commentary on Question:

This questions asked candidates to recall the events that led to the recent economic crisis, especially those that related to regulatory risk. Then they were presented with a scenario that asked them to critique a faulty compensation structure and propose improvements to it.

Solution:

(a) Define regulatory risk.

Commentary on Question:

For this section, most candidates did well and were able to earn full credit. Those who did not earn full credit failed to outline the potential negative effect a change could have on a company rather than merely stating a regulation could change or be newly implemented, which in isolation, is not a risk.

- Regulatory risk is associated with the uncertainty of how a transaction will be regulated or with the potential for regulations to change-
- Unregulated markets face the risk of becoming regulated, thereby imposing costs and restriction where none existed previously.
- Risk that an organization will fall foul of legislation or regulations that are already in place.

3. Continued

(b) Explain the role regulations played in the 2007-2010 Global Financial Crisis.

Commentary on Question:
Many candidates performed well on this section, although not as well as part a). Candidates who did not earn full credit did not provide enough details or did not show sufficient knowledge of the main risks that arose.

- Gramm-Leach-Bliley Act
- Banks were allowed to perform investment banking duties
- In stressed markets, catastrophic losses in the investment banking arm can adversely affect retail and commercial account holders.

- Basel I
- Banks were incentivized to convert credit risk with respect of mortgages to market risk by securitizing loans (e.g., MBS).
- This failed to recognize that banks were linked to each other through exposure to the housing market, and this increased the potential for catastrophic losses.

(c) Describe the limitations of each of the following in measuring liquidity risk.

(i) Bid-ask spread

(ii) Transaction volume

(iii) Illiquidity ratio, which measures the price impact per $1 million traded in a day

Commentary on Question:
Most candidates earned at least partial credit on this section, but only a few earned most to full credit. A number of candidates failed to answer this section of the question, while others were unable to specify the feature of the measurement method that limited its ability to measure liquidity risk.

(i) Bid-ask spread
- quotes apply only to specified, usually small size, trades, and are thus an imprecise measure of liquidity risk
- must be stated as a proportion of stock price to control for differences in security prices

3. Continued

(ii) Transaction Volume
- historical volume patterns may not repeat themselves at times when the liquidity they imply is most needed.

(iii) Illiquidity Ratio
- complex
- no explicit transaction volume is available for many OTC instruments.

(d) Explain how liquidity risk played a role in the evolution of the 2007-2010 Global Financial Crisis.

Commentary on Question:
Most candidates earned at least partial credit on this section. A small number earned full credit. Areas where candidates failed to earn full credit were insufficient explanation

- Widespread exposure to mortgages meant that many banks made large losses.
- Because banks could not easily quantify their exposure, it made them reluctant to lend to each other.
- Banks' reliance on short-term funding in this situation left them at higher risks of insolvency.
- As a result the liquidity crisis spread from the financial sector to the wider economy, as firms and individuals found it harder to borrow.
- Some government assistance was provided, either in purchasing illiquid assets from banks or providing cash in exchange for equity stakes in banks, in some circumstances going as far as complete nationalization.

(e) Identify the risk that the fund's compensation structure creates.

Commentary on Question:
Many candidates earned full credit on this section. Areas where candidates did not earn full credit were failing to recognize the main risk.

The primary risk is performance netting risk, i.e.,
The result that occurs when positive and negative returns offset, but due to the asymmetric incentive fee structure, the firm incurs a loss.

(f) Propose a solution to manage this risk.

Commentary on Question:
Most candidates performed will on this section. Areas where candidates did not earn full credit were failing to explain how their solution improved the current compensation structure.

3. Continued

- Change the compensation structure from asymmetric to symmetric, e.g., with claw-backs or a high water mark.
- Establish individual manager performance thresholds.

4. Learning Objectives:

2. The candidate will understand and be able to apply the components of an effective risk management system.

Learning Outcomes:

(2b) Identify and describe the various kinds of risks, including market, credit, operational, etc.

(2c) Identify and describe various approaches for managing risks including risk budgeting, position limits, etc.

Sources:

Maginn & Tuttle Chp 9; Sweeting Chp 7; Haslett Chp 18

Commentary on Question:

Commentary listed underneath question component

Solution:

(a) Explain why credit risk is difficult to analyze.

Commentary on Question:

This question is pretty straightforward and most candidates earned credits for explaining lack of data and non-normal distribution.

Credit risk is difficult to analyze because:

- Lack of historical data or infrequency of the loss events makes it difficult to quantify and estimate default probabilities.
- It is not normally distributed and difficult to use common methods such as VaR
- Losses differ considerably from losses resulting from market moves, and it is one-sided risk.

(b) Identify three examples of credit risk based on the list above.

Commentary on Question:

Candidates generally did well on this question. Candidates who got full credits were able to describe the credit risk faced in each business.

- For the universal life reinsurance, there is a risk that XYZ Re can't pay the claims due to default or financial hardship.
- For the variable annuity business, there is a risk that the counterparties fail to pay with regard to trading of derivatives.
- For the invested asset, there is a risk that the assets will suffer loss due to the spread and default probabilities changes.

4. Continued

(c) Describe three strategies for how ABC can manage its credit risk in its life insurance business.

Commentary on Question:
Candidates were generally able to describe the strategies in details once identified. Full credits were given for any three of the strategies of the following.

- Limit exposures – limit the amount of exposure to any given party such as use more than one reinsurers.
- Mark to market – used in derivative trading and the market value will be recalculated taking into account of current market conditions.
- Post collateral – post sufficient collateral to cover mark-to-market deficiencies.
- Use credit derivatives – transferring credit risk using credit default swaps, total return swaps and etc.
- Require minimum credit standards – ensure all the counterparties maintain adequate levels of credit quality.
- Use netting –reduce all obligations owed between counterparties into a single cash transaction.

(d) Compare the correlations of the funds within each division.

Commentary on Question:
Candidates who earned the credits demonstrated clear understanding of relationship between correlation and diversification. Candidate who didn't earn credit either didn't get to the point or mixed up the relationship of correlation and diversification.

- The sum of the VaRs is less than the total VaR for each division, so the fund correlation within each division are less than one.
- The International funds are less correlated than the Domestic funds. The International funds have more diversification benefits.

(e) Explain how each of the following ideas contribute to a well-conceived risk budget framework.

(i) Scenario analysis limits

(ii) Position concentration limits

(iii) Liquidity limits

4. Continued

Commentary on Question:
Candidates were generally able to describe and explain (i) and (ii) well but not (iii)

- Scenario analysis limits – It helps to protect the portfolio under extreme event. Establish the maximum loss amount under specific scenario and construct a portfolio that doesn't exceed that risk limit.
- Position concentration limits – It helps to reduce concentration risk. Enforce diversification by mandating a specific maximum amount for individual positions.
- Liquidity limits – It helps to manage liquidity exposure. Set position limits as a specified maximum percentage of daily volume, float, or open interest.

(f) Calculate the optimal risk allocation for the International Value fund. Assume all correlations between funds are zero.

Commentary on Question:
There were very few candidates who earned full credit for this part. The candidate who earned full credits demonstrated full understanding of this question and calculated correctly. The calculation is straightforward. Partial credits are given for candidate who demonstrated some level of understanding the approach but weren't able to calculate correctly.

- $TE_i = TE_{max} \; x \; (IR_i^* / IR_p)$
- *Assuming correlations are 0:*
- $TE_3 = TE_{max} \; x \; (0.59 / IR_p)$
- $IR_p^2 = 0.35\text{^}2 + 0.50\text{^}2 + 0.59\text{^}2 + 0.45\text{^}2 = 0.9231$
- $IR_p = 0.9608$
- $72 = TE_{max} \times (0.35 / 0.9608)$
- $TE_{max} = 197.65$
- $TE_3 = 197.65 \times (0.59 / 0.9608) = 121.37$

(g) "The implied information ratios indicate areas where risk is being overspent or underspent and thus provide a useful monitoring tool. Based on the table, risk is being overspent for Domestic Small Cap, Domestic Large Cap and Emerging Markets."

Critique the above statement.

Commentary on Question:
To get full credit candidates were expected critique each statement. Contradictory statements were not given any credit.

4. Continued

- First statement is correct. The implied information ratio is an useful monitoring tool.
- Second statement is incorrect. Risk is being underspent for Domestic Small Cap and Domestic Large Cap, and/or risk is being overspent for Emerging Markets and International Value.

5. Learning Objectives:

2. The candidate will understand and be able to apply the components of an effective risk management system.

3. Understand and be able to apply different approaches to risk measurement.

Learning Outcomes:

(2b) Identify and describe the various kinds of risks, including market, credit, operational, etc.

(3a) Evaluate a company's or a portfolio's exposures to various risks.

(3b) Explain the advantages and limitations of different risk metrics including value at risk.

Sources:

Risk Management: Foundations for a Changing World, Haslett, 2012

- Ch 2: Practical Issue in Choosing and Applying Risk Management Tools
- Ch 5: Risk Management: A Review
- Ch 14: Merging the Risk Management Objectives of the Client and Investment Manager

Financial Enterprise Risk Management, Sweeting

- Ch. 7: Definitions of Risk

Commentary on Question:

The objective of this question is to test candidates' understanding of the Pension risk exposure and their ability to apply different risk metrics to manage tail risk. Candidates should also demonstrate their knowledge by evaluating different risk reporting and monitoring approaches. Candidates generally did well in this question. Some candidates lost points by not relating to the issue to the tail risk exposure when responding part b.

Solution:

(a) Describe three risks that are exhibited in this plan.

Commentary on Question:

Most candidates did very well in this part. Some candidates lost points by only listing risks without descriptions and by describing risk without relation to the liability referred in the question.

This pension plan is exhibited to the following risks:

- Interest Rate Risk: Low interest rate environment will decrease the discount rate used to calculate future liability. Hence, it will lead to an increase in pension fund liability.

5. Continued

- Economic Risk: Inflation adjusted benefits affect the pension plan's expected future liabilities. If the inflation is higher than expected, future liability increases. Salary inflation is also related (based on final salary) to economic environment, so the projection of expected future final salary will impact the expected future liability.
- Mortality / Demographic Risk: The pension plan liability may be misestimated if the mortality assumption developed back in 1906 is in line with the mortality experience.
- Liquidity Risk: This pension scheme has a relatively short duration, but most of the assets are invested in illiquid and long duration assets. This will likely lead to negative cashflow position in earlier years and expose the pension plan to the risk from asset liability mismatch.

(b) Based on the graph above:

(i) Critique the use of VaR(99) in measuring the tail risk of this portfolio.

Morris recommends the following alternative risk measures to analyze the tail risk of the pension fund:

- Omega
- Expected Shortfall
- Worst Case Expectation
- Standard Deviation

(ii) Identify and explain the two least appropriate risk measures to quantify the tail risk.

Commentary on Question:
Most candidates were able to indicate that VAR only captures the percentile loss and ignores the funding risk under extreme scenarios. Some candidates lost points for not giving an explanation on how VAR is not an appropriate measure risk of the distributions with heavy fat tail behaviour.

(i) The distribution of the funding ratio is asymmetric and has a fat tail. The "expected loss" beyond the 99^{th} percentile implies a fat tail. Since VAR ignores the exposure beyond the 99^{th} percentile, the use of CTE would be more appropriate for this fat tailed distribution. CTE also gives more information about the funding risk under extreme scenarios.

5. Continued

Candidates only earned partial points for identifying the two least appropriate risk measures. Many candidates lost points for not appropriately explaining why omega and standard deviation do not capture tail risk

(ii) Omega: This is a unitless measure that does not give sufficient information about funding the liability based on a given threshold. That is, it measures the likelihood of achieving a given return once that return is chosen. It does not give you any information of how underfunded the liability would be if you are below the chosen threshold.

Standard Deviation: This is not appropriate in isolation because it only gives information about the dispersion of the funding ratios. The standard deviation can be low, even though the average funding ratio is also low.

(c) Morris came up with the following additional suggestions to improve ABC's tracking error methodology for the pension portfolio:

- Portfolio managers will be replaced if they have 3 consecutive months of poor performance.
- Portfolio managers will use S&P 500 Index as a benchmark for all tracking error calculations sent to the client.
- Tracking error models will not be released until they are adequately back tested.
- At least 40% of back testing observations in tracking-error forecasts should fall within 2 standard deviations for the model to be used.

Critique each guideline above.

Commentary on Question:
Most candidates do well in this question. For the second guideline, some candidates lost points for not stating that the S&P has little correlation to the liabilities. For the forth guideline, some candidates lost points for only mentioning that the threshold of 40% is too low without justifications.

- This is a bad guideline. Each portfolio manager's performance is evaluated based on monthly tracking error for portfolios that have 10 years investment horizon. Three months period is too short and insufficient to evaluate the performance of a portfolio manager. A longer monitoring period should be used before assuming underperformance / overperformance in comparison to a strategy.

5. Continued

- This is a bad guideline. Benchmark used for tracking error calculation should represent the client's liabilities' characteristic, otherwise the tracking error number would render meaningless. If there is little correlation between the benchmark and what is being tracked, then a high tracking error can be expected. The investment performance used should be consistent with the liability.
- This is a good guideline. Adequate back test should be performed before releasing the tracking error model.
- This is a bad guideline. The 40% threshold is too low. Assuming normal distribution, at least 95% of the observations should fall within the 2 standard deviations for the model to be used. If most of the observations are outside the 95% confidence interval (for two-sided normal distribution test), then it is a poor performing model for tracking error forecasts.