QFI IRM Model Solutions
Fall 2015

1. 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.

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

(3d) Analyze and evaluate risk aggregation techniques, including the use and misuse of correlation, integrated risk distributions and copulas.

Sources:

Maginn and Tuttlle Chap 9

The Devil is in the Tails: actuarial mathematics and the subprime mortgage crisis, Donnelly and Embrechts, ASTIN 2010

QFII-108-14: Developments in Modelling Risk Aggregation, pp. 76-87

Commentary on Question:

This question tested the candidates knowledge of techniques for managing credit risk and their understanding of different techniques for aggregating risk and the limitations of the aggregating methodologies.

Solution:

(a) List four alternative techniques for managing credit risk.

- Netting of trades
- Collateral requirements
- Limits on counterparty exposure
- Minimum credit requirements

In addition to the 4 items above, other appropriate responses were also given credit

1. Continued

(b) Compare and contrast credit default swaps and total return swaps.

Commentary on Question:
Most candidates were able to identify stand alone features of credit default swaps and total return swaps. However, to receive full credit candidates also needed to provide comparative analysis of the two types of swaps.

Credit default swap –buyer pays seller for the right to receive payment in event of a specified credit event

Total Return swap -- buyer pays total return on a reference obligation (or reference portfolio) in return for floating rate payments

With total return swap protection seller exposed to both credit and market risk, with CDS only exposed to specified credit event

(c) Critique the use of rank correlation and linear correlation to measure dependence in (i) and (ii) respectively.

Commentary on Question:
Candidates were generally able to identify the circumstances that required rank correlation or allowed for linear correlation but most did not describe limitations even when measure would be appropriate

(i) Lognormal distributions are non-elliptical
Linear correlation not recommended for non-elliptical
Should use rank correlation
Limitations associated with rank correlations

(ii) Multivariate t distributions are a member of the class of elliptical distributions
Linear correlation appropriate for modeling dependence
Identification of limitations of linear correlations when using multivariate t

Limitations of both linear and rank correlation as simple scalar measures

(d) Compare the Gaussian copula, multivariate t-copula and the Archimedean copula by referencing the following properties:

- Ease of simulation
- Capable of modeling tail dependence
- Symmetry

1. Continued

Commentary on Question:
Most candidates identified ease of simulation and tail dependence modeling characteristics. Many candidates did not distinguish symmetry/asymmetry characteristics of Gaussian and Multivariate-t distributions

ease of simulation:
Gaussian - easy
Multi-variate - t - easy
Archimedian - difficult

capable of modeling tail dependence
Gaussian - no
Multi-variate t- yes
Archimedian - yes

Symmetry
Gaussian -symmetric in 2 dimensions
Multi-variate t - generally asymmetric in higher dimensions
Archimedian - symetric

(e) Recommend one copula from above to price and stress test CDOs and Synthetic CDOs.

Commentary on Question:
To get full credit candidates needed to provide a recommendation and provide rationale for its choice.

Recommend the t-distribution copula

Easy to create simulation

CDOs have strong tail dependence, the chosen copula should be capable of modeling tail dependencies

Since the copula will be chosen to price CDO as well, it is important to have asymmetry from the copula. The copula chosen should exhibit asymmetry.

2. 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.

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

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.

(2e) Evaluate a company's risk management process.

(3c) Compare different approaches to stress testing.

Sources:

Risk Management: Foundations for a Changing World, Haslett, 2012: Chapter 33: Risk Management Programs

Advances in Risk Management and Risk Governance (QFII-103-14), Leslie Rahl;

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Identify two other ways risk governance contributes to an effective risk management program.

Commentary on Question:

Part (a) required only "two other ways" but some candidates listed more than two for which, of course, no additional credit was given.

Two other ways risk governance contributes to an effective risk management program:

1. Segregation of functions: e.g. different roles of the Chairman, CEO, CIO, CRO, etc.
2. Independent controls: e.g., to what degree traders or portfolio managers have control of valuations, etc. An organization's risk appetite must be clearly communicated & everyone needs to be headed in the same direction.

2. Continued

(b) Describe four actions you could take to develop an effective risk-conscious culture in the firm.

Commentary on Question:
There were very few candidates who earned full credit for this part, although the solution is straight from the course reading. It could be partly due to candidates merely listing four actions while the question asks to "Describe."

Four actions to develop an effective risk-conscious culture:
1. Comprehensive employee education: It is essential that everyone in the organization, including e.g. the receptionists, understands the role that he/she has in risk awareness and management
2. Development of clear and well defined policies and procedures
3. Risk tolerance should be established and tracked. It is extremely important for an organization to understand its risk attitude, how much risk it is willing to take, and the types of risk it is vulnerable to
4. Encourage the CRO to champion a risk-conscious culture, for example, lead by example.

(c) Identify and explain four other elements for measuring and controlling risks.

Commentary on Question:
For this part too very few candidates earned full credit, although the solution is straight from the course reading.

1. A value-at-risk measure: The VAR measure need not be one that all the other firms are using; it could be one developed internally.
2. Independent risk oversight: It is preferable to have this function performed by an independent department, e.g. a controller or an oversight person involved in risk measurement reporting. Should provide oversight not only of in-house trading but also of external managers and the reporting of information to customers.
3. Specific written policies and controls: Specific written documents that highlight the requisite checks and balances are an important aspect of a properly functioning risk management program.
4. Daily mark to market: The purpose of marking to market is to avoid surprises. In mutual funds, or in markets that experience rapid moves, daily valuations are not only desirable, they are necessary. But if the firm is investing in private placements or instruments that are not valued frequently, daily valuations would not be needed.

2. Continued

(d)

(i) Describe the advantages and disadvantages of each approach.

(ii) Recommend the most appropriate approach.

(i) X

Advantages: This is static-shock scenario testing. It provides a snapshot of the risk position of the portfolio reflecting a parallel shift up or down in the yield curve.
Disadvantages are its inability to view:
Risk on a dynamic basis.
Optional components within the portfolio that may change significantly even without a change in rates.
Changes in the shape of the yield curve, in currency rates, or other markets to which the portfolio's behavior is linked.

Y

Advantages: This is multiple static-shock scenario testing. The primary advantage over X is its ability to capture the impact of nonparallel shifts or twists in the yield curve.
Disadvantages: Its inability to view risk on a dynamic basis.
The degree that the portfolio contains options, or positions not linked to the U.S. dollar, reality may be obscured.
Predefined buckets can mask the existence of significant risks within buckets.

Z

Advantages: Simulation allows testing of multiple shock scenarios on a dynamic basis, i.e., over time.
Disadvantages: The quality of any stress test depends on the ability to select appropriate scenarios.
The increasing complexity and optionality of many derivatives make scenario selection even harder.

(ii) The approach recommended is Monte Carlo simulation (Z). This is because the life insurance company manages a diversified portfolio which is affected by multiple risk factors, not only by changes in the yield curve. Hence a dynamic and multiple risk factor stress testing is needed. Both X and Y fail to provide this.

3. 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:

(2a) Explain the importance of risk culture in an investment firm.

(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.

(2d) Explain the features of a best practices enterprise risk management system.

(2e) Evaluate a company's risk management process.

(2f) Examine examples of risk management failure.

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

Sources:

Financial Enterprise Risk Management by P. Sweeting, Ch 7 "Definitions of Risk"

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Evaluate the significance of each of these risks for ABC and XYZ Re.

Commentary on Question:

Candidates needed to explain the significance of each (important or not) and also provide a reason for each. A complete answer identified individual reason for each risk/company combination, without using "same as" a previous answer. Candidates who used the table provided generally scored better.

3. Continued

Risk	ABC	XYZ Re
Data	-Important as data from policyholders must be accurate -Data to XYZ Re must be accurate and used to determine claims	-Very important as data depends on external source, i.e., ABC -Data determines whether a payment is required
Legal	-Important as properly worded documents are needed to eliminate misunderstandings between ABC and its policyholders -Contract with XYZ Re must be unambiguous	-Important as contract with ABC must be unambiguous
Longevity	-Important as this will determine length of payment period -Limited assumptions with only 3 years of experience; industry data an option	-Not important as a lump sum is paid and only on annuitization
Model	-Important for anticipating timing and level of annuity payments	-Important to capture capital market and investment risks

(b) Explain how higher than expected surrenders impacts XYZ Re.

Commentary on Question:
Candidates needed to identify there were more than one impact at play with higher surrenders (both lower claims and lower future reinsurance premium). Full points were awarded if the candidate could explain that the net impact could hurt or help XYZ Re depending on anti-selection.

Higher lapses will benefit from XYZ Re because fewer policies will receive claims. This will be partially offset by the lost future premium income from ABC. If the lapsed policies are anti-selecting against ABC, this could hurt XYZ Re because remaining claims may be higher than expected.

(c) Propose four ways to mitigate the operational risk associated with the consultants.

Commentary on Question:
Candidates performed well when applying the readings to the situation in the question. Little or no points were given for a generic list without application to the situation.

3. Continued

- Ascertain that consultants are knowledgeable for their assignment. (reconciliation)
- Ensure that any consultant under consideration is independent and fully disclose any compensation arrangements with vendors.
- Remember that vendor-supplied implementation consultants may not have experience working within a buy-side firm and consequently may be unaware of the best-practice workflows or the upstream and downstream impacts of key activities or errors.
- On a large-scale system or outsourcing implementation, it is advisable to engage specialized consultants as well as the vendor consultants to ensure your firm's priorities and objectives are kept in sharp focus.
- Confirm that consultants have a plan for transferring their knowledge to your staff during the project. Otherwise you may be working with them forever.

(d) Evaluate the accountant's statement.

Commentary on Question:
Candidates that correctly provided both positive and negative aspects of the statement received full points.

- In some cases it makes sense to reconcile transactions on a daily basis. The need for such activity generally depends on several factors including portfolio turnover, instruments traded and the normal level of cash available.
- Daily transactions reconciliations are expensive
- Daily transactions are time consuming.
- Reconciliation teams find themselves hunting down what we call "known ghosts" that will disappear of their own accord, such as dividends that the manager credits to cash on the pay date but the custodian or prime broker credits one business day later.

(e)

(i) Identify the areas for improvement.

(ii) Recommend improvement for three of the areas identified in (i).

Commentary on Question:
Candidates who provided commentary on each of the 9 points performed the best. Although this part was worth 4 points, several candidates either skipped or minimally answered this question.

3. Continued

1. The investment managers' records are compared to the prime brokers' records.
   - Needs improvement. Ideally, a three-way reconciliation should take place among the administrator's records, the manager's records, and the safekeeper's records (the prime broker). (pg 42)

2. The prime brokers' records consist of an electronic consolidated report from one of the prime brokers.
   - Needs improvement. Many safekeepers will not stand by their electronic representation of an account, but rather consider the paper statements alone to be official. (pg 42) Consolidated data merely parrots information obtained electronically from the other service providers. The firm offering aggregated data is usually clear they are not guaranteeing the accuracy of information on assets not held in custody by them. (pg 42)

3. Position reconciliation is done by comparing the quantity held on each set of books.
   - Needs improvement. Full position reconciliations will examine cost basis and market value in local currency terms. (Tolerances are generally established on these items. (pg 42)

4. The International Securities Identifying Number (ISIN) is also compared for each position.
   - Needs improvement. Where possible, the CUSIP for US and Canadian issues and the SEDOL for non-North American securities should be compared. An ISIN does not distinguish the market in which a given security was purchased and is held. (pg 43)

5. Local-currency cash balances are compared in all position reconciliations.
   - Works well. Local-currency cash balances must be included in any position reconciliation. (pg 43)

6. 100% of trade tickets are matched to counterparty confirmations.
   - Works well. It is a best practice to match 100% of trade tickets to counterparty transactions. (pg 44)

7. Since ABC holds derivative positions, reconciliation is done with statements received from the party holding the collateral.
   - Needs improvement. Managers that trade derivative instruments or have some other reason to have assets held as collateral or margin need to ensure they are receiving statements from the party holding the margin or collateral, and that these statements are the ones used for reconciliation. (pg 45)

3. Continued

8. The manager who conducted the review initials a reconciliation checklist containing the accounts reconciled and the date each was completed.
   - Works well. Management should confirm that each portfolio was reconciled. (pg 46)

9. Trade support staff, and occasionally traders help with the reconciliation process.
   - Needs improvement. Trade support staff, portfolio managers, and traders should not help with the reconciliation process to protect the firm from fraudulent activities. (pg 46)

4. Learning Objectives:

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

Learning Outcomes:

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

Sources:

"Marginn & Tuttle, Managing Investment Portfolio, Chapter 9 Risk Management"

"Jorion, Value at Risk, Chapter 14 Stress Testing"

"Value-at-Risk: Evolution, Deficiencies and Alternative"

Commentary on Question:

This question asks candidates to compare and contrast various methods for setting economic capital and tests their knowledge on strengths and limitations of various methods.

Solution:

(a) Calculate the 95% annual VaR for the portfolio based on the Variance-Covariance method, assuming the returns of both asset groups follow the normal distribution.

Expected annual Return of the portfolio = 0.65*0.08 + 0.35*0.11= 0.0905

Standard Deviation of the annual Return
=[(0.65*0.2)^2+(0.35*0.4)^2+2*0.8*0.65*0.35*0.2*0.4]^0.5 = 0.256164

Annual VaR = 0.0905 – 1.65*0.256164 = -0.33217

95% annual VaR = - $100M* (-0.33217) = - $33M

(b) Calculate the 95% annual VaR for the portfolio using the historical method.

VaR with a 5% probability is the worst 5^{th} return = -0.4
95% annual VaR = $100M* (-0.4) = -$40M

(c) Describe the limitations of the two approaches from (a) and (b) to determine required Economic Capital after the inclusion of the caps.

The first approach assumes that asset returns have a normal distribution. The return of caps in the portfolio does not have a normal distribution. The first approach does not capture the risk of significantly higher losses further in the tail.

4. Continued

The second approach relies on historical data. Since the caps are newly added, the historical portfolio return does not reflect the return of the caps. The historical data the VaR metric is based on only covers about previous 9 years, therefore, may not cover a true 95% loss event. Future loss event may be worse than the historical loss.

(d) You are considering alternatives to setting Economic Capital.

(i) VaR with standard error bounds

(ii) Conditional Tail Expectation

(iii) Worst case from various stress tests

Evaluate each alternative above.

Commentary on Question:
The action verb is "Evaluate". Candidates are expected to discuss both the strength and weakness of each approach. Some candidates failed to get full credit because they only discussed the strength or the weakness of certain approach.

(i) VaR with standard error bounds
   a. Strength: takes into account the estimation error of VaR
   b. Weakness: only captures on point on the loss distribution

(ii) CTE
   a. Strength: does not reply on one point in the tail, but takes into account the average of the entire tail to better reflect the extreme events in the tail
   b. Weakness: relies on an assumption of a particular distribution

(iii) Worse case from various stress tests
   a. Strength: does not rely on an assumed loss distribution
   b. Weakness: scenarios chosen for the stress test can be subjective

(e) Explain the advantages and disadvantages of the three approaches above for setting Economic Capital.

Commentary on Question:
This question tests candidates' understanding of different methods for stress testing and the importance of appropriately calibrating correlations among scenarios. Most candidates are able to recognize that the second approach takes into account correlation whereas the first does not. A few candidates are able to point out that the third approach reflects correlation during financial crisis.

4. Continued

Approach (i):
Benefit: the scenarios are easy to create and implement
Drawback: does not take into account the correlation between economic variables

Approach (ii):
Benefit: takes into account the correlation between the economic variables
Drawback: the correlations between X and Y in stress scenarios may be different from their normal historical correlation

Approach (iii)
Benefit: reflects the actual correlation among economic variables during a financial crisis
Drawback: future financial crises could be worse or different from the 2008-2009 financial crisis.

(f) Recommend the most appropriate approach for setting Economic Capital.

Commentary on Question:
Candidates that recommended the third approach recognizing the time and resources limitation got full credits. Partial credits are given for candidate recommending the second approach with well supported reasons.

The third approach is recommended. ABC is a small company that does not have the technical resources or adequate time to develop sophisticated stress scenarios with appropriate stressed correlations. Historical data on correlations during a financial crisis is readily available for the third approach

5. 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:

(1a) Compare the interest of key stakeholders.

(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.

(2d) Explain the features of a best practices enterprise risk management system.

(2e) Evaluate a company's risk management process.

(2f) Examine examples of risk management failure.

Sources:

"Financial Enterprise Risk Management, Sweeting , Ch 1: An Introduction to ERM"

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Evaluate the CRO's view regarding the structure of the risk management function.

Commentary on Question:

The action verb "evaluate" indicates that candidates should identify both the strengths and limitations of the CRO's view to get full credit.

In a complex and diverse holding company, the decentralized risk management has its metrics because industry specific expertise that is needed to manage risks in each subsidiary can be better developed when the risk management functions are embedded within the subsidiaries.

However, XYZ needs to establish an Enterprise Risk Management framework to make sure that risks are managed holistically for the whole organization.

Without an enterprise risk management framework, certain risks may be missed altoghether due to lack of ownership.

5. Continued

Other benefits of a centralized risk management framework are:
1. Better view of enterprise-wide concentration and diversification;
2. Consistent risk appetite;
3. Improves efficiency and save transaction costs

(b) Describe the main steps to establish an Enterprise Risk Management (ERM) framework for XYZ according to Sweeting.

Commentary on Question:
Most candidates answered this question well. Other steps not listed here, such as communication and documentation, earn candidates points too.

1. Understand the internal and external environment of XYZ
2. Develop consistent risk taxonomy
3. Identify the risks
4. Determine risk appetites and measure current exposures against the risk appetites
5. Implement risk management actions
6. Establish an effective monitoring system

(c) Evaluate the recommendations above.

Commentary on Question:
Some candidates are able to make correct determination of whether the recommendation is appropriate or not, but failed to provide appropriate reasons for their determination to get full credits.

1. A) The Board level ERM Committee should oversee the effectiveness of the Company's risk management function. The CRO, as the head of the risk management function, should not chair a committee that oversees his/her own management effectiveness.
   B) CRO should not appoint members of the committee. The structure impedes the independence of the committee.
2. The auditor should not report directly to the chair of the ERM Committee. Since the auditor is the third line of defense, he/she should be independent of the CRO and the ERM Committee.
3. The report should be generated on a more frequent and regular basis.
4. Not allowing the shareholders of XYZ's competitors to serve on the committee is a good recommendation since it reduces conflict of interests. However, committee members could have other direct or indirect interests in XYZ that may influence their independence.

5. Continued

5. The proposed structure gives the committee too much power over other committees of the Board. Moreover, since the CRO is the chair of the ERM committee, the CRO's influence is flowing into compensation committee and auditing committee and may facilitate self-dealing.

(d) Identify problems in the above and recommend improvements.

Commentary on Question:
The key words are "identify problems" and "recommend improvements". If a fact does not have any problem, then it does not need to be discussed. To get full credits, candidates need to recommend reasonable improvements.

Fact #2: Committee members who indirectly own shares of competitors of XYZ's subsidiaries have a conflict of interests that may impede their independence.
Recommendation: Replace committee members who own shares of competitors of XYZ's subsidiaries with people who do not have any direct or indirect ties with any of XYZ's subsidiaries.

Fact #3: A conflict of interests is created when the outside auditor also provides consulting services to subsidiaries of XYZ.
Recommendation: XYZ should choose another outside auditor who does not provide consulting services to subsidiaries of XYZ.

Fact #4: Cutting back on safety standards may increase the operational risk of the subsidiary.
Recommendation: The ERM Committee should ask the CRO to increase oversight on the business unit and to work with the business unit to reinforce safety standards.

Fact #5: Layoff and consolidation of responsibilities create the risk that the top performers be overwhelmed with their added responsibilities, which leads to higher rate of errors in their work or lowering of safety standards..
Recommendation: The ERM Committee should ask the CRO to enhance risk oversight of the pharmaceuticals subsidiary to guard against or detect early any operational risks that may arise due to the reorganization.