QFI IRM Model Solutions
Spring 2018

1. Learning Objectives:

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

Learning Outcomes:

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

(1f) Explain how governance may be structured to gain competitive advantages and efficiencies.

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

Sources:

QFII-101-14: Chapter 11 of Strategic Management: An Integrated Approach, Hill & Jones

Investment Ethics, Peck, Sarah, 2011 – Chapter 7

Commentary on Question:

Overall, candidates performed slightly better than expected. Candidates performed well in part (a), followed by (b). Candidates found part (c) and (d) relatively harder than the others.

Solution:

(a)

(i) Identify which bullets are deficient from a governance perspective.

(ii) Recommend improvements for the bullets identified in (i).

Commentary on Question:

Most of candidates performed well. Most picked all 4 bullet points while there were less candidates who provided the improvements for all 4 bullet points. Some candidates mixed up the bullet numbers, for example pick "bullet 5" for part (i) then give improvement recommendation for bullet 6 in part (ii).

1. Continued

Following bullets are deficient from a governance perspective. Each point is followed by the improvement.

• First bullet and/or The CEO is the chairman of the board.
(Improvement) To prevent CEO from self-dealing (using company money for personal use), CEO and chairman should be separate and chairman should come from outside.

• Second bullet and/or The CRO reports only to CEO.
(Improvement) CRO should not only report to the CEO. CRO should also report directly to the board. (If there is disagreement between CRO and other chiefs, then escalate the issues to CEO. If disagreement is between CRO and CEO, then escalate it to the board.)

• Fourth bullet and/or The compensation committee consists of 10% insider directors and 90% outside directors.
(Improvement) Compensation committee should have only outside directors.

• Sixth bullet and/or All outside director terms are limited to 1 year to prevent directors from becoming entrenched.
(Improvement) 1-year turnover for directors may be too short. While it is important to prevent directors from becoming entrenched, it is also important for there to be some continuity.

(b) Assess each statement.

Commentary on Question:
Candidates performed as expected on this part. A small number of candidates failed to "assess" the statements. "Assess" requires candidates to evaluate right, wrong, partially right or wrong. Also some candidates made recommendations rather than assessments, for example 'should consider other merit…' or 'should mix more younger directors who care about reputation'. Candidates should review the common exam verbs such as 'assess', 'recommend', 'identify', etc. to avoid this confusion.
For statement 1, many pointed out specialty is important but failed to mention the independence is a more important quality for outside directors. For statement 2, more candidates clearly pointed out the first sentence as right and the second as wrong part of the statement. But quite a few gave 'conflict of interest' or 'reputation' as a reason for the statement to be wrong.

1. Continued

Statement 1 is only partly true.
It is important for inside directors to possess deep industry knowledge, but that is not the 'most important quality' for outside directors. While it is important that outside directors have enough knowledge to assess firm performance, it is probably more important that they are impartial.

Statement 2 is also only partly true.
It is true that individual who are retired from their primary professions usually make good candidates for outside directors since they are able to invest the time to execute on board responsibilities. However, it is not a good thing to have directors who are involved on too many boards since that would detract.

(c) Identify and describe two forms of option grant abuses.

Commentary on Question:
The performance on this question was average. Some failed to use 'backdating' or 'spring-loading' so failed 'identify' part of the question.

1) Option Backdating – Use of hindsight to change the grant date or exercise price to be on the date of the lowest stock price of the year. There is nothing wrong with backdating options, as long as the practice is fully disclosed to investors and all relevant taxes are paid. But most of the time, this is not what happens.

2) Option Spring-Loading – This occurs when options are granted before the release of positive information, such as higher-than-expected earnings.

(d) Recommend two ways to discourage earnings manipulation in setting accounting-based bonuses.

Commentary on Question:
Candidates performed worst on this part of the question. Many failed to provide the exact term even though explained the concept of either LTIPs or clawback provision. Some candidates also got credit for mentioning independent external audit.

1) Make bonuses part of a long-term incentive plans (LTIPs). Here accounting performance is taken into consideration not only for the current year, but for a longer time period like 5 years. This gives managers disincentives to manipulate accruals to improve the current year's performance at the expense of later years.

1. Continued

2) Add Clawback Provisions. If earnings are restated, bonuses based on misstated higher earnings must be repaid. This will act as a disincentive to manipulate earnings in the short term.

2. Learning Objectives:

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

Learning Outcomes:

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

Sources:

Investment Ethics, pp. 6-8, 13-18, 20-22, 27-35, 43-48, 53, 56, 58, 59
"Ch. 1: Introduction: the Case for Investment Ethics"
"Ch. 2: Fiduciary Duty of Investment Professionals: the Ethical Treatment of the Client"
"Ch. 3: Ethical Reporting of Investment Performance"

Commentary on Question:

Overall, candidates did not perform well on this question, particularly in sections a) and b). Details of performance, including common errors made, are outlined below.

Solution:

(a) Recommend the appropriate allocation of shares. Justify your recommendation with two reasons.

Commentary on Question:

Candidates did not perform well on this section. While most candidates successfully allocated shares according to the account sizes, most failed to conclude that since the total number of shares requested exceeded the number allocated, Dale should not have received any shares, putting his clients first.

Dale is required to put his clients first. As the total requested number of shares exceeds the amount available, Dale cannot receive any shares.

To avoid any preferential treatment of clients, Dale's brother should be treated as any other client and so is eligible to receive shares.

Total accounts = 300 + 200 + 50 = 550
A: 300/550 x 2000 = 1,090.91 ~ 1,091 < 1,200
B: 200/550 x 2000 = 727.27 ~ 727 < 2,000
Pat: 50/550 x 2000 = 181.82 ~ 182 < 500

The allocation is:
A: 1,091; B: 727; Pat: 182: Dale: 0

(b) Recommend any actions Dale should take. Justify your recommendation with two reasons.

2. Continued

Commentary on Question:
Candidates did not perform well on this section. Many candidates did not provide adequate recommendations.

Dale should refuse his brother's request
- Dale has just overheard potentially material inside information, and this information is clearly not available to the general public.
- He would be violating both legal and ethical standards.

Dale should make sure no one can trade on this company
- Dale has just overheard potentially material inside information, and this information is clearly not available to the general public.
- Restricting trades / putting the company on a restricted list is the fairest way to treat all clients the same.

Dale must inform his manager and/or appropriate company department (eg. compliance department).
- Dale has just overheard potentially material inside information, and this information is clearly not available to the general public.
- Dale should make senior management aware of the situation, and should work with them or could defer to their decision on the matter.

Dale could go to the company itself and inform them of the irresponsible action of the executive.
- The information divulged could be material.
- Ethically, they should know how irresponsible the executive behaved.
- Dale is not responsible at that point of any actions the firm then takes, but it is not up to him, and deferring to them would be ethical.

(c) Recommend any actions, if any, Dale should take. Justify your recommendation with two reasons.

Commentary on Question:
Candidates performed well on this section. Some candidates did not provide sufficient support and some provided reasons unrelated to the specifics of this situation.

Dale should inform his clients:
- It may be considered unethical not to keep his clients informed. It may be safer to disclose the update even if not required to do so.
- Without further details, it appears a change from 18.5% to 8.5% may be significant so Dale should inform his clients of this.

2. Continued

Dale does not need to inform his clients:
- Dale made a recommendation based on information available at that time. It is likely that other analysts had access to the same information.
- Dale is not to blame for the error made by the company and is not legally obligated to inform his clients.

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:

(1a) Compare the interest of key stakeholders.

(1b) Explain principal versus agent conflict.

(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:

Chapter 11 of "Strategic Management: An Integrated Approach", Hill & Jones

Chapter 9 of "Managing Investment Portfolios", Maginn and Tuttle

Chapters 7 and 8 of "Financial Enterprise Risk Management", Sweeting

Commentary on Question:

This question provided candidates with an opportunity to demonstrate their ability to identify risks and recommend mitigation actions for a unique firm with an odd combination of insurance products in its rental agreements. Candidates were also asked to apply their knowledge of risk identification techniques. Finally, candidates were asked to identify and explain stakeholder interests as well as instances of principal-agent relationships.

Overall, candidates did well on this question. The lowest scoring parts for candidates were parts c and d.

A lack of interpretive commentary was the main reason that candidates missed points across various parts of this question. In particular, parts c and f saw a lot of candidates simply repeat things from the question as their explanations or justifications. Candidates may, and often should, pull things from the question, such as data from the table for part f, in order to make a point, but they must demonstrate their understanding of what the data means.

3. Continued

On the other end of the spectrum, a lot of candidates missed points by not connecting their answers to the case more specifically. Part a saw a lot of this, despite candidates doing well overall, as candidates often gave very generic explanations of each stakeholder's interests. Relating answers to the case more would have benefitted candidates.

The last thing that led to a lot of missed points was a generally poor understanding of principal-agent relationships for part d.

Solution:

(a) Identify four stakeholders explicitly mentioned in the case and describe their interests in ABC.

Commentary on Question:
Most candidates did very well on this part. The most common issue was either candidates producing generic stakeholders that were not explicitly mentioned in the case or not adequately describing the interests of the stakeholders identified.

- Social media partner: earn a good return or raise publicity through their partnership with ABC
- Stockholders: provide risk capital to ABC and expect management to maximize their return on investment
- Reinsurer XYZ: shares insurance risk with ABC and wants ABC to have sound underwriting practices in order to minimize losses
- Investors: provide funds for ABC to manage in exchange for a reasonable, reliable return

(b)

(i) Explain how ABC and its funds' investors are each exposed to credit risk.

(ii) Recommend actions that could be taken to mitigate these risks.

Commentary on Question:
Most candidates did well on this part. The most common issue was not clearly or correctly identifying whether it was ABC or the investors that were exposed to each particular risk.

3. Continued

ABC's exposure to credit risk:

- ABC is exposed to counterparty risk because it reinsures part of its insurance business with XYZ. If claims are so high as to cause XYZ's failure, then ABC would be responsible for covering their portion of the losses as well.

Investors' exposure to credit risk:

- The fund's investors are subject to default risk from its renters. If they are not able to pay their rents, then the fund will suffer a loss borne by the investors.
- The fund's investors are subject to default risk from the mortgages in the fund.

Mitigation actions:

- ABC could limit its exposure to reinsurer XYZ by spreading its reinsurance among multiple reinsurers.
- The fund could establish thorough underwriting procedures for prospective renters.
- The fund could establish minimum credit quality standards for the mortgages it purchases.

(c)

(i) Explain how ABC is exposed to insurance risk.

(ii) Recommend actions that ABC could take to mitigate these risks.

Commentary on Question:
Most candidates did poorly on this part. Many candidates simply repeated back part of the question by stating that ABC was exposed to insurance risk because it offered insurance. In order to receive credit, the candidate needed to identify the underlying risk in each insurance type and explain how that risk could affect ABC.

Many candidates were able to recommend increasing the amount of ABC's insurance business that is reinsured, but other mitigation actions were less common.

3. Continued

ABC's exposure to insurance risk:

- Demographic/mortality risk – ABC issues life insurance, so higher than expected mortality will harm it.
- Non-life insurance risk – ABC issues renter's insurance, so higher than expected claims will harm it.
- Volatility component of insurance risk could be an issue because of relatively few number of renters making up entire risk pool.

Mitigation actions:

- Expand the risk pool for its insurance business by offering to people outside its renter population.
- Increase the amount of its insurance business that is reinsured.
- Discontinue offering renter's insurance to its renters.

(d) Explain whether each of the following pairings constitutes a principal-agent relationship.

(i) ABC and its social media partner.

(ii) ABC and XYZ.

Commentary on Question:
Most candidates did poorly on this part. Many candidates were able to explain how ABC and its social media partner were a principal-agent relationship, but the majority of candidates were not able to do so for ABC and XYZ.

Usually, when candidates were unable to correctly identify a pairing as a principal-agent relationship, they justified it by stating that the relationship was simply a partnership or a business contract. A principal-agent relationship can exist independently of these.

When candidates were able to correctly identify a pairing as a principal-agent relationship, they often did not clearly identify which party was the agent and which party was the principal and explain why.

(i) ABC is acting as the principal, delegating control of its distribution channel (the award-winning app) to its social media partner, the agent.

(ii) XYZ is acting as the principal, delegating underwriting decision-making to ABC, the agent.

3. Continued

(e) Analyze ABC's business strategy using a SWOT analysis.

Commentary on Question:
Candidates received around half credit on average for this part, though there was a lot of volatility, with some candidates producing very thorough answers that garnered nearly full credit while others struggled.

In general, candidates should have been more precise in categorizing their statements, as strengths and weaknesses are internal, whereas opportunities and threats are external. Reiterating that the company had credit and insurance risk exposures did not receive credit, as this part was focused on the business strategy of ABC.

Strengths:

- Award-winning app to attract investors through partnership with social media company
- Differentiated products due to life and renter's insurance being embedded into rental agreements

Weaknesses:

- Lack of direction because it offers insurance (renter's and life) when it specializes in real estate and property management
- ABC has limited brand recognition because it is small

Opportunities:

- Growing investor target market (millennials)
- Growing rental markets in cities where properties are located

Threats:

- Competitor stealing social media partner risks distribution channel
- Industry-wide pressure to decrease fees

(f) Determine the risk identification technique represented in each column of the table above. Justify your response for each technique using the data in the table.

Commentary on Question:
Candidates did well on this part, though there was a lot of volatility in the responses, with some candidates receiving full credit and others struggling. The survey technique was usually correctly identified, while the other two techniques varied a bit more across candidates.

3. Continued

The most common issue was for candidates to simply restate the data from the table as justification without providing any interpretation. For example, some candidates would indicate that the sample size was 1000 for survey, but they would not comment on the significance of it (the sample is very large).

A is brainstorming:
Some free-riders are present, as part of the sample size does not respond (4/20).
Convergent thinking is evident by likelihood of new ideas decreasing over time.

These are common features of brainstorming, since not everyone will actively participate in the discussion and the ideas that come up early in the discussion often steer the rest of the conversation as people are influenced by those early ideas.

B is survey:

The sample size is very large (1000).

The response rate is very low (250/1000 = 25%).

These are common features of a survey, as it is usually distributed to many individuals in the hopes of receiving enough responses for a meaningful sample size.

C is Delphi technique:

The sample size is very small (5).
All respondents are "very familiar" with the risks, indicating that only experts on the company's risks were asked to participate.

These are common features of the Delphi technique, as the group usually consists of a small number of carefully selected individuals with deep knowledge on the topic at hand.

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.

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

Sources:

"Financial Enterprise Risk Management" by P. Sweeting Ch 1

"Financial Enterprise Risk Management" by P. Sweeting Ch 7

"Managing Investment Portfolios" by Maginn & Tuttle Section 6

"Risk Management: Foundations for a Changing World" by Haslett Ch 18.

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Identify and describe two quantitative frameworks for liquidity risk measurement.

Commentary on Question:

Candidates performed exceptionally on this section. Most candidates were able to describe quantitative frameworks.

- Bid-ask spread is the spread between the bid and ask prices stated as a proportion of security price. When markets are illiquid, dealers expect to sell at relatively high prices and buy at relatively low prices to justify their assumption of exposure to liquidity risk.

- Illiquidity ratio is the measure of the price impact per $1 million traded in a day expressed in percentage terms. Note that no explicit transaction volume is available for many OTC instruments.

- Transaction volumes can be used to measure liquidity. A rule of thumb is that the greater the average transaction volume, the more liquid the instrument in question is likely to be.

4. Continued

(b)

(i) Rank the liquidity risk for a life insurance company, a bank and a non-life insurance company.

(ii) Explain the differences in liquidity risk among these three financial institutions.

Commentary on Question:
Candidates performed as expected on this section. Most candidates were able to explain the difference in the liquidity profile of these financial institutions.

Life insurance companies have the lowest liquidity risk of all 3. Non-life insurance companies have moderate liquidity risk. Banks have the highest liquidity risk of all 3.

Life insurance firms generally have long-term liabilities and greater cash-flow predictability than banks, so they generally have lower liquidity risk (all things equal) and thus have the capacity to take on more illiquid assets.

Non-life insurance liabilities fall somewhere between bank and life insurance liabilities in terms of both term and predictability, depending on the class of business, so the appropriate level of liquidity is similarly variable.

In both cases, insurance companies are generally less reliant on short-term finance, so financing liquidity is also less of an issue for them than for banks. Banks generally have short-term liabilities (deposits) and long-term assets (loans)

(c) Explain the differences between asset allocation and risk allocation.

Commentary on Question:
Candidates performed as expected on this section. Most candidates were able to explain the difference in the liquidity profile of these financial institutions.

- How the allocation is expressed: Asset allocation models express optimal allocation in terms of portfolio weights whereas risk allocation models convert these portfolio weights into tracking-error allocations or VaR assignments.

- How the allocation is monitored: Asset allocation models focus on changes in portfolio weights whereas risk allocation models focus on the effect those changes have on the riskiness of the portfolio.

4. Continued

- How the allocation is rebalanced: Asset allocation rebalancing takes place through readjusting the portfolio weights back to a constant mix whereas risk allocation rebalancing is done through readjusting the risk of the portfolio.

- How much emphasis is put on historical correlations and volatilities: Asset allocation models use long-term historical time series to calculate correlations and volatilities whereas risk allocation models use recent history which aims to capture the changing market environments.

(d) Describe how the total Daily VaR would change if the CFO's belief were correct.

Commentary on Question:
Candidates performed as expected on this section. Most candidates have shown understanding of the situation.

Increasing correlations will reduce the diversification benefit of allocating capital to different asset classes and increase the company's VaR.

Under perfect correlation, the company's VaR will increase from $20M to $25M.

(e)

(i) Recommend the sub advisor from which to withdraw capital.

(ii) Calculate how much capital needs to be withdrawn from the sub advisor identified in (i).

(iii) Calculate the impact on the company's annual investment profits.

Commentary on Question:
Candidates performed below expectation on this section. Most candidates were able to determine which asset class to withdraw capital from, but only few candidates were able to quantify the impact on the company's profits.

For each group, calculate the ratio of investment returns to the daily VaR. Real Estate = 400%, Alt = 250%, Fixed Income = 150%. For each group, calculate the return on capital, RE = 20%, Alt = 8.3%, Fixed Income = 7.5%.

Fixed income has the lowest returns relative to VaR as well as the lowest Return on Capital, so we can cut the capital allocation to fixed income first with the least impact on profitability.

4. Continued

With a correlation of 1 between each group, the companywide VaR can be calculated as the sum of the VaRs from each sub manager (companywide VaR = $25M). Hence, to comply with the new limit of $18M, the company needs to reduce their VaR by $7M.

For the fixed income group, the Daily VaR is 10M/200M = 5% of the allocated capital. So in order to reduce the VaR for the fixed income group by $7M, we must cut their capital allocation by 70% or $140M.

Investment returns are equal to 15M/200M = 7.5% of invested capital. So the lost investment returns/profit after cutting the capital allocation by $140M will be 0.075* 140M = 10.5M.

5. 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.

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

Sources:

QFII-105-14: Risk²: Measuring the Risk in Value at Risk

QFII-108-14: Developments in Modelling Risk Aggregation

Commentary on Question:

This question is aimed to test the knowledge of the candidates on scenario aggregation analysis through copulas. While most candidates were able to compute the calculations laid out in part d), some candidates failed to demonstrate the theoretical basis behind copulas in part b) and c).

Solution:

(a) Explain the advantages of scenario based risk aggregation analysis.

Commentary on Question:

Candidates did well on this question. Most candidates were able to identify at least one advantage of scenario based risk aggregation analysis.

Advatanges of proper scenario-based risk aggregation analysis include but not limited to the following:

1) Allows the firm/ company to adequately identify and understand the financial positions of the firm
2) Allows the firm/ company to identify risk drivers of underlying business both internally and externally.
3) Allows the firm to develop relationships of risk exposures and risk drivers to preserve a certain level of simplicity.
4) Allows easy and meaninful interpretatopm in an economic and financial context.
5) Allows a firm to develop emergency or recovery plans from extreme scenarios.

5. Continued

(b) Describe three types of models or algorithms that are commonly used as scenario generators.

Commentary on Question:
Most candidates were able to provide examples of each algorithm, but were unable to identify each of the algorithms clearly.

1) **Algorithm:** The first category consists of models that tries to describe and proxy "real physical processes or natural laws".
    - **Description:** These processes usually rely on dynamic modelling that let risk factors develop through time. Examples includes pandemics, for which models describe howt he virus can change, propagate between individuals and how it acts on the individual resulting in states of sickness of various severity or in death.

2) **Algorithm:** The second category would be models that describe processses for which there is no real physical model. The model in this category may rely on a particular theory which might fit certain historical observations.
    - **Description:** These models then underlie the scenarios simulated Often certain ad-hoc distribution assumptions are used to perform the simulations. Examples include interest rate and equities prices financial times series analysis.

3) **Algorithm:** The third class of processes combines the first two categories and mixes physical and theorectial descriptive and empirical processes.
    - **Description:** Examples might include integrated natuaral catastrphe scenarios with economic and financial scenarios.

(c) Describe the steps you should use to sample aggregate losses with a copula.

Commentary on Question:
Candidates did not do well on this question. There were often critical steps that were omitted or skipped.

Step 1 - Draw a joint sample of uniform random variables $(u_1, \ldots., u_n)$ from the distribution specified by the copula

Step 2 - Translate the sample from the copula distribution to the sample from the conjoined loss distribuion by calculating the u_1-th percentile of Y_1, and u_2-th percentile of Y_2 etc. (in vector form, this is $(F_{x1}^{-1}(u_1), \ldots., F_{xn}^{-1}(u_n))$

Step 3 - Calculate the realized sample for the aggregate loss as the sum of the percentiles drawn from each of the distribution (i.e. $F_{x1}^{-1}(u_1) + \ldots + F_{xn}^{-1}(u_n)$)

5. Continued

Step 4: Drawing many samples for the aggregate loss distribution will produce a simulated distrbution. Any measure of risk (such as VaR or expected shortfall) can be computed from this simulated distrbution.

(d) Calculate the unknowns Z and X.

Commentary on Question:
Candidates performed very well in this section.

Calculation of unknown Z:
$F(x) = 1 – \exp(-x/\theta)$
Substitute $x = 13.25$, $F(x) = Z$
$Z = 1 – \exp(-13.25/15)$
$Z = 0.5866$

Calulation of unknown X:
$F(x) = 1 – (\theta / (x + \theta))^{\alpha}$
$x = (1 – F(x))^{(-1/\alpha)} * \theta – \theta$
Substitute $\alpha = 3$, $\theta = 5$, $F(x) = 0.052$
$x = 0.0897$

Aggregate Loss $X = 0.0897 + 24.52 = 24.6097$

(e) Determine which VaR estimation methodologies were used as Method 1 and Method 2. Justify your response using the data in the table.

Commentary on Question:
Candidates did not do well on this question due to the lack of justification or explanation.

VaR estimation method 1 is Quantile-based.
VaR estimation method 2 is Sigma-based.

Similarities and Differences:
1. The average under both VaR method 1 and 2 are consistent and similar.
2. The Asymptotic Standard Error is close to the standard error under both VaR methods and percentiles
3. VaR method 2 is about twice as efficient as the VaR method 1 under 10% percentile when comparing the standard errors (i.e. 0.066 vs 0.033) or similarly under 1% percential comparison (i.e. 0.152 vs 0.067).

6. 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.

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

Commentary on Question:
Commentary listed underneath question component.

Solution:

(a) Calculate the monthly 5% VaR using the Analytical Method.

Commentary on Question:
Candidates performed well in this question.

Monthly Expected Return = μ = (Annual Expected Return)/(Periods in a Year) = .0159/12 = .1325%

Monthly Standard Deviation = σ = (Annual Standard Deviation)/(Periods in a Year)1/2 = .0121/121/2 = .3493%

Monthly 5% VaR = $\mu - 1.645*\sigma$ =.1325% – 1.645 * .3493% = -.4421%
.4421% * 9,000,000 = 39,788.408

(b) Calculate the monthly 5% VaR using the Historical Method based on the monthly returns above.

Commentary on Question:
Candidates performed well in this question.

Number of Monthly Returns = (Number of Years) * (Periods in a Year) = 5 * 12 = 60

60 * .05 = 3

Based on the histogram or table, the 3rd worst return is -.43%

Monthly 5% VaR = -.43% * 9,000,000= 38,700

6. Continued

(c) Recommend either the Analytical Method or the Historical Method. Justify your answer.

Commentary on Question:
Candidates performed well on this question.

Recommendation: Historical Method

Disadvantages of Analytical Method
Reliance on normal distribution, which is inappropriate for stress environments or portfolios containing options
Not suitable for portfolios with non-linear positions
Not appropriate for negatively skewed distribution

Advantages of Historical Method
Not subject to model risk or non-parametric
Historical data includes interest rate option position

(d) Critique the fund manager's statements. Justify your response using the data in the tables.

Commentary on Question:
Candidates performed poorly on this question. Candidates could identify the weaker part of the statements but with little justification.

"We monitor the correlation matrix annually to measure dependencies between assets."
- Correlation matrix cannot capture tail dependence.
- Correlation is appropriate only for risks with elliptical distributions.

"The values do not change much based on our experience."
- Correlations move towards 1 in stressed markets.

"Most coefficients are far from 1 and -1 indicating low tail dependence. In addition, Treasury Inflation Protected Securities (TIPS) exhibit near zero correlation with other securities, which demonstrates independence of risks.
- ABS and MBS correlations move towards 1 in stressed market environments.
- These are especially true for structured securities. Correlation increased to .97 during the Financial Crisis.

6. Continued

"The new allocation can be developed based on this assumption."
- Correlation matrix cannot capture tail dependence.
- Correlation is appropriate only for risks with elliptical distributions.

(e) Verify whether the copula exhibits the lower tail dependence. Show all work.

Commentary on Question:
Candidates performed poorly on this question.

$$C(x,y) = \left(x^{-\theta} + y^{-\theta} - 1\right)^{-1/\theta}$$

$$Lower\ Tail\ Dependence = \lim_{v\to 0} \frac{C(v,v)}{v}$$

$$= \lim_{v\to 0} \frac{\left(v^{-\theta} + v^{-\theta} - 1\right)^{-1/\theta}}{v}$$

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

$$= \lim_{v\to 0} \left(v^{\theta}\right)^{-1/\theta} * \left(2v^{-\theta} - 1\right)^{-1/\theta}$$

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

$$= 2^{-1/\theta}$$

A limit greater than zero indicates lower tail dependence. The copula exhibits lower tail dependence when the limit is greater than zero.
It is greater than zero for $\theta \neq 0$