

Exam QFIIRM

Date: Thursday, November 4, 2021

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 6 questions numbered 1 through 6 with a total of 40 points.

The points for each question are indicated at the beginning of the question.

2. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions provided in this document.

Written-Answer Instructions

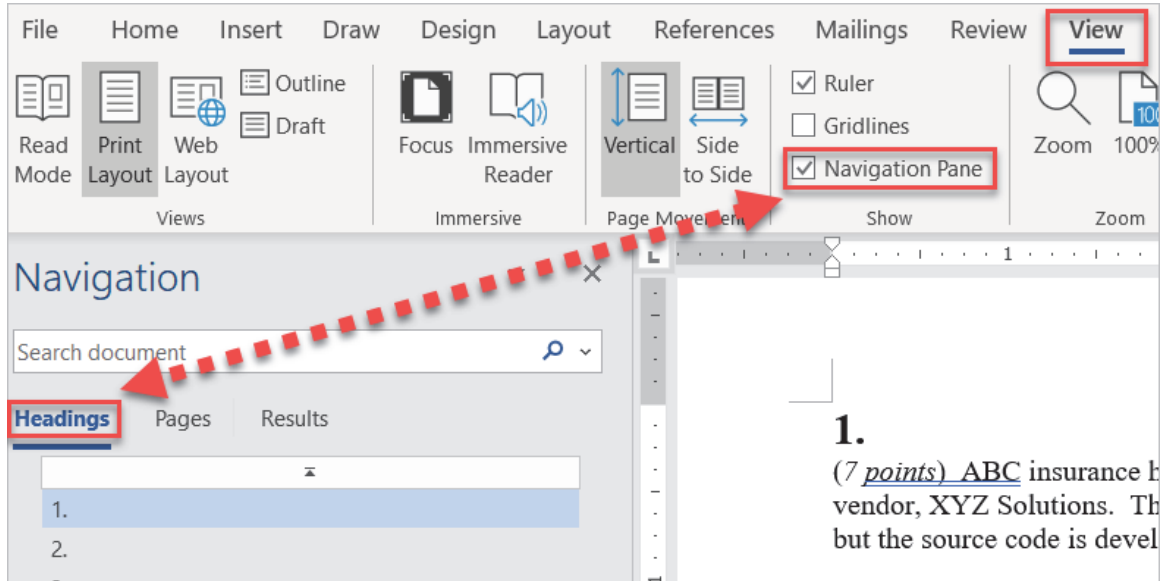
1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.
 - a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 (and ^ used to indicate a superscript).
 - b) In the Excel document formulas should be entered. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.
 - c) Individual exams may provide additional directions that apply throughout the exam or to individual items.
2. The answer should be confined to the question as set.
3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.
4. The Word and Excel files that contain your answers must be uploaded before the five-minute upload period expires.

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Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:



1.

(7 points) You manage the investments for the defined benefit pension plan of XYZ, a large company in the US. XYZ makes regular contributions to the fund and promises a stream of fixed payments to its employees when they retire.

- (a) (1 point) Describe two sponsor risks faced by XYZ.

ANSWER:

You are given the following covariance matrix for three asset classes held by the fund:

Table 1: Covariance Matrix

	Equity	Fixed Income	Commodities
Equity	0.0415	0.0028	0.0250
Fixed Income	0.0028	0.0025	0.0012
Commodities	0.0250	0.0012	0.0588

XYZ's pension fund has a market value of \$150 million. Your coworker sends you return expectations for the next plan year as well as the current asset allocation.

Table 2: Return and Allocation Assumptions

	Return	Allocation
Equity	7.3%	35%
Fixed Income	4.3%	60%
Commodities	2.0%	5%

Plan guidelines state that the expected annual 99% VaR of the fund should not exceed a loss of \$20M.

- (b) (1.5 points)

- (i) Calculate the expected annual volatility of the fund.

The response for this part is to be provided in the Excel spreadsheet.

- (ii) Determine if the plan violates the VaR guidelines.

The response for this part is to be provided in the Excel spreadsheet.

1. Continued

XYZ's fund is invested in five passive indexes. Market beta and allocations are in the table below:

Table 3: XYZ Fund Allocation

Index	Beta	Allocation
Equity (Developed Markets)	1.840	25%
Equity (Emerging Markets)	2.812	10%
Corporate Bonds	0.372	40%
Sovereign Bonds	0.175	20%
Commodities	1.500	5%

(c) (1.5 points)

(i) Explain the meaning of Beta in the table above.

The response for this part is to be provided in the Excel spreadsheet.

(ii) Identify which index makes the greatest contribution to the total risk of the fund. Justify your response.

The response for this part is to be provided in the Excel spreadsheet.

In your quarterly review of the plan with XYZ management, you are asked to provide suggestions to reduce the risk of the fund. Your coworker projects a correlation of -0.4 between the Equity (Developed Markets) index and the Equity (Emerging Markets) index and suggests short selling the Equity (Emerging Markets) index to reduce risk and increase return.

(d) (1 point) Critique your coworker's suggestion.

ANSWER:

1. Continued

During the quarterly review, XYZ management expresses concern with recent fund performance relative to the benchmark. Two fund managers on your team that specialize in emerging markets believe they can produce positive alpha above the passive Equity (Emerging Markets) index in which the fund is currently invested. The managers have historically achieved active returns that are independent of each other.

Tracking Error	2%
Tracking Error Volatility	5%

For the emerging equity allocation, your firm has set a tracking risk budget of \$0.7M at the 99% level.

- (e) (1 point) Determine whether allocating 30% to each active manager would cause the fund to exceed the firm's risk budget.

The response for this part is to be provided in the Excel spreadsheet.

- (f) (1 point) Explain the advantages of risk budgeting over the use of notional limits.

ANSWER:

2.

(6 points) ZYX is a U.S.-based asset management company that has two portfolios, a domestic bond portfolio and a foreign bond portfolio. The Board of Directors of ZYX has expressed concern regarding the decentralized risk governance structure of ZYX.

(a) (1 point)

(i) Describe one drawback of a decentralized governance structure.

ANSWER:

(ii) Describe one way to address this drawback while maintaining a decentralized governance structure.

ANSWER:

To address the concerns of the Board, ZYX establishes a central risk management team and appoints you as the head of the team. You have identified the following risks as the top priorities:

1. Interest rate risk
2. Exchange rate risk
3. Credit risk
4. Model risk

You learn the following:

- USD is expected to appreciate against most foreign currencies.
- Interest rates are projected to increase by 150 bps over the next 6 months.
- There is no expert on the risk-neutral equilibrium model used by the company.
- Corporate bonds issued by two companies make up over 25% of ZYX's portfolio.

(b) (1 point) Explain how each of the risks above apply to ZYX.

ANSWER:

2. Continued

You present your findings to the Board, which is particularly concerned about ZYX's exposure to credit risk.

- (c) (1.5 points) Describe three approaches for ZYX to mitigate credit risk.

ANSWER:

In order to manage market risk, you implement risk budgeting within ZYX's two portfolios. Below is the performance data from last year:

	Domestic bond portfolio	Foreign bond portfolio
Use of Capital	\$200 million	\$300 million
Daily 95% VaR	\$17 million	\$38 million
Annual Profits	\$6.50 million	\$9.75 million

- (d) (2.5 points)

- (i) Compare the relative performance of the two portfolios.

The response for this part is to be provided in the Excel spreadsheet.

- (ii) Recommend how to allocate the capital next year if the portfolios are fully correlated. Justify your response.

The response for this part is to be provided in the Excel spreadsheet.

- (iii) Calculate the annual profits and daily 95% VaR after making your proposed change to the allocation of capital, assuming returns on VaR for each portfolio will not vary based on the size of the portfolio.

The response for this part is to be provided in the Excel spreadsheet.

3.

(8 points) Company X is a large U.S. based firm that sells annuities. You are part of the compliance team at Company X.

A recent review of company culture by a third-party firm revealed that a tribal culture exists within the sales team.

(a) (1 point)

(i) Describe how tribal culture forms in a company.

ANSWER:

(ii) Explain two reasons why tribal culture adversely impacts the effectiveness of governance.

ANSWER:

Management requests that the compliance team review the culture within the sales team and propose a strategy to address the situation. Two proposed solutions from coworkers are shared:

- Coworker 1 proposes that Company X needs to set the tone from the executive level. Senior management can show their commitment by signing off on all quarterly statements. The compliance team should draft a governance document that clearly defines company policy.
- Coworker 2 proposes strict requirements at the individual level. Employees will spend significant time on detailed documentation of each sale. The sales team will be required to sign non-compete paperwork that prevents any associate from working for a competing firm for a full year after leaving Company X, a significantly longer time period than is standard for the industry.

(b) (1.5 points) Critique each of the proposed solutions.

ANSWER:

3. Continued

Upon further review of the sales team's practices, you learn the following:

- Many employees on Company X's sales team have spent part of their careers at either Company Y or Company Z, two other leading firms in the U.S. annuity industry.
- Sales representatives at all three firms attend the same conferences during the year and have friendly relationships.
- It is informally understood that the sales representatives at each company will not target prospective clients in geographic regions where one of the other firms is dominant.

(c) (2 points)

- (i) Identify two stakeholders of Company X who are adversely affected by these practices.

ANSWER:

- (ii) Describe how each stakeholder is adversely affected.

ANSWER:

3. Continued

You conduct a series of interviews with sales managers and learn the following about Company X's selling practices:

- Fixed dollar commissions are paid upfront upon the sale of each variable annuity.
- The commission structure is always clearly communicated to prospective clients.
- Company X's book of business consists of a large quantity of small annuities, with very few wealthy clients who tend to purchase larger annuities.

(d) (1.5 points)

- (i) Critique the Company X's selling practices.

ANSWER:

- (ii) Explain two risks that these practices pose to Company X.

ANSWER:

Your next assignment is to review the practices of the investment team, which is responsible for both the Company X's proprietary trading program and hedging its annuities.

Management has mandated that equity risk in the annuities be fully hedged. The investment team does this by purchasing derivatives that perfectly match the equity risk of the annuities. They rebalance their positions on a weekly basis.

- (e) (1 point) Describe how sensitivity testing can be used to supplement the investment team's current methodology.

ANSWER:

3. Continued

Company X has established market value limits on each trader's portfolio to prevent any one trader from putting the company at risk of substantial losses.

John Smith, a trader at Company X, believes he has identified an arbitrage opportunity by selling deep out of the money puts.

- (f) (1 point) Explain whether the limits that Company X currently has in place will protect the company from potential losses under this strategy.

ANSWER:

4.

(7 points) You are a market risk analyst for an institutional asset management firm and are assigned the task of assessing tail risks for a large client's portfolio.

The portfolio's asset allocation includes only two asset classes, public equities and venture capital. To assess the joint return distribution of the portfolio, you consider three types of copulas:

1. Fundamental copula
2. Implicit copula
3. Explicit copula

(a) (2 points)

(i) Describe each type of copula listed above.

ANSWER:

(ii) Recommend the best copula to model returns for this portfolio. Justify your response.

ANSWER:

4. Continued

As a first step to building your model, you consider two basic functional forms the copula could take:

$$\text{Form A: } C_1(u, v) = \max(u, v)$$

$$\text{Form B: } C_2(u, v) = uv$$

(b) (2.5 points)

- (i) List three requirements a function $C : [0, 1]^2 \rightarrow [0, 1]$ must meet for C to be a copula.

ANSWER:

- (ii) Assess whether each of Form A and Form B is a copula. Justify your response.

ANSWER:

- (iii) Identify the functional form of each of the upper and lower bounds of all bivariate copulas.

ANSWER:

4. Continued

Your manager reviews your initial results and recommends that you consider a copula that can incorporate tail-dependency. Your colleague suggests using the following form:

$$C_C(u, v) = \max \left(\left[u^{\frac{1}{2}} + v^{\frac{1}{2}} - 1 \right]^{-2}, 0 \right)$$

(c) (1.5 points)

(i) Define upper and lower tail dependence.

ANSWER:

(ii) Explain the interpretation and importance of lower tail dependence in the context of portfolio risk management.

ANSWER:

(iii) Assess whether the copula $C_C(u, v)$ above exhibits lower tail dependence. Justify your response.

ANSWER:

You conclude that a Gumbel copula is most appropriate for the client's portfolio and need to determine the copula's single parameter. You obtain a selection of paired return data for the portfolio's two asset classes.

(d) (1 point) Describe two methods of calibrating the copula parameter.

ANSWER:

5.

(7 points) ABC is a large U.S.-based life insurance company. You have recently been appointed CRO and have been asked to participate on the Risk Management Committee of the Board.

- (a) (1 point) Describe the role of the Board with regard to a company's risk management framework.

ANSWER:

A Board member has proposed the following actions:

1. Require a detailed summary be presented to the Risk Management Committee for each potential risk-related activity.
2. Add a new Board member who has worked most of her career in running the financial aspects of a stage theater company.
3. Develop a Key Performance Indicator to ensure that net amount at risk is low enough so that you, the new CRO, are comfortable with the risk level.
4. Include time for questions on all items presented in the agenda for each Committee meeting.

- (b) (1.5 points) Evaluate the appropriateness of each action above.

ANSWER:

Your next objective is to improve the risk culture of the organization.

- (c) (2 points)

- (i) Explain two reasons why an effective risk culture is important.

ANSWER:

- (ii) Propose three ways to improve the risk culture of a company.

ANSWER:

5. Continued

The company is adding a new life insurance product to help increase earnings and diversify their product offerings. The product development process involves the following elements:

- A. Due diligence on the product is generally conducted by the product team, which focuses on the size of the market and the needs of consumers.
- B. The company begins development as soon as possible on each new product type it sees appear in the market, as it wants to keep up with the offerings of competitors.
- C. The pricing and product teams engage senior management near the end of the product development process in order to seek approval.

You consider how the enterprise risk management (ERM) team could be involved in the development of this product.

(d) (1.5 points)

- (i) Critique each element of the product development process.

ANSWER:

- (ii) Recommend how the ERM team could be involved in each element of the process.

ANSWER:

5. Continued

The new life insurance product the company is exploring would result in profits in early years, but earnings beyond the first few years are less certain. The product development team will be paid a bonus based on the first five years of profits.

(e) (1 point)

(i) Explain how moral hazard could apply in this situation.

ANSWER:

(ii) Recommend an alternative compensation structure for the product development team.

ANSWER:

6.

(5 points) You have been recently hired by a large bank and are discussing CDOs and securitization of mortgages with a colleague.

- (a) (0.5 points) Describe two examples of moral hazard in the securitization of mortgages during the 2008 financial crisis.

ANSWER:

Your colleague mentions that after the 2008 financial crisis, your firm learned the importance of having a risk-conscious culture. The firm hired a chief risk officer who regularly updates the board on the risk management process.

- (b) (1 point) Describe four other strategies that the firm can use to promote a risk-conscious culture.

ANSWER:

6. Continued

You gather historical data on aggregate losses from your firm's CDO portfolio and graph results in the chart below.



Analysts use a copula, Copula X, to model the joint dependency of the individual credit loss distributions. Copula X is used to simulate aggregate losses from your firm's CDO portfolio. Results from the simulation are summarized in the table below.

Simulation Results

Loss Interval	Number of Data Points
$0 < x \leq 2$	9,500
$2 < x \leq 4$	499
$x > 4$	1

(c) (1 point)

- (i) Assess the appropriateness of Copula X for this loss distribution based on the simulated results.

ANSWER:

- (ii) Recommend an alternative type of copula for this loss distribution.

ANSWER:

6. Continued

Management expresses concerns with the complexities of copulas and requests that your team consider another approach.

- (d) (1 point) Describe two alternatives to copulas for modeling CDOs.

ANSWER:

Your colleague disagrees with management and makes the following statement:

“The near bankruptcy of AIG during the mortgage crisis was caused by inadequate risk modeling. Models that incorporate more complexity, not less, are necessary to adequately model CDOs and securitization of mortgages.”

- (e) (1.5 points)

- (i) Critique your colleague’s statement.

ANSWER:

- (ii) Describe two lessons learned from AIG’s failure.

ANSWER:

****END OF EXAMINATION****