SOCIETY OF ACTUARIES®

QFI Investment Risk Management Exam

Exam QFIIRM

Date: Thursday, May 6, 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 time expires.

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Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:
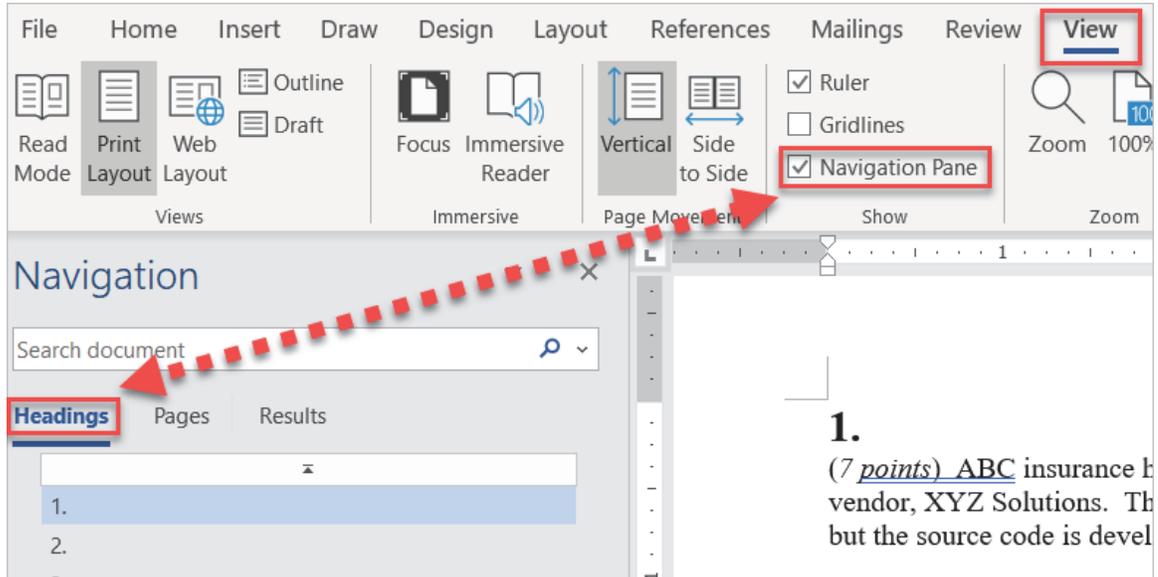
1.

(*6 points*) You are a portfolio manager for a large, well-diversified pension plan with $1 Billion assets under management. You recently read the following statements in a research report on portfolio management:

- The Sortino ratio measures a portfolio's return in excess of a target return, taken as a percentage of the downside deviation.
- Sortino ratio does not penalize a portfolio manager for volatility from positive performance.
- The Sortino ratio addresses the non-normality issues associated with the Sharpe ratio.
- If the target return is the risk-free rate, the Sortino ratio equals the Sharpe ratio.

(a) (*1.5 points*) Assess the validity of each of the four statements.

ANSWER:

1. Continued

The asset allocation of the fund and the associated risk budgets are given in the following table, consistent with the Board of Trustees' decision to have an annual volatility profile for the pension fund of 9%. To improve diversification, you propose changing the equity and corporate bond asset compositions such that their category volatilities change, while keeping the portfolio volatility and principal in each asset category unchanged.

Asset Category	Principal ($Millions)	Initial Risk Budgets at 99% Confidence Level ($Millions)	Current Volatility	Proposed Volatility
US Equities	250	99	17%	18%
Corporate Bonds	450	115	11%	9.5%
Other	300	56	8%	8%
Total Portfolio	1000	210	9%	9%

(b) (*1.5 points*)

   (i)   Determine the impact that this proposed change has on the risk budget diversification level, assuming asset returns are normally distributed.

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

   (ii)   Assess whether the proposed change achieves your objective to improve diversification benefits.

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

1. Continued

Your team conducts a risk prompt list analysis and recommends that the portfolio expand its asset classes to include more international investments, particularly in company XYZ. You know the following about XYZ:

- XYZ is a mining company that has operations in a few different countries: Countries A, B, and C.
- Leaders of Country A recently underwent intense scrutiny by local media due to evidence that there might have been favoritism shown in awarding lucrative mining rights to some of XYZ's competitors.
- Country B's legislature has been focusing on enacting laws aimed at improving workplace safety and otherwise improving workers' rights.
- The coastal region of Country C in which XYZ operates to extract certain minerals that can be toxic to marine animals has been experiencing increasing rates of flooding in recent years.
- XYZ sponsors employee pension plans in each country it operates in. XYZ's home country's pension plan member mortality table is used in calculating the liabilities under these plans.

(c) (*1.5 points*)

(i) Describe four key non-financial risks involved in investing in XYZ.

ANSWER:

(ii) Assess XYZ's choice of mortality table for modeling its pension plans.

ANSWER:

1.   Continued

In a recent conversation, your colleague highlighted how a low interest rate environment presents a cost-effective opportunity to increase the portfolio size through borrowing. Your colleague mentions that they have already employed this tactic with the portfolio that they manage and did not communicate the change with their client, as the client should not be bothered with the extra complexities having to be explained to them.

(d)   (*1.5 points*)

(i)   Identify the investment tactic described above.

ANSWER:

(ii)   Describe the potential impact of this tactic on the portfolio.

ANSWER:

(iii)   Explain how your colleague's approach could be unethical.

ANSWER:

2.

(*7 points*) You are a client risk manager at an asset management firm, where you are responsible for assisting clients in using risk metrics and other methods to uncover the market risks of their portfolios. One client is concerned about risks present in their CDO portfolio, which they currently model using a Gaussian copula.

(a)   (*1.5 points*)

(i)   Explain two limitations of using the Gaussian copula for risk management of CDOs.

ANSWER:

(ii)   Describe an alternative approach to quantify the risk of a CDO portfolio using stress testing.

ANSWER:

2. Continued

This client also invests in two corporate bond portfolios, X and Y. They are concerned that large losses in one portfolio may frequently occur simultaneously with large losses in the other.

To assist the client, you gather a 9 month sample of loss data for each portfolio and calculate the Pearson correlation coefficient and Kendall's τ, shown in the table below.

$Month_i$	$Loss_X$	$Loss_Y$
1	30	390
2	9	230
3	400	400
4	28	280
5	3	301
6	10	308
7	22	302
8	0	0
9	35	398

Risk Measure	Value
Pearson correlation coefficient	0.398
Kendall's τ	0.722
Spearman correlation coefficient	

(b)   (*3 points*)

   (i)   Calculate the sample Spearman correlation coefficient.

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

   (ii)   Calculate the concordance for the first pair (x_1, y_1).

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

   (iii)   Assess your client's concern using the risk measures above. Justify your response.

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

2. Continued

The client manages their combined portfolio risks with a 95% CTE loss limit of $200M. The client wishes to perform a reverse stress test. The joint dependency structure of the annual change in portfolio value (N, M) is assumed to follow a Gumbel copula. You are also provided the following information:

- $C_{Gumbel}(u, v) = \exp\left\{ -\left[(-\ln u)^a + (-\ln v)^a \right]^{\frac{1}{a}} \right\}$

- $p_{loss}^n = \Pr[N < 0] = p_{loss}^m = \Pr[M < 0] = 1/e^2$

- $Loss_n = Loss_m = \$100\ Million$; losses are constant and independent

- For the Gumbel copula, $a = \dfrac{1}{1 - \tau}$

(c) (*2.5 points*)

   (i) Explain two reasons why a firm would use a reverse stress test.

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

   (ii) Calculate the 95% CTE if an independence copula is used.

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

   (iii) Determine the smallest value of Kendall's τ such that the limit is breached.

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

3.

(*7 points*) Electric truck company ABC manufactures electric commercial trucks for use in delivery fleets. The CEO asked you, the newly hired CRO, to meet to discuss the formation of a risk committee.

(a) (*0.5 points*) List three best practices in operating an effective risk committee.

ANSWER:

(b) (*1.5 points*)

(i) Identify four important qualities of a risk conscious culture.

ANSWER:

(ii) Explain how two of the qualities identified were lacking in the Space Shuttle Challenger case study.

ANSWER:

The CEO responds that her former company's CRO is a friend and willing to join the committee. Her friend has experience in the same industry and would bring an outside perspective to the Board.

(c) (*0.5 points*) Recommend whether the Board should include this candidate on its risk committee. Justify your response.

ANSWER:

3. **Continued**

As part of the company's environmental scanning process, the previous CRO required management to complete an annual survey to collect views on a list of predefined risks.

(d)   (*1 point*)

(i)   Critique the previous CRO's approach to the environmental scan.

ANSWER:

(ii)   Recommend two ways to expand upon this scan for scenario planning.

ANSWER:

Your environmental scan identified five major risk factors, and you created the following influence matrix.

Risk Factor	1.	2.	3.	4.	5.
1.Government Contract	-	0	2	0	0
2.Production Capability	2	-	0	0	0
3.Product Design	0	1	-	2	2
4.Market Demand	1	1	0	-	1
5. Laws/Regulations	2	1	2	2	-

A colleague says that the best approach to addressing the risk associated with production capability is to explore changes to the product design.

(e)   (*1.5 points*)

(i)   Critique your colleague's approach.

ANSWER:

(ii)   Identify the risk with the greatest influence.

ANSWER:

3. Continued

During your environmental scan, you noted the following risks:

    A. All trucks are manufactured at a single facility overseas.

    B. Trucks are only sold domestically.

    C. The government is ending tax incentives for purchasing electric vehicles.

(f)   (*2 points*)

    (i)   Explain how each of these three risks can impact ABC.

> ANSWER:

    (ii)   Classify each risk (A, B, and C) under the most appropriate risk factor from the influence matrix in part e).

> ANSWER:

    (iii)   Propose a strategy for ABC to mitigate each of the three risks identified above.

> ANSWER:

4.

(*7 points*) You have joined a compliance team at a U.S. investment bank, XYZ.

(a)   (*0.5 points*) Define the term moral hazard.

> ANSWER:

Your first assignment is to review four company policies:

1. XYZ allows any executive to take a one-time loan of up to $500,000 as part of the executive benefit package. For any loan, the principal plus interest must be repaid within two years.

2. XYZ's M&A advisors have fulfilled their fiduciary obligation to a client if all fees and charges are understood by both parties.

3. XYZ allows all brokerage clients access to some of the research performed by XYZ analysts but requires clients to pay a fee to have access to additional resources.

4. XYZ displays portfolio returns over the last three years in its marketing materials. This period immediately followed a significant corporate tax cut.

(b)   (*2 points*) Recommend whether each policy should be maintained, discontinued, or adjusted. Justify your recommendations.

> ANSWER:

4. Continued

The research department at XYZ is considered best-in-class. Many of XYZ's clients are mutual funds that are willing to pay brokerage fees above the industry average to have access to this research.

(c)   (*1.5 points*) Assess how this arrangement affects each of these parties:

(i)   XYZ

ANSWER:

(ii)   Mutual fund managers

ANSWER:

(iii)   Mutual fund clients

ANSWER:

XYZ has been approached to assist in the IPO of a small insurance company, ABC. The IPO has an estimated value of $20M. XYZ's broker takes the following actions:

- Calls four of the firm's five wealthiest clients.
- Offers each client $5M of shares of ABC.
- Decides that IPO shares would not be appropriate for the fifth wealthiest client.

(d)   (*1.5 points*)

(i)   Critique the broker's actions above.

ANSWER:

(ii)   Recommend an alternative action where appropriate.

ANSWER:

4. Continued

XYZ would like to diversify its asset mix by including hedge funds. It is considering hiring HFC, an investment firm dedicated to managing alternative investment portfolios. Your investigation into the firm reveals the following:

- HFC established a due diligence team about one year ago. The team was given veto power to hold back an investment that does not meet minimum internal control standards.
- Senior management at HFC is required to review and sign-off on the internal financial controls.
- HFC requires monthly net asset values from its hedge fund managers.
- The employee turnover rate at HFC has been high in the past three years compared to the industry average.

(e) (*1.5 points*)

    (i)   Assess each of the findings from your investigation above.

> ANSWER:

    (ii)   Recommend whether XYZ should hire HFC, based on your investigation.

> ANSWER:

5.

(*7 points*) You are an analyst working in the risk department of a large U.S. life insurance company. Your role is focused on the development of stress scenarios.

(a)   (*1 point*) Describe each of the following attributes of stress scenarios:

   (i)   Comprehensive

   ANSWER:

   (ii)   Extreme

   ANSWER:

   (iii)   Plausible

   ANSWER:

Senior management requests that your team develop a set of scenarios that will help the firm assess the worst possible losses it could realistically suffer.

Your colleague makes the following suggestions:

- "Our firm already runs a series of prescribed scenarios that have been fully specified by state regulators to all life insurance companies domiciled here. We should use these scenarios for management's request."
- "Senior management should not be included in the design of scenarios because it would introduce bias."
- "We should develop probabilities for our scenarios, but make sure to communicate that the probabilities are subjective and have significant uncertainty."

(b)   (*1.5 points*) Critique each suggestion above.

   ANSWER:

5. Continued

Your firm has entered into two large derivative positions. Returns on these two exposures have historically been inversely related. The firm has also established lines of credit with several banks for its short-term funding needs.

Your manager states: "In a stressed environment, we cannot depend on negative correlations to hold. Instead, we should rely on the lines of credit to meet margin calls when the derivatives lose value."

(c) (*1 point*) Assess the validity of your manager's statement.

ANSWER:

You develop a top-down scenario that you believe would put your firm under significant financial distress due to the high interest rate guarantees embedded in its life insurance contracts. The key features of your scenario are a lengthy period of stagnant economic growth and historically low interest rates in the U.S.

You present your results to management who compare them to the 2008 financial crisis and 2020 pandemic, where rapid declines in equity values were followed by periods of growth as the economy recovered. As a result, management does not believe your scenario is plausible as the results are too extreme.

(d) (*1.5 points*)

(i) Explain the importance of a stress scenario narrative.

ANSWER:

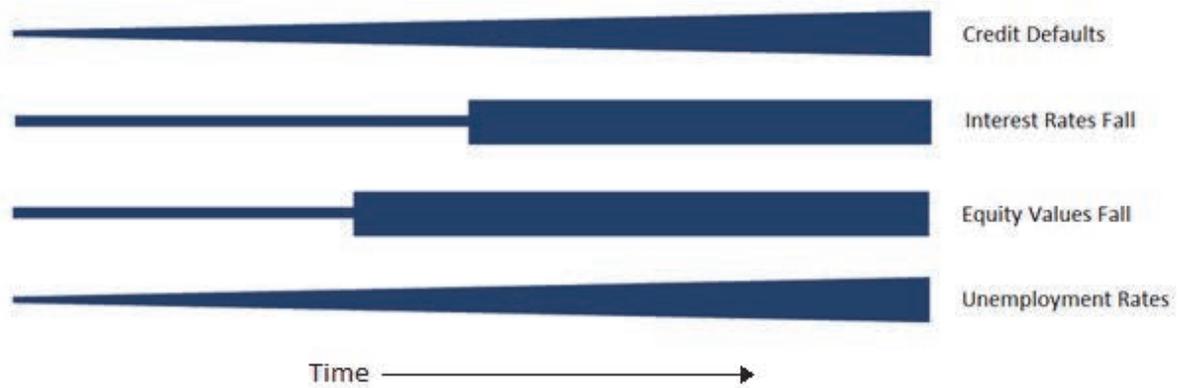(ii) Identify the type of behavioral bias exemplified by senior management's assessment.

ANSWER:

(iii) Assess the appropriateness of your scenario.

ANSWER:

5. **Continued**

To better understand the scenario you have presented, management asks to see a timeline of key risk factors. You present the below timeline at a follow-up meeting.

Management highlights three pairs of risk factors shown below.

- Credit and Unemployment
- Credit and Equity
- Equity and Interest Rates

(e) (*2 points*)

(i) Identify the type of dependency present in each risk factor pair above.

ANSWER:

(ii) Explain how the dependency arises in each risk factor pair above.

ANSWER:

6.

(*6 points*) You are an actuary at investment management firm ABC, responsible for mitigating operational risk.

(a)   (*1 point*)

   (i)   Define operational risk.

   > ANSWER:

   (ii)   Explain two reasons why ABC needs an effective operational risk control process.

   > ANSWER:

ABC has decided to start a company-wide initiative to automate manual processes to help minimize operational risk. An actuarial student who reports to you has written some documentation about how to automate manual processes and makes the following statements:

1. The use of computers in place of humans ensures accurate results.

2. As the automated process matures and moves into production, the need to understand the manual calculation becomes obsolete. Automation implies an understanding of the manual calculation and the ability to adapt when software or methodologies change.

3. The main driver of incomplete audit trails is the age of systems: newer applications are less susceptible than older vendor systems.

4. Interfaces between multiple systems are usually sources of problems.

(b)   (*2 points*) Evaluate each of these statements.

   > ANSWER:

6. **Continued**

ABC's senior management is considering partnering with XYZ, a technology consulting firm, to assist in the implementation and validation of an automated trading system. The trading system is maintained and sold by DEF, a software vendor and subsidiary of XYZ.

(c)   (*1 point*) Describe the interests of ABC and XYZ in this engagement to implement the automated trading system.

You make the following observations about ABC's engagement with XYZ:

1. XYZ did not select the particular automated trading system to be implemented but instead relied on the decision made by ABC's technology department.

2. XYZ plans to validate the system as a joint effort with the subject matter experts at DEF.

3. XYZ's expertise focuses on software for activities that are common to most financial services firms.

4. ABC's staff will not be involved in the actual implementation process because of their existing workloads, so XYZ plans to be available for guidance after the project is complete.

(d)   (*2 points*) Critique each aspect of the engagement in the context of operational risk.

ANSWER:

END OF EXAMINATION