SOCIETY OF ACTUARIES

QFI Investment Risk Management Exam

Exam QFIIRM

Date: Friday, May 13, 2022

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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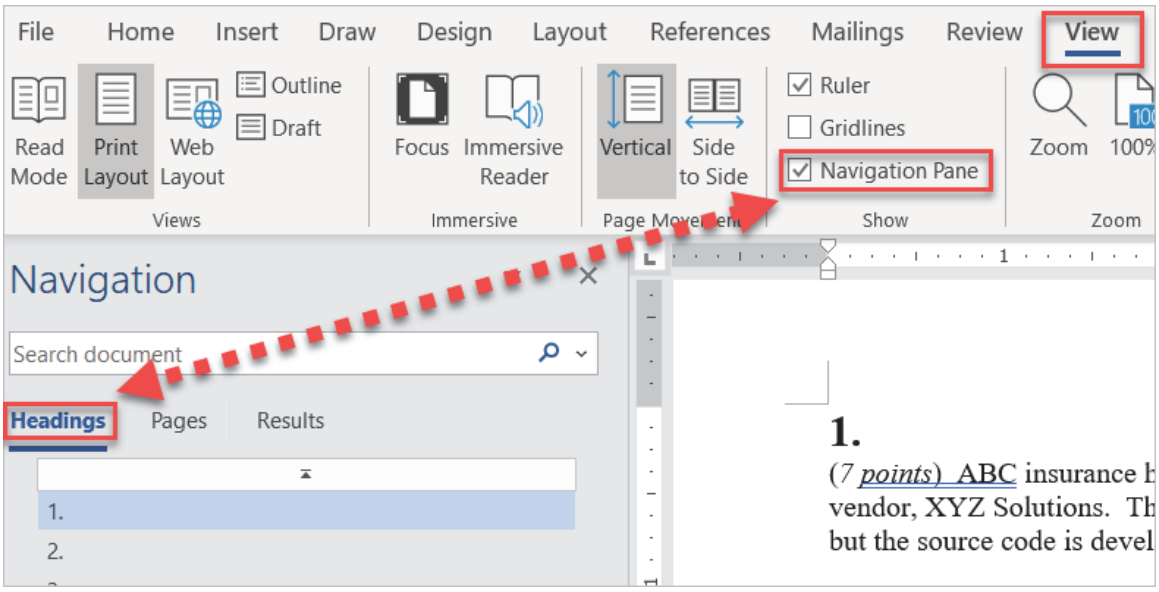
Navigation Instructions

Open the Navigation Pane to jump to questions.

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



1.

(*7 points*) You are a portfolio manager at Company ABC. Some of your friends are interested in becoming portfolio managers at ABC as well, but they aren't sure they are suited for the investments industry. They know you have experience with investment ethics, so they ask for your opinion.

(a) (*0.5 points*) Describe two motivations for unethical behavior in the investment industry.

ANSWER:

Your friend John is hired at ABC to market the firm's funds. To illustrate the importance of corporate governance with respect to unethical behavior, you mention the actions of Nick Leeson and the consequences for Barings Bank.

(b) (*1.5 points*)

(i) Define the four principles of investment ethics.

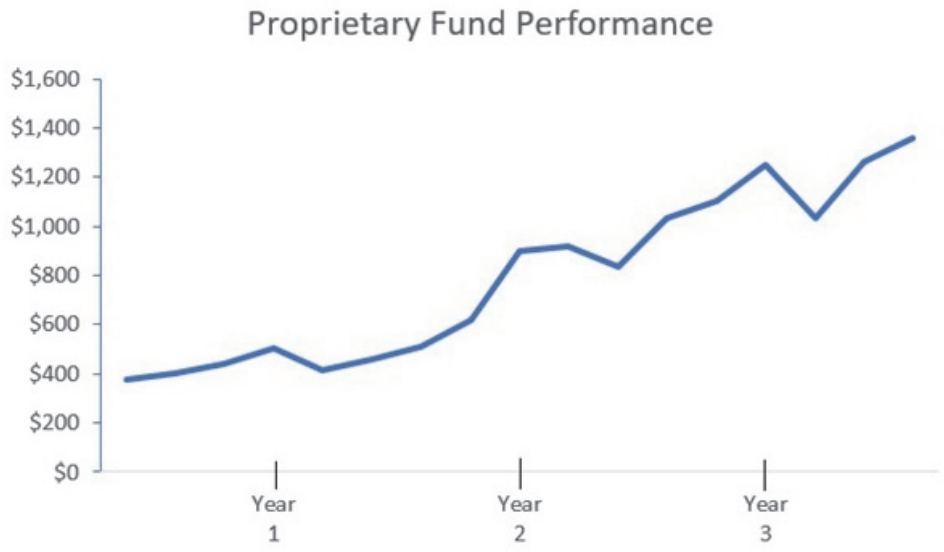
ANSWER:

(ii) Explain which principle was violated by Nick Leeson.

ANSWER:

1. Continued

John walks you through his sales pitch before presenting to potential investors. To illustrate the historical performance of one of your firm's proprietary funds, John provides the chart below and the annual returns of the fund over the last 3 years.



**Investment fees vary with account size*

(c) (*2 points*) Recommend four improvements to more accurately and ethically present historical performance.

ANSWER:

1. Continued

ABC is considering adding a newer asset class that is susceptible to political risks. John asks you how to illustrate performance of this asset class under alternative scenarios.

(d) (*1.5 points*)

(i) Describe three types of scenarios used to present performance in alternative economic environments.

ANSWER:

(ii) Identify the most appropriate type of scenario for this situation. Justify your response.

ANSWER:

You are considering adding company LMNO, a pharmaceutical firm, to a portfolio you manage. You observe that:

- Executive compensation at LMNO includes a base salary plus an annual bonus.
- The bonus is issued as company stock and based solely on LMNO's stock performance over the prior year.

(e) (*1.5 points*)

(i) Identify three issues with LMNO's compensation structure.

ANSWER:

(ii) Recommend an improvement to address each issue.

ANSWER:

2.

(*6 points*) You serve as a risk management consultant for a large casualty insurance company seeking to evaluate its risk culture. The managers identify the following risks facing the insurer.

1. The company has a large block of business in one region of the country.

2. The company invests its assets in bonds, both domestic and international.

3. The insurance market is supervised at the state and federal level.

4. Recent changes allow more individuals in the target insurance market to opt out of coverage.

(a) (*1 point*)

(i) Classify each of the risks using a risk taxonomy.

ANSWER:

(ii) Explain how the risk arises from the situation presented.

ANSWER:

2. Continued

You note the following upon interviewing both upper- and lower-level managers in the company and its subdivisions:

1. The company tracks progress on its risk culture objectives through use of an enterprise-wide survey taken at regular intervals. Metrics have been consistent over the past several years.

2. The company hired a CRO to complete the risk management team, which now consists of the CRO and CEO.

3. The company currently has a well-regarded incentive program for employees who report risk. The CRO recently implemented his own annual recognition of employees who report risk.

4. The company holds an annual event for upper management to review and discuss the risk management processes at the company.

5. Managers indicate significant reporting requirements to the CRO and are not able to provide examples of CRO follow-up.

6. Besides some additional reporting, teams' processes have not changed since the introduction of the risk management team.

7. Product lines must meet risk management benchmarks in order for managers to receive bonuses.

8. Managers routinely express pride for "taking care of a risky situation" without needing to inform the CRO or involve higher management.

(b) (*2 points*) Critique the risk culture within the firm based upon each observation.

ANSWER:

(c) (*1 point*) Recommend four ways to improve risk culture deficiencies identified in part (b).

ANSWER:

2. Continued

The insurer recently conducted an analysis of its pension fund investment strategy and determined the following.

Source of Risk	VaR
Policy-Mix VaR	15.2%
Active Mgt. VaR	12.1%
Asset VaR	20.0%

(d) (*1 point*)

(i) Define Policy-Mix VaR and Active Management VaR.

ANSWER:

(ii) Interpret what the above VaR values imply about the investment strategy.

ANSWER:

The insurer is confident in the current active management strategy and the benchmark choice.

(e) (*1 point*) Recommend a strategy to decrease asset VaR based on the information in the table above.

ANSWER:

3.

(*8 points*) You work for a leading annuity provider in Country XYZ. Cryptocurrency holdings recently became prohibited in Country XYZ and there are no cryptocurrency derivatives markets. Your company's product managers see an immense market opportunity from the surging consumer interest in a specific cryptocurrency, CrypTik (CT). The product managers propose a new annuity with a crediting rate linked to CT's performance, which would make your company the only provider of (synthetic) exposure to CT in Country XYZ.

(a) (*2 points*)

(i) Identify two categories of external risk and one category of internal risk (other than operational risk) applicable to the company's decision to sell a CT-linked annuity.

ANSWER:

(ii) Describe one specific risk within each category in (i).

ANSWER:

Management would like to perform stress testing using scenarios other than historical scenarios.

(b) (*1.5 points*)

(i) Recommend two types of scenarios that could be used to assess the risks in the company's proposed CT-linked annuity.

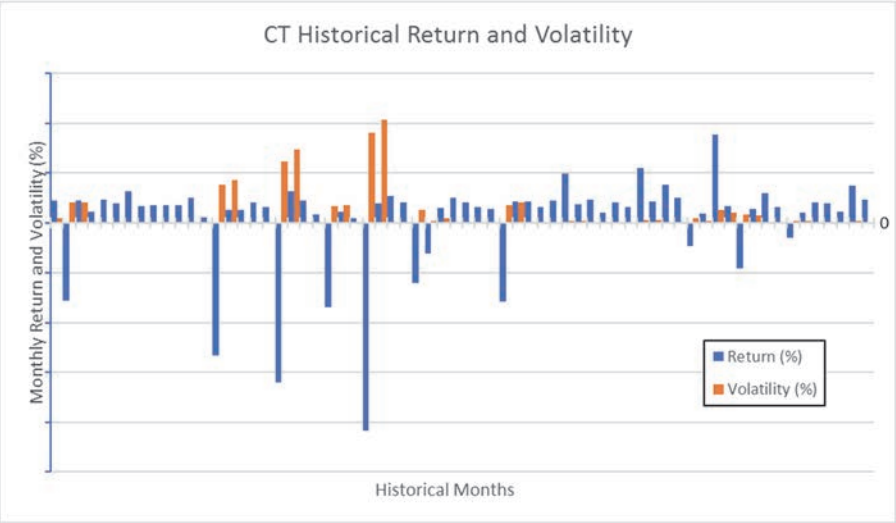
ANSWER:

(ii) Explain how the annuity's risks could be captured by each type of scenario in (i).

ANSWER:

3. Continued

You are provided the following historical data for CT:



The company is capable of creating three types of models:

- Lognormal
- GARCH
- Regime-Switching

(c) (*1 point*) Recommend which model above would best capture the features of CT's price.

ANSWER:

3. Continued

The company will credit X% of CT's total return to annuitants over the period with a guarantee that the crediting rate will not go below 0%. Product management believes X must be at least 80% to be viable in the marketplace. The company has also set a risk limit at a 10% loss on assets under management for the product based on 1-year 99% VaR.

While the models are being developed, you decide to make your own estimate using the following:

- R = annual expected return on investment portfolio
- 0.00 = Annual expected return on CT
- 0.53 = Δ of theoretical at-the-money 1-year call option on CT
- 0.15 = Approximate annual standard deviation of the return on CT
- 0.01 = Approximate annual standard deviation of the return on investment portfolio
- $\Phi(2.326) = 0.99$

(d) (*3 points*)

(i) Describe how the CT-linked annuity is related to a one-year call option on CT.

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

(ii) Explain how the Delta-Normal method approximates losses.

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

(iii) State the mean and variance of the Delta-Normal approximated loss as a function of the investment portfolio return R and annuity participation X%.

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

(iv) Determine the minimum portfolio return required for the product to be viable and within the company's risk limit.

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

3. Continued

Your colleague has proposed an asset mix that he believes will provide sufficent returns to make the CT-linked annuity viable. Testing this asset mix over 1,000 economic scenarios resulted in 15 instances where annual losses exceed 10%.

(e) (*0.5 points*) Assess the results with respect to the company's risk limit.

ANSWER:

4.

(*8 points*) You are an actuarial consultant working at an ERM consulting firm. The firm is organizing a risk identification workshop for each of three different organizations:

Organization A:
The company is a small hedge fund. The company has a hierarchical risk culture, and senior management has an aggressive, dominating leadership style. Due to the size of the firm, there is little internal oversight to review the work of others.

Organization B:
The company is a startup investment firm. The firm's portfolio managers (PMs) base their investment decisions heavily on outputs of models built by analysts, yet they appear to be unclear on the limitations of the models. The head PM also oversees back-office analysis. In order to incentivize growth, the bonus structure for PMs is based on the monthly increase in portfolio size.

Organization C:
The company is a medium-sized insurance firm. The CEO has over 15 years of experience in the life insurance industry, so he is reluctant to adopt new practices and technologies used by competitors. When the concept of Enterprise Risk Management was introduced, the CEO took on the role of CRO as well. Given his limited time, the CEO delegates responsibility for ERM to a lower-level manager. The CEO explains to this manager that he is comfortable with the current risk concentration in a few best-selling products.

Case studies can be useful for risk identification, so you plan to provide some information on relevant case studies for each organization.

(a) (*3 points*)

(i) Identify two case studies most relevant for each organization.

ANSWER:

(ii) Explain how the identified case studies apply to each organization.

ANSWER:

4. Continued

You collect the following information about the participants in each organization's workshop and the goals for the session.

Organization A (started in 2012):
The participants include one trading associate, one junior accountant, one junior research analyst, and the Chief Operating Officer (one of the founding members of the company). The goal of the workshop is to have a holistic and strategic view of positive and negative aspects of the firm's risk exposure, considering internal and external contexts, while utilizing expertise from the COO and documentation of the company's processes.

Organization B (started in 2021):
The participants include six portfolio managers from the investment department, one lawyer, two accountants, and two back-office junior analysts. The goal of the workshop is to start at a very high level by identifying risks that should be considered and then progress to a more detailed categorization of risks that may or may not apply to the company.

Organization C (started in 2009):
The participants include two underwriters, one marketing associate, two claims managers, three valuation actuaries, and two financial reporting analysts. All are experienced employees, and they were involved with responding to several incidents in the past year.

You are given a list of risk identification tools:

- SWOT analysis
- Risk prompt lists
- Risk check lists
- Risk trigger questions
- Risk-focused process analysis
- Risk taxonomy

4. Continued

(b) (*3 points*)

(i) Recommend the two risk identification tools best suited to each organization from the list provided. (Note that each tool from the list must be used exactly once in your recommendations.)

ANSWER:

(ii) Justify your recommendations.

ANSWER:

The risk identification workshop will be one hour long and will be led by a facilitator. Your co-worker recommended the following risk identification technique for each organization:

- Organization A: Delphi technique
- Organization B: Independent group analysis
- Organization C: Brainstorming

(c) (*2 points*)

(i) Critique your co-worker's choice of technique for each organization.

ANSWER:

(ii) Recommend an alternative technique for Organization A, other than those listed prior to part (b).

ANSWER:

5.

(*6 points*) Company XYZ, a farm equipment manufacturer, is considering engaging a regional investment bank, ABC, to prepare them for an Initial Public Offering (IPO). Under the proposed contract, XYZ is to pay ABC a flat fee, part of which will be paid up front and the remainder of which will be paid after the IPO concludes. You are an employee with Company XYZ and are charged with assessing potential governance issues with ABC, including those that arise with respect to the IPO.

(a) (*0.5 points*) Explain the key issue addressed by agency theory.

ANSWER:

(b) (*1 point*) Explain how agency problems apply to the proposed relationship between ABC and XYZ.

ANSWER:

(c) (*1 point*) Describe two actions XYZ could take to mitigate these agency problems.

ANSWER:

5. Continued

After the IPO, you are asked to assess the effectiveness of XYZ's board membership and structure. You note the following:

- Company XYZ was founded by members of the Smith family, who currently occupy all executive positions.
- The CEO, CFO, and Chief Accountant comprise the set of executive directors.
- Each executive director is over 50 years old and has been a board member for at least 30 years.
- All three independent directors are retired agricultural equipment industry executives with engineering expertise, and each has served on this board for at least 20 years.

(d) (*2.5 points*) Assess the composition of the current board.

ANSWER:

You obtain the following new information regarding the XYZ board structure:

- The CEO is Chairperson and is present for all board meetings
- The audit committee is the sole subcommittee and is made up of one independent director and the CFO

(e) (*1 point*) Recommend four improvements to the current board structure based on this new information.

ANSWER:

6.

(*5 points*) To quantify potential losses on its life insurance business, your company is considering the risk measure ρ defined by $\rho(Z) = E[Z] + 3\sqrt{Var(Z)}$, for loss random variable Z.

Let X be a uniformly distributed random variable on the interval $(-8, 2)$ and Y be a uniformly distributed random variable on the interval $(2, 3)$. Note that:

$$Var(Z) = \frac{1}{2}(b-a)^2 \text{ where } Z \sim \text{Uniform}(a, b)$$

(a) (*1 point*) Calculate $\rho(X)$ and $\rho(Y)$.

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

You are given that $\sqrt{Var[X+Y]} \leq \sqrt{Var[X]} + \sqrt{Var[Y]}$ for any two claims variables X and Y whose variances exist.

(b) (*3 points*)

(i) Describe the conditions needed for a risk metric to be coherent.

ANSWER:

(ii) Demonstrate whether $\rho(Z)$ satisfies each of these conditions.

ANSWER:

6. Continued

Your colleague makes the following statements about the risk measure $\rho(Z)$:

1. $\rho(Z)$ is desirable because the risk metric for the sum of two risks will not exceed the sum of the risk metrics of each individual risk.

2. $\rho(Z)$ is desirable for economic capital purposes because it captures the tail risk well.

(c) (*1 point*) Assess the validity of your colleague's statements.

ANSWER:

****END OF EXAMINATION****