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**SOCIETY OF ACTUARIES**  
**QFI Investment Risk Management Exam**

# **Exam QFIIRM**

**Date:** Friday, May 1, 2015  
**Time:** 2:00 p.m. – 4:15 p.m.

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## INSTRUCTIONS TO CANDIDATES

### General Instructions

1. This examination has a total of 40 points.  
  
This exam consists of 5 questions, numbered 1 through 5.  
  
The points for each question are indicated at the beginning of the question.
2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.
3. 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 on the exam booklet.

### Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.
2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.
3. The answer should be confined to the question as set.
4. When you are asked to calculate, show all your work including any applicable formulas. When you are asked to recommend, provide proper justification supporting your recommendation.
5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate Exam QFIIRM.
6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.





**\*\*BEGINNING OF EXAMINATION\*\***

- 1.** (8 points) Portfolio A has a total market value of \$100 Million, and there are two asset classes invested in the portfolios, 75% of stock and 25% of bond. Assuming 240 trading days, here are the 15 worst daily total return of the portfolio within a year:

	Portfolio Return
15 <sup>th</sup>	-2.01%
14 <sup>th</sup>	-2.09%
13 <sup>th</sup>	-2.11%
12 <sup>th</sup>	-2.13%
11 <sup>th</sup>	-2.27%
10 <sup>th</sup>	-2.42%
9 <sup>th</sup>	-2.57%
8 <sup>th</sup>	-2.63%
7 <sup>th</sup>	-2.79%
6 <sup>th</sup>	-2.80%
5 <sup>th</sup>	-2.89%
4 <sup>th</sup>	-2.94%
3 <sup>rd</sup>	-2.98%
2 <sup>nd</sup>	-3.01%
1 <sup>st</sup>	-3.21%

- The expected annual return of the stock is 10% with a standard deviation of 20%.
  - The expected annual return of the bond is 5% with a standard deviation of 7%.
  - The correlation between the two asset classes is 0.15.
- (a) (1.5 points) Determine a 95% annual VaR using Variance-Covariance Method and interpret the result.
- (b) (1.5 points) Determine the one day 95% VaR using Historical Method and interpret the result.

A new chief marketing officer (CMO) commented that Portfolio B has a VaR of \$25M and concludes that Portfolio A is less risky.

- (c) (2 points) Identify and explain the additional information on the VaR measure to validate CMO's assessment.
- (d) (1.5 points) Recommend two approaches to complement VaR in measuring the tail risk.

## 1. Continued

The daily 95% VaR of the stock and bond for Portfolio A are shown below, and are calculated using the Historical Method:

	Portfolio Size	Daily 95% VaR
Stock	\$75M	\$2.75M
Bond	\$25M	\$1.90M

- (e) (1.5 points) Calculate and explain the diversification effect.

2. (7 points) ABC Company sells single premium income annuities (SPIAs) and single premium deferred annuities (SPDAs) in the U.S. ABC's operations are all conducted at its headquarters in Washington, DC. ABC's CEO is a strong advocate of employee collaboration and believes that centralizing operations at its headquarters is conducive to effective collaboration.

The company manages its general account investments in-house and has recently made significant investments into new asset classes such as private placements, high yield and foreign bonds. ABC's CEO argues these asset classes have helped achieve competitive pricing and increased the company's market share. Furthermore to help the company compete in the current low interest rate environment, the company has shifted its investments to longer term bonds.

- (a) (1 point) Identify ABC's risk exposures.
- (b) (1 point) Explain how the company is exposed to the risks in (a).

ABC's CEO is concerned that some emerging risks have not yet been identified.

- (c) (1.5 points) Describe the risk identification techniques to identify the emerging risks.

ABC's CEO wants to ensure that managers are appropriately incented to hedge risks. He is considering the following compensation schemes:

- 100% of Flat Salary
  - 80% of Flat Salary + Performance-Driven Bonus (Bonus calculated as a percentage of company earnings)
  - 100% Flat Salary + immediately vested Stock Options
- (d) (1.5 points) Recommend one of the above compensation packages.

## 2. Continued

ABC currently focuses on just fixed income investments and the actuaries are comfortable with how these are modeled for the annuity products. ABC's CEO would like to evaluate the possibility of supporting the SPIA and SPDA blocks with equities. A junior actuary makes the following statement:

“From an asset liability management perspective the use of equities makes sense for both SPIAs and SPDAs and our pricing would become even more competitive. I would model the equities like fixed income assets by overriding the yield assumption with a long term equity assumption using the average of historical S&P 500 index returns. The term maturity of equities can be set equal to 30 years, which is the longest maturity in our fixed income portfolio.”

- (e) (2 points) Assess the junior actuary's statement based on the following:
- (i) Asset Liability Management
  - (ii) Modeling Assumptions

**3.** (8 points) XYZ Life Insurance Company is a large mutual insurance company with the following Board structure:

- The Board is composed of both internal and external directors.
  - The internal directors are employees of the company.
  - The external directors are not full-time employees, but many of them are executives who serve on the boards of XYZ's competitors.
  - Most of the directors are appointed by the CEO.
- The CEO is the Chairperson of the Board.

(a) (1.5 points) Critique the above Board structure.

XYZ sells with-profits pension policies with minimum guaranteed annuity payout rates, which are locked in at issue for all future contributions. There is no limitation on the amount of future contributions.

The CEO, who is also the Appointed Actuary, approved a strategy of distributing as much free assets as possible to the policyholders. The distribution incorporates no smoothing between generations.

The CEO argued that these strategies will help XYZ be more competitive.

(b) (2 points) Assess the above organizational structure and strategies.

(c) (1 point) Explain how the following economic environment could pose serious risks to XYZ.

- (i) Sustained low interest rates
- (ii) Sharp spike in interest rates

(d) (1 point) Recommend solutions to mitigate XYZ's interest rate risk exposure.

The Futures Trading Desk at XYZ is only authorized to do futures arbitrage to profit from temporary mispricing. In order to improve efficiency all trading and accounting tasks are managed by the head trader of the futures desk who reports to the CEO quarterly. The CEO rarely raises questions unless the results are poor. A substantial part of the earnings of the head trader is composed of bonuses linked to profits of the trading desk.

(e) (1.5 points) Critique the above operation, indicating the factors that could cause catastrophic losses within the Futures Trading Desk.

(f) (1 point) Recommend changes that could help prevent such losses.



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4. (9 points) The Chief Risk Officer of ABC Life is concerned about the risk profile of his company's main business line. He is considering using the following risk metrics to evaluate the company's exposure:

Risk Metrics

- Value at Risk
- Worst Case Expectation
- Conditional Value at Risk
- Omega

The Haslett textbook describes four families of risk metrics which can be used to classify the metrics above:

Families

- Monetary
- Convex
- Coherent
- Spectral

- (a) (1 point) Describe the Convex Risk Measure.
- (b) (1 point) Identify the risk metrics above that can be classified as Convex Risk Measure.

The CRO runs a stochastic risk model with 1,000 simulations which projects ABC's capital over a three year horizon. He wants to measure the potential loss of the firm's capital. Capital at the start of the projection is \$1,450M. The results at the end of the third year are as follows:

- (i) Table below shows the ending capital under the worst 20 scenarios.
- (ii) The average ending capital of the best 990 scenarios is \$2,200M.

**ABC Life - Capital at the end of year 3(\$M)**

Rank	Capital	Rank	Capital	Rank	Capital	Rank	Capital
1	123	6	345	11	390	16	578
2	156	7	348	12	436	17	605
3	198	8	349	13	487	18	634
4	204	9	380	14	499	19	689
5	280	10	390	15	505	20	695

#### 4. Continued

In addition, the CRO performs two additional stochastic runs assuming two other risk distributions. The Conditional Value at Risk at the 99<sup>th</sup> percentile of the capital loss for each of these distributions is \$950M and \$1,200M respectively.

- (c) (3 points) Calculate each of the four risk metrics at the 99<sup>th</sup> percentile for ABC Life. Use the primary stochastic analysis for each metric, and the two additional stochastic analyses only when needed.

The CRO has identified several risks which affect ABC Life's business:

- A new strain of influenza with an uncertain distribution which has a 1 in 1000 chance of becoming a pandemic.
  - A certain lawsuit which will cost the firm \$300M.
  - Hurricane activity which has a high chance of affecting the most profitable business line.
- (d) (4 points) Assess the suitability of each of the four risk metrics to measure the potential risks described above.

**5.** (8 points) You are the Chief Actuary for XYZ, a large public life insurance company. You have been tasked by the board of directors to create an Enterprise Risk Management (ERM) framework for the company.

(a) (1 point) List the common steps of an ERM framework.

You have determined that XYZ is currently using an “offense and defense” model to manage risk as defined by Sweeting.

(b)

(i) (1 point) Describe this model and explain any shortcomings associated with it.

(ii) (1.5 points) Recommend an alternative risk management model to address its shortcomings.

The board of directors is working to create a new Chief Risk Officer (CRO) position for XYZ. The board’s vision for the new position is outlined below:

The CRO will:

- lead the Risk Management Board Committee and will be responsible for policing risk at the firm.
- be a senior-level position reporting to the CEO.
- assess the risk to the business by focusing on historically based scenarios.
- be given veto power over any business decisions to ensure that the company does not exceed a reasonable level of risk.
- be responsible for providing an annual risk report to senior management.
- have incentive compensation linked to the company’s profits over the past two years.

(c) (2 points) Evaluate each bullet point above.

## 5. Continued

The board of directors appoints you as the new CRO for XYZ. As part of your new role, you have been asked to review XYZ's corporate governance practices below:

- The contents of each Board meeting are kept confidential to avoid disseminating potentially sensitive information.
- XYZ's directors receive continuing education training periodically to help them perform their roles.
- Board members' performance is appraised annually against a series of goals that are mutually agreed upon by the chairman with each member. The chairman assesses his own performance to ensure consistency.
- Board members are required to own shares in XYZ. Board members are compensated based on the performance of XYZ's stock over the past year to ensure that their performance will be aligned with the interests of shareholders.

(d) (2.5 points) Evaluate each bullet above.

**\*\*END OF EXAMINATION\*\***

**USE THIS PAGE FOR YOUR SCRATCH WORK**