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

**Exam QFIIRM**

**Date:** Tuesday, October 27, 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.** (7 points) You work for the investment department of a multi-line non-life insurance company. The Chief Risk Officer (CRO) is concerned about the following risks:

- Credit risk
- Operational risk
- Surrender risk

The CRO has identified using credit derivatives such as credit default swaps and total return swaps as one way to manage credit risk.

- (a) (1 point) List four alternative techniques for managing credit risk.
- (b) (1 point) Compare and contrast credit default swaps and total return swaps.

The risk department has discovered the following about the firm's operational and surrender risks:

- (i) operational risks from several departments have a lognormal marginal distribution
- (ii) surrender risks from several product lines have multivariate t-distribution.

The risk department is considering linear correlation and rank correlation as risk dependence measures.

- (c) (2 points) Critique the use of rank correlation and linear correlation to measure dependence in (i) and (ii) respectively.

Your company is considering copulas to price and stress test Collateralized Debt Obligations (CDOs) and Synthetic CDOs.

- (d) (2 points) Compare the Gaussian copula, multivariate t-copula and the Archimedean copula by referencing the following properties:
- Ease of simulation
  - Capable of modeling tail dependence
  - Symmetry
- (e) (1 point) Recommend one copula from above to price and stress test CDOs and Synthetic CDOs.

**2.** (9 points) You are the Chief Risk Officer (CRO) of a life insurance company that manages a diversified portfolio. You know that risk governance contributes to an effective risk management by creating a risk-conscious culture.

- (a) (1 point) Identify two other ways risk governance contributes to an effective risk management program.
- (b) (2 points) Describe four actions you could take to develop an effective risk-conscious culture in the firm.

Your team has suggested stress testing and simulation as one key element of an effective program for measuring and controlling risks.

- (c) (2 points) Identify and explain four other elements for measuring and controlling risks.

Your team suggested the following approaches to stress testing and simulation:

- X. Evaluation of the risk position given a 200 basis point upward and downward shift in the U.S. dollar yield curve.
- Y. Evaluation of the risk position assuming that predefined buckets of U.S. dollar yield curve shifts 100 basis points with all other buckets held constant.
- Z. Evaluation of the risk position assuming multiple shock scenarios over time provided by a Monte Carlo simulation.

- (d) (4 points)
  - (i) Describe the advantages and disadvantages of each approach.
  - (ii) Recommend the most appropriate approach.

3. (9 points) ABC Insurance Company sells variable annuities with a special income rider. When the policyholder activates the rider, the policyholder will receive a fixed income stream until death.

Prior to the activation of the rider, ABC pays XYZ Re monthly reinsurance premiums. Upon activation of the rider, XYZ Re will pay ABC a lump sum, which is equal to the actuarial present value of the fixed income stream.

You have identified the following risks:

Risk Category	ABC	XYZ Re
Data Risk		
Legal Risk		
Model Risk		
Longevity Risk		

- (a) (2 points) Evaluate the significance of each of these risks for ABC and XYZ Re.

XYZ Re has identified policyholder behavior risk as a potential risk.

- (b) (1 point) Explain how higher than expected surrenders impacts XYZ Re.

The company is hiring consultants to build the company's financial reporting process on the reinsurance transaction, which may increase ABC's operational risk.

- (c) (1 point) Propose four ways to mitigate the operational risk associated with the consultants.

ABC is examining the reconciliation process for the assets backing the block of variable annuities. ABC currently reconciles its asset transactions on a weekly basis. One accountant makes the following statement:

*“Given the recent improvements in technology and the growth of our variable annuity business, we should reconcile all of our transactions on a daily basis.”*

- (d) (1 point) Evaluate the accountant's statement.

### 3. Continued

The following are details of ABC's reconciliation process:

1. The investment managers' records are compared to the prime brokers' records.
2. The prime brokers' records consist of an electronic consolidated report from one of the prime brokers.
3. Position reconciliation is done by comparing the quantity held on each set of books.
4. The International Securities Identifying Number (ISIN) is also compared for each position.
5. Local-currency cash balances are compared in all position reconciliations.
6. 100% of trade tickets are matched to counterparty confirmations.
7. Since ABC holds derivative positions, reconciliation is done with statements received from the party holding the collateral.
8. The manager who conducted the review initials a reconciliation checklist containing the accounts reconciled and the date each was completed.
9. Trade support staff, and occasionally traders help with the reconciliation process.

(e) (4 points)

- (i) Identify the areas for improvement.
- (ii) Recommend improvement for three of the areas identified in (i).

4. (8 points) You are the new Chief Risk Officer of a start-up life insurance company ABC with a \$100 million portfolio consisting of two asset groups, high yield corporate bonds and public equities. The current approach for determining Economic Capital is to calculate the 95% annual VaR of the portfolio.

	High Yield Corporate Bonds	Public Equities
Allocation percentage	65%	35%
Expected annual return	8%	11%
Standard deviation of the annual return	20%	40%
Correlation	0.8	

- (a) (1 point) Calculate the 95% annual VaR for the portfolio based on the Variance-Covariance method, assuming the returns of both asset groups follow the normal distribution.

You also obtained the rolling 12-month returns of the portfolio from the last 100 rolling 12-month period. The table below shows the worst 10 returns.

Rank	Rolling 12-Month Return
1	-56.0%
2	-51.0%
3	-47.0%
4	-42.0%
5	-40.0%
6	-30.0%
7	-10.0%
8	-2.0%
9	3.0%
10	5.0%

- (b) (0.5 points) Calculate the 95% annual VaR for the portfolio using the historical method.

The Investment Committee of ABC recently decided to buy interest rate caps on the 10-year Treasury rate at a strike price of 7% to protect against the potential market value loss of the bond portfolio if interest rates spike. To reduce the cost of this protection, the Committee also decided to sell caps on the 10-year Treasury rate at a strike price of 9%.

- (c) (1.5 points) Describe the limitations of the two approaches from (a) and (b) to determine required Economic Capital after the inclusion of the caps.

#### 4. Continued

You are considering alternatives to setting Economic Capital.

- (i) VaR with standard error bounds
  - (ii) Conditional Tail Expectation
  - (iii) Worst case from various stress tests
- (d) (1.5 points) Evaluate each alternative above.

The CEO is going to report the Economic Capital to a potential investor in two days. He wants to use the stress test approach to set the Economic Capital. Your team proposed the following approaches to meet the tight timeline.

- (i) Set the Economic Capital as the sum of A and B where:
    - A is the market value loss of the portfolio at the end of Year 1 assuming a 500bps parallel shift of the current yield curve in that year.
    - B is the market value loss of the portfolio at the end of Year 1 assuming a 50% drop in the S&P 500 index in that year.
  - (ii) Set the Economic Capital as the market value loss at the end of Year 1 assuming a hypothetical scenario in which:
    - the yield curve is shifted up in parallel by X bps and the S&P 500 index simultaneously drops by Y% in that year.
    - the correlation of X and Y will be calibrated based on historical data.
  - (iii) Set the Economic Capital as the historical market value loss at the end of Year 1 based on the change in the yield curve and S&P 500 index from March 1, 2008 to March 1, 2009.
- (e) (2.5 points) Explain the advantages and disadvantages of the three approaches above for setting Economic Capital.
- (f) (1 point) Recommend the most appropriate approach for setting Economic Capital.

**5.** (7 points) XYZ Holdings Company has grown into a multinational company with subsidiaries in financial services, manufacturing and pharmaceuticals. Due to the complexity and diversity of its operations, the Chief Risk Officer (CRO) of XYZ advocates a decentralized risk management system where each business unit oversees its own risk.

(a) (1.5 points) Evaluate the CRO's view regarding the structure of the risk management function.

The CEO of XYZ has made the executive decision to centralize all risk management systems to better manage the risk at an enterprise level.

(b) (1.5 points) Describe the main steps to establish an Enterprise Risk Management (ERM) framework for XYZ according to Sweeting.

Given the multifaceted lines of business, an ERM Committee is to be created within the Board of Directors. The following recommendations will apply to the ERM Committee:

1. The CRO should be the chair of the ERM Committee and appoint the members to the committee.
2. The auditors from each subsidiary should report directly to the chair of the ERM Committee.
3. Risk reports to the committee are generated on an ad-hoc basis as material ERM issues arise.
4. Only members who do not own shares of XYZ's competitors are eligible for appointment to this committee.
5. The ERM Committee has the power to override decisions made in other board committees such as the Remuneration, Audit and Appointments Committee.

(c) (2 points) Evaluate the recommendations above.

## 5. Continued

After the recommendations were adopted, the newly created ERM Committee discovered the following facts:

1. A quarter of XYZ's Board members own XYZ shares.
  2. A fifth of XYZ's Board member indirectly own shares of subsidiaries of XYZ's competitor.
  3. The external auditing firm that reviews XYZ's financial statements has also been providing valuable consulting services to XYZ's financial services subsidiary.
  4. The manufacturing subsidiary has been improving its profitability partly by cutting back on safety standards.
  5. The pharmaceuticals subsidiary has undergone a reorganization, which involved laying off personnel and consolidating responsibilities to a few top performers.
- (d) (2 points) Identify problems in the above and recommend improvements.

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

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