# SOCIETY OF ACTUARIES
# QFI Investment Risk Management Exam

# Exam QFIIRM

**Date:** Friday, April 28, 2017
**Time:** 2:00 p.m. – 4:15 p.m.

## 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.

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****BEGINNING OF EXAMINATION****

**1.** (*5 points*) You are a newly hired actuary in an investment management company. Your job is to work with both potential investors outside the company as well as financial analysts within the company. You have been asked to analyze the credit risk for a securitization structure with three tranches: equity, mezzanine, and senior.

(a) (*1 point*) Explain why the senior tranche can achieve a higher rating than the underlying pool of assets.

A co-worker has recommended using Gaussian copulas in helping to analyze the credit risk of the securitization structure.

(b) (*1 point*) List three advantages and three disadvantages of using Gaussian copulas in modeling credit risk.

Another co-worker has pointed out that Gumbel copulas may be superior to Gaussian copulas in certain scenarios.

(c) (*1 point*) Explain whether Gumbel copulas can address the disadvantages of Gaussian copulas.

Your CEO is considering expanding the company's activities to developing countries where higher yields can be earned on loans and mortgages. The borrowers come from all over the world, but they all work in the manufacturing industries. You are tasked to develop a plan to securitize the loans and mortgages, as well as quickly and competitively price them to quantify the credit risk.

(d) (2 *points*) Recommend whether Gaussian copula with conservatism in its parameters or Gumbel copula is appropriate for this task.

**2.** (*8 points*) Becky is working as the pension fund manager for Company ABC. She has been tasked with performing a strategic asset allocation analysis. The pension plan has the following objectives:

- Risk Objective: Maximize return for every unit of risk
- Return Objective: 5.5% annually

She has constructed four sample portfolios with varying asset allocations as shown in the table below:

| **Portfolio** | **A** | **B** | **C** | **D** |
|---|---|---|---|---|
| **Expected Annual Return** | 3.0% | 4.4% | 6.0% | 6.6% |
| **Annual Standard Deviation** | 4.0% | 6.0% | 11.0% | 12.0% |
| **Sharpe Ratio** | 0.5 | 0.5667 | | |

(a) (*1 point*) Calculate the Sharpe ratio for portfolios C and D.

(b) (*0.5 points*) Recommend a portfolio based on your answer to part (a) that achieves the risk and return objectives of the plan.

Becky would like to recommend the use of Sharpe ratio in evaluating the investment decisions for the pension plan.

(c) (*1.5 points*)

(i) Identify two shortcomings to using Sharpe ratio in performing the strategic asset allocation analysis for the pension plan.

(ii) Recommend improvements to the Sharpe ratio approach.

The plan assets consist of global and domestic equities, as well as domestic bonds. ABC is concerned about fulfilling the plan's obligations and has made a substantial contribution to the pension fund. The plan now has a funding ratio (asset/liabilities) of 1.2. Becky notes that the domestic bond allocation after the contribution is just sufficient to cover the plan liabilities, which are highly correlated with a domestic bond index. Becky is considering the following investment strategies:

- Increase equity allocation and decrease bond allocation.
- Within the equity allocation, increase the allocation to global equities and decrease the allocation to domestic equities.
- Replace a portion of the domestic bonds with global bonds.

(d) (*2 points*) Evaluate each investment strategy and recommend which one(s) should be implemented.

## 2. Continued

An economic downturn caused a loss on the fund, which created a large deficit. Despite the recent financial events, interest rates are expected to increase for the next 20 years. The duration of the plan assets is currently tightly matching the duration of its liabilities, but due to legislative uncertainty the liabilities are expected to exhibit greater noise. Becky is proposing the following changes to improve the funding ratio of the plan:

- Relaxing the duration constraints.
- Increasing allocations to equity.
- Offering lump sum payments as a benefit option under the plan.

(e) (*2 points*) Assess the appropriateness of these changes for improving the plan's funding ratio.

After the economic downturn, the funding ratio is at 0.8. Becky notes that the plan pays out 6.5% of its liabilities each year and would like to maintain the same funding ratio as the objective.

(f) (*1 points*) Calculate the annual required return on assets in excess of the return on liabilities that achieves Becky's objective.

**3.** (*12 points*) Company XYZ is a new US public company that manufactures widgets and sells them to individual consumers. XYZ is searching for a property to locate its factory and is considering a small town where the local government has offered to waive property taxes over the first 5 years. The town would supply most of the factory's labor force.

(a) (*1.5 points*)

(i) Identify three internal and three external stakeholders.

(ii) Describe their interests in XYZ.

You are hired by ABC investment firm as a consultant to evaluate the performance of XYZ. You have learned that XYZ has recently set up an operational due diligence unit at the request of senior management.

(b) (*0.5 points*) List five of the ten steps for implementing an operational due diligence program

You receive the following information about the new operational due diligence unit:

- The CFO of XYZ had the following message for members of the new operational due diligence unit :
  "The purpose of this new unit is to protect shareholder value by evaluating operational risk in potential investments. I have the utmost confidence in you guys. Good luck with your mission! Let's touch base in a year."
- Only the business development team was informed of the new unit's creation. The unit work well with the business development team, which educates the unit on the business risks when evaluating potential investments.
- When the business development team completes their review, they communicate their findings to the operational due diligence unit, which thoroughly documents them.
- The operation due diligence unit's review is based solely on interviews with business leaders and reviewing HR data for red flags such as employee turnover.

(c) (*1.5 points*) Evaluate XYZ's operational due diligence unit.

(d) (*1.5 points*) Recommend four improvements.

## 3. Continued

Three years into the operations of company XYZ, company ABC is finalizing its decision on investing in XYZ. They meet with XYZ's CFO to better understand XYZ's governance framework.

- XYZ's CFO requests financial statements from the business units on an ad-hoc basis. This allows her to gauge how well the company is doing and assess the value of her stock option grants.
- The CFO evaluates the company's performance on an absolute return basis.
- In order to minimize expenses, the financial statements are only audited internally.
- The CFO says that the financial statements are reliable because the company has aligned the interests of the business unit managers with senior management by linking their compensation to the reported earnings.

(e) (*1.5 points*) Assess XYZ's governance framework.

(f) (*1.5 points*) Recommend improvements for two of the deficiencies identified in (e).

As part of your assessment, you use a balanced scorecard model to evaluate XYZ's organizational performance. You collect the following data to help you. All revenues come from either widgets or new products.

| | **Year 1** | **Year 2** | **Year 3** |
|---|---|---|---|
| Widgets produced (# of units) | 8,000 | 9,000 | 8,000 |
| Widgets sold (# of units) | 7,700 | 8,800 | 7,500 |
| Widgets delivered to customers on time (# of units) | 7,650 | 8,700 | 7,450 |
| Defective widgets returned by customers (# of units) | 200 | 330 | 400 |
| Employee hours spent making widgets (hours) | 80 | 95 | 95 |
| Revenue from widgets ($M) | 7,500 | 8,470 | 7,100 |
| Total revenue from all products ($M) | 8,000 | 9,500 | 8,000 |

***Question 3 is continued on the next page.***

**3.** **Continued**

(g) (*2.5 points*) Efficiency and quality are two building blocks of competitive advantage used in a balanced scorecard model.

(i) List the other two building blocks.

(ii) Identify a metric and define a formula (based on the data above) for each of the four building blocks.

(h) (*1.5 points*)

(i) Evaluate XYZ in terms of efficiency and quality over years 1 to 3.

(ii) Evaluate XYZ in terms of efficiency and quality as compared to the industry. Assume that the industry average for each metric is half of XYZ's metric.

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**4.** (*8 points*) Big Life Insurance acquired Niche Life Insurance recently. Niche Life does not currently run an ERM program as it was considered too expensive to adopt. The Board of Directors of Big Life has tasked you with developing an ERM program for Niche Life.

(a) (*1 point*) Describe four of eight steps for implementing an ERM program.

The Board formed a working group to integrate Niche Life's risk management into Big Life's ERM program. The following is an excerpt from a report produced by this working group:

*The asset portfolio of Niche life consists of 90% bonds and 10% cash. The bond portfolio consists of 50% private bonds and 50% high yield bonds. The duration of the asset portfolio is 8.5 years while that of the liabilities is 4.5 years. Niche Life primarily sells fixed rate deferred annuity products. Historical portfolio return has been excellent, and Niche Life has been able to offer about 100bps higher crediting rate than its competitors. This combined with the current low interest rate environment has boosted sales tremendously, generating sales growth of 40% a year for the past several years while the industry average was only 2%.*

(b) (*1 point*) Identify four key risks implied by the excerpt and explain how Niche Life is exposed to these risks.

(c) (*2 points*) Propose actions to mitigate each risk identified in Part (b).

The Board was concerned with unidentified and potential emerging risks in the near future and assigned you to assess the current coverage of risks. You are considering the following methods to do the task.

(i) Independent group analysis

(ii) Interviews

(iii) Working groups

**4.** **Continued**

(d) (*2 points*) Critique each method and recommend the most effective method for the task.

You are now focusing on the operational impacts of the acquisition. You note the following operational changes:

- To reduce duplication of effort, all of Niche Life's valuation and financial reporting staff will be terminated in two months after the acquisition and their operations will be transferred to Big Life's personnel.
- All remaining roles at Niche Life will be consolidated where every three managers will be replaced by the top performing one.
- All remaining employees will be required to comply with Big Life's two-week mandatory vacation without access to the office or systems.

(e) (*2 points*) Evaluate each operational change on the basis of potential operational risks.

**5.** (*7 points*) You are a liquidity risk consultant. XYZ insurance company is one of your clients. XYZ has a business line of Single Premium Deferred Annuities (SPDAs). The policies in the SPDA line have a book value surrender feature with no market value adjustment. Your client is concerned with funding cash outflows from a spike up in interest rates and a rating downgrade.

The company expects the business line to fund its own liquidity requirement.

The company is looking to calculate a six month cash flow cushion factor under the following economic scenarios.

- Scenario 1 – No change in interest rates; XYZ’s credit rating remains unchanged.
- Scenario 2 – A positive 300 basis point interest rate parallel shift; no change in XYZ’s crediting rating.
- Scenario 3 – A positive 300 basis point interest rate parallel shift; XYZ’s credit rating downgraded by two notches.

All liquid assets in the SPDA line are unencumbered. For this exercise, the company categorizes its SPDA assets into four (4) asset classes. Selected information on the asset classes is as follows:

| Asset Class | Statutory Book Value ($billion) | Current Market Value ($billion) | Market Value after +300 bps parallel shift of the interest rate ($billion) | Haircut for Marketability |
|---|---|---|---|---|
| Government Bonds | 0.60 | 0.65 | 0.55 | 5% |
| Investment Grade Public Corporates | 1.80 | 2.00 | 1.66 | 10% |
| Highly Liquid Mortgage-Backed Securities | 2.00 | 1.75 | 1.50 | 10% |
| Illiquid Assets | 5.60 | n/a | n/a | n/a |

**5.** **Continued**

You are given the following information regarding expected SPDA line cashflows over the next six months:

- The expected cash inflow from the illiquid asset class is \$0.5 billion.
- With no credit rating downgrade, SPDA sales are expected to be \$1.0 billion.
- With a two notch credit rating downgrade, SPDA sales are expected to drop to \$0.1 billion.
- The scenario 1 expected cash outflow due to benefit payout is \$1.0 billion.
- The incremental additional outflow under scenario 2 is +\$2.0 billion vs scenario 1.
- The incremental additional outflow under scenario 3 is +\$3.5 billion vs scenario 1.

The company defines cash flow cushion factor over a period as: $\dfrac{\text{Forecast cash inflow over period}}{\text{Forecast cash outflow over period}}$

(a) (*3 points*) Calculate the cash flow cushion factor under all three scenarios.

(b) (*2 points*) Recommend actions to address the implication of Scenario 2.

(c) (*2 points*) Recommend additional actions to address the implication of Scenario 3 relative to part (b).

****END OF EXAMINATION****

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