SOCIETY OF ACTUARIES

QFI Investment Risk Management Exam

Exam QFIIRM

Date: Friday, May 3, 2019
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 6 questions, numbered 1 through 6.

   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.

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Exam QFIIRM Front Cover

****BEGINNING OF EXAMINATION****

1. (*6 points*) Jane was approached by an investment manager to invest in their equity funds. You know the following:

- The funds were established 10 years ago
- The funds invest in small-cap and large-cap stocks
- The stocks are traded on the New York Stock Exchange

(a) (*1.5 points*)

(i) Identify the following in the above scenario:

- an issuer
- an intermediary
- an investor

(ii) Describe the interests of the stakeholders identified in (i).

Jane subsequently learned the following:

- The manager discloses the funds' average return over the last three years
- No risk-return measure was provided
- Part of the trading commission covers operating expenses

(b) (*2 points*)

(i) List the four Fundamental Principles of Investment Ethics.

(ii) Explain how the manager violated all of these principles.

The manager shared more details on the funds' performance with Jane:

- An illustration of how a $100 investment in one of the funds would have performed over the most recent three-year period
- A comparison of equally weighted composite return of the funds against a corporate bond index as a benchmark

(c) (*1.5 points*) Recommend three improvements to ensure ethical presentation of the funds' performance. Justify your response.

1. Continued

To help Jane with her decision, the manager provided more details on past performance:

Year	0	1	2
End-of-period assets value ($M)			
Client A	10	11	12
Client B	20	21	22
Client C	100	120	140
Asset-weighted composite returns (%)			
Return X		17	14
Return Y		19	16

- All clients made a single deposit at time 0
- Client B terminated his account during year 3
- Return X: Asset-weighted composite return including terminated accounts
- Return Y: Asset-weighted composite return excluding terminated accounts

(d) (*1 point*) Explain whether Return X or Return Y is the more appropriate measure to demonstrate the performance. Justify your response.

2. (*8 points*) Your company, XYZ, is a publicly traded insurance company. XYZ currently calculates a historical 99% one-month value-at-risk (VaR) as its sole risk metric.

(a) (*1 point*) Explain two ways that sensitivity testing supplements historical VaR.

XYZ sells variable annuities (VA) with living benefit riders that require an additional fee for a guaranteed level of lifetime income. Policyholders can invest in fixed income, domestic equity, and foreign equity funds. One of your coworkers has proposed the following list of univariate sensitivity tests for XYZ's VA block:

1. Shock to foreign exchange rates where foreign currencies depreciate relative to the domestic currency
2. Steepening of the yield curve where shorter maturity rates decrease, and longer maturity rates increase
3. Increase in domestic unemployment
4. Decline in major equity indices
5. Decline in implied equity volatilities

(b) (*2 points*) Recommend two sensitivity tests that will have the most adverse impact on XYZ from the list above. Justify your response.

In addition to the tests above, the actuarial department is concerned with the exposure to the following risks:

1. Financial crisis similar to the 2008 crisis
2. Company-specific liquidity crisis from a credit downgrade to XYZ

(c) (*1 point*) Explain how to structure multivariate scenario tests for each risk.

Management has decided to focus on tail risk and asks you to develop a strategy that would achieve the following objectives:

1. Reduces the firm's exposure to extreme market movements
2. Reacts to market movements in a timely manner
3. Makes efficient use of shareholder capital

2. Continued

You propose that the firm set aside economic capital equivalent to 150% of the losses sustained in a scenario like the 2008 financial crisis.

(d) (*1.5 points*)

(i) Explain which objective(s) are not met.

(ii) Recommend a strategy meeting all three objectives. Justify your response.

Management wants to see higher returns on capital and would like to invest in mortgage backed securities (MBS) to support these guarantees. Your manager suggests using the Gumbel copula to help quantify the default probability of a portfolio of MBS.

$$H(x,y) = \exp\left\{-\left(\left(-\ln\left(F(x)\right)\right)^{\theta} + \left(-\ln\left(G(y)\right)\right)^{\theta}\right)^{\frac{1}{\theta}}\right\}$$

- $H(x,y)$ = Gumbel copula, joint distribution function of time until default for both MBS X and MBS Y
- $F(x)$ = individual distribution function of time until default of MBS X
- $G(y)$ = individual distribution function of time until default of MBS Y
- θ = dependency measure

You are uncertain what value of θ should be used in your model.

(e) (*1 point*) Describe how increasing θ will affect model results.

(f) (*1.5 points*) Assess the appropriateness of using the Gumbel copula for quantifying default risk of the MBS portfolio.

3. (*7 points*) You are a liquidity analyst at a rating agency, and your manager has asked you to assess the immediate and long-term liquidity risks of two banks, Bank A and Bank B.

Balance Sheet – 12/31/2018		
	Bank A	**Bank B**
Assets		
Sticky Assets (Loans)	45	80
Volatile Assets (Trading Assets)	50	10
Volatile Assets (Security Borrowings)	30	10
Liabilities		
Sticky Liabilities (Non-bank deposits)	35	70
Sticky Liabilities (Equity)	10	15
Volatile Liabilities (Trading Liabilities)	80	15

(a) (*0.5 points*) Explain the difference between sticky assets and volatile assets.

(b) (*1.5 points*)

(i) Calculate the liquidity ratios for each bank using balance sheet liquidity analysis.

(ii) Compare and contrast their liquidity positions based on the ratios from (i).

Your manager wants you to determine whether Bank A will be able to withstand any immediate and long-term liquidity risk exposure. You learn that Bank A has an unused credit line of 100 from diversified sources.

(c) (*1 point*) Identify the two reasons why balance sheet liquidity analysis could not be used for this assignment. Justify your response.

You decide to expand your liquidity analysis of Bank A.

(d) (*1 point*) Describe two appropriate qualitative assessments.

3. Continued

You decide to analyze Bank A's cash flow projections based on the following:

- Scenario 1: Baseline
- Scenario 2: Interest rates decrease 100 bps in all years from baseline

Bank A – Cash Flow Projections				**Funding Ratios**	
Scenario 1	**End of Year 1**	**End of Year 6**	**End of Year 10**	**Above 1 Year**	**Above 6 Years**
Loans	100	90	80	1.11	1.13
Retail Deposits	51	55	57		
Money Market Deposits & Certificate of Deposits	35	39	41		
Scenario 2	**End of Year 1**	**End of Year 6**	**End of Year 10**	**Above 1 Year**	**Above 6 Years**
Loans	120	162	138	X	Y
Retail Deposits	49	53	55		
Money Market Deposits & Certificate of Deposits	25	30	33		

(e) (*3 points*)

(i) Explain why the cash flows changed under scenario 2 in each asset.

(ii) Calculate Bank A's funding ratios above 1 year and 6 years in scenario 2.

(iii) Evaluate Bank A's long-term liquidity risk exposure based on the funding ratios from (ii).

4. (*8 points*) You have been hired by a small public university to perform a risk analysis as the first step toward implementing an enterprise risk management (ERM) framework at the university.

(a) (*0.5 points*) List the steps of an effective ERM framework.

(b) (*1 point*) Propose an implementation plan for establishing an effective ERM framework.

You have obtained the following information about the university:

1. University leaders closely watch developments in higher education
    - Increasing competition for students with other universities
    - Earning university credit in high school is more common
    - Establishing an advocacy office to assist international students with overcoming immigration issues

2. The university is trying to drive enrollment by doing the following:
    - Improving access to courseware via online degrees
    - Updating its classrooms with the latest technology
    - Building and renovating recreational facilities and dormitories

3. The university is focused on improving fiscal responsibility.
    - Government funding of the university is dependent upon the favorable employment outcomes of its graduates
    - Postponing improvements to roadway and parking infrastructure have saved the university money
    - Suspending investments in improving admission and registration processes

You conduct a strategic risk analysis at the small public university that focuses on the following categories:

1. Environmental risks
2. Industry risks
3. Company risks

(c) (*3 points*) Identify and describe two risks per category based on the case above.

4. Continued

(d) (*1 point*)

(i) List the steps in a scenario planning approach.

(ii) Propose a scenario to be evaluated for each of the two environmental risks identified in (c) above.

Your assistant drafted an influence matrix based on the following risks:

Risk 1. Affordability: tuition costs for students
Risk 2. Employee Satisfaction: faculty and staff satisfaction
Risk 3. Relevant Degrees: programs in popular and in-demand areas
Risk 4. Enrollment/Demand: number of students enrolled

Influence Matrix	Risk 1	Risk 2	Risk 3	Risk 4
Risk 1				
Risk 2				
Risk 3				
Risk 4				
Total				

(e) (*2.5 points*)

(i) Propose the values for the influence matrix. Justify the values chosen.

(ii) Identify the most important risk based on the results from the matrix. Justify your response.

5. (*5 points*) HAQ is a multinational life insurer with 3 core lines of business: insurance, annuities, and investments.

Approximately 95% of HAQ's general account is allocated to below investment grade private corporate bonds.

(a) (*0.5 points*) Describe risk neutral pricing.

(b) (*1 point*) Explain the rationale for using risk neutral pricing on interest-sensitive securities.

(c) (*1.5 points*) Recommend the most appropriate interest rate model for pricing securities in HAQ's portfolio. Justify your response.

Your colleague suggested the following interest rate model to be used by HAQ for stress testing:

$$du = \kappa(t)\left(\theta(t) - \lambda(u,t) - u\right)dt + \sigma(t)\,dz$$

where

- u is the natural logarithm of the short rate
- $\kappa(t)$ is the rate of mean reversion
- $\lambda(u,t)$ is the term premium
- $\sigma(t)$ is the instantaneous volatility of the short rate process
- $\theta(t)$ is the mean level to which u is reverting

(d) (*2 points*)

(i) Identify the above model.

(ii) Explain two limitations of using this type of model for stress testing.

(iii) Recommend a more appropriate type of model for stress testing. Justify your response.

6. (*6 points*) You are an external consultant to a public company selling widgets. You have been tasked to complete a stakeholder impact analysis with special consideration for the following stakeholders and actions:

Stakeholders

1. Employees
2. Consumers
3. Stockholders

Actions

1. Automate manual processes
2. Invest in customer service technology

(a) (*2 points*) Describe the impacts of the two actions on the three stakeholders:

(i) Over a short-term period.

(ii) Over a long-term period.

You are reviewing the board composition of the company and notice the following:

1. Seven of the eight members were previously managers at the company
2. Three members have been on the board for over ten years
3. All of the members are retired from full-time employment

(b) (*1.5 points*) Critique the positive and negative characteristics of this board.

The board is re-evaluating the compensation for senior management. They are considering awarding stock options with a specified date of January 1st, 2020, but they know that there will be a favorable earnings announcement on January 8th, 2020.

(c) (*1 point*) Recommend whether the board should approve the stock options. Justify your response.

The board has the following objectives for the new compensation package:

1. Encourage management to stay with the company for a long tenure
2. Increase earnings as compared to competitors
3. Increase the stock price over the next 5 years

(d) (*1.5 points*) Recommend the most appropriate type of compensation for each of these objectives. Justify your response.

****END OF EXAMINATION****

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