
SOCIETY OF ACTUARIES
QFI Investment Risk Management Exam

Exam QFIIRM

Date: Tuesday, October 31, 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.

Tournez le cahier d'examen pour la version française.

****BEGINNING OF EXAMINATION****

- 1.** (7 points) Company ABC is a large public life insurance company in Country XYZ. The Company has long avoided purchasing hedges as the former Chief Risk Officer (CRO) regarded them as being excessively costly. The new CRO would like to re-evaluate the economics of buying hedges.

The Investment Management team put together the following analysis:

Without hedging, the pre-tax earnings are as follow:

Probability	Pre-Tax Earnings (\$M)
50%	200
30%	300
20%	75

With hedging, there is 100% probability that the pre-tax earnings will be \$200M.

Country XYZ follows a progressive tax regime in which the first \$150M of earnings is tax-free and the remainder is taxed at a 35% corporate tax rate.

- (a) (2 points) Evaluate the appropriateness of buying hedges.

The CRO just shared with you a report that the direct costs of financial distress have increased.

- (b) (1 point) Explain how higher costs of financial distress would affect the economics of buying hedges.

The Chief Executive Officer (CEO) is concerned about the impact of hedges on various stakeholders and requested a stakeholder impact analysis.

- (c) (0.5 points) List the key steps of a stakeholder impact analysis.
- (d) (1.5 points) Assess whether the company should hedge from the viewpoint of:
- (i) Bondholders
 - (ii) Shareholders

1. Continued

The CEO has plans to revamp the compensation structure for his management team. He has set the following goals for the new compensation package:

- Reward strong managerial performance.
 - Provide a minimum level of stable income.
 - Create strong alignment of interest between managers and stockholders.
 - Ensure appropriate incentives to hedge excessive risks.
- (e) (2 points) Recommend a compensation structure for ABC's management that addresses the CEO's goals. Justify your answer.

2. (8 points) You work in the investment management area. You are having a debate with John, an analyst, on the credit risk exposure of the new fixed income portfolio with significant allocation to mortgages from one geographical location.

John questioned the need to perform stress testing in addition to daily VaR analysis.

- (a) (1 point) Describe two areas where stress testing can supplement VaR.

He zoned in on the Collateralized Debt Obligations in the portfolio and said that “linear correlation helps capture the tail risks”.

- (b) (1.5 points) List four problems of using linear correlation as a dependency measure.

He then countered by saying, “you can use copula to supplement linear correlation.”

- (c) (0.5 points) Identify a family of copula that does not exhibit tail dependency.

Your manager needs John’s and your immediate attention to review the results from the capital allocation model. He reviewed your stress testing results and they have revealed unacceptably large losses when interest rates rise and default rates spike. It would be uneconomical to set aside enough capital to absorb the losses.

- (d) (1 point) Identify three actions to mitigate the losses in this scenario.

Your next assignment is to investigate the dependency structure between the mortgages and the corporate bonds in the portfolio. You have used a copula to generate joint samples of uniform random variables for your simulation. You are auditing the loss model and the details are given below:

- Loss distribution of mortgages (X) follows exponential distribution with mean 6.
- Loss distribution of corporate bonds (Y) follows exponential distribution with mean 9.
- Cumulative Distribution Function for the exponential distribution:

$$F(x) = 1 - e^{-\lambda x} \text{ with mean } \lambda^{-1}, x \geq 0$$

- Sample set of uniform random variables = (0.892, 0.438).
- (e) (1.5 point) Calculate the loss of mortgages (x) and corporate bonds (y) respectively based on the simulated sample set of uniform random variables.

2. Continued

- (f) (2.5 points) Calculate the joint probability that the loss of mortgages and corporate bonds are less than the result calculated in part (e). Assume the copula distribution follows Gumbel with $\theta = 2$ as shown below (*Hint: Calculate $P(X < x, Y < y)$*).

$$C_{\theta}^{gum}(u, v) = \exp\left\{-\left((-\ln u)^{\theta} + (-\ln v)^{\theta}\right)^{\frac{1}{\theta}}\right\}, \quad 1 \leq \theta < \infty, \quad \forall u, v \in [0, 1]$$

3. (7 points) ABC is a public company which manages assets for a number of large pension funds. They cover a wide range of asset classes including U.S. and international equities.

The Chief Risk Officer (CRO) has decided to set risk allocation guidelines to maximize expected excess return at the overall fund level subject to a constraint on the maximum allowable tracking error. The following Information Ratios (IR) have been supplied for each asset class.

Asset Class	Standard IR	Correlation-Adjusted IR
U.S. Equities	0.40	0.47
International Equities	0.70	0.39

- (a) (1 point) Calculate the optimal risk allocation for each asset class with and without correlation given that the overall risk budget is 200bps.

The CRO of ABC makes the following statement:

“If excess returns are positively correlated but the risk allocation has assumed uncorrelated excess returns, the fund will overspend its overall risk budget. An investment decision maker who is worried about overspending the risk budget could simply not use the full risk budget in the risk allocation process to avoid overspending as a result of positive correlations.”

- (b) (1 point) Critique the CRO’s statement.

The CRO is looking to improve the risk culture and make enhancements to the risk management process at ABC. He implemented the following changes:

- Appropriately segregate the functions between front and back office operations.
- Require peer review with internal and external auditors.
- Conduct cultural training and round table discussions that have less emphasis on hierarchy.
- Establish clear reporting lines for each individual.

- (c) (3 points) For each of the above changes:

- (i) Identify a real life, high-profile, risk management failure where the change could have prevented the failure.
- (ii) Explain how the change could have prevented the failure.

- (d) (0.5 points) Recommend other ways the CRO could encourage a strong risk culture.

3. Continued

ABC acquired a smaller asset management firm, XYZ, which specializes in managing assets for wealthy individuals particularly interested in foreign equity markets. XYZ operates in 30 different countries but does not have an ERM process. The CRO is tasked with integrating XYZ into ABC's ERM process. To be prudent, the CRO reviewed three of the steps of ABC's ERM process:

- Identify each risk factor to which the company is exposed.
- Quantify each exposure's size in monetary terms.
- Set up a process to report on these risks periodically to senior management, who will set up a committee of division heads and executives to determine capital allocations, risk limits and risk management policies.

The CRO sends the following email to the Chief Executive Officer (CEO) on his approach:

"We have identified that ABC is exposed to market risk and credit risk. Prior to the acquisition, the market and credit risk limits were \$20 billion and \$3 billion respectively. XYZ only had credit risk of \$15 billion prior to the acquisition. We have updated our risk limits to \$20 billion and \$18 billion for market risk and credit risk respectively. The CRO will send a report to senior management once a year on our risk exposures at XYZ."

- (e) (1.5 points) Critique the approach described in the email with respect to the ERM steps stated above.

4. (11 points) Larry has recently been hired as Chief Risk Officer (CRO) at ABC Bank, a large commercial bank. ABC has been the nation's leading commercial mortgage lender for many years and is currently considering acquiring XYZ, a large retail bank. XYZ specializes in selling Certificates of Deposit (CDs) with high minimum guarantee rates and has a small residential mortgage business which ABC would like to expand. The Chief Executive Officer (CEO) has asked Larry to evaluate the impact of the XYZ acquisition from a liquidity risk perspective.

(a) (1 point) Explain how liquidity risk differs from market risk in regards to risk measurement.

The Chief Financial Officer (CFO) presents Larry with current balance sheets for ABC and XYZ and asks him to evaluate the liquidity risk on ABC's balance sheet if the firm acquired XYZ. Larry uses balance sheet liquidity analysis when assessing liquidity risk.

Balance Sheet (\$M): ABC, XYZ and ABC+XYZ (post-acquisition)

Assets (\$M)	ABC	XYZ	ABC + XYZ
Mortgages	180	5	185
Derivatives	60	20	80
Corporate Bonds	25	25	50
Long-Term Government Bonds	20	45	65
Security Borrowing	15	10	25
Commercial Real Estate	25	5	30
Total	325	110	435

Liabilities (\$M)	ABC	XYZ	ABC + XYZ
CDs	0	40	40
Mortgage Backed Securities (Short position)	65	5	70
Equity	55	5	60
Security Lending	30	5	35
Other Non-Bank Deposits	175	55	230
Total	325	110	435

4. Continued

- (b) (2 points) Evaluate quantitatively and qualitatively ABC's liquidity position before and after the acquisition using balance sheet liquidity analysis.
- (c) (1 point) Identify two shortcomings of Larry's approach.
- (d) (0.5 points) Identify and describe an alternative approach that could address these shortcomings.
- (e) (1.5 points) Explain how the approach identified in part (d) would improve Larry's evaluation of ABC's liquidity position before and after the acquisition.

To further analyze the acquisition, Larry would like to use deterministic stress scenarios to understand the liquidity risk. Larry developed a list of drivers that would have an impact on cash flows if ABC were to acquire XYZ:

Drivers:

- Contractual agreements.
- Economic conditions.
- Counterparty confidence.
- Bank management decisions.

The following are the specific cash flows that Larry would like to focus on:

Cash Flow:

- Loan prepayments.
 - Renewal of CDs.
 - Short-term funding for ABC.
- (f) (2 points)
 - (i) Identify the main cash flow driver(s) for each of the above cash flows.
 - (ii) Describe how each driver impacts each cash flow.

Question 4 is continued on the next page.

4. Continued

The CEO is encouraged by Larry's analysis and asks him to evaluate extreme scenarios as a final step before recommending the acquisition of XYZ to the Board. Larry creates two different stress scenarios to test ABC's liquidity position if XYZ were acquired:

- I. Short term rates rise while long term interest rates decline so that the yield curve becomes inverted.
 - II. ABC introduces a "Buy and Save" program where customers with lower credit quality will qualify for a mortgage in three years if they purchase the new three year CD.
- (g) (3 points) Evaluate qualitatively, for each of the scenarios above, the impact on the following items, post ABC's acquisition:
- (i) Net cumulative cash outflow
 - (ii) Net cumulative cash inflow
 - (iii) Overall liquidity

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5. (7 points) ABC is a mining company based in Country JLK that specializes in gold production.

- The company is highly profitable partly because poorly enforced labor laws in Country JLK allow for low labor costs.
- The company used to be family-owned until it went public. Now, the father is the chairman of the board as well as the Chief Risk Officer (CRO) while his son is serving as the Chief Executive Officer (CEO).
- There are three other board members, one of whom is a retired industry regulator who was nominated by the chairman because he was instrumental in helping the company secure government contracts in its early years.
- The other two board members have backgrounds in the agricultural and forestry industries and were elected by stockholders because of their good track records with environmental issues.
- The only committee is the compensation committee, which is comprised of the retired regulator and the other two board members. The board deals with all other functions as a group.

(a) (3 points) Evaluate each bullet point from an ethics and/or governance perspective.

XYZ is a new multi-strategy hedge fund headquartered in New York. It seeks investment opportunities in Country JLK.

The hedge fund has US\$ 2M to invest between two strategies. Assume a floating exchange rate that is currently at US\$ 1 per J\$ 100 (i.e. the local currency of Country JLK).

Strategy 1

XYZ originates a J\$ 100M loan in Country JLK to Company ABC to be repaid over 5 years at a fixed annual rate of 15%. Trading volume in the secondary market for loans in Country JLK is low. This opportunity is limited to J\$ 100M as ABC does not need more than that to finance its expansion.

Strategy 2

XYZ can invest in Country JLK's 5-year government bonds yielding 3% per year.

(b) (2 points) Compare and contrast the financial risks in each strategy.

5. Continued

Suppose that XYZ enters into a 5-year currency swap with a bank in Country JLK where XYZ pays a fixed rate of 15% per year on a J\$-denominated notional amount of 100M and receives a floating rate of US\$ LIBOR + 8.3%.

- (c) (1 point) Describe how introducing the swap changes the financial risks in strategy 1.

XYZ can borrow US\$ from a New York bank at a fixed rate of 1% for 5 years and use the proceeds to increase its investment in strategy 2.

- (d) (1 point) Explain how the loan changes the financial risks of strategy 2.

****END OF EXAMINATION****

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