SOCIETY OF ACTUARIES
Quantitative Finance and Investment Core

Exam QFICORE

AFTERNOON SESSION

Date: Wednesday, April 30, 2014
Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 6 questions numbered 11 through 16 for a total of 40 points. 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 morning or afternoon session for Exam QFICORE.

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.

475 N. Martingale Road
Schaumburg, IL 60173-2226

Printed in the U.S.A.
Exam QFICORE-Front Cover

****BEGINNING OF EXAMINATION****
Afternoon Session
Beginning with Question 11

11. (*7 points*) You work as a risk manager for a publicly traded bank. Your CFO is concerned about net income volatility. Your bank purchased 75 at-the-money 2-year call options on ABC's stock where one call option allows the trading of one share of ABC's stock. You want to delta hedge the options.

You are given the following:

- Risk-free rate = 5% per annum,
- ABC's stock dividend = 3% per annum,
- ABC's stock price = $100,
- Price of at-the-money 2-year call option on ABC's stock = $12.33,
- Implied volatility of at-the-money 2-year call option = 20% per annum,
- 250 days in a year.

Based on your estimated volatility of 30% per annum, the Black-Scholes formula indicates the option price would be $17.43.

(a) (*1 point*) List factors that can drive the market price away from the Black-Scholes model price.

(b) (*2 points*)

(i) Compare and contrast delta hedging using estimated volatility with delta hedging using implied volatility.

(ii) Recommend the appropriate choice for your situation.

(c) (*2 points*) Calculate, based on your recommendation in (b), the number of at-the-money call options you need to buy long or sell short to neutralize delta for the portfolio.

(d) (*2 points*) Calculate your expectation of the one-day mark-to-market profit or loss, if hedging with implied volatility, based on your estimated volatility.

12. (*9 points*) You are hired as a portfolio associate at XYZ investment bank. Your client asked your opinion of three different manager hire options.

- Option 1: Hire a single manager in either a growth or value style, but not both
- Option 2: Hire two managers, one in each style
- Option 3: Hire one manager in market-oriented style

Your director, who oversees all active managed funds within the bank, asked you to draft a presentation to the client.

(a) (*2.5 points*)

(i) Compare value, growth and market-oriented investing styles.

(ii) List advantages and disadvantages of each of the three options that the client was asking about.

You have obtained a copy of your client's portfolio.

	Client's Portfolio	Market Benchmark
Number of stocks	20	200
Weighted average market cap	1 billion	2 billion
P/E	8	19
Price to Book Ratio	1.3	2.0
Dividend Yield	5%	1%
EPS projected growth	8%	15%

Industry weightings:	Client's Portfolio	Market Benchmark
Healthcare	0%	20%
Utilities	35%	20%
Finance	15%	10%
Consumer Discretionary	30%	10%
Information Technology	0%	10%
Telecommunications	0%	10%
Materials	20%	10%
Industrials	0%	10%

(b) (*1.5 points*)

(i) Explain how investing styles can be evaluated using holdings based style analysis.

(ii) Evaluate the investment style of your client's portfolio.

12. Continued

Your director has decided to propose a new investment manager to the client. Based on his research and client's investment constraints, only two investment managers are eligible for consideration.

- Manager A follows 400 stocks with annual forecasts and the information coefficient for each of the forecasts is 0.04
- Manager B follows 500 stocks with annual forecasts and the information coefficient for each of the forecasts is 0.03

(c) (*1.5 points*) Recommend which manager A or B should be selected.

Another client has expressed interest in lower investment management fee products while maintaining market exposure.

(d) (*1.5 points*) Describe the advantages and disadvantages of passive investing using exchange traded funds, conventional indexed mutual funds and indexed institutional portfolios.

The client has decided to structure her portfolio of managers as shown below:

Manager	Allocated Assets ($MM)	Expected Alpha (%)	Expected Tracking Risk (%)
W	800	0	0
X	100	2	4
Y	100	3	6
Z	100	4	8
Total Investment	1,100		

The client assumes the managers' alphas are uncorrelated. The client's objectives call for an information ratio of at least 0.6, with a tracking risk of no more than 1% per year.

(e) (*2 points*)

(i) Characterize the structure of the above portfolio of managers.

(ii) Evaluate whether the portfolio of managers is expected to meet the investment objectives.

13. (*7 points*) The Organic Cauliflower Grower Association of Greenminded Valley (OCGAGV) represents the interest of its member producers. Its mission is to advertise its producers, to stabilize the income of its members, and to promote healthy living and environmental value.

OCGAGV created a marketing fund of $1,000,000, and no other contribution to this fund are expected or planned. Every year, $100,000 from this fund is to be used to promote the consumption of organic cauliflower among kids. This marketing program is expected to last for 20 years. These cash flows constitute the fund's liability. At the end of that period, OCGAGV will assess whether it will return the initial fund, which is expected to remain intact, to the members, or to implement a new marketing program.

As long as the fund is administered solely for the benefits of its members, this association is not subject to tax.

You are given a universe of possible assets:

Symbol	Stocks	μ	σ
AIR	African Indian Rice	7%	25%

Symbol	Bonds	Rating	Coupon	Price	Yield to maturity	Term	Duration	σ
GP	Greenpeace	A	5.00%	106.55	4.50%	20	13.40	10%
UST	US Treasury	N.A.	3.00%	100.00	3.00%	20	15.41	5%

And the correlation matrix among AIR and GP is following:

ρ	AIR	GP
AIR	1.00	
GP	0.55	1.00

Assuming that:

- The Greenpeace bond is used as a proxy to model the fund's liability
- Spending occurs twice a year and amounts are known in advance
- The duration of the fund's liability is 12.15

13. Continued

(a) (*2 points*) Develop a suitable investment policy for this fund. List and briefly describe all elements.

(b) (*2 points*) Calculate:

(i) the rate to use in modeling the fund's liability, and

(ii) the present value of this liability.

Assuming your only investment options are the Greenpeace bond and the African Indian Rice stock:

(c) (*1.5 points*) Calculate the minimum investment in equities needed to prevent the surplus from shrinking.

(d) (*1.5 points*) Calculate the investment in equities that minimizes the surplus risk.

14. (*6 points*) Ron Burgundy is a pension fund manager at a large mining company and has contracted you as an actuarial consultant to help brainstorm on fund asset allocation strategies for its defined benefit (DB) pension plan. Prior to consulting with you, Ron read an article about modern portfolio theory and believed that the company should explore maximizing the asset portfolio's Sharpe ratio. You bring up the idea of using an alternative metric, the risk-adjusted change in surplus (RACS).

(a) (*1 point*) Describe two shortcomings of using the Sharpe ratio as a risk-return measure.

(b) (*1.5 points*) Assess the appropriateness of using the RACS relative to the Sharpe ratio for the pension fund's asset allocation strategy.

The risk and return assumptions of a few of the key plan assets and liabilities are as follows:

					Correlation Matrix			
Asset Class	Excess Return	Standard Deviation	Sharpe Ratio	Duration	Domestic Equity	Global Equity	Long Term Bonds	Liability Index
Domestic Equity	4.00%	16.0%	0.25		1			
Global Equity	3.80%	14.5%	0.26		0.90	1		
Long Term Bonds	0.60%	8.0%	0.08	20	0.20	0.16	1	
Liability Index	0.90%	9.0%	0.10	23	0.18	0.15	0.85	1

Due to a recent prolonged market upswing, the DB pension plan is currently overfunded.

(c) (*1.5 points*) Assess the appropriateness of using the following assets to support the pension fund:

(i) Long term bonds

(ii) Equities – both Domestic and Global

(d) (*1 point*) Assess how the appropriate allocation between bonds and equities will change if the plan is underfunded.

(e) (*1 point*) Critique the following statements:

(i) "Whereas the Sharpe ratio evaluates investments relative to cash, the RACS evaluates them relative to surplus."

(ii) "Considering the duration and size of our pension liabilities, we should be concerned about the duration of bonds we purchase from a liquidity standpoint."

THIS PAGE INTENTIONALLY LEFT BLANK

15. (*7 points*) You are an investment manager at a large bank. Your intern has produced estimates for expected return, standard deviation, and correlation assumptions for various asset classes.

Asset Class	Expected Return	Standard Deviation	Correlation Matrix				
			A	B	C	D	E
A. Domestic Equity	11.0%	16.0%	1.00				
B. Intermediate Bonds	3.5%	7.0%	0.10	1.00			
C. Long-term Bonds	4.5%	8.0%	0.30	0.90	1.00		
D. International Bonds	6.0%	9.0%	0.40	0.60	0.50	1.00	
E. Real Estate	8.0%	11.0%	0.20	−0.10	0.00	0.20	1.00

(a) (*1 point*) List and briefly describe the criteria for effectively specifying asset classes.

Using these assumptions and sign-constrained optimization, your intern constructed the following table of corner portfolios. Portfolio number 8 is the global minimum variance (GMV) portfolio.

Portfolio Number	Expected Return	Standard Deviation	Asset Class (Portfolio Weight %)				
			A	B	C	D	E
1	11.0%	16.0%	100.0	0.0	0.0	0.0	0.0
2	9.4%	10.5%	48.3	0.0	0.0	0.0	51.7
3	8.8%	9.3%	37.5	0.0	0.0	14.5	48.0
4	8.3%	8.5%	30.7	0.0	8.7	15.7	44.9
5	7.8%	7.7%	27.7	19.2	0.0	10.6	42.5
6	6.8%	6.5%	19.7	38.6	0.0	4.1	37.6
7	6.2%	5.9%	14.8	50.7	0.0	0.0	34.5
8 (GMV)	5.2%	5.6%	5.3	66.4	0.0	0.0	28.3

Upon reviewing the table, you believe a portfolio was included in the table by mistake.

(b) (*1.5 points*) Identify which two of the portfolios in your intern's optimization table may not be corner portfolios.

(c) (*1.5 points*) Calculate the asset-class weights in an efficient portfolio with an expected return of 9.00%. Assume that the entries in the optimization table are correct.

15. Continued

(d) (*1 point*) List and describe any special strategic asset allocation considerations for a bank.

(e) (*1 point*) Explain how strategic asset allocation helps to manage systemic risk exposure.

(f) (*1 point*) Explain the relative importance of asset allocation versus other investment decisions.

16. (*4 points*) LMN Life Insurance Company is specialized in selling fixed deferred annuity products and currently has $9.6 billion of assets. Liabilities are expected to be $8 billion next year. The following are the four strategic asset allocation choices available:

Strategic Asset Allocation	A	B	C	D
Expected Return	9%	8%	7%	6%
Standard Deviation of Return	17.3%	15%	10%	5%
Portfolio Component				
Equity	30%	25%	20%	15%
Corporate Bonds	40%	47.5%	55%	62.5%
Structured Assets	30%	27.5%	25%	22.5%
Economic Risk Charge				
Equity (Equity Risk)	40%	40%	40%	40%
Corporate Bonds (Credit/Rate Risk)	4%/0%	4%/0%	4%/4%	4%/4%
Structured Assets (Credit/Rate Risk)	25%/0%	25%/0%	25%/4%	25%/4%

The company's risk/return criteria are as follows:

- The company's risk tolerance is to have enough economic surplus to withstand a 1-in-200-year stress event. The economic capital requirement for next year to withstand a 1-in-200-year stress event is approximately $2.0 billion.
- The company adopted Roy's safety-first criterion as a risk/return criteria
- Fully diversified economic risk charges for each asset class are calculated from the economic capital model, and the company's Investment Risk Committee recently established a set of Investment Risk Limits based on an economic framework.

Risk Factor	Risk Limit ($billion)
Equity Risk	1.3
Credit Risk	1.0
Interest Rate Risk	0.3

(a) (*3 points*) Recommend one of the four strategic asset allocations.

(b) (*1 point*) Describe the core elements of an integrated risk management framework.

****END OF EXAMINATION****
Afternoon Session

USE THIS PAGE FOR YOUR SCRATCH WORK

USE THIS PAGE FOR YOUR SCRATCH WORK