SOCIETY OF ACTUARIES
Quantitative Finance and Investment Core

Exam QFICORE

AFTERNOON SESSION

Date: Wednesday, April 25, 2018
Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 7 questions numbered 10 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.

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Exam QFICORE-Front Cover

****BEGINNING OF EXAMINATION****
Afternoon Session
Beginning with Question 10

10. (*6 points*) *ABC*, a US life insurer, is emphasising growth in its strategy for investing its surplus assets. *ABC* has a large surplus position and is exploring an alpha and beta separation strategy.

(a) (*1 point*) Identify investment constraints that *ABC* needs to consider in its investment policy.

ABC is looking for obtaining pure beta exposure to a relatively efficient part of the US equity market.

(b) (*1 point*) Explain this concept and describe how *ABC* can obtain this exposure.

ABC is looking for obtaining pure alpha exposure through the liquidity investment style.

(c) (*1 point*) Describe how *ABC* can obtain this exposure.

(d) (*1 point*) Describe the liquidity investment style in detail and compare it to other investment styles such as size, value, and momentum.

The following table shows the performance of an active asset manager that you are evaluating.

Year	Portfolio	Benchmark
1	4%	2%
2	9%	10%
3	-2%	-5%
4	-3%	-3%

(e) (*2 points*) Evaluate based solely on this information whether the asset manager should be hired.

11. (*5 points*) You are given information on the following bonds, all issued on Sep 30, 2015 at par. The bonds pay annual coupons.

Bond A: ABC Corp 6.5% due in 2025
Bond A has the following call schedule for each $100 par value:
Noncallable for the first 3 years
Callable at call premium of $5 for the next 3 years
Callable at call premium of $3 for the remaining years

Bond B: DEF Corp 5.25% due in 2025
Bond B has the following call schedule for each $100 par value:
Nonrefundable for the first 3 years
Call premium of $6 for the first 3 years
Callable and refundable at call premium of $5 for the next 3 years
Callable and refundable at call premium of $4 for the remaining years

Bond C: JKL Holding 6% due in 2027
Bond C has the following call schedule for each $100 par value:
Noncallable for the first 4 years
Callable at the greater of (1) 100% of the principal amount plus accrued interest and (2) the make-whole redemption price calculated with an interest rate equal to Treasury rate of 2027 maturity plus 20 basis points

(a) (*1 point*) Compare the reinvestment risk for Bond A and Bond B.

Assume that the Treasury curve on Sep 30, 2022 is:

Maturity	Rate
1 year	2.0%
2 year	2.5%
3 year	3.0%
5 year	3.5%
7 year	4.0%
10 year	4.5%

(b) (*1.5 points*) Calculate the call price if JKL Holding calls Bond C, with outstanding par value of $300 million, on Sep 30, 2022.

11. Continued

You would like to use $5 million of your own plus some additional borrowed money investing in a strategy involving Bond B that would achieve a 6% return. Assume that you are able to borrow the money at a repo rate of 4% by entering into a repurchase agreement.

(c) (*1 point*) Develop a strategy to achieve your goal using leverage as a tool.

(d) (*0.5 points*) List two actions that you can take to lower the repo rate.

MNO Energy, an electric utility company issued a 20-year bond with a sinking fund provision in which the annual sinking-fund payment equals 5% of total initial issuance.

(e) (*1 point*) List two advantages and two disadvantages of a sinking-fund bond from a bondholder's perspective.

12. (*7 points*) You are managing a portfolio of an insurance company whose investment policy prohibits using derivatives. The portfolio has the following asset allocation.

Asset Class	Allocation	Yield
Public bonds	28%	2.8%
Private bonds	32%	3.3%
Mortgages	20%	3.5%
Equities	5%	5.0%
Cash	15%	0.0%

The risk-free rate is 1.5%. The standard deviation of the portfolio returns is 1%.

Upon realizing that the high amount of cash is causing a drag in return, the Chief Investment Officer has instructed you to invest the cash as soon as possible. You talked to your dealer and she recommended that that you invest all the cash in "Smart-Bond ETF", a fixed-income exchange-traded fund.

(a) (*1 point*) Describe three advantages of using fixed-income ETFs in general and how you are using Smart-Bond ETF in this situation.

(b) (*1.5 points*) Describe three other investment strategies involving ETFs that you can use in managing this insurance company investment portfolio.

The dealer commented that Smart-Bond ETF is a good choice since it has very good liquidity and has also provided the following information:

1. Income distribution of the ETF for the current month is 0.3%, which is equal to the expected yield and is distributed monthly.
2. ETFs develop their own independent exchange liquidity.
3. There has been a lot of demand for fixed income ETFs in the recent months, therefore creation cost is high.
4. It has been difficult for the dealers to source bonds for executing the ETF trades at the current bid/offer prices.

(c) (*1 point*) Evaluate the dealer's comment that "Smart-Bond ETF is a good choice since it has very good liquidity" based on the information given.

12. Continued

(d) (*1 point*) Explain how an arbitrage opportunity driven by strong supply of ETFs can be capitalized by:

(i) An authorized participant

(ii) An investor

You decided to use mean-variance analysis to determine whether you should invest in fixed income ETFs. Based on your analysis, Smart-Bond ETF has a standard deviation of returns of 1.3%, and the correlation between the ETF and your current portfolio is 60%.

(e) (*1.5 points*) Determine using mean-variance analysis whether you should invest in Smart-Bond ETF.

The dealer has also suggested an alternative ETF, "Global-Bond ETF" which is an ETF consisting of international bonds.

(f) (*1 point*) Describe two special issues, other than currency risk, that you should consider if you decide to invest in Global-Bond ETF in addition to Smart-Bond ETF.

13. (*7 points*) For a 3-year annual-coupon Treasury bought at par the current annualized effective yield to maturity (YTM) is 3.4%. You are also given the forward rates in the table below, where $f(s,t)$ is the t-year forward rate for borrowing starting s years from now.

Type	$f(0,1)$	$f(1,1)$	$f(3,2)$	$f(3,4)$	$f(7,3)$
Rates:	2.50%	3.70%	4.50%	5.00%	5.10%

(a) (*3 points*) Calculate the following to the nearest 1 basis point:

(i) $f(0,5)$

(ii) $f(2,5)$

(iii) Price of a 2-year, annual-coupon, Treasury bond [with par value of \$100 and coupon of 5%] purchased a year from now assuming that spot rates in the future are those implied by today's forward rates.

Company A has an obligation to pay \$1 million in 5 years and needs to build a bond portfolio (Portfolio I) using the following securities in order to meet this obligation. Bonds 1 and 2 are annual coupon bonds. Assume that purchasing a fraction of a bond is allowed.

Security	Price (\$)	Par Value	Coupon Rate	Modified Duration	Maturity
Bond 1	105.366	100	5.0%	4.385	5
Bond 2	116.692	100	7.0%	5.604	7

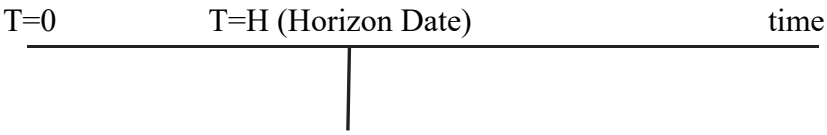
(b) (*1.5 points*) Construct an immunizing portfolio involving only Bonds 1 and 2.

Company A discovers another immunized portfolio (Portfolio II) consisting of the following 2 annual coupon bonds.

Security	Price (\$)	Par Value	Coupon Rate	Modified Duration	Maturity
Bond 3	101.692	100	4.0%	2.791	3
Bond 4	82.261	100	2.0%	7.869	9

13. Continued

The cash-flow chart below illustrates the liability obligation.



(c) (*0.5 points*) Illustrate cash flows of Portfolio I and Portfolio II in separate cash-flow charts. The charts do not need to be perfectly scaled.

(d) (*1 point)* Identify the strategy of each of the two portfolios based on the cash flow charts and explain which portfolio provides better immunization when interest rates move in a parallel way.

Company A wants to minimize immunization risk and expects that short rates will decline while long rates will go up.

(e) (*1 point*) Explain which portfolio provides better immunization under such scenario.

14. (*4 points*) You manage the following two individual investors' portfolios:

Bob – A 25 year-old affluent individual investor with no outstanding debt who is looking to maximize the return on his investment

Sue – A 60 year-old small business owner with large outstanding mortgage payments who is looking to make a marginal return on her investment

The portfolios that are available at your firm are:

	Portfolio A	Portfolio B	Portfolio C
P/B	1	3	
P/E	7	22	
Dividend Yield	7%	2%	N/A
EPS Growth	8%	10%	
	Sector Allocation		
Information Technology	15%	15%	0%
Finance	10%	10%	0%
Energy	15%	7%	0%
Health Care	10%	50%	0%
Utilities	40%	8%	0%
Fixed Income	10%	10%	100%
Total	100%	100%	100%

After a prolonged period of economic contraction, during which the United States had four calendar quarters with negative GDP, the economic forecast is signaling a bull equity market.

(a) (*1 point*) Outline the benefits of including equities in their portfolio.

(b) (*1.5 points*) Identify the investment styles for Portfolios A and B.

(c) (*1.5 points*) Recommend appropriate portfolios for your two clients, respectively, from Portfolios A, B, and C.

15. (*5 points*) You manage assets of a defined benefit plan for a company that provides well drilling and maintenance services in the oil industry. Due to strong performance over the past decade, the plan is 100% funded. The average age of its employees is 45, while the average retirement age of its employees is 65.

You are reviewing and updating sections of the current Investment Policy Statement (IPS).

(a) (*2 points*) Assess the following by describing the factors to be considered.

(i) Risk and return objectives.

(ii) Liquidity needs and time horizon.

(b) (*3 points*) Assess the appropriateness of the following investments against your IPS:

(i) Invest in US Treasury bonds that mature in 1 to 3 years.

(ii) Invest in an ETF that actively invests in oil companies.

(iii) Invest in an illiquid long duration fixed income fund that focuses on renewable energy.

16. (*6 points*) Tom is 60 years old and will retire in 5 years. He currently owns $2 million of assets managed by a financial advisor. Tom told his financial advisor that in one year he will need to withdraw $15,300 for charitable donations. Tom has deposited $15,000 today in a bank to earn a risk-free return of 2% to meet his donation liquidity requirement, and asked his financial advisor to perform an asset allocation optimization for the rest of his assets ($1.985 million).

The following summarizes the key information Tom provides to his financial advisor:

Investment Objectives:

- Return objective: Generate annual return of 8% in a year;
- Risk objective: Tom is willing to accept a standard deviation of return of 14% or less.

Investment Constraints:

- Liquidity requirement: Set aside $15,000 from the $2 million asset to be withdrawn in a year;
- Time horizon: Tom expects to retire in 5 years, then money will be withdrawn from the fund for his retirement income.
- Tax consideration: All assets that Tom owns are held in taxable accounts.

Other:

- Borrowing: Tom does not want to borrow to invest.
- Evaluation: Absolute risk-adjusted performance should be used for evaluation.

The table below exhibits Tom's market expectations for all the assets available to use for asset allocation:

				Correlation				
	Asset Class	Expected Return	Standard Deviation	1	2	3	4	5
1	U.K Equities	11.0%	20.0%	1				
2	Euro Equities	9.0%	18.0%	0.8	1			
3	Long term Bonds	4.5%	7.5%	0.4	0.04	1		
4	International Bond	5.0%	9.5%	0.5	0.3	0.8	1	
5	Real Estate	7.0%	14.0%	0.35	0.35	0.1	0.2	1

16. Continued

Based on Tom's market expectation above, the financial advisor generated corner portfolios given below using mean-variance optimization (MVO) analysis.

				Asset Class Weight				
Corner Portfolio	Expected Return	Standard Deviation	Sharpe Ratio	1	2	3	4	5
A	11.0%	20.0%	45.0%	100%				
B	10.0%	16.6%	48.3%	75%				25%
C	X	Y	Z	65%	5%			30%
D	7.9%	11.6%	50.7%	35%	5%		30%	30%
E	5.8%	7.1%	53.5%		15%	60%		25%
F	5.3%	6.7%	49.5%		10%	75%		15%

(a) (*1 point*) Calculate X, Y, and Z for Corner Portfolio C within the table.

(b) (*1 point*) Determine, using the linear interpolation between the corner portfolios, the strategic asset allocation (weights for each of the 5 asset classes) that is most appropriate for Tom based on the traditional MVO analysis.

(c) (*1.5 points*) Justify the asset allocation chosen in part (b), based on each of the following perspectives:

(i) Investment Objectives

(ii) Investment Constraints

(iii) Other information Tom provided

(d) (*1.5 points*) Critique the traditional MVO asset allocation method and propose another method under the following circumstances:

(i) Tom is planning for early retirement next year and will start withdrawing retirement payments from the fund.

(ii) Tom is no longer confident about his market expectations, especially the expected returns.

(e) (*1 point*) Recommend a change in asset allocation after considering Tom's current human capital.

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

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