SOCIETY OF ACTUARIES®

**Quantitative Finance and Investment
Portfolio Management Exam**

Exam QFIPM

Date: Friday, October 25, 2024

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 14 questions numbered 1 through 14 with a total of 70 points.

   The points for each question are indicated at the beginning of the question.

2. 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 provided in this document.

Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.

   a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 (and ^ used to indicate a superscript).

   b) In the Excel document formulas should be entered. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.

   c) Individual exams may provide additional directions that apply throughout the exam or to individual items.

2. The answer should be confined to the question as set.

3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your unique candidate number in the filename. To maintain anonymity, please refrain from using your name and use your candidate number instead.

4. The Word and Excel files that contain your answers must be uploaded before time expires.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:
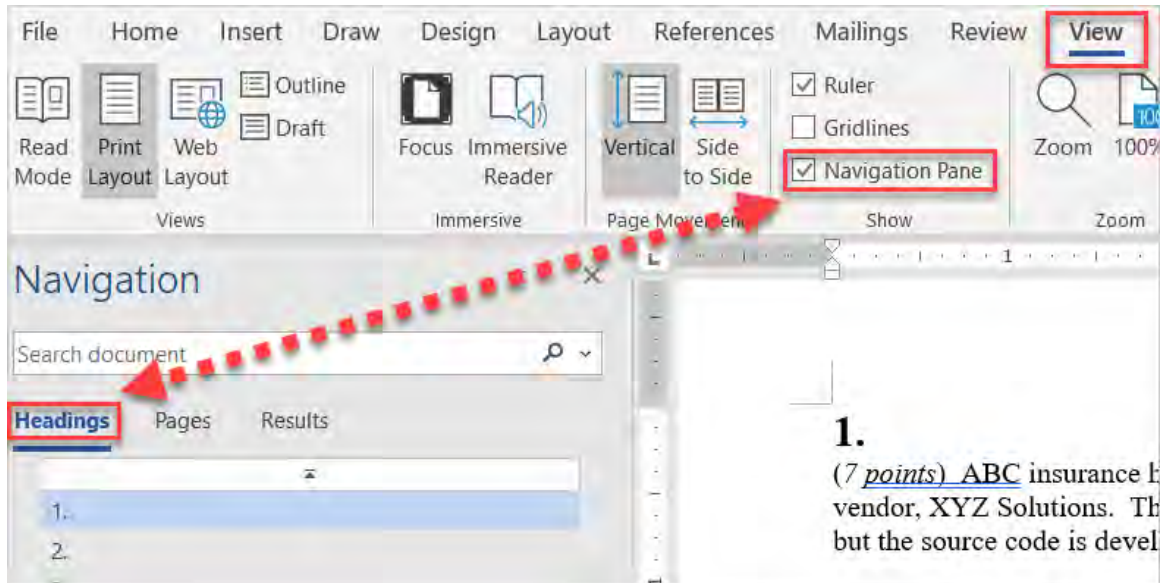
1.

(*4 points*) You work for ABC Insurance Company as an investment actuary. The company is considering adding exposure to the commodities market within its investment portfolio as a hedge against inflation.

(a)   (*0.5 points*) Explain two of the differences between commodities and capital assets.

> ANSWER:

(b)   (*1 point*) Explain four reasons why a commodity producer or ABC may be willing to enter into a commodities futures contract that has a slightly negative expected payoff.

> ANSWER:

ABC is considering the following two investment options to add exposure to the commodities markets:

- 1-year $50M par value structured note with a base coupon of 4.5% and an embedded call option on the XYZ Commodities Index with strike price of 925.
- 1-year $50M par value structured note with a base coupon of 5% and a long futures contract on the XYZ Commodities Index.
- The maturities of the futures contract and the structured notes are the same.
- The current price of the futures contract is 900.

One of your colleagues has provided the following probability distribution for the value of the XYZ Commodities Index one year from now when the two investment options above will mature.

Value	800	850	900	950	1,000
Probability	15%	15%	25%	30%	15%

1. **Continued**

(c)   (*2.5 points*)

(i)   (*1.5 points*) Calculate the expected returns of both investment options.

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ANSWER:


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(ii)   (*1 point*) Recommend the best investment option for ABC.

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ANSWER:


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2.

(*4 points*) You are asked to review a portfolio that is currently backing a block of fixed deferred annuities. The portfolio consists of government and corporate bonds. Senior management is interested in adding alternative fixed income assets, such as private debt funds or high yield bonds, to the portfolio to improve the overall returns.

(a)   (*2 points*) Compare in terms of return, risk, market, and cash flow characteristics each of the following as they relate to investment grade bonds.

(i)   Private debt funds

ANSWER:

(ii)   High yield bonds

ANSWER:

Senior management is focused on asset transparency and liquidity.

(b)   (*1 point*) Recommend which of these two assets to add to the portfolio.

ANSWER:

An analyst on the asset management team suggests selling credit default swaps (CDS) with reference to high yield bonds instead of investing in high yield bonds directly. This would limit the cash outflow and eliminate interest rate risk.

(c)   (*1 point*) Critique the analyst's suggestion.

ANSWER:

3.

(*4 points*) You are an actuary at XYZ Mutual. XYZ has a large fixed-income portfolio with a diverse mix of investment grade and high-yield assets, including corporate bonds, municipal bonds, mortgage-backed securities, and U.S treasuries. You have been assigned to help manage the portfolio's credit risk.

(a)   (*2 points*) Describe four practices that occur at Level 2 (Intermediate) CPM as defined in Bouteille, "The Handbook of Credit Risk Management".

> ANSWER:

XYZ's analysts believe that an economic downturn in the housing market is possible within the next 2 years, and XYZ is considering purchasing credit derivatives to help mitigate their current credit risk.

Your boss agrees that XYZ could use additional protection against credit events, but is not sure how CDS could help with XYZ's credit management objectives.

(b)   (*1 point*) Describe three uses for CDS in the market.

> ANSWER:

(c)   (*1 point*) Recommend whether XYZ should utilize CDS.

> ANSWER:

4.

(5 *points*) Insurer XYZ is seeking to apply simulation techniques to evaluate asset allocations for its pension fund.

(a) (*1 point*) List three considerations in which Monte Carlo simulation methods can help to confirm the quality of mean-variance or surplus optimization recommended allocations.

ANSWER:

You are assisting in this simulation exercise and have elected to apply a three-step asset-liability management method as defined by Sharpe. The objective function is:

$$U_m^{ALM} = E(SR_m) - 0.5R_A\sigma^2(SR_m)$$

(b) (*1 point*) Describe each expression within the above objective function.

ANSWER:

The risk aversion of Insurer XYZ is 8.
You are asked to assess the following asset allocations for the portfolio:

Asset Allocation	Expected Surplus Return	Standard Deviation of Surplus Return	U_m^{ALM}
Current Portfolio	4%	10%	0
Alternative Portfolio A	?	14%	
Alternative Portfolio B	2%	?	

(c) (*2 points*)

(i) Calculate the increase in expected surplus return required for Insurer XYZ to prefer Alternative Portfolio A over its current portfolio.

ANSWER:

(ii) Calculate the decrease in standard deviation required for Insurer XYZ to prefer Alternative Portfolio B over its current portfolio.

ANSWER:

4. **Continued**

Following application of the objective function and the assessment of various portfolios, you are asked to assess the simulation results for a given asset allocation.

(d)   (*1 point*)

(i)   Recommend statistical measures by which to judge the projected performance of the portfolio with respect to the funded ratio.

ANSWER:

(ii)   Propose a criterion that Insurer XYZ could utilize in determining the appropriateness of the portfolio.

ANSWER:

5.

(*7 points*) You were hired by a small life insurance company called ABC Life Insurance as an Investment Actuary. The Chief Investment Officer (CIO) told you that ABC has a small equity portfolio, based on exchanged-traded funds (ETFs).

(a)   (*1 point*) Describe the economically significant differences between conventional index mutual funds and ETF's.

> ANSWER:

ABC Life has been maintaining a passive investment approach in its equity portfolio.

(b)   (*1 point*) Explain the hidden danger in ABC's approach.

> ANSWER:

A year later, ABC's equity portfolio began to explore semi-active equity management. It evaluated 3 investment managers using Grinold and Kahn's Fundamental Law of Active Management, considering the Information Coefficient (IC) and Breadth to compute the Information Ratio (IR).

> Manager A follows 200 stocks with annual forecasts; IC of each forecast is 0.03.
>
> Manager B follows 100 stocks with annual forecasts, IC for each forecast is 0.04.
>
> Manager C follows 300 stocks, with 200 independent forecasts (IC is 0.02 for each), while the remaining 100 are dependent forecast (IC is 0.03 for each).

(c)   (*1 point*) Assess which manager gives the highest IR.

> ANSWER:

The investment team at ABC Life is considering alternatives to its passive approach.

(d)   (*1 point*) Describe possible limitations of the semi-active stock selection approach.

> ANSWER:

5. Continued

Manager X is a US value-oriented portfolio manager. You are given the following:

> 15% = Manager X's portfolio return
> 10% = S&P 500 Index return
> 14% = S&P 500 Value Index return
> 5% = The active risk taken by the Manager X, based on her investment strategy.
> 4% = The misfit risk that arises from the Manager X's unintentional deviation from her investment strategy or benchmark.

(e) (*2 points*) Calculate

    (i)   Total active risk of Manager X

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ANSWER:


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    (ii)   IR of Manager X

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ANSWER:


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(f) (*1 point*) Explain how the distinction between "true" and "misfit" can be used in portfolio construction optimization.

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ANSWER:


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6.

(5 *points*) You just joined a bank that specializes in structuring Non-Agency Residential Mortgage-Backed Securities (RMBS) as a market risk manager.

Your manager expects that interest rates will decrease in the next few years and does not expect collateral credit loss to be a major concern. They recommend utilizing a senior subordination shifting interest structure as an internal credit enhancement structure.

(a)   (*1.5 points*) Describe the mechanics of the recommended structure.

ANSWER:

Your intern provides you with a summary of the company's counterparty exposure:

- Gross exposure is the absolute amount at risk and, thus, the worst case scenario
- There is one contract that posted a letter of credit issued by the counterparty's parent as collateral, so we don't have any credit exposure to this counterparty.
- We've provided a revolver to some of our borrowers in the auto industry but they've never used it, so we should adjust the exposure to reflect the actual historical usage.

(b)   (*1 point*) Critique each of the above statements.

ANSWER:

(c)   (*1.5 points*) Describe the most commonly used methodology to assign a default probability to a counterparty.

ANSWER:

You are concerned about interest rates falling and enter into a 5-year, $100M notional interest rate swap to manage the duration. The agreement specifies that you will pay a floating rate of SOFR + 100 bps per annum and the counterparty will pay you a fixed rate of 4%, with annual payments. At the end of the 3rd year, your counterparty goes bankrupt.

Your intern remarks that this simply means that the swap is terminated, there is no further settlement to consider, and we are lucky that we did not have any financial loss from this transaction.

6. Continued

(d)   (*1 point*) Assess your intern's statement.

> ANSWER:

7.

(*5 points*) MDW is an insurance company selling life insurance and disability income products. MDW has $30 billion in assets that are currently being internally managed by their investment department. MDW is considering outsourcing the investment management to ORD, a third-party investment management company.

(a)   (*2 points*) Describe the four planning steps that ORD should go through as part of the portfolio management process.

> ANSWER:

(b)   (*1.5 points*) Describe active, semi-active, and passive investment strategies.

> ANSWER:

(c)   (*0.5 points*) Describe a situation where the portfolio's actual asset allocation differs from the strategic asset allocation.

> ANSWER:

ORD has created an IPS and has implemented this plan. One year later, MDW announces that it is merging with ABC, another insurance company which is heavily into the annuities market.

(d)   (*0.5 points*) Explain how the merger impacts ORD's IPS.

> ANSWER:

Five years later ORD conducts an assessment of its investment performance.

(e)   (*0.5 points*) Identify two components that are part of this assessment.

> ANSWER:

8.

(*5 points*) Your manager, in creating a new asset portfolio, has decided which asset classes to include and which to exclude from the portfolio.

(a)   (*1 point*) Describe three additional steps in designing this new investment portfolio.

ANSWER:

(b)   (*1 point*) Critique the benchmarks below in measuring portfolio performance.

(i)   Investment style index

ANSWER:

(ii)   Factor model

ANSWER:

A fund has the following cash flows and quarterly simple returns.

Quarter	Cash flow	Quarterly simple Return
0	1000	
1	0	0.06
2	500	-0.03
3	0	0.05
4	0	0.02

(c)   (*1.5 points*) Calculate both the time-weighted rate of return (TWR) and the money-weighted rate of return (MWR) over the year.

The response for this part is to be provided in the Excel spreadsheet.

8. Continued

A hedge fund is holding substantial short positions in certain assets.

(d)   (*0.5 points*) Explain the challenges in determining the rate of return in a long/short hedge fund.

> ANSWER:

(e)   (*1 point*) Describe the difficulty in creating benchmarks for hedge funds and recommend a solution.

> ANSWER:

9.

(*5 points*) Company FDE sells fixed index annuities. You have been asked by Company FDE management to manage the equity portfolio.

(a)   (*2 points*) Describe the following index weighting choices, including their respective biases.

(i)   *Price Weighted*

ANSWER:

(ii)   *Value Weighted*

ANSWER:

(iii)   *Equal Weighted*

ANSWER:

In your portfolio, you have a long position in S&P 500 index, which is a value-weighted index, as well as an equal and opposite short position in S&P 500 Equal Weight index. Suppose the share price of the second largest company in the index by market capitalization dropped by 10% and no other S&P 500 share price changes have occurred.

(b)   (*1 point*) Explain the expected net change in your portfolio as the result of this drop.

ANSWER:

You are now asked to construct a portfolio to track the S&P 500 index utilizing full replication, stratified sampling, or optimization.

(c)   (*2 points*) Compare these three methods.

ANSWER:

10.

(*5 points*) You are working at a Leverage Buyout (LBO) firm as an analyst and have collected some financial information for the ABC company, one of the largest clothing retailers in the world. Your findings are summarized below:

- The operating and net margins are 15% and 8%, respectively.
- The share price has declined over 35% since the end of last year.
- They have generated $135 million of free cash flow per year after interest and tax.

Balance Sheet	Millions
Current assets	650
Noncurrent assets	320
Other assets	30
Total assets	1000
Current liabilities	350
Noncurrent liabilities	150
Total debt	500
Shareholders' equity	500

Your manager claims ABC is a good LBO candidate.

(a) (*1.5 points*) Explain whether you agree with your manager.

> ANSWER:

The company generates an EBITDA (free cash flow from operations) of $150 million. An LBO firm offers $1,200 million to purchase the equity of the company and to pay off the outstanding debt at face value.

(b) (*1 point*)

    (i) Calculate the return on capital for the company's shareholders and debtholders in aggregate.

> *The response for this part is to be provided in the Excel spreadsheet.*

    (ii) Calculate the return for the equity holders if they sell their shares to the LBO offer.

> *The response for this part is to be provided in the Excel spreadsheet.*

10. Continued

Assume that $1,200 million LBO is financed with $1000 million in debt (with a 10% coupon rate) and $200 million in equity. The company expects the free cash flow (EBITDA) will improve to $200 million a year after the LBO.

(c)   (*2.5 points*)

(i)   (*0.5 points*) Calculate the annual interest payment obligation.

The response for this part is to be provided in the Excel spreadsheet.

(ii)   (*1 point*) Calculate the number of years it will take the company to clear the debt, assuming no dividends and using free cash flow to pay down the existing debt.

The response for this part is to be provided in the Excel spreadsheet.

(iii)   (*0.5 points*) Calculate the value of the company after it pays off the debt, assuming a long-term growth rate of 2% per year and a discount rate of 12%.

The response for this part is to be provided in the Excel spreadsheet.

(iv)   (*0.5 points*) Calculate the total return on the investment for the LBO transaction.

The response for this part is to be provided in the Excel spreadsheet.

11.

(*6 points*) Company XYZ is a traditional life insurance company that is considering insuring pensions.

(a) (*1 point*) Explain how pension funds have similar needs for long term asset and liability management strategies as life insurers.

> ANSWER:

To manage the long-term liabilities, Company XYZ's CRO has suggested introducing derivatives into the asset portfolio as a tool for asset liability management.

(b) (*1.5 points*)

  (i) Identify three common types of derivatives used by insurance companies and/or pension funds to manage interest risk.

> ANSWER:

  (ii) Explain why Company XYZ might use each of the identified derivatives as a tool for asset liability management.

> ANSWER:

Company XYZ is considering launching a Single Premium Whole Life insurance product with a cash surrender value that increases each year based on the 1-year US Treasury rate (1yr UST).

$$CSV(t) = CSV(t-1) * (1+ 1yr\ UST(t-1))$$

(c) (*1.5 points*) Describe how the rolling 1-year crediting rate in the cash surrender value adds complexity to asset liability management.

> ANSWER:

11. Continued

To make the product more competitive, the company is considering offering a guaranteed minimum interest rate on the product so the interest credited to policyholder would not drop below a guaranteed interest rate (GIR).

(d)   (*1 point*) Describe how this guaranteed interest rate feature adds complexity to asset liability management.

ANSWER:

(e)   (*1 point*) Explain how derivatives can be used to manage the risks introduced by the rolling 1-year crediting rate and guaranteed interest rate features described above.

ANSWER:

12.

(*5 points*) You are on an ALM team and given the following information from your manager:

A portfolio has bonds X, Y, and Z		
Bond	Duration	Market Value
X	4.8	$ 5.0M
Y	7.3	$ 3.2M
Z	12.7	$10.4M

The cheapest-to-deliver bond for a futures contract has:

- Price of $100,000
- Duration of 5
- Conversion factor of 1.2

Your manager has a target dollar duration for the portfolio of $150M and is interested in using futures contracts to achieve this.

(a)   (*1.5 points*) Calculate the number of futures contracts your manager needs to buy or sell to meet the $150M dollar duration target.

> ANSWER:

Your manager is happy with your work and, as a follow-up, is interested in using interest rate swaps to achieve the target dollar duration. In addition to bonds X, Y, and Z above, your manager gives you the following information about the interest rate swap:

- The underlying fixed rate bond has a price of $100,000 and a duration of 6.5
- The underlying floating rate bond has a price of $100,000 and a duration of 0.4

(b)   (*1.5 points*) Calculate the amount and position in the swap needed to match the $150M target dollar duration.

> ANSWER:

12. Continued

Your manager is interested in learning more about using swaps and futures to manage duration targets.

(c)   (*1 point*) Compare using futures or interest rate swaps to meet the target dollar duration.

> ANSWER:

A year later you are working with a U.S fixed income fund that has holdings in yen-denominated Japanese bonds. Your manager is considering whether to hedge the funds' exposure to the yen with a dollar-yen forward contract. You are given:

- U.S 1-year return = 4%
- Japanese 1-year return = 4.5%
- Your manager expects the Yen to appreciate against the U.S. dollar by 0.8%
- Interest Rate Parity holds

(d)   (*1 point*) Recommend whether your manager would hedge the fund's exposure using dollar-yen forward contracts.

> ANSWER:

13.

(*4 points*) You are an actuary working for the XYZ insurance company. The company is analyzing its current investment portfolio in terms of valuation metrics and asset classes.

(a)   (*0.5 points*) Describe two characteristics that differentiate the real estate market from the typical securities investment environment.

> ANSWER:

Company XYZ is interested in extending their investment to the real estate market for the first time.

Analyst A highly recommends direct investment in properties because:

- the company can take advantage of the predictability to buy low and sell high with extensive research and
- there are greater opportunities for making successful market timing decisions.

(b)   (*1 point*) Evaluate analyst A's comments.

> ANSWER:

Analyst B recommends REITs, based on favorable NAVs, share prices, and cost of capital projections.

(c)   (*1 point*) Contrast the quantification of REIT NAVs and REIT share prices.

> ANSWER:

You are given the total return performance history in the stock market for two REIT companies:

- REIT Company C has an average cost of capital of 6% and a price/earnings multiple of 10
- REIT Company D has an average cost of capital of 8% and a price/earnings multiple of 12

13. Continued

    (d)   (*1.5 points*) Assess whether REIT Company C can afford to pay a higher price for a given property than REIT D based on the above two metrics.

> ANSWER:

14.

(*6 points*) You are an investment actuary working for ABC Insurance Co. ABC primarily writes Universal Life and Long-Term Care products, although has recently begun offering Term products on a limited basis.

Your boss has scheduled a meeting to discuss ABC's investment portfolio, which is currently 50% municipal bonds, 40% investment-grade corporate bonds, and 10% cash. One of your co-workers suggests that mortgages be introduced to the investment portfolio.

(a)   (*1 point*) Identify four differences between residential and commercial mortgages.

ANSWER:

Your boss is particularly interested in adding commercial mortgage-backed securities (CMBS) to ABC's investment portfolio.

(b)   (*1.5 points*) Describe key players in the CMBS securitization process.

ANSWER:

Following some discussion, your team has settled on the following Tranches to potentially invest in:

Tranche A: Senior/ Investment Grade, $125M, 7.5% Coupon
Tranche B: Junior/Non-Investment Grade, $50M, 12% Coupon
IO Strip: Notional Par $100M, 3% Coupon

(c)   (*2 points*) Critique the appropriateness of each of the above tranches that ABC Insurance Co. is considering adding to its investment portfolio.

ANSWER:

14. Continued

(d)   (*1.5 points*) Describe moral hazard and adverse selection and how they create challenges for the CMBS industry.

ANSWER:

END OF EXAMINATION