SOCIETY OF ACTUARIES®

**Quantitative Finance and Investment
Portfolio Management Exam**

Exam QFIPM

Date: Thursday, April 29, 2021

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 16 questions numbered 1 through 16 with a total of 100 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 five-digit candidate number in the filename.

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

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Navigation Instructions

Open the Navigation Pane to jump to questions.

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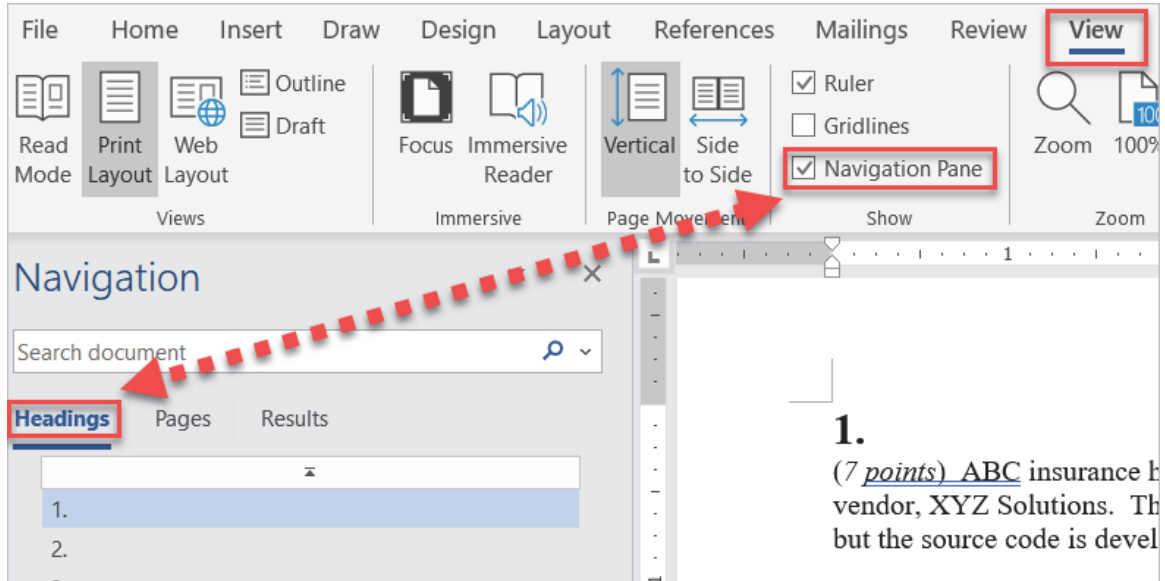
1.

(*5 points*) You recently started up your own equity investment firm and have several meetings scheduled with prospective clients. As part of your marketing efforts, you are coming up with educational material to explain different investment styles.

(a)   (*0.5 points*) Define passive, active, and semi-active equity investing.

ANSWER:

Your firm aims to create a new equity index consisting of a portfolio of 3 stocks whose current information is shown below.

Ticker	Price ($)	Market Value ($ Millions)	Free Float Factor
ABC	84	25,000	1
PQR	42	40,000	0.50
XYZ	35	36,000	0.75

(b)   (*1.5 points*) Calculate the weighting of XYZ under each of the following index weighting methods:

(i)   Price-weighted

ANSWER:

(ii)   Equal-weighted

ANSWER:

(iii)   Float-weighted

ANSWER:

1. Continued

A prospective client is looking for a manager to track the Russell 2000, a float-weighted small-cap index, because their existing manager significantly underperformed the index. They explained that their existing manager used a full replication approach and that there were several periods of inflows and outflows to the fund last year.

(c)   (*1 point*) Explain why the existing manager may have underperformed the index.

ANSWER:

Your final meeting is a consultation with a client who is evaluating two active investment choices. One is a long-only portfolio benchmarked to the LMN 50, an index of the 50 largest domestic stocks. The other is a long-short portfolio using domestic stocks with an overlay of LMN 50 futures. The LMN 50 index performance is dominated by a few of the largest stocks.

(d)   (*1 point*) Describe how equitized long-short portfolios are typically structured.

ANSWER:

(e)   (*1 point*) Explain why the long-short strategy may be more appropriate than the long-only strategy.

ANSWER:

2.

(*6 points*) You have recently joined XYZ Asset Management as a fixed income analyst to help support several portfolios. Each portfolio is managed to a well-defined benchmark. In addition, you help manage assets for several pension plans.

Your first task relates to the Long Corp Portfolio, which is mandated to track very closely a long duration, investment grade corporate bond index. Based on recent experience, you notice that the Long Corp Portfolio is consistently lagging behind the benchmark. Upon discussion with the fund manager, you learn that the Long Corp Portfolio is currently utilizing a full replication approach.

(a)   (*1.5 points*)

(i)   (*0.5 points*) Describe one advantage and one disadvantage of the full replication approach investment strategy.

ANSWER:

(ii)   (*1 point*) Describe an alternative fixed income investment strategy for the Long Corp Portfolio which could improve performance.

ANSWER:

2. Continued

Your next task relates to two additional portfolios – the Investment Grade Corp Portfolio and the Growth Portfolio. You have been given historical returns for both portfolios, as well as their respective indices.

	Year 1	Year 2	Year 3	Year 4
Investment Grade Corp Portfolio	5.0%	2.5%	4.0%	3.5%
Investment Grade Corp Index	4.5%	3.0%	4.0%	4.0%
Growth Portfolio	8.0%	-2.0%	10.0%	6.0%
Growth Fund Index	6.0%	4.0%	5.0%	3.0%

(b)   (*1.5 points*) Calculate the average active return and tracking risk for each of the portfolios.

> ANSWER:

Your colleague is looking at ways to improve Investment Grade Corp Portfolio performance. Based on current market trends, they believe that interest rates are set to decline significantly at longer durations. As a result, your colleague wants to use leverage so that they can increase the fund's exposure to long duration assets. Your colleague plans on buying interest rate futures to capitalize on their forecasts.

(c)   (*1.5 points*) Critique your colleague's strategy.

> ANSWER:

Your pension client sends you projected liability cash flows from which you are expected to develop and implement asset strategies for a defined benefit plan. The client is very sensitive to interest rate risk and wishes to control their investment expenses. The plan is frozen and very mature with the majority of members having already retired. It is well funded.

(d)   (*1.5 points*) Recommend an investment strategy to employ for this client.

> ANSWER:

3.

(*5 points*) You, an investment actuary in a public life insurance company, are reviewing an internal report about the equity holdings in the company's investment portfolio. The equity holdings section considers Environmental, Social, and Governance (ESG) and non-ESG companies.

(a)   (*1 point*) Explain two factors that have contributed to increased attention to ESG criteria.

> ANSWER:

(b)   (*1 point*) Explain why an environmental crisis makes ESG criteria more important.

> ANSWER:

You have been asked to perform a back-testing analysis in order to rank ESG stocks in the S&P 500 according to their Sharpe ratio.

(c)   (*1 point*) Explain the reasons for the presence of back-testing bias.

> ANSWER:

(d)   (*2 points*) Describe methods to deal with the back-testing bias.

> ANSWER:

4.

(*8 points*) You are the investment actuary in XYZ corporate pension plan with 1.2 billion in total assets under management. The status of the pension plan is the following:

1. It is open to new members.
2. The average age of its members is 44 years old.
3. It has 20% of the asset invested in public equities.

(a)   (*1.5 points*) Evaluate the suitability of allocating 5% of its asset portfolio to private equity investments to increase its overall returns and portfolio diversification.

> ANSWER:

The CEO is a bit confused about the following information about Fund ABC and asks you to provide explanations.

> *Fund ABC, a private equity fund, has gross annual returns of 12.7%, 4.5%, and 7.8% reported in each of the past three years. Its management fee is 2%, carried interest is 20% with a preferred return of 6%.*

(b)   (*1 point*) Explain the fee structure of a private equity fund

> ANSWER:

(c)   (*1.5 points*) Estimate ABC's average net annual return for the past three years.

> ANSWER:

(d)   (*1.5 points*) Evaluate the differences between the direct and indirect private equity investments

(e)   (*1.5 points*) Recommend a private equity investment for the pension plan.

> ANSWER:

4. Continued

The CEO chooses to pursue direct private equity investment in order to push for dividend recapitalization to boost the investment returns.

(f)   (*1 point*) Critique the CEO's choice.

> ANSWER:

5.

(*5 points*) You are a portfolio manager for a bond fund and you are considering adding a variety of fixed income securities to your portfolio.

One of your colleagues makes the following statements regarding preferred stock:

  I.   Preferred stockholders have a claim on cash dividends paid by the issuing corporation, and their claim is senior to that of common shareholders.
  II.   Dividends paid to the preferred stockholders are usually determined annually by the issuing corporation and usually correlated to its annual earnings.
  III.   If an issuing corporation fails to make a preferred dividend payment in arrears, the preferred shareholders may be granted voting rights to elect some members of the Board of Directors.
  IV.   Most Adjustable Rate Preferred stock has maturities of 30 years or less.
  V.   Adjustable Rate Preferred stock would trade below par value after issuance if the spread demanded by the market as compensation for the risk of the security is less than the dividend reset spread.
  VI.   Preferred stock is rated differently than corporate bonds.

(a)   (*1 point*) Explain why 4 of the above statements are false.

ANSWER:

 Alternatively, you are interested in high yield bonds.

(b)   (*1 point*) Explain one advantage and one disadvantage of investing in extendible reset bonds.

ANSWER:

As an institutional investor you are also considering fixed income ETFs in your fund for the purposes of Cash Equitization, Transition Management and Tactical Allocations

(c)   (*1.5 points*) Explain why ETFs would be advantageous in each situation.

ANSWER:

5. Continued

Lastly you are also considering a callable bond to add to the portfolio.

A 2-year bond is issued with semi-annual coupons at a bond equivalent yield (BEY) of 3%. You are given the following yields.

Yield to maturity (BEY) 4.0%

Yield to call (BEY) 6.0%

The bond is to be called at the end of 1 year.

(d)   (*1.5 points*) Calculate the call price of the bond

ANSWER:

6.

(*5 points*) Company ABC has a bond portfolio that was purchased in 2010 during a time of good market liquidity.   In 2016, there was a market liquidity crisis and the company was forced to sell two bonds from their portfolio. The Chief Investment Officer (CIO) has asked you to analyze the liquidity risk of these two bonds over the last 6 years and has provided the partial table below.

	Liquidity Cost Score (LCS)			Excess returns over US treasuries		
	2010	2013	2016	2010	2013	2016
Bond X	70	110	150	3.0%	4.0%	5.0%
Bond Y	115	220	550	4.0%	5.0%	-2.0%

(a)   (*2 points*) Explain the relationship between the LCS and the excess returns over the US treasuries for the two bonds.

(i)   (*1 point*) in 2010

ANSWER:

(ii)   (*1 point*) in 2016

ANSWER:

6. Continued

It is now two years later, the market liquidity crisis has passed, and the CIO is looking to purchase bonds for the Company's new portfolio. The CIO has asked you to evaluate three new bonds and has provided you with the OAS decomposition levels for the new bonds. He has set a ceiling of 25 bps on the default component, and a ceiling of 100 bps on the liquidity component. The CIO has not set a ceiling for market risk.

	Yield	Risk Premium Component	Default Component
Bond 1	3.4%	20 bps	30%
Bond 2	4.0%	50 bps	15%
Bond 3	4.5%	80 bps	5%

The risk free rate is 2.5%.

(b)   (*1.5 points*) Assess which of the bonds are to be added to the portfolio, if any.

ANSWER:

(c)   (*1.5 points*) Explain whether the restrictions are appropriate for a buy and hold strategy.

ANSWER:

7.

(*9 points*) ABC Bank's balance sheet as of 30 Jun 2020 consists of the following:

Assets:

- A commercial loan with $50M of principal outstanding with interest that compounds annually at 2.75% maturing on 30 Jun 2022 with no prepayment ability.
- Current market yields are at 3% for similar loans.
- Interest only commercial mortgage loan with a 7% annual coupon payment and $50M of outstanding principal maturing on 30 Jun 2024 with no prepayment ability, current market yields are at 7% for similar loans.

Liabilities:

- $75M of Demand Deposits (i.e. Checking & Savings Accounts).
- $20.1M market value of 1-year Certificate of Deposit (CDs) with $20M of principal and 3% annual interest payable at maturity on 30 Jun 2021 with no prepayment ability.

(a)   (*2 points*) Calculate the one-sided modified duration of ABC Bank's fair value of equity based on an instantaneous 25bp parallel increase to the yield curve.

> ANSWER:

(b)   (*1 point*) Recommend 4 ways ABC Bank can reduce its maturity gap.

> ANSWER:

7. Continued

Senior management is concerned about its interest rate exposure due to an instantaneous 100bp parallel shift up in the yield curve. ABC Bank's current asset market value will drop by $2.6M upon an instantaneous 100bp parallel increase in the yield curve. They would like to limit the liability market value drop to $2.34M for an instantaneous 100bp parallel increase in the yield curve.

To meet the limit, ABC Bank has decided to offer its demand deposit customers a discount of 0.5% (i.e. customer would pay $99.50 for $100 of face amount) to convert into a 5-year CD yielding 3.5% interest with no pre-payment option. ABC Bank is able to immediately convert as many demand deposit customers as it wants.

(c)   (*2 points*) Calculate ABC Bank's minimum cost of complying with the new risk limit by immediately converting demand deposits into 5-year CDs.

> ANSWER:

$100M of interest only balloon commercial mortgage loans with maturity 1 year from now have been pooled together and then carved into the following 4 tranches of commercial mortgage-backed securities:

Tranche	Par ($M)	Coupon	Price ($M)
A (Senior)	75	6.00%	74.40
B (Mezzanine)	24	7.25%	23.80
C (Junior)	1	31.00%	0.30
Interest Only (IO)	100 (Notional)	1.89%	1.78

ABC Bank is very familiar with the properties collateralizing this pool of loans and is interested in investing $0.3M in one of the tranches of this pool. ABC's quantitative analyst assumes there will be a $1.5M loss arising from this pool of loans and all interest will be paid at the end of the year. The analyst recommends investing in the C tranche due to his expectation that it will have the highest yield.

(d)   (*2 points*) Critique the quantitative analyst's recommendation.

> ANSWER:

7. Continued

To date, ABC Bank has only considered investing in commercial mortgage loans and commercial mortgage-backed securities. As Chief Investment Officer (CIO) of ABC Bank, you are proposing that the bank start investing in non-agency residential mortgage-backed securities. ABC Bank's senior management team is not as familiar with non-agency residential mortgage backed securities, and they have asked you to provide an overview of that market before they start investing in it.

(e) (*1 point*) Describe the key collateral characteristics to consider when valuing non-agency residential mortgage-backed securities.

ANSWER:

(f) (*1 point*) Explain why the prices of residential mortgage backed securities exhibit negative convexity and its impact on their pricing performance.

ANSWER:

8.

(*7 points*) Insurance Company ABC is a fast growing life insurance company selling an array of life and annuity products.

Senior management is considering strategies intended to improve and stabilize its earnings:

- Introduce high yield bonds to the general account assets.
- Use interest rate swap or swaption transactions to hedge the sensitivity to interest rate movements of the variable annuity reserves.
- Customize a life insurance product tailored to high net worth individuals, using a stop-loss reinsurance transaction to control the tail risk.

(a)   (*2 points*) Describe each strategy's credit risk and any implications.

ANSWER:

(b)   (*1 point*) Describe four dimensions by which to analyze and compare the credit exposures of individual contracts.

ANSWER:

(c)   (*2 points*) Describe stress testing for credit risk and how it can complement quantitative risk measurement approaches such as value-at-risk.

ANSWER:

(d)   (*2 points*) Describe the purpose and key aspects of each of credit portfolio management (CPM) levels 1 and 2, as described in Handbook of Credit Risk Management.

ANSWER:

9.

(*6 points*) ABC is a life insurance company that is subject to IFRS 17 and sells mainly term life insurance and whole life insurance with guaranteed cash surrender values.

(a)   (*2 points*) Compare and contrast distinct and non-distinct "investment components" under IFRS 17.

> ANSWER:

(b)   (*2 points*) Explain key considerations in developing the IFRS 17 discount rate.

> ANSWER:

The company's whole life insurance contracts allow for policy loans. The policyholder can borrow against the policy for up to 75% of the cash surrender value. The outstanding policy loan amount will be repaid when the death benefit is paid.

(c)   (*2 points*) Explain the presentation and measurement of policy loans under IFRS 17.

> ANSWER:

10.

(5 *points*) For the year 2019, the quarterly performance of a pension portfolio manager is shown below: The values were calculated on a money-weighted rate-of-return basis.

Quarter 1	5.3%
Quarter 2	-3.2%
Quarter 3	4.5%
Quarter 4	1.2%

Since the pension portfolio manager has no control over the size and timing of external cash flows into or out of his accounts, he believes that time-weighted rate of return is a more appropriate measure of account performance.

(a)   (*1 point*) Explain how you would approximate a time-weighted rate of return for the entire year of 2019.

> ANSWER:

(b)   (*0.5 points*) Discuss the limitation of approximating a time-weighted rate of return calculation this way.

> ANSWER:

(c)   (*0.5 points*) Determine the approximate time-weighted rate of return.

> ANSWER:

10. Continued

The table below shows the results of a micro attribution analysis on an investment manager.

Economic Sectors	Portfolio Weight (%)	Sector Benchmark Weight (%)	Portfolio Return (%)	Sector Benchmark Return (%)
Basic materials	6.79	6.45	-0.97	-0.76
Capital goods	8.28	8.87	-3.06	-3.59
Consumer durables	3.09	3.83	0.64	-0.12
Consumer nondurables	30.87	33.57	1.94	1.99
Energy	6.51	5.10	0.35	0.16
Financial	22.74	20.19	2.95	2.07
Technology	12.41	16.20	2.05	-0.25
Utilities	7.46	5.79	0.42	-0.36
Cash and equivalent	1.85	0.00	0.12	
Buy/Hold + Cash	100.00	100.00	1.28	0.66
Trading and Other			-0.15	
Total Portfolio			1.13	0.66

(d)   (*2 points*) Determine how the investment manager performed on the Technology sector based on performance attribution analysis.

> ANSWER:

10. Continued

Below are the results of a micro attribution analysis using fundamental factor model.

Market return	6.09%
Normal portfolio return	5.85%
Total market timing return	5.76%
Total Fundamental Risk Factor return	5.24%
Total Economic Sector return	6.00%
Actual Portfolio return	6.05%

(e) (*1 point*)

(i) Calculate the specific or unexplained return component.

ANSWER:

(ii) Interpret the attribution.

ANSWER:

11.

(*6 points*) You are asked to model losses due to defaults on a bond portfolio consisting of 1000 obligors with a total par value of 2 billion. You decide to model the losses using a one-factor Gaussian threshold model with the following latent variable for each obligor n:

$$y_n = \sqrt{10\%}\, G + \sqrt{90\%}\, \in_n$$

where G and $\in_n$ are independent and identically distributed standard normal variates for all $n \in \{1, \dots, 1000\}$.

Your manager asks you to use the homogenous portfolio approximation for your model, as described in "Credit Risk Modelling" by Bolder.

(a)   (*1 point*) Describe any simplifying assumptions or insights required in order for this approximation to be valid.

> ANSWER:

You decide to use your analytic approximation with an assumption that the probability of default for any obligor in the portfolio is 1%.

(b)   (*2 points*) Calculate the probability that the number of defaults for the portfolio is less than or equal to 15, using your analytic approximation.

> ANSWER:

You decide to revise your model and modify the latent variable for each obligor in the Gaussian threshold model to the following:

$$y_n = \sqrt{V}\left(\sqrt{10\%}\, G + \sqrt{90\%}\, \in_n\right)$$

where G and ϵ_n are independent and identically distributed standard normal variates for all $n \in \{1, \dots, 1000\}$ and V is a gamma distributed random variable.

(c)   (*1 point*) Describe drawbacks of this revised model.

> ANSWER:

11. Continued

You are given the following facts:

I. the kurtosis of y_n is

$$K(y_n) = \mathbb{E}\left[\left(\frac{y_n - \mathbb{E}(y_n)}{\sqrt{\mathrm{var}(y_n)}}\right)^4\right] = 3\frac{\mathbb{E}(V^2)}{\mathbb{E}(V)^2} = 4, \text{ and}$$

II. the covariance between y_n and any y_m is 8%

(d)   (*2 points*) Calculate $E\left[V^2\right]$.

ANSWER:

12.

(*6 points*) JKL Life is upgrading its liquidity model and you, as the head of risk management, are working on several issues.

(a)   (*1 point*) List four principles of liquidity risk management.

> ANSWER:

The company maintains a portfolio of 500 million in assets with 250 million in liquid assets and $300 million of liabilities. You are provided the below simulations of the following univariate stresses on company assets and liabilities based on the current balance sheet.

Stress scenario	Asset decline due to bid/ask spread (millions)	Time Factor 1-week	Time Factor 1-month
Base Case	0	25%	25%
Elevated Withdrawal	0	75%	75%
Market Crisis	50 (split evenly between liquid and illiquid assets)	75%	90%

You wish to reflect added conservatism by using 150% of any asset haircuts.

(b)   (*2 points*) Calculate the 1-week ratio of net assets to liabilities under the elevated withdrawal and market crisis scenarios.

> ANSWER:

The treasurer is considering establishing a line of credit of up to 100 million with PQR Bank to improve the liquidity ratio. You would like to target having a ratio of at least 115% under all scenarios and time periods.

(c)   (*2 points*) Assess the amount of the line of credit needed in order to meet the ratio requirement.

> ANSWER:

12. Continued

(d)   (*1 point*) Recommend two additional ways that JKL Life could remediate the liquidity risks of its assets.

ANSWER:

13.

(*7 points*) Derivatives can be classified into several different groups by the way in which they are collateralized and transacted.

(a) (*1 point*) Describe each of these classification groups, including the relevant risks of each group.

> ANSWER:

(b) (*1 point*) Explain the difference between risk-neutral and real-world default probabilities.

> ANSWER:

Company XYZ is launching a new Single Premium Deferred Annuity product in Hong Kong. The policyholder will pay the premium in Hong Kong dollars (HKD) and receive annuity payments in Canadian dollars (CAD) after the deferral period.

The investment actuary suggests using a 3-year forward FX contract to hedge the FX risk and has asked you to look at two strategies:

Strategy 1: Enter a centrally cleared OTC forward contract with Company Beta3 (rated BBB) to exchange 10 million HKD for 1.72 million CAD at the end of year 3.

Strategy 2: Enter OTC collateralized bilateral 3-year forward contracts with two counterparties:

- Company Alpha2 (rated AA) to exchange 7 million HKD for 1.204 million CAD
- Company Alpha1 (rated A) to exchange 3 million HKD for 0.516 million CAD

13. Continued

You obtained the credit spread and the recovery rate market data for the three counterparties:

	Company Beta3 (rated BBB)	Company Alpha2 (rated AA)	Company Alpha1 (rated A)
Recovery rate	30%	55%	40%

Year	Credit spread in basis points (Linear interpolation should be used to obtain any interim values)		
	Company Beta3 (rated BBB)	Company Alpha2 (rated AA)	Company Alpha1 (rated A)
1	290	135	190
2	268	154	190
3			
4			
5	190	190	190

The "xVA Challenge" reading by Gregory describes a commonly-used approximation for estimating company default probabilities.

(c)   (*0.5 points*) Explain the limitations of this approximation.

> ANSWER:

(d)   (*3 points*) Approximate the following for each company Beta3, Alpha2 and Alpha1:

   (i)   The probability that the company defaults during year 3, and

   > ANSWER:

   (ii)   The probability that the company defaults at any time within the first three years

   > ANSWER:

13. Continued

(e)   (*1.5 points*) Discuss the advantages and disadvantages for each of the two strategies.

ANSWER:

14.

(*8 points*) You are an ALM (Asset Liability Management) manager at XYZ Insurance Company. You are concerned that the current environment of persistent low interest rates and slow economic recovery will negatively affect life insurers, especially as the central bank recently cut interest rate to 0%.

(a)   (*1 point*) Identify four issues outside of interest rates and credit risk arising from an adverse macroeconomic environment that could influence insurer investing.

> ANSWER:

Tom is an analyst on your team. He argues that monetary policy involving quantitative easing aims to stabilize the financial system and foster economic recovery regardless of any future risks. Therefore, it will have minimum impact for insurers from an ALM perspective.

(b)   (*2 points*) Critique Tom's comment relating to how changes in the macroeconomic environment could impact both assets and liabilities from an ALM and a risk perspective.

> ANSWER:

The product team is designing a new product that features surrender options embedded in the insurance contract.

(c)   (*1 point*) Explain how the low interest rate environment can be a major challenge for insurers that provide products featuring surrender options.

> ANSWER:

XYZ Insurance Company currently has exposures to the following asset classes: direct private equity and infrastructure.

(d)   (*2 points*) Describe XYZ's two asset classes.

> ANSWER:

14. Continued

Climate change is one of the factors affecting XYZ Insurance Company's long-term investment decisions. The investment team is considering adding green investments to its portfolio.

(e)   (*2 points*) Identify benefits and limitations/constraints from XYZ's perspective of adding green alternative assets to its portfolio.

ANSWER:

15.

(*5 points*) Life Insurance Company XL, based in the US, provides pension scheme for its employees with the following characteristics:

- Each employee receives a fund balance that increases with benefit and interest credits.
- Benefit credits are at a rate of 6% of their base salary and employees can opt to contribute an equivalent amount to the fund balance.
- Interest credits at a rate of 30-year Treasury yield + 50 bps
- A statement showing the current fund balance is provided to employees quarterly.

(a)   (*1 point*) Explain why the Pension scheme offered by XL is a hybrid plan.

ANSWER:

15. Continued

On 1 Jan 2020, it is determined that the 30-year Treasury yield is 5% throughout the year, the company is holding USD 50,000,000 of assets in support of the entire Pension scheme, and the scheme has no active retirees, although the average age of XL's employees is 56 years. The invested assets are assumed to grow at the same rate as the employee fund balances in 2020.

XL has been enjoying a pleasant period of growth and been consistently reported rising earnings, and it has been able to reduce its debt usage over the past 5 years. Due to this success, XL has been paying its 50 employees quite well with the average annual base salary of USD 100,000 each. All of the employees have opted to contribute 6% of their base salary at the end of the year to the fund.

The pension liability is determined to be USD 52,000,000 as of 31 Dec 2020, and the duration of the liabilities is 26.5.

(b)   (*2 points*)

   (i)   (*1 point*) Calculate the funding ratio of the plan.

   ANSWER:

   (ii)   (*1 point*) Describe XL's pension scheme's risk tolerance.

   ANSWER:

15. Continued

XL has just acquired MNO, a Canadian insurance company, which has its own DB pension plan. The MNO plan has the following characteristics:

- Monthly payments are a function of the average last five years salary and are paid in Canadian dollars.
- The plan assets are CAD 35,000,000 and the liability is CAD 32,500,000.
- Currently retired members have an average age of 70 and compose 35% of the plan liabilities.
- The average age of the active participants is 50.
- Participants can take early retirement at 62 as a lump-sum or monthly payments.
- The plan does have some USD investments.
- XL has a policy against using leverage in pension plan portfolios.

You have been asked to prepare the section on constraints for the plan's investment policy statement.

(c)   (*2 points*) Describe the relevant investment constraints for the MNO pension plan.

ANSWER:

16.

(*7 points*) ABC Life's liability portfolio consists of traditional life products, universal life with secondary guarantees, and variable annuities with guaranteed riders.

(a)   (*1point*)

(i)   Identify the common strategies under the two dimensions of ALM practice.

> ANSWER:

(ii)   Determine which ALM strategies are the more appropriate for ABC Life.

> ANSWER:

ABC Life's investment policy statement (IPS) requires an annual net real return of 5% on its investments. The average annual inflation rate is 2% and the annual investment cost is 1%.

(b)   (*1 point*) Calculate the minimum gross return requirement under ABC Life's IPS.

> ANSWER:

ABC Life's IPS only permits investments in four asset classes: equities, bonds, mortgages, and real estate. The historical data for these four asset classes are given in Table 1 below.

	Asset Class	Mean Return	Standard Deviation	Correlation (Asset Class)			
				Equity	Bond	Mortgage	Real Estate
Table 1	Equity	15%	32%	1	-0.72	0.45	0.74
	Bond	5%	10%		1	-0.23	-0.86
	Mortgage	10%	12%			1	0.23
	Real Estate	12%	28%				1

16. Continued

With the above data, your analyst used the Mean-Variance Approach to calculate five corner portfolios (as shown in Table 2 below) to construct the efficient frontier for portfolio optimization. No short-selling is allowed. The current risk-free rate is 3%.

	Corner Portfolio	Mean Return	Standard Deviation	Sharpe Ratio	Portfolio Weight (Asset Class)			
					Equity	Bond	Mortgage	Real Estate
Table 2	1	15%	32%		100%	0%	0%	0%
	2	13%	A	B	60%	0	40%	0
	3	11%	13%	61.5%	20%	2%	72%	6%
	4	C	7%	85.7%	11%	36%	40%	13%
	5	7%	3.6%	111.1%	2%	70%	8%	20%

(c)   (*1.5 points*) Calculate A, B, and C in Table 2.

> ANSWER:

(d)   (*1.5 points*) Calculate using the Corner Portfolio Theorem the respective weight for equity and for bond in the efficient portfolio that will meet ABC Life's investment objective.

> ANSWER:

ABC Life is considering two alternative approaches for portfolio optimization:

(i)   Black-Litterman Approach

(ii)   Experience-Based Approach

(e)   (*2 points*) Critique the above alternative approaches for portfolio optimization.

> ANSWER:

END OF EXAMINATION