QFI PM Model Solutions
Spring 2021

1.   **Learning Objectives:**
2.   The candidate will understand:
- The credit risk of fixed income portfolios, securities, and sectors and be able to apply a variety of credit risk theories and models.
- How rating agencies rate corporate and sovereign bonds.

Learning Outcomes:
(2a)   Demonstrate an understanding of credit risk analysis and models

(2f)   Understand and apply various approaches for managing credit risk in a portfolio setting

Sources:
1. Maginn & Tuttle, Managing Investment Portfolios, 3rd Edition, Chapter 7, p. 410.
2. Maginn & Tuttle, Managing Investment Portfolios, 3rd Edition, Chapter 7, p. 432-433.
3. Maginn & Tuttle, Managing Investment Portfolios, 3rd Edition, Chapter 7, p. 414-415.
4. Maginn & Tuttle, Managing Investment Portfolios, 3rd Edition, Chapter 7, p. 425-427.
5. Maginn & Tuttle, Managing Investment Portfolios, 3rd Edition, Chapter 7, p. 452-454.

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a)   Define passive, active, and semi-active equity investing.

   Commentary on Question:
   The candidates performed very well on this section. They demonstrated an understanding of the basic concepts surrounding passive, active, and semi-active investing that was in line with the level expected.

   -Passive: The investor is not expressing his investment expectations through changes in security holdings.
   -Active: Investor seeks to outperform a benchmark portfolio by identifying stocks that will perform well and avoiding stocks that will underperform
   -Semi-active: Investor seeks to outperform the benchmark but is mindful of tracking risk relative to the benchmark

1. Continued

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

(i) Price-weighted

(ii) Equal-weighted

(iii) Float-weighted

Commentary on Question:
The candidates performed very well on this section. Successful candidates needed to show their work using the formulas for each method in order to receive full credit.

(i) **Price-Weighted**:
Sum of all prices: 84+42+35 = 161
Price-weighted weight of XYZ = 35 / 161 = 22%;

(ii) **Equal-Weighted**:
3 stocks equally weighted, so 1/3 = 33% each.
Equal-weighted weight of XYZ = 33%

(iii) **Float-Weighted:**
Sum of all free-float = [25,000 + (40,000 x 0.5) + (36,000 x 0.75)] = 72,000
Float-weighted weight of XYZ = (36,000 x 0.75) / 72,000 = 27,000 / 72,000 = 38%

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

Commentary on Question:
The candidates performed below average on this section. They mostly correctly commented on transaction costs, but management expenses and taxes were often omitted. Candidates needed to state and explain how those four items could result in the investment underperforming the index, in order to receive full credit.

- Expenses: the fund manager has expenses to manage and administer the fund, while the index does not have expenses.
- Transaction Costs: the fund manager pays transaction costs to buy/sell securities which they need to do when there are inflows/outflows to the fund. The index does not have transaction costs.
- Illiquidity of Small Cap: small cap stocks are less liquid with higher bid-ask spreads, and full replication means taking many small positions. The index does not reflect bid-ask spreads or illiquidity of index components.

1. Continued

- Taxes: the fund must pay takes on dividends and realized capital gains which the index does not reflect.

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

Commentary on Question:
The candidates performed as expected on this question. Candidates needed to specify that base long-short beta is likely near 0 and also specify the instruments that are used to obtain equity exposure (futures or ETFs), in order to receive full credit.

- Long position in stocks expected to outperform
- Short position in stocks expected to underperform
- Beta from long-short position is likely close to zero
- Futures or ETFs are used to obtain equity exposure and add pure beta to portfolio

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

Commentary on Question:
The candidates performed below average on this question. Candidates needed to reference the specific situation in the answer in order to receive full credit – general comments about long-only or long-short investing received partial credit. Candidates were also expected to discuss the presence of leverage in this type of strategy..

- Long-short strategies have an inherent efficiency advantage, which is ability to act on negative insights that the investor may have, and which can never be fully exploited in a long-only context.
- In order to magnify the difference in alphas between two stocks, long-short managers sometimes leverage their capital as much as 2-3 times using borrowed money. Although leverage magnifies the opportunity to earn alpha, long-short portfolio is subject to borrowing constraints and other risks.
- With the given long-short approach, not only can the investment manager take equivalent long or short positions in all 50 stocks in the index, the manager may also be able to use stocks not included in the index in order to increase the opportunity set.

2. **Learning Objectives:**
1. The candidate will understand how to work with the variety of fixed income instruments and evaluate fixed income portfolios.

Learning Outcomes:
(1b) Demonstrate an understanding of common techniques to enhance yield and manage liquidity in fixed income portfolios

(1d) Construct and manage portfolios of fixed income securities using the following broad categories:
- Managing funds against a target return
- Managing funds against liabilities

Sources:
Maginn and Tuttle Ch 6

Commentary on Question:
This question tested the candidate's knowledge of fixed income portfolio strategies. Overall, candidates performed as expected..

Solution:
(a)

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

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

Commentary on Question:
Candidates performed brilliantly on this section. For part (i) many candidates identified low tracking risk and high transaction costs as the advantage and disadvantage of the strategy, respectively. One common mistake in part (i) is that candidates suggested that a fully-replicated portfolio is easy to implement – this may not be the case as certain investments within a benchmark may be illiquid.

For part (ii) many successful candidates described enhanced indexing or stratified sampling strategies to help improve fund performance. Candidates who suggested using active or semi-active strategies were not awarded points as the purpose of this fund is to closely track an index.

(i) Advantages to a full replication strategy include:
- Minimizing tracking risk relative to the benchmark
- Lower management fees
- Outperforming a broadly based market index on a consistent basis is difficult.

2.   Continued

Disadvantages to a full replication strategy include:
- Full replication is difficult to set up and expensive to implement.
- Many issues in a typical bond index are quite illiquid and very infrequently traded.

(ii)   Enhanced indexing would be a viable alternative to full replication for this portfolio. Enhanced indexing involves selecting a sample of assets within the benchmark such that the duration, sector, credit quality, etc. are not materially different from the benchmark. It reduces construction and maintenance cost of the portfolio, and enables managers to enhance portfolio's return by using bonds that are perceived undervalued.

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

Commentary on Question:
Candidates performed above average on this section. Candidates who performed well on this question included the formulas for active returns and tracking risk, and successfully computed their values. Two common mistakes that candidates made was that they used the incorrect denominator of the tracking risk calculation, or they calculated the variance of portfolio instead of the tracking risk.

Active return = AR_i = portfolio's return – benchmark index's return

Average active return = Avg AR = $\dfrac{\sum_1^n (r_i - b_i)}{n}$

Tracking Risk = standard deviation of the active returns = $\sqrt{\dfrac{\sum_1^n (AR_i - Avg\ AR)^2}{n-1}}$

For the High Yield ETF, average active return = -0.13%
For the High Yield ETF, tracking risk = 0.48%
For the Growth ETF, average active return = 1.00%
For the Growth ETF, tracking risk = 4.83%

(c)   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.

Critique your colleague's strategy.

2. **Continued**

Commentary on Question:
Candidates performed below average on this section. Successful candidates were able to conclude that, based on your colleague's analysis, the proposed strategy would work. Successful candidates also noted that interest rate futures contain leverage, and as such this would be a risky approach. Many candidates wrote that a decline in interest rates would result in a decline in value of an interest rate future – this is not correct.

Note that the candidate did not need to include all remarks listed below in order to achieve full marks.

The purpose of leverage is to potentially magnify return. Leverage cuts both ways however. If markets do not play out as expected then the fund will underperform even more. While the statement about leverage is true at face value, there is a significant risk associated with using a large amount of leverage in a portfolio.

Interest rate futures are frequently used portfolio strategy to target a specific duration target. When interest rates decline, futures prices will increase; this means buying interest rate futures is appropriate. The statement is therefore true, your colleague is correct in their assessment.

(d)   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.

Recommend an investment strategy to employ for this client.

Commentary on Question:
Candidates performed below average on this section. Successful candidates identified cash flow matching or cash flow matching for the initial period with duration matching thereafter as appropriate strategies to meet the pension plan's objectives. Candidates who wrote duration-matching or immunization did not receive full marks as these strategies only protect the plan against parallel shifts in the interest rate curve. Several candidates suggested specific asset classes to invest in – this was not accepted as an answer as the question specifically asked for an investment strategy. In order to receive full marks, a candidate must explain how their proposed strategy addressed both of the pension funds concerns.

2. **Continued**

I would recommend a cash flow matching strategy for this client. Cash flow matching minimizes interest rate risk exposure as assets and liabilities will move in the same direction based on changes in the interest rate. Cash flow matching also requires the least amount of rebalancing, so there will be lower transaction costs.

3. **Learning Objectives:**

3.   The candidate will understand the variety and assess the role of equities in investment portfolios. The candidate will demonstrate an understanding of the distinguishing investment characteristics and potential contributions to investment portfolios of the following major asset groups:
   - Real Estate
   - Public Equity
   - Private Equity
   - Infrastructure
   - Commodities
   - Hedge Funds

Learning Outcomes:

(3f)   Demonstrate an understanding of issues related to incorporating Environmental, Social, and Governance (ESG) criteria into the investment process

Sources:

Managing Investment Portfolios, Maginn & Tuttle, 3rd Edition, 2007 - Ch. 7: Equity Portfolio Management

QFIP-133-19: Environmental, Social, and Governance Criteria: Why Investors Should Care

Commentary on Question:

This question tests candidates' understanding of why companies focus on ESG criteria, its importance in the investment process and the issues of back-testing. Candidates performed well in explaining the factors of ESG investing but performed poorly on parts that require deeper comprehension of back-testing bias. Candidates were particularly unsuccessful in fully explaining the back-testing bias and methods to correct it which was required to receive full credit in part (d). Overall, candidates performed below average on this question.

Solution:

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

Commentary on Question:
Candidates performed above average on this question. Successful candidates clearly explained at least two factors as reasons for the increased attention given to ESG investing in companies. Candidates who provided any two explanations received full credit.

3. Continued

We can use the following factors to argue why we need to increase our attention to ESG holdings:

(1) Firms may produce socially undesirable public bads, even when operating within the laws of the land, as regulation may take time to catch up with social concerns.

(2) Stocks are long lived assets as most of the value is from cash flows that occur in the distant future. The majority of the present value came from capital gains realized at the end of the ten year period, which in turn depended on investors' expectations about what will happen over the years that followed.

(3) Such long horizon cash flows are difficult to forecast and will likely be affected by future changes in regulations and socially acceptable business practices. It is not surprising that active portfolio managers, who rely on fundamental analysis and take concentrated positions, tend to invest in well-managed firms in good businesses: These firms are better positioned to adapt to changing regulatory conditions and consumer tastes. Further, there is growing evidence that all else being equal, the returns on stocks of well governed, socially responsible firms may contribute less to portfolio risk.

(4)Many individual investors have ethical considerations about investments that are somewhat blind to fiduciary responsibilities. Easier access to information has allowed more people to become informed on these issues, and put pressure on money managers and firms to reduce negative externalities. Increasingly, investors are even demanding total divestment from fossil fuel interests.

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

Commentary on Question:
Candidates performed poorly on this part of the question. Candidates that did well explained how various environmental issues can significantly reduce a company's balance sheet, operations, cash flow or stock value. Full credit was awarded if candidates were able to connect the negative repercussions of various environmental crises when companies don't consider the ESG in their equity holdings. Candidates who did poorly tend to repeat their responses to part (a).

- Given their increased severity and frequency, environmental crises are more likely to cause sudden changes in regulations, technology, and consumer tastes. These rapid changes can cause large swings in asset prices, leaving investors with limited ability to react.
- By incorporating ESG criteria into their investment strategy, portfolio managers can proactively select firms which are well prepared to deal with these changes and protect themselves from downside risk.

3. **Continued**

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

Commentary on Question:
Overall, candidates performed as expected. Successful candidates were able to reasonably explained that back-testing ESG stocks would suffer from survivorship bias , the limitation of using the Sharpe ratio and so the method would not be appropriate.

- Sharpe ratio is not directly observable, and we must estimate it using whatever methods of evaluation we have at our disposal, yielding estimators.
- We would like to choose stocks with the highest Sharpe ratios, but because we only observe the estimated Sharpe ratios, it is tempting to select the stocks with the highest estimated Sharpe ratio.
- By selecting on the basis of imperfect estimates, we may be confounding genuine investment performance with random estimation error. In other words, by selecting the 50 stocks with the biggest estimated Sharped ratios, we hope to be getting the biggest Sharpe ratio, but we may, in fact, be getting some of the biggest estimation errors instead.
- Given the inherent noisiness of even the best investment performance evaluation methods, it is impossible to completely eliminate the estimation error.
- When you use the S&P 500 to rank ESG stocks based on Sharpe ratio that exist today for a back-test, you are only considering that stocks that are available or alive at this point. So you end up missing out on the stocks that are no longer listed. In fact, you consider only the stocks that have survived, ignoring the delisted one which introduces survivorship bias.

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

Commentary on Question:
Subsequent to the exam sitting it was determined this question was defective as it referenced dated syllabus material. Below illustrates the intended solution; however, the grading committee ensured candidates were not disadvantaged in their ability to pass this exam based on their performance on this part of the question.

- The first and most obvious method is to treat all investment performance records with a healthy dose of skepticism and acknowledge that even a stellar track record contains some element of sheer dumb luck. How much historical success is luck versus skill is another way of asking how much $\hat{\theta}_i$ is θ_i and how much is ϵ_i .

3.   Continued

- The second method is to use additional information to distinguish θ_i from ϵ_i. For example, if a manager claims to be a talented stock picker, we can check whether this manager's stock-picking success materially changed during bear markets; if so, then perhaps the manager's "skill" is more beta than alpha. If, on the other hand, the manager's stated strength is asset allocation, a standard performance attribution analysis lets us verify this claim by separating the manager's cumulative returns into market and asset-class timing, security selection, and other sources of value-added.
- The third and most direct way to distinguish between θ_i and ϵ_i is to conduct live out-of-sample experiments. Follow manager's performance over the course of the next year or two and evaluate the manager at the end of that period. By collecting new data on the manager's performance that are statistically independent of the past, we minimize backtest bias. If the manager's out-of-sample record is comparable to the backtest, then $\hat{\theta}_i$ may be more θ_i than ϵ_i.
- In each of these three approaches, we seek additional information that can confirm the link between $\hat{\theta}_i$ and θ_i. If we can't find such information, then the more likely explanation for attractive historical performance$\hat{\theta}_i$ is lucky ϵ_i.

4. **Learning Objectives:**
   3. The candidate will understand the variety and assess the role of equities in investment portfolios. The candidate will demonstrate an understanding of the distinguishing investment characteristics and potential contributions to investment portfolios of the following major asset groups:
   - Real Estate
   - Public Equity
   - Private Equity
   - Infrastructure
   - Commodities
   - Hedge Funds

Learning Outcomes:
(3b) Demonstrate an understanding of the types of equity investments available for an investor's growth allocation and their most important differences

(3c) Demonstrate an understanding of the investment strategies and portfolio roles that are characteristic of each equity investment

(3d) Explain the basic active equity selection strategies including value, growth and combination approaches, and compare techniques for characterizing investment style of an asset manager

Sources:
Maginn & Tuttle, Managing Investment Portfolios: A Dynamic Process 3rd Edition (Chapter 8.1-8.5)

Commentary on Question:
This question tests the candidate's understanding of the suitability and structure of private equity investments.

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

   Commentary on Question:
   Candidates performed above average on this section.

   Most candidates were able to correctly identify the longer time horizon of the pension plan and its ability to tolerate the risk profile of private equities.

   Some candidates received no credit for incorrectly arguing the high degree of diversification between public and private equities as a reason to incorporate private equity assets in the asset allocation decision.

4. **Continued**

Private equity investment bears higher risk than public equity investments. Since we only plan to invest 5% of the asset, the plan should be able to tolerate this higher risk. Private equity returns and public traded share returns have moderately high correlation. Private equity may be a moderate risk diversifier only.

The plan has a relatively longer time horizon as the plan is open to new entrants and has a younger membership profile. This indicates that the plan can tolerate:
- the illiquid nature of private equity investments
- the long-term commitments required by private equity investments
- the higher risk than seasoned public equity investments

Therefore, private equity is suitable for XYZ pension plan.

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

Commentary on Question:
Candidates performed above average on this section.

Most candidates were able to define the fee structure of a typical private equity fund. Those candidates that also provided an explanation of how the fees are applied received full credit.

- Management fee is a flat fee of 2%, on limited partner commitments to the fund.
- Carried interest is fund manager's incentive fee of private equity fund's total profits; the 20%, means that the fund manager's share of the profit.
- Preferred return is the hurdle rate that fund manager has to reach to get the carries interest. The 6% means the fund manager will not get any share unless the profit is above 6%.
- Under the claw-back provision, the fund manager returns specified amount of money if at the end of a fund's life if investors have not received back their capital contributions and share of profit.

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

Commentary on Question:
Candidates performed as expected on this section.

Most candidates were able to correctly carry out the calculation of management fee, carried interest, and preferred return. Candidates received credit for using arithmetic averaging to derive the annual return.

4. Continued

- Year 1 net return: 12.7% - 2.0% - 20% · (12.7% - 6.0%) = 9.36%
- Year 2 net return: 4.5% - 2.0% = 2.5%
- Year 3 net return: 7.8% - 2.0% - 20% · (7.8% - 6.0%) = 5.44%

The average annual return is therefore:

$[(1+9.36\%)(1+2.5\%)(1+5.44\%)]^{\wedge}(1/3) - 1 = 5.73\%$

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

Commentary on Question:
Candidates performed as expected on this section.

Most candidates were able to correctly point out the differences in investment vehicles between direct and indirect private equity investments.

Direct private equity is an investment in the preferred convertible stock of a private company, which is senior to common stock in its claims to liquidation value. An event (e.g. buyout or acquisition of its common stocks) will trigger the conversation of preferred stock into common stock.

In contrast, indirect private equity is invested through venture capital or buyout funds. Funds are typically structured as limited partnerships or limited partnership companies with an expected lifetime of 7 to 10 years. The fund manager's objective is to realize the value of the investment portfolio investment by the fund's liquidation date.

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

Commentary on Question:
Candidates performed below average on this section.

Many candidates repeated their response from part d) without considering the question in the context of XYZ pension plan.

The purpose of the private equity investment is to increase the investment return and diversification of the portfolio and indirect private equity is recommended.

With indirect private equity, the pension plan can benefit from the fund manager's ability to select worthy investment opportunities, maintain active involvement in the course of the investment, and shore up weaknesses in the company's management.

4. **Continued**

Direct private equity, on the other hand, would require the pension plan to conduct additional due diligence to identify opportunities, which the pension plan may not have expertise in.

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

Critique the CEO's choice.

Commentary on Question:
Candidates performed below average on this section.

Most candidates did not provide the correct definition of the concept of dividend recapitalization and its effect on leverage.

Some candidates disagreed with the strategy without giving proper justification, and did not receive credit.

Dividend recapitalization involves the issuance of debt to finance a special dividend to owners, sometimes refinancing existing debt in the process.
It is not to use dividend recapitalization to increase the fund returns in the short term while weakening the company by overleveraging it. XYZ pension plan should consider the long-term aspects of the investments to be consistent to the long-term nature of the plan.

5. **Learning Objectives:**
1.　　The candidate will understand how to work with the variety of fixed income instruments and evaluate fixed income portfolios.

Learning Outcomes:
(1a)　Describe the cash flow of various fixed income securities considering underlying risks such as interest rate, credit and event risks

Sources:
Fabozzi, chapters 12, 21, 23 and QFIC-135-19: High Yield Bond Market Primer

Commentary on Question:
This question tested the ability to identify and describe the risks in the underlying cash flows for several securities, and has a related callable bond calculation. Candidates achieve full credit for identifying the false statements relating to preferred stock, explaining the advantages of extendible reset bonds.

Solution:
(a)　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.

Explain why 4 of the above statements are false.

Commentary on Question:
Candidates performed as expected on this question. Many identified the false statements correctly. Some candidates added explanations for each.

Statements II, IV, V, and VI are false. Dividends are fixed on preferred stock, it has no maturity date, the market would demand greater compensation, and it is rated the same as corporate bonds, respectively.

5. Continued

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

Commentary on Question:
Candidates performed below average on this question. Many identified the advantage of holding the bond but few identified a disadvantage.

The advantage is that the coupon rate will reset to the market rate, keeping the issue at par. The disadvantage is experience has been poor during periods of difficulty in the high yield bond market. Thus, sharp increases in default rates will require rate increases so high that they cause default risk.

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

Commentary on Question:
Candidates performed brilliantly on this question. Most identified and explained all three advantages.

They are ideal for cash equalization, transition management, and tactical allocation. ETFs provide greater access to the fixed income market, establish the target porfolio's exposure, and combine the liquidity of futures and the diversified exposure of and index total return swap.

(d) Calculate the call price of the bond

Commentary on Question:
Candidates performed below average on this question. Most set up the calculation of the initial bond price. Some completed it. Few completed the second step below equating the value upon call equal to the current price.

First calculate the initial price of the bond
YTM = 4%
Semi-Annual coupons of 3%/2 = 1.5%

Period (0.5 yr)	Cashflow	Discount factor @ 2.0%	Discounted CF @ 2.0%
1	1.5	.980	1.47
2	1.5	.961	1.44
3	1.5	.942	1.41
4	101.5	.924	93.77
	Price		98.10

Second, calculate the call price, X by setting up the PV of cashflows to equal to the initial bond price.

5. **Continued**

Since the bond is called at the end of year 1 there are only 2 cashflows

Period (0.5 yr)	Cashflow	Discount factor @ 3.0%	Discounted CF @ 3.0%
1	2.0	.971	1.46
2	2.0 + X	.943	(1.5 + X) *.943
	Equal to initial price		98.10

$1.46 + (1.5 + X).943 = 98.10$
Call price, $X = \$101.03$

6. **Learning Objectives:**
4. The candidate will understand the nature, measurement and management of liquidity risk in financial institutions.

Learning Outcomes:
(4b) Demonstrate an understanding of various liquidity measurement tools and metrics

Sources:
QFIP-134-19: Quantitative Credit Portfolio Management, Ben-Dor, et. al., 2012, Ch. 5, 6

Commentary on Question:
This question tests the candidate's comprehension of the relationship between bond liquidity and returns and the decomposition of bond spreads into liquidity, risk premium, and default components.

Solution:
(a) Explain the relationship between the LCS and the excess returns over the US treasuries for the two bonds.

    (i)   in 2010

    (ii)   in 2016

Commentary on Question:
The candidates performed as expected on this section. While most candidates explained the relationship between LCS and excess returns, many did not directly explain the movements for the two bonds specifically.

    (i)   During times of good market liquidity, potential buyers of a bond with a higher LCS would demand a higher yield.
Bond Y has a higher LCS than Bond X, indicating lower liquidity. Therefore, we would expect Bond Y to have a higher excess return over the US treasuries when compared to Bond X.

    (ii)   During times of a market liquidity crisis, when liquidity risk is realized, severe mark to market impact of holding illiquid bonds can produce large negative excess returns.

        Bond Y has a higher LCS score indicating lower liquidity. Conversely, Bond X has lower LCS score, indicating higher liquidity. Bond Y returns are reduced by the mark to market impact of holding illiquid bonds (the returns remained level from 2013 to 2016). Bond X returns are less impacted by mark to market (the returns increased from 2013 to 2016).

6.   **Continued**

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

Commentary on Question:
Candidates performed as expected. The candidates either received full marks or very few points in this section.. In order to conclude on which bond to be added to the portfolio, the candidate must be able to calculate the default and liquidity costs to compare to the thresholds.

Only bond 2 meets the CIO thresholds and would qualify to be added to the portfolio.
Default Cost
Bond 1: 30% * (3.4% - 2.5%) = 27 bps
Bond 2: 15% * (4.0% - 2.5%) = 22.5 bps
Bond 3: 5% * (4.5% - 2.5%) = 10 bps

Liquidity Cost
Bond 1: (1-30%) * (3.4% - 2.5%) – 20 bps = 43 bps
Bond 2: (1-15%) * (4.0% - 2.5%) – 50 bps = 77.5 bps
Bond 3: (1-5%) * (4.5% - 2.5%) – 80 bps = 110 bps

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

Commentary on Question:
The candidates performed as expected on this section. Many candidates were able to explain that liquidity risk is a lesser concern in a buy and hold strategy but did not comment on the appropriateness of the default or risk premium components.

Under a buy & hold strategy, there should be less concern about liquidity risk since the company will be able to ride out periods of high liquidity cost.

Should have a higher tolerance for market risk (risk premium).

Should focus on the ceiling of the default component. With a focus on a lower default component, the ceilings appear appropriate.

7. **Learning Objectives:**
1. The candidate will understand how to work with the variety of fixed income instruments and evaluate fixed income portfolios.

Learning Outcomes:
(1a) Describe the cash flow of various fixed income securities considering underlying risks such as interest rate, credit and event risks

(1c) Demonstrate an understanding of the cash flow patterns and risks of whole loan commercial mortgages

Sources:
Commercial Real Estate Analysis and Investments, Miller & Geltner, 3rd Edition, 2014, Chapters 19 & 20

Handbook of Fixed Income Securities, Fabozzi, F.J., 8th Edition, 2012, Chapters 24 & 31

Commentary on Question:
This question tests the understanding of the cash flow patterns, risks and underlying drivers of commercial mortgage loans and mortgage-backed securities.

Solution:
(a) 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.

Commentary on Question:
The candidates performed below average on this section. Most candidates did not use the correct formula for the duration of equity. Many candidates only calculated asset values and asset durations and thus received partial credit. Some candidates omitted this part of the question.

$\text{Dur}(E) = -(\Delta E/E)/\Delta YTM = -((\Delta A - \Delta L)/E)/\Delta YTM$

Starting Asset Value = $50,000,000*(1.0275)^2/(1.03)^2 + $50,000,000 = $99,757,576 (Interest only loan MV = principal since coupon = yield)

Starting Liability Value = $75,000,000 + $20,100,000 = $95,100,000

Starting Equity = Starting Asset Value – Starting Liability Value = $4,657,576

New Asset Value = $50,000,000*(1.0275)^2/(1.0325)^2 + $\sum_{i=1}^{4}$($50,000,000 * .07)/(1.0725)^i$ + 50,000,000/(1.0725)^4 = $99,095,888

Market yield on CD = $20,000,000*1.03/$20,100,000 – 1 = 2.49%

7. Continued

New Liability Value = \$75,000,000 + \$20,000,000*(1.03)/(1.0274) = \$95,051,089 (demand deposits have 0 duration because depositors can move funds quickly to another institution if another institution offers better interest rates)

Dur(E) = -((($99,095,888-$99,757,576) – ($95,051,089-$95,100,000)) /$4,657,576)/.0025 = 52.6

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

Commentary on Question:
The candidates performed as expected on this section. Many candidates provided two or more valid ways for ABC Bank to reduce its maturity gap. Partial credit was awarded for each acceptable recommendation.

- Make more short-term loans
- Make fewer long-term loans
- Buyer shorter dated, more liquid assets
- Issue floating rate or adjustable rate loans as they are less sensitive to interest rate changes
- Sell long-term loans in the secondary market
- Expand CD offerings to longer-term maturities than the current 1yr maturity offered
- Invest in derivative products such as interest rate swaps or interest only securities to hedge the interest rate risk

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

Commentary on Question:
The candidates performed poorly on this section. Most candidates did not consider the drop in fair value of the existing 1-year CD when determining the needed drop in fair value of the 5-year CDs. No candidates got the correct minimum face amount that needs to be converted. Many candidates omitted this part of the question.

Drop in fair value of its existing 1-year CDs = \$20M*1.03/1.0349 - \$20.1M = \$194,226

Therefore, ABC Bank needs a drop in the fair value of 5-year CDs = \$2.34M - \$194,226 = \$2,145,774

Drop in fair value of 5-year CDs = Face*[1–1.035^5/1.045^5] = \$2,145,774

---

7. Continued

To meet the limit, ABC Bank at a minimum needs to convert total face amount = $2,145,774/[1–1.035^5/1.045^5] = $45,713,243

The cost of converting $45.7M of demand deposits = 0.5%*$45.7M = $228,566

(d) Critique the quantitative analyst's recommendation.

Commentary on Question:
The candidates performed below average on this section. Many candidates correctly noted that the C tranche (most junior tranche) would be the first to absorb principal losses and would only receive interest based on the assumed default rate, and it therefore would have the lowest return. However, most candidates did not calculate the cash flows and IRRs for each tranche to support their assertion that the C tranche has the lowest expected return and thus were awarded partial credit. Most candidates did not provide a recommendation on which tranche to invest in. Some candidates omitted this part of the question.

CFs and IRRs for each of the tranches are below. IRRs are used to compare the value of each tranche using the specified assumption for the default rate.

Interest CFs = Par Value * Coupon % (cash flows get allocated to interest first)

Principal CFs:
IO Tranche Principal CF = 0 (this tranche only receives interest)
C Tranche Principal CF = 0 (losses get allocated to most junior tranche first, expected defaults are 1.5M which is greater than the 1M of par in this tranche)
B Tranche Principal CF = 24 – 0.5 = 23.5 (remaining .5M of losses get allocated to B tranche since it is subordinate to the A Tranche)
A Tranche Principal CF = 75 (no losses left to allocate, A tranche gets all of its principal)

Total CF = Interest CF + Principal CF

IRR = Total CF / Price – 1

Tranche	Interest	Principal	Total	Price	IRR
A	4.50	75.00	79.50	74.40	6.85%
B	1.74	23.50	25.24	23.80	6.05%
C	0.31	0.00	0.31	0.30	3.33%
IO	1.89	0.00	1.89	1.78	6.18%

7. **Continued**

The quantitative analyst's recommendation is inaccurate. The C tranche has the lowest IRR, despite its large coupon rate, due to the expected defaults. Instead, the quantitative analyst should have recommended the A tranche as it has the highest IRR.

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

Commentary on Question:
The candidates performed below average on this section. Some candidates provided four or more collateral characteristics with appropriate descriptions. Many candidates just listed collateral characteristics without any description and thus did not receive credit.

- Fixed vs hybrid rate loans: hybrid loans could face payment shock if rates increase, and hybrid borrowers also tend to be leveraged more and thus perform worse
- Vintage: refers to origination year, which is important since underwriting standards have changed significantly over the years ('06/'07 standards were particularly loose)
- Loan-to-Value Ratio: measure of how little equity the borrower has in the house. Higher LTVs mean the borrower has less equity and is more likely to be delinquent/default
- Credit Score: Used to help predict the borrower's credit and prepayment performance. Higher credit scores imply better credit performance.
- Debt-to-Income: Debt-to-Income is a measure of the borrower's ability to pay. Higher ratios imply lower ability to pay.
- Documentation: Lenders typically require documentation of the borrower's income and assets (paystubs, W-2s, bank statements, etc.). Loans underwritten with incomplete/no documentation are riskier.
- Geography: Local economies and housing markets have a material impact on mortgage credit performance. Distressed areas will have worse performance
- Negative Amortization and Recast: loans that allow minimum payments below the monthly interest amount are riskier, as they increase the LTV and stretch borrower's ability to pay. Once negative amortization limit is hit, loan will recast and start to amortize down, and the monthly payments increase.
- Other acceptable answers with appropriate description: loan purpose, occupancy, interest only vs. amortization, property type, prepayment penalties, lien status

7. Continued

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

Commentary on Question:
The candidates performed as expected on this section. Most candidates correctly stated that the negative convexity is caused by changes in prepayment rates and also that as interest rates decrease, prepayments increase due to borrowers refinancing their mortgages. Most candidates, however, did not mention that RMBS prices underperform relative to other assets without prepayment exposure and thus were awarded partial credit.

- The negative convexity is caused by changes in prepayment rates.
- As interest rates increase, prepayments tend to slow, as there is less/no incentive for borrowers to refinance. This causes duration and average life of the RMBS to extend.
- Conversely, prepayments tend to increase when interest rates decrease as more borrowers refinance their mortgages. This will shorten duration and average life of the RMBS.
- Negative convexity causes RMBS prices to underperform relative to other assets without prepayment exposure.
- As rates rise, duration extends, which causes prices to fall more. As rates fall, duration shortens, which results in less price appreciation.
- Investors are compensated for taking on this prepayment risk through higher base-case yields.

8.

Learning Objectives:
2.   The candidate will understand:
- The credit risk of fixed income portfolios, securities, and sectors and be able to apply a variety of credit risk theories and models.
- How rating agencies rate corporate and sovereign bonds.

Learning Outcomes:
(2a)   Demonstrate an understanding of credit risk analysis and models

(2f)   Understand and apply various approaches for managing credit risk in a portfolio setting

Sources:
Bouteille, Handbook of Credit Risk Management, Chapter 1, 4, 5 and 9

Commentary on Question:
This question tested candidates understanding of credit risk and of various approaches for managing that risk. They needed to correctly identify the risk present in this case. Candidates performed below average on that question. They were often asked to both list and describe or explain. When the lists were there and correct, the description or explanation were sometimes missing or deficient.

Solution:
(a)   Describe each strategy's credit risk and any implications.

Commentary on Question:
Candidates performed as expected on this part. We expected them to recognize that the three strategies increased the credit risk and how and why that credit risk increased. Not many candidates identified the implications from those strategies, especially the capital implications.

-High-yield bond
        -high-risk/high-reward
        -high risk of default, thus increase credit risk
        -increase the capital needed
-Derivative position
        -introduce counterparty risk
        -may reduce risk by:
                -requiring collateral
                -carefully choosing counterparty
                -avoid concentration by spreading exposure across different counterparties

8. Continued

        -Stop loss reinsurance
                -counterparty risk
                        -subject to financial health of the reinsurer
        -All 3 strategies increase credit risk
        -Size of credit risk should be measured with due diligence
        -Increased capital requirements

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

        Commentary on Question:
        *Candidates performed as expected on this part. They generally identified the
        dimensions correctly, but the description was often missing. The description did
        not need to be long and detailed.*

        -exposure
                -amount of money at risk
        -default probability
                -likelihood of default
        -recovery rate
                -amount of money relative to exposure that can be recovered
        -tenor
                -time period in which some or all of the money is outstanding

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

        Commentary on Question:
        *Candidates performed below average on this part. They mostly correctly
        described the basic of stress testing, but answers were short and incomplete. The
        main idea was to identify what stress testing is doing that VAR is not doing, and
        how: in particular, financial consequences of event occurring in the tail of the
        distribution, beyond the VAR definition.*

        Stress-testing:
                -evaluating economic consequences of unexpected but plausible events
                -allow for looking at extreme and hypothetical events
                -company specific scenarios: no one size fits all
                        -must identify main factors that influence financial performance

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8. **Continued**

Value-At-Risk:
  -parameters reflect historical economic circumstances
  -capture data across economic cycles
  -may fail to account and evaluate event in the tail of the distribution, which stress testing can
  -VAR adds a probability dimension to the mark to market concept
      -probability-weighted distribution of exposures

(d) 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.

Commentary on Question:
Candidates performed below average on this part. Most answered with an almost complete list for level 1 CPM, but a description of each item was required for full credit. The list on its own was only given partial credit even if complete. The descriptions did not need to be long. 4 items for each level, along with descriptions, were required to receive full credit.

Level 1: Basic CPM
  -Aggregation : measuring accumulation of risk for each counterparty
  -Reporting : frequent and regular update on the content of the portfolio
  -Credit limit : Define and implement the absolute amount of exposure the firm wants to take.
  -Surveillance : monitoring the performance
  -Mitigation : transfer of risk

Level 2 : intermediate CPM
  -Capital: quantification of the required capital at the firm's level
  -Allocation of capital and profitability at transaction level
  -Stress testing : evaluation economic consequences of unexpected events
  -hedging strategy: managing the risk of unwelcomed risk by buying protection or any other transaction that reduced consequences from those risk (definition of hedging)
  -rebalancing :optimize the allocation of capital by updating the composition of the portfolio.

9. **Learning Objectives:**
5. The candidate will:
- Demonstrate an understanding of regulatory and accounting frameworks around investment governance.
- Understand how to develop an investment policy including governance for institutional investors and financial intermediaries within regulatory and accounting constraints.
- Understand how rating agency frameworks affect portfolio construction and management.

Learning Outcomes:
(5f) Analyze international accounting treatment for insurance liabilities and the investments and hedging that supports them

Sources:
LFV-648-19: PwC In depth A look at current financial reporting issues IFRS 17, Jun 2017 (p2, p7-9. p22-24, p84).

Commentary on Question:
This question tests IFRS 17 implication on life insurance products with specific consideration of the investment component and its accounting treatment.

Solution:
(a) Compare and contrast distinct and non-distinct "investment components" under IFRS 17.

Commentary on Question:
Candidates performed below average on this part..

Most candidates generally were able to identify the "separability" of distinct investment components as compared to non-distinct, but unsuccessful candidates failed to accurately illustrate the appropriate actuarial accounting treatment to apply to distinct vs. non-distinct.

An investment component is an amount to repay to a policyholder even if an insured event does not occur.

Investment component can be distinct or non-distinct

For investment component to be distinct, it needs both following conditions to be met:
1. not highly interrelated with the insurance component; and
2. is a contract with terms equivalent to the investment component is sold or could be sold, separately in the same market or jurisdiction.

9. **Continued**

Distinct investment component is accounted as a financial instrument within the scope of IFRS 9, and similarly, receipts and repayments of such investment components recognized in revenue and claims.

Non-distinct investment, on the other hand, is not separated from the insurance contract.

Cash flow from the non-distinct investment component
1. is accounted together with the insurance contract; and
2. is measured at a probability-weighted basis; and
3. is discounted using the same rate as other cash flows from insurance contract; and
4. is excluded from insurance revenue and insurance service expenses in the statement of profit and loss.

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

Commentary on Question:
Candidates performed below average and in general did not demonstrate a clear and comprehensive understanding of key considerations surrounding the components of the discount rate within the IFRS 17 framework.

Successful candidates were generally able to list "bottom up" and "top down" approaches to determine the discount rate.

IFRS 17 does not specify whether the insurer should use a yield curve or single discount rate.

IFRS 17 does not permit the use of an asset-based discount rate if asset return does not affect the CF of insurance contracts but could be a starting point.

For accretion of interest on the CSM of current portfolio of products, with the general method, required to use interest rates locked in at the inception of the group insurance contracts.

Characteristics of CF and liquidity of insurance contracts must be reflected.

Consistent with observable current market prices for financial instruments with CF whose characteristics are consistent with the insurance contracts in terms of timing, currency and liquidity.

Exclude the effect of factors that influence such observable market prices but do not affect future CF of the insurance contracts.

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9. **Continued**

If negative interest rates in the current economic environment, then should use it with IFRS 17.

Since time value of money is independent from estimate of future cash flow, risk of changes in discount rates is therefore not part of the risk adjustment.

Two methods to determine the discount rate: The "bottom up" approach and the "top down" approach both reflecting the characteristics of the liability.

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

Commentary on Question:
Candidates performed poorly and generally lacked clear understanding of the concepts and actuarial practices in regard to policy loans under IFRS 17.

Specifically, candidates more than often failed to apply non-distinct investment component accounting treatment to policy loans within IFRS 17 framework.

With the separation of insurance contracts, we need to distinguish the investment component.

For the investment component, we need to determine if it is distinct or not.

In this case it is non-distinct since policyholder loan depends on whether the contract is in force. So, this component for policy loan is not separated from the insurance contract.

Then payments of interest and principal are measured on a current probability weighted basis and discounted with other cash flow of the insurance contract using the same discount rate.

Under IFRS 17 policy loans are no longer separately visible on the balance sheet. Cash flows do include components that might sometimes be seen as separate but are not separated under IFRS 17 such as policy loans, and repayments of policy loans as well as interest accrued on outstanding loans are part of fulfillment cash flows.

10.

Learning Objectives:
7.   The candidate will understand the need for and goals of assessing the performance of a portfolio, and the methods and limitations of performance attribution.

Learning Outcomes:
(7b)   Apply performance measurement methodologies to various asset portfolios

(7c)   Describe and assess techniques to select or build an asset benchmark for a given investment objective

(7d)   Assess and interpret performance attribution metrics for a given asset or portfolio

Sources:
Managing Investment Portfolios, Maginn & Tuttle, 3rd Edition, 2007, Ch. 12

Commentary on Question:
This question tests the concept of performance measurement and attribution.

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

   Commentary on Question:
   The candidates performed brilliantly on this section. Most candidates successfully identified the LIRR approach and chain-link method. A few candidates did not receive credit for providing answers to why you would approximate a time-weighted rate of return.

   Use a linked internal rate of return (LIRR) approach to approximate a time-weighted rate of return for the entire year of 2019. This approach takes the money-weighted rate of return values and then chain-links the returns over the entire evaluation period.

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

   Commentary on Question:
   The candidates performed as excepted on this section. Those candidates that specified that large cashflows and volatile swings would affect time-weighted return received full credit. Some candidates received partial credit for simply saying that the cashflows have an impact on time-weighted rate of return.

10. **Continued**

Only under unusual circumstances would the LIRR fail to provide an acceptable representation of the time-weighted return. Specifically, the LIRR would fail if both large external cash flows (generally over 10 percent of the account's value) and volatile swings in subperiod performance occurred during the evaluation period.

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

Commentary on Question:
The candidates performed above average on this section. Most candidates successfully calculated the time-weighted rate of return.

rLIRR = $(1 + 5.3\%) * (1 - 3.2\%) * (1 + 4.5\%) * (1 + 1.2\%) - 1 = 7.8\%$.

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

Commentary on Question:
The candidates performed above average on this section. Most candidates successfully calculated two or three performance impact factors. Partial credit was given to those candidates that just calculated the factors without providing proper comments and analysis.

The performance impact of the technology sector allocation:
$(12.41\% - 16.20\%) * (-0.25\% - 0.66\%) = 0.03\%$
The decision to underweight a sector that performed worse than the overall benchmark resulted in a positive contribution to the performance of the portfolio relative to the overall benchmark.

The performance impact of security selection within the technology sector:
$16.20\% * (2.05\% - (-0.25\%)) = 0.37\%$
The portfolio held technology stocks that in total performed better than the aggregate performance of the technology stocks contained in the sector benchmark, indicating the security analysts outperformed the benchmark by identifying significantly mis-valued securities and recommending appropriate action.

The allocation / selection interaction return for technology:
$(12.41\% - 16.20\%) * (2.05\% - (-0.25\%)) = -0.09\%$

10. Continued

(e)

    (i)   Calculate the specific or unexplained return component.

    (ii)   Interpret the attribution.

Commentary on Question:
The candidates performed poorly on this section. Some candidates correctly calculated specific and unexplained components, but only a few candidates properly interpreted the attribution. Candidates that simply stated that the fund underperformed due to negative factors received partial credit.

    (i)   The portfolio manager's investment skill or value added = 6.05% - 5.85% = 0.20%
The return due to specific (unexplained) = 0.20% - (5.76% - 5.85%) – (5.24% - 5.85%) – (6% - 5.85%) = 0.75%

    (ii)   The unexplained return is so large, which suggests it might miss fundamental risk factor or economic sector in the attribution. Or it could indicate the benchmark or normal portfolio is not based solely on the exposures to investment risk factors. In this case, the benchmark portfolio will have a specific or unexplained return component. The difference between it and the portfolio's specific return should be attributed to the investment manager.

11.

Learning Objectives:

2.   The candidate will understand:
- The credit risk of fixed income portfolios, securities, and sectors and be able to apply a variety of credit risk theories and models.
- How rating agencies rate corporate and sovereign bonds.

Learning Outcomes:

(2a)   Demonstrate an understanding of credit risk analysis and models

(2c)   Apply both threshold and statistical models of the term structure of defaults to analyze credit risk exposure

Sources:

Credit Risk Modelling, Bolder, 2008, Chapter 4

Commentary on Question:

This question tests the candidates understanding of one-factor Guassian Vasicek limit loss models.

Solution:

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

   Commentary on Question:
   Candidates performed below average on this part. Candidates that identified and briefly described each of the points mentioned below received full credit. Most candidates received some credit for describing only the first and second bullets.

- The probability of default is the same for each obligor or the portfolio is homogenous.
- Each obligor in the portfolio has the same exposure, recovery, and loss given default. The portfolio is infinitely grained.
- $p(G)$ is strictly a decreasing function of G, decreases in G will lead to increased probability of default.
- The target variable, number of defaults in the portfolio, is redefined from Dn to Dn*=Dn/N , which is the proportion of defaults in the portfolio.

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

   Commentary on Question:
   Candidates performed poorly on this part. Most candidates did not receive credit for using an incorrect formula, Many candidates that used the correct formula received full credit.

11. Continued

$$P(Dn^* \leq x) = \Phi((\sqrt{1-\rho} \cdot \Phi^{-1}(x) - \Phi^{-1}(p))/\sqrt{\rho})$$

x = 15/1000 = 1.5%

ρ = 10% *based on the latent variable*

p = 1%

$P(Dn^* \leq x)$ = 80%

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

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

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.

Describe drawbacks of this revised model.

Commentary on Question:
Candidates performed below average on this part. Most candidates received partial credit for identifying one or two drawbacks. Those candidates that identified at least four of the points mentioned below received full credit.

- The gamma distribution lacks a power tail
- The model lacks positive tail dependence.
- The models are not analytically tractable.
- Require specialized functions and large number of computations, slowing determination of risk measures
- The models are not popular and do not appear often in the academic literature

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

Commentary on Question:
Candidates performed poorly on this part. Some candidates did not utilize the information provided on the kurtosis and received no credit. Those Candidates that recognized the correct formula and were successfully able to solve for the answer received full credits.

cov(y_n, y_m) = $\rho \cdot E[V]$

$E[V^2] / E[V]^2 = 4/3$

$E[V^2] = E[V]^2 * 4/3$

$= (\text{cov}(y_n, y_m) / \rho)^2 * 4/3$

$= (8\% / \rho)^2 * 4/3$

$= 0.8 \wedge 2 * 4/3$

$= .8533$

12. **Learning Objectives:**
4. The candidate will understand the nature, measurement and management of liquidity risk in financial institutions.

Learning Outcomes:
(4a) Demonstrate an understanding of liquidity risk and the threat it represents to financial intermediaries and markets

(4b) Demonstrate an understanding of various liquidity measurement tools and metrics

(4d) Apply liquidity risk models using scenario analysis with various time horizons

(4e) Understand and apply techniques to manage stress liquidity risk

Sources:
QFIP 123-16: CRO Forum Note

QFIP 105-13: AAA Report of the Life Liquidity Working Group

Commentary on Question:
This question tests the concepts of liquidity risk management, first by defining principles of liquidity risk management, followed by engaging in the calculation of liquidity ratios under different time horizons and given stress scenarios, with applications to the calculation of liquidity source requirements, and finally the selection of feasible liquidity management tools under the setting of the question.

Solution:
(a) List four principles of liquidity risk management.

> **Commentary on Question**:
> *Candidates performed as expected on this section. Many candidates received full credit for listing four of the eight principles provided in the reading. A common mistake candidates made was listing the tools of liquidity risk management instead of the principles.*

1. Liquidity risk is an asset/liability concern
2. Mgmt. should set its tolerance for liquidity risk by using qualitative and quantitative tools
3. Cost of securing liquidity should be reflected in product design and valuation
4. Strategic asset allocation & contingent liquidity planning should directly reflect expected & contingent liquidity needs of liabilities
5. Company should manage access to financial markets
6. Mgmt. should require written liquidity risk policy be maintained
7. Company should maintain written liquidity stress mgmt. plan that is approved by senior management
8. Requiring capital to provide for liquidity risk is ineffective means of managing this risk

12. Continued

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

Commentary on Question:
Candidates performed below average on this section. Most candidates received partial credit for demonstrating an understanding of liquidity ratios. Those candidates that were able to correctly calculate asset and liability values under the given stress scenarios received full credit.

Scenario	Liquid Asset Value	Liability Value	Ratio
Elevated Withdrawal	250	225 = 75% x 300	1.111
Market Crisis	212.5 = 250 x (1- (150% x 50/500))	225 = 75% x 300	0.944

Partial marks were granted for the correct calculations of asset and liability values under the given stress scenarios shown in the table.

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

Commentary on Question:
Candidates performed below average on this section. Most candidates received partial credit for showing the correct approach to determining the required line of credit, A few candidates received full credit for successfully solving for the required line of credit.

The most adverse liquidity stress is under market crisis scenario for 1 month. The liability value is given by: 90% x 300 = 270.
Under the liquidity ratio constraint, the asset value needs to be 115% of 270 = 310.50.
Therefore, asset value before line of credit is 212.5.
Hence, the required line of credit of 310.5 – 212.5 = 98.0.

Partial marks were granted for miscalculated asset values carried over from part (b).

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

Commentary on Question:
Candidates performed below average on this section. Many candidates received credit for mentioning improving asset liquidity but only a few received full credit for providing specific examples of instruments and derivatives to purchase.

12. Continued

1. Laddering asset maturities to closely match liability maturities
2. Entering repurchase agreements to meet short-term liquidity needs. This may allow company to hold onto liquid assets while allowing for orderly divestment of the less liquid ones.
3. Purchasing credit derivatives that pay in the event of downgrade or spread widening.
4. Purchasing liquidity options.
5. Purchasing equity put options.

13.

Learning Objectives:
2.   The candidate will understand:
- The credit risk of fixed income portfolios, securities, and sectors and be able to apply a variety of credit risk theories and models.
- How rating agencies rate corporate and sovereign bonds.

Learning Outcomes:

(2a)   Demonstrate an understanding of credit risk analysis and models

(2b)   Demonstrate an understanding of the basic concepts of credit risk modeling such as probability of default, loss given default, exposure at default, and expected loss

(2c)   Apply both threshold and statistical models of the term structure of defaults to analyze credit risk exposure

(2d)   Demonstrate an understanding of modeling approaches for correlated defaults

(2f)   Understand and apply various approaches for managing credit risk in a portfolio setting

Sources:

The xVA Challenge: Counterparty Credit Risk, Funding, Collateral, and Capital, Gregory, Jon, 3rd Edition, 2015, Chapter 3, 4 and 12

Commentary on Question:
This questions tests candidates' understanding of risks associated with the OTC derivatives market, computations used in credit risk modeling, and strategies for mitigating counterparty credit risk. Overall, candidates performed as expected on this question.

Solution:

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

     Commentary on Question:
     Candidates performed as expected on this question. Successful candidates clearly described all four classification groups and provided relevant risks associated with each group. Candidates who did poorly tended to only list the classifications without any description of relevant risks.

     Derivatives are typically divided into the following types by the way they are collateralized and transacted:
- Exchange traded: most simple and liquid derivatives that are centrally cleared and collateralized.
- OTC centrally cleared: more complex and illiquid, standardized OTC contracts are centrally cleared.

13. Continued

- OTC collateralized: not centrally cleared but counterparties post collateral.
- OTC uncollateralized: not centrally cleared and uncollateralized.

In terms of risks:
- Exchanges and central clearing has the least amount of counterparty credit risk, but is not immune to systemic risks.
- OTC contracts are relatively more complex, non-standard, and therefore have more liquidity risk.
- Collateralized transactions have less counterparty risk but collateral risks including operational risk, market risk and liquidity risk are still relevant. While the netting mechanism mitigates the counterparty risk, it creates legal risk in some cases.
- Uncollateralized derivatives have the most counterparty credit risk.

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

Commentary on Question:
Candidates performed above average on this question. Most candidates were able to define both risk-neutral and real-world probabilities, and explain their difference.

Real-world default probability is estimated from historical default data. Risk-neutral default probability is derived from market data using instruments such as bonds and CDSs.

Risk-neutral probability is larger than real-world due to an embedded premium i.e. risk-neutral probability = real-world probability + risk premium.

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

Explain the limitations of this approximation.

Commentary on Question:
Candidates performed poorly on this question. Candidates generally failed to provide limitations specific to the approximation from the "xVA Challenge" reading.

The formula is only an approximation because it does not account for the shape of the credit spread curve prior to the time t(i-1), and the more sloped the curve is, the worse the approximation.

13. Continued

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

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

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

Commentary on Question:
Candidates performed as expected on this question. Common mistakes made by candidates included not using the correct formula in part (i), or not recognizing that the formula produces unconditional probabilities when calculating the cumulative default probabilities in part (ii).

The approximation formula for default probabilities is:

$$PD(t_{i-1}, t_i) = \exp\left(-\frac{s_{t_{i-1}} t_{i-1}}{LGD}\right) - \exp\left(-\frac{s_{t_i} t_i}{LGD}\right)$$

Where,
$$LGD = 1 - \text{recovery rate}$$

Linearly interpolate to obtain year 3 credit spreads for each company:

Year	Company Beta3 (rated BBB)	Company Alpha2 (rated AA)	Company Alpha1 (rated A)
3	242	166	190

Compute the default probabilities using the approximation formula, where $t_{i-1} = 2$ and $t_i = 3$:

Year	Company Beta3 (rated BBB)	Company Alpha2 (rated AA)	Company Alpha1 (rated A)
3	2.480%	3.861%	2.926%

Compute the cumulative default probabilities using the approximation formula, where $t_{i-1} = 0$ and $t_i = 3$:

Year	Company Beta3 (rated BBB)	Company Alpha2 (rated AA)	Company Alpha1 (rated A)
3	9.852%	10.476%	9.063%

13. Continued

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

Commentary on Question:
Candidates performed above average on this question. Successful candidates discussed at least one advantage and disadvantage for each of the two strategies.

Option A is centrally cleared. Therefore, option A might actually have less credit risk, in spite of the lower credit rating of the counterparty.

It's also worth noting the contract with Company Beta3 has a lower recovery rate even though the PD is similar. However, the recovery process is often much longer for OTC contracts. If fast recovery is important to the company, option A is preferable. Otherwise, option B is preferable from a recovery standpoint.

We also see that the annual default probabilities are increasing at a very fast speed for Company Alpha2. This represents a significant settlement risk for option B.

Option B has two counterparties instead of 1 for option A. Since the correlation between the two counterparties is less than perfect, a diversification benefit is expected. However, correlation and dependency are difficult to estimate. A careful assessment is necessary if the company believes the correlation effect is significant.

14.

Learning Objectives:

6. The candidate will understand:
   - Investment dimensions of designing product offerings and managing inforce product liabilities.
   - Managing investment portfolios in the context of financial institution liabilities (asset liability management).
   - The theory and techniques of portfolio asset allocation.

Learning Outcomes:

(6a) Demonstrate an understanding of how the behavioral characteristics of individuals and firms influence liability design, management, and ALM

(6c) Evaluate the difficulties of investing for long tail liabilities (i.e. beyond 30 years) such as inflation indexed pension plans and secondary guarantee universal life insurance

Sources:

The Evolution of Insurer Portfolio Investment Strategies for Long-term Investing, OECD 2016, p 28-30

The Evolution of Insurer Portfolio Investment Strategies for Long-term Investing, OECD 2016, p 39

The Evolution of Insurer Portfolio Investment Strategies for Long-term Investing, OECD 2016, p 28-30p46-47

Commentary on Question:
This question tests candidates' knowledge of strategies related to long-term investing and how they affect insurers' asset liability management. Overall, the candidates performed below average on this question.

Solution:

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

   Commentary on Question:
   The candidates performed poorly on this section. Some candidates were able to name legal/regulatory risk and political risk. Many candidates did not read the question and only named interest rate and credit risks, which were specifically asked not to be included in the answer.

   Issues are:
   - High unemployment rate
   - Aging population
   - Legal/Regulatory
   - Political Risk

14. Continued

(b)   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.

Commentary on Question:
The candidates performed below average on this section. Many candidates received partial credit, where they were able to comment on changes related to assets and liabilities, and ALM mismatch risk.

There were multiple components to the question: the critique, and also how assets and liabilities would change from both an ALM and risk perspective. Most did not critique Tom's comment. Many also did not include any other risks than ALM, especially solvency and surrender risks.

Critique:
- The statement is incorrect. Low rate environment can cause distress for life insurers.
- Assets: Low interest rates could reduce profits through lower expected investment returns, particularly for life insurers that invest many of their assets in long-term, fixed income securities.
- Liabilities: The value of insurers' liabilities tends to increase when lower discount rates are applied.

Risks:
- Contagion risks from exposure to bonds: A deterioration of sovereign or corporate credit quality induces higher credit risks for insurers.
- Emerging risks such as cyber risk and health risk are of substantial concern to the insurance industry.
- ALM duration mismatch risks: Prevailing interest rates are substantially lower than that at inception, the existing stock of liabilities becomes more expensive to fund, as assets that come due are reinvested at a lower return.
- Surrender and mortality risk: Early death of or early surrender by policyholders are significant drivers of insurers' default risk.
- Solvency risk: Persistently low interest rates will have a strong negative impact on the solvency situation of insurers.

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

14. Continued

Commentary on Question:
The candidates performed below average on this section. Many candidates received partial credit. Most candidates were able to state the last two points (opting for more attractive investments elsewhere and assets need to be reinvested at a lower return). Few candidates mentioned default and liquidity risks.

- Early surrenders by policyholders are significant drivers of insurers' default risk
- Policyholder's surrender option requires liquidity from the insurer. Such liquidity needs to be supported by liquid assets, which reduces the insurer's capacity for investing in illiquid, long term assets.
- Policyholders, in times of highly volatile financial market returns, may opt for more attractive investments elsewhere. Life insurers have the incentive to offer higher guaranteed returns, with a consequent increase in their interest rate risk exposure.
- At the same time, insurers' assets that come due are reinvested at a lower return.

(d) Describe XYZ's two asset classes.

Commentary on Question:
The candidates performed above average on this section. Many candidates received full credit. Most candidates were able to describe both direct PE investment and infrastructure investment, their risks and returns well. Some did not state the liquidity issue or the long-term nature of both assets.

- Both are considered long term investments.
- Direct private equity investment: an investment is made directly into unlisted companies, financing innovative start-up companies.
- Risk/return: uncertain, consequently generating high risk premiums for investors.
- Long-term infrastructure projects can be in industrial, extractive, environmental and other projects/public services.
- Risk/return: face illiquidity risk, with a long economic lifetime and capital commitment of around 60 years.

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

14. Continued

Commentary on Question:
The candidates performed below average on this section. Many candidates received partial credit. Most candidates stated positive public relation as a benefit and investment horizon/correlation/liquidity as constraints. Few mentioned ratings, currency, accounting, solvency capital charges as constraints.

Benefits:
- It can be used to hedge against risks of investments associated with climate change.
- Green investments can have a positive public relation impact for insurers
- Potential returns to finance guarantee and expected profits
- Diversification

Constraints:
- Liquidity charges
- Investment time horizon
- Correlation with other existing asset classes
- Internal limits: company may have its investment policy that specifies either a maximum percentage of alternative investments or country (currency) exposure limits.

15. Learning Objectives:

5.   The candidate will:
   - Demonstrate an understanding of regulatory and accounting frameworks around investment governance.
   - Understand how to develop an investment policy including governance for institutional investors and financial intermediaries within regulatory and accounting constraints.
   - Understand how rating agency frameworks affect portfolio construction and management.

Learning Outcomes:

(5b)   Explain how investment policies and strategies can manage risk and create value

(5c)   Identify a fiduciary's obligations and explain how they apply in managing portfolios

(5d)   Determine how a client's objectives, needs and constraints affect investment strategy and portfolio construction. Considerations and constraints include:
   - Capital and expected return on allocated capital
   - Risk appetite and risk-return trade-off
   - Tax
   - Accounting
   - Regulators
   - Rating agencies
   - Liquidity

Sources:

Maginn & Tuttle, ch 3 (pages 68 – 69, pages 84 – 85) and Maginn & Tuttle, ch 5 (page 288)

Commentary on Question:

This question tests the candidate's understanding of DB and DC pension plans. In order to receive full credit, the candidate needs to know the feature of both plans, be able to determine a plan's risk tolerance based on the company's financial situation and employee demographics, and be able to identify the investment constraints of a plan with participants in different jurisdictions based on plan-specific information.

Solution:

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

Commentary on Question:

The candidates performed above average on this section. The candidates don't have to mention all the features to obtain full credits. Most candidates correctly concluded that the plan contains features from both DB and DC plans. Most candidates failed to recognize that the employer bore the investment risk of this plan. Some candidates failed to recognize that receiving a statement showing the balance of the fund account is a feature of DC plans.

15. Continued

It contains features from both DB and DC plans.

DC features:
- Employees see a fixed percentage of their salaries / contribution credit made as contribution to the fund account.
- Employees see an earning credit / fund growth to the account balance.
- Employees receive a statement showing the balance of the fund account.

DB feature:
- The employer bears the investment risk of a cash balance plan.

(b)

    (i)   Calculate the funding ratio of the plan.

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

Commentary on Question:
The candidates performed as expected on this section. In part (i), many candidates didn't include the 50 bps premium of the interest credits or the employer's contribution (6% of base salary) to the benefit credits. Only few candidates correctly calculated the total fund balance. Most candidates provided the correct formula to calculate the funding ratio. In part (ii), many candidates incorrectly concluded that the plan had a high risk tolerance, while providing one or more of the correct reasons, and thus received partial credit.

    (i)   The balance of the invested assets at the end of 2020 is:

           $50,000,000 \times (1 + (5\% + 0.5\%)) = 52,750,000$, plus
           $50 \times 100,000 \times (6\% + 6\%) = 600,000$

           Hence the total Fund balance is 53,350,000, which is 2.6% higher than the pension liability on the same date. 102.6% is the funded ratio.

    (ii)   XL's pension scheme appears to have a slightly above average risk tolerance, for the following reasons:

         a. The plan has a slight surplus (2.6% of plan liabilities) and is **overfunded** by 1,350,000.
         b. The company's balance sheet is strong (with reducing use of debt)
         c. The company is profitable in the past years
         d. However, the company's average age of its workforce is high.

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

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15. Continued

Commentary on Question:
The candidates performed below average on this section. The majority of candidates correctly concluded that the liquidity requirement was high and leverage was not permitted. Only few candidates correctly concluded that the time horizon is medium to long, and the plan needed to review applicable Canadian regulations. Some candidates mentioned the funding ratio of the plan, which was not part of the investment constraints.

Relevant constraints:

Liquidity – The plan should have a higher liquidity due to 35% of the participants are receiving payments and the ability for participants to take early retirement as a lump-sum.

Time Horizon - The time horizon is medium to long given the average remaining life of the retired population and that 65% of the participants are active.

Tax considerations – Not taxable as private plan.

Policies related to leverage – Not to be permitted per XL policy.

Restrictions on investment in foreign securities – Review applicable Canadian regulations.

Foreign currency management – Need to incorporate foreign currency strategy, either hedging or spot trading, given USD assets supporting CAD liabilities.

16.

Learning Objectives:

6.   The candidate will understand:
  - Investment dimensions of designing product offerings and managing inforce product liabilities.
  - Managing investment portfolios in the context of financial institution liabilities (asset liability management).
  - The theory and techniques of portfolio asset allocation.

Learning Outcomes:

(6a)   Demonstrate an understanding of how the behavioral characteristics of individuals and firms influence liability design, management, and ALM

(6b)   Develop and critique asset allocation strategies appropriate to underlying liability profiles such as pension plans and long tail insurance liabilities

(6c)   Evaluate the difficulties of investing for long tail liabilities (i.e. beyond 30 years) such as inflation indexed pension plans and secondary guarantee universal life insurance

(6d)   Understand and apply the concept of risk factors in the context of asset allocation

Sources:

Maginn & Tuttle, chapter 5, 7.7

Commentary on Question:

This question tests the concepts and applications of asset liability management for long tail insurance liabilities.

Solution:

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

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

  Commentary on Question:
  The candidates performed average on this section. Most students gave adequate answers for one dimension: cashflow matching versus duration matching (or immunization), but many missed the second dimension of static versus dynamic.

  - (i)
      1. Cashflow matching vs duration matching (or immunization)
      2. Static approach vs dynamic approach

16. Continued

(ii)
1. Duration matching. Given that ABC Life has long term liabilities and is exposed to significant interest rate risk, the duration matching strategy is more appropriate for ABC Life.
2. Dynamic approach. The risks embedded in the ABC Life's liability products are too complex and significant in volume, dynamic rebalancing strategy is more appropriate for ABC Life.

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

Commentary on Question:
The candidates performed well on this section. A few candidates failed to properly incorporate inflation or solved for the required return additively.

GrossRet = (1 + NetRet) * (1 + Inflation) * (1 + Cost of Investment) – 1
= (1+5%) * (1+2%) * (1+1%) – 1
= 8.17%

(c) 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%

Calculate A, B, and C in Table 2.

Commentary on Question:
The candidates performed well on this section. Those that did not do well failed to incorporate correlations and portfolio weightings to calculate A.

A = StDev(CornerPort2)
= sqrt[(EquityWeight * EquityVariance)^2 + (MortgageWeight * MortgageVariance)^2 + 2 * EquityWeight * MortgageWeight * EquityVolatility * MortgageVolatility * Correlation (Mortgage , Equity))
= sqrt(60%^{2} * 32%^{2}) + (40%^{2} * 12%^{2}) + 2*60%*40%*32%*12%*0.45
= 21.79%

16. Continued

B = SharpeRatio(CornerPort2)
  = [Ret(CornerPort2) – RiskFree) / StDev(CornerPort2)
  = (13% - 3%) / 21.79%
  = 45.90%

C = Ret(CornerPort24)
  = 11% * EQRet + 36% * BondRet + 40% * MortageRet + 13% *RealEstateRet
  = .11*.15+.36*0.05+.40*.10+.13*.12
  = 9.01%

(d)   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.

Commentary on Question:
The candidates performed well on this section. Those that did not do well did not solve for weights by interpolating between corner portfolios 4 and 5.

TargetRet = w*Ret(CornerPort4) + (1-w)*Ret(CornerPort5)
        w = (TargetRet – Ret(CornerPort5))/(Ret(CornerPort4)- Ret(CornerPort5))
        w = (8.17% - 7%) / (9% - 7%)
        w = 58.5%
Target Equity Weight = CornerPort4w1*w + CornerPort5w1*(1-w)
                = 11% * 58.5% + 2% * (1 – 58.5%)
                = 7.27%

Target Bond Weight = CornerPort4w2*w + CornerPort5w2*(1-w)
               = 36% * 58.5% + 70% * (1 - 58.5%)

(e)   ABC Life is considering two alternative approaches for portfolio optimization:

    (i)   Black-Litterman Approach

    (ii)   Experience-Based Approach

    Critique the above alternative approaches for portfolio optimization.

Commentary on Question:
The candidates performed average on this section. Most candidates provided a few characteristics of each approach. Most candidates failed to mention that the Black-Litterman approach is more stable and diversified than Mean Variance Optimization, and reduces estimation errors.

16. Continued

Black-Litterman Approach

This approach reverse-engineers the expected returns implicit in the diversified market portfolio (or reverse optimization) and combines them with the investor's own views on expected returns
in a systematic way that takes into account the investor's confidence in his or her views.
Black-Litterman Approach is more stable and diversified than Mean Variance Optimization, incorporates investor's view, and reduces estimation errors.

Experience-Based Approach

Most common experience-based approaches use tradition, experience and rules of thumb in making strategic asset allocation recommendations:
- 60/40 stock/bond asset allocation is appropriate or at least a starting point for an average investor's asset allocation.
- Allocation to bonds should increase with increasing risk aversion.
- Investors with longer time horizons should increase their allocation to stocks.
- A rule-of-thumb for the percentage allocation to equities is 100 minus the age of the investor

This approach is more appropriate for investment managers serving individual clients.