QFI PM Model Solutions
Spring 2023

1. **Learning Objectives:**

5.   The candidate will understand:

- The design and management of asset portfolios in alignment with investment objectives and strategies, including investments in fixed income, equity and alternative assets.
- The theory and techniques of portfolio asset allocation.

Learning Outcomes:

(5b)   Construct and manage portfolios of fixed income investments under various strategies, including indexing and target return.

Sources:

Managing Investment Portfolios: A Dynamic Process, Maginn & Tuttle, 3rd Edition, Ch 6

Commentary on Question:

This question tests the topics in constructing and managing portfolios of fixed income investments under various strategies, including indexing and target return.

Solution:

(a)   Assess which index fund (or funds) from the above table is most suitable for each of the three types of employees: "young", "mid-aged", and "near retirement".

Commentary on Question:

Candidates performed as expected on this part. Many were able to recommend one fund (and some were able to recommend more than one funds) to each of the three types of employees.

For young employees: the level of risk aversion is low, and the time-to-retirement is long. Therefore, the investment objective is mainly driven by achieving a long-term higher return in relation to bearing a higher risk. Fund A, B and D are suitable. Fund C may not be suitable

For mid-aged employees: both the level of risk aversion and time-to-retirement fall to medium range, so all of the four funds could be suitable.

1. Continued

For "near retirement" employees: the level of risk aversion is high, and time-to-retirement is short. Therefore, the investment objective is mainly driven by protecting the capital from the market loss. Fund B, C and D are suitable. Fund A may not be suitable.

(b) Explain how six different approaches could be used to reduce the tracking error.

Commentary on Question:
Candidates performed poorly on this part. Though some were able to correctly identify the approaches to reduce the tracking error, many answers were not directly related to tracking error reduction.
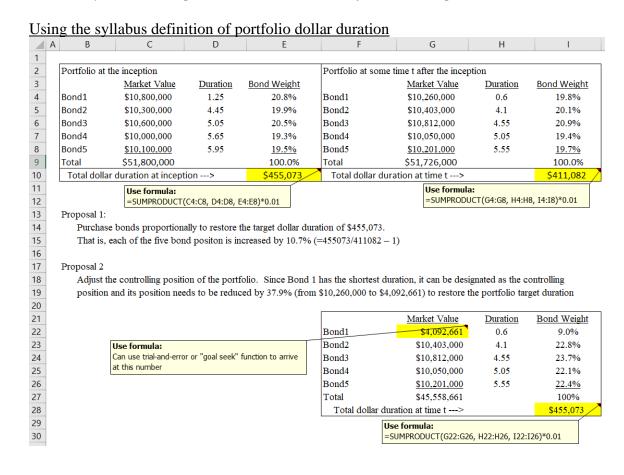
1. Reduce the duration mismatch between the portfolio and the benchmark. This helps when the yield curve exhibits parallel shift

2. Reduce the mismatch of key rate duration and the distribution of cash flows between the portfolio and the benchmark. This helps when the yield curve exhibits non-parallel shift.

3. Reduce the mismatch of "sector weight" and "quality weight" between the portfolio and the benchmark. This helps when the portfolio contains the same sector and quality exposure as the index. For example, a missing sector in the portfolio could lead to large tracking error if the sector is the main driver of the index movement.

4. Reduce the mismatch of sector duration. This ensures that the change in sector spreads has the same impact on both the portfolio and the index.

5. Reduce the mismatch of credit spread duration. Changes in the spread between qualities of bonds will also affect the index return. The easiest way to ensure that the indexed portfolio closely tracks the benchmark is to match the amount of the index duration that comes from the various quality categories.

6. Reduce the mismatch of sector/coupon/maturity cell weight with respect to callable bonds. This is more feasible than matching the convexity of the index especially for callable bonds which tend to be illiquid and expensive to trade.

7. Reduce the mismatch of issuer exposure. If the portfolio contains too few securities than the index, event risk could lead to large tracking error.

(c) Propose two different trades (without using derivatives) that could be done at time t to meet the target dollar duration requirement.
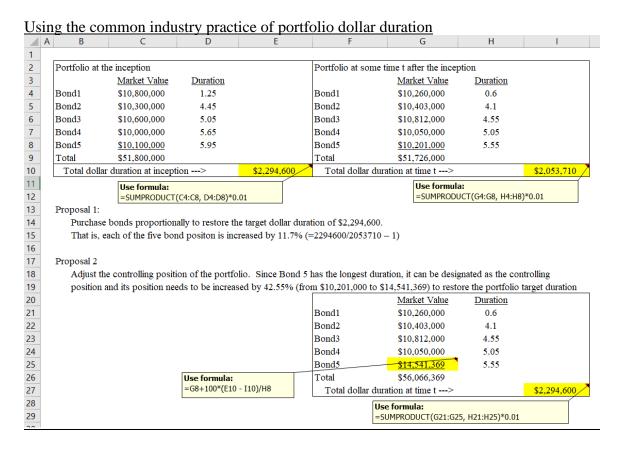
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1. Continued

Commentary on Question:
Candidates performed above expectations on this part. Two definitions of the "portfolio dollar duration" below were accepted as long as the proposed trade met the requirements:
   a. *Based on the syllabus material, the weighted average of dollar duration of each of the underlying securities.*
   b. *Based on the common industry practice, the sum of the dollar duration of each of the underlying securities.*
Since many trades were possible, shown below are just two examples.

Using the syllabus definition of portfolio dollar duration

	B	C	D	E	F	G	H	I
1								
2	Portfolio at the inception				Portfolio at some time t after the inception			
3		Market Value	Duration	Bond Weight		Market Value	Duration	Bond Weight
4	Bond1	$10,800,000	1.25	20.8%	Bond1	$10,260,000	0.6	19.8%
5	Bond2	$10,300,000	4.45	19.9%	Bond2	$10,403,000	4.1	20.1%
6	Bond3	$10,600,000	5.05	20.5%	Bond3	$10,812,000	4.55	20.9%
7	Bond4	$10,000,000	5.65	19.3%	Bond4	$10,050,000	5.05	19.4%
8	Bond5	$10,100,000	5.95	19.5%	Bond5	$10,201,000	5.55	19.7%
9	Total	$51,800,000		100.0%	Total	$51,726,000		100.0%
10	Total dollar duration at inception --->			$455,073	Total dollar duration at time t --->			$411,082
11		Use formula:				Use formula:		
12		=SUMPRODUCT(C4:C8, D4:D8, E4:E8)*0.01				=SUMPRODUCT(G4:G8, H4:H8, I4:I8)*0.01		
13	Proposal 1:							
14	Purchase bonds proportionally to restore the target dollar duration of $455,073.							
15	That is, each of the five bond positon is increased by 10.7% (=455073/411082 – 1)							
16								
17	Proposal 2							
18	Adjust the controlling position of the portfolio. Since Bond 1 has the shortest duration, it can be designated as the controlling							
19	position and its position needs to be reduced by 37.9% (from $10,260,000 to $4,092,661) to restore the portfolio target duration							
20								
21						Market Value	Duration	Bond Weight
22					Bond1	$4,092,661	0.6	9.0%
23		Use formula:			Bond2	$10,403,000	4.1	22.8%
24		Can use trial-and-error or "goal seek" function to arrive			Bond3	$10,812,000	4.55	23.7%
25		at this number			Bond4	$10,050,000	5.05	22.1%
26					Bond5	$10,201,000	5.55	22.4%
27					Total	$45,558,661		100%
28					Total dollar duration at time t --->			$455,073
29					Use formula:			
30					=SUMPRODUCT(G22:G26, H22:H26, I22:I26)*0.01			

1. Continued

Using the common industry practice of portfolio dollar duration

	A	B	C	D	E	F	G	H	I
1									
2		Portfolio at the inception				Portfolio at some time t after the inception			
3			Market Value	Duration			Market Value	Duration	
4		Bond1	$10,800,000	1.25		Bond1	$10,260,000	0.6	
5		Bond2	$10,300,000	4.45		Bond2	$10,403,000	4.1	
6		Bond3	$10,600,000	5.05		Bond3	$10,812,000	4.55	
7		Bond4	$10,000,000	5.65		Bond4	$10,050,000	5.05	
8		Bond5	$10,100,000	5.95		Bond5	$10,201,000	5.55	
9		Total	$51,800,000			Total	$51,726,000		
10		Total dollar duration at inception --->			$2,294,600	Total dollar duration at time t --->			$2,053,710
11			Use formula:					Use formula:		
12			=SUMPRODUCT(C4:C8, D4:D8)*0.01					=SUMPRODUCT(G4:G8, H4:H8)*0.01		
13		Proposal 1:								
14		Purchase bonds proportionally to restore the target dollar duration of $2,294,600.								
15		That is, each of the five bond positon is increased by 11.7% (=2294600/2053710 – 1)								
16										
17		Proposal 2								
18		Adjust the controlling position of the portfolio. Since Bond 5 has the longest duration, it can be designated as the controlling								
19		position and its position needs to be increased by 42.55% (from $10,201,000 to $14,541,369) to restore the portfolio target duration								
20							Market Value	Duration	
21						Bond1	$10,260,000	0.6	
22						Bond2	$10,403,000	4.1	
23						Bond3	$10,812,000	4.55	
24						Bond4	$10,050,000	5.05	
25						Bond5	$14,541,369	5.55	
26			Use formula:			Total	$56,066,369		
27			=G8+100*(E10 - I10)/H8			Total dollar duration at time t --->			$2,294,600
28							Use formula:		
29							=SUMPRODUCT(G21:G25, H21:H25)*0.01		

(d) Calculate the duration of the cheapest-to-deliver bond, indicating if the futures trade is a "buy" or "sell".

Commentary on Question:
Candidates performed as expected. Full credit was given when either of the two "portfolio dollar duration" definition was used, as long as the resulting duration of the cheapest-to-deliver bond was computed correctly.

Use the formula below to calculate the duration of the cheapest-to-deliver (CTD) bond

$$Duration_{CTD} = \frac{Target\ dollar\ duration - Current\ dollar\ duration}{\#of\ Futures\ contract\ *\ Price_{CTD}} * ConversionFactor$$

If using the syllabus definition of portfolio dollar duration:

$$Duration_{CTD} = \frac{455073 - 411082}{6 * 100000 * 0.01} * 1.16 = 8.5$$

1. Continued

If using the common industry practice of portfolio dollar duration:

$$Duration_{CTD} = \frac{2294600 - 2053710}{6 * 100000 * 0.01} * 1.16 = 46.57$$

The trade is to "buy" futures in order to increase the current portfolio dollar duration to its target level.

2. **Learning Objectives:**

6. 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:

(6a) Construct and manage portfolios of fixed income investments relative to the liabilities that they support.

(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) Demonstrate an understanding of and apply tools and techniques of measuring and managing interest rate risk in an ALM context, including duration and convexity.

Sources:

Fixed Income Securities, Veronesi - Ch. 3 Basics of Interest Rate Risk Management

Fixed Income Securities, Veronesi - Ch. 4 Basic Refinements in Interest Rate Risk Management

QFIQ-121-20: A Guide to Duration, DV01, and Yield Curve Risk Transformations, Coleman

Commentary on Question:
Commentary listed underneath question component.

Solution:

(a) Calculate the values A1, A2, and B2 in the table.

Commentary on Question:
Candidates performed below average on this section. While most candidates were able to identify the correct methodologies, many used incorrect formulas or misstated the relationships between DV01, modified duration and Macaulay duration.

A1: DV01 $= \frac{\sum_{i=1}^{5} t_i \, CF_i \, (1+y)^{-(t_i+1)}}{100} = 1 * 3 * (1 + 0.035)^{-2} + 2 * 3 * (1 + 0.035)^{-3} + 3 * 103 * (1 + 0.035)^{-4} = 2.774878$

Alternatively, PV+1bp = 98.571438, DV01 ~ (PV-PV+1bp)/100 = 2.77435

2. **Continued**

A2: $PV = \sum_{i=1}^{5} CF_i\ (1 + y)^{t_i} = 97.74247$

$ModDur = \frac{DV01*100}{PV} = \frac{(2.774878*100)}{98.59918} = 2.8143$

B2: $MacDur = ModDur * (1 + y) = \frac{DV01*100}{PV} * (1 + y) = \frac{(7.71*100)}{92.28} * (1 + 0.05) = 8.7727$

(b) Describe the properties of B1 and C1 in the table, considering how bond durations are generally impacted by the coupon rates.

Commentary on Question:
Candidates performed as expected on this section. Most candidates were able to recognize the relationship between coupon rate and duration given a same time to maturity. Full credits were given to candidates who stated the modified duration for zero-coupon bonds and explained the impact of coupon cashflows on the weights and on the sensitivity to interest rate changes.

C1 will always be the same as time to maturity for zero-coupon bonds.
B1 will be lower than C1 as coupon cashflows will shift the weights earlier, relative to the last cashflow and reduce the duration of the bond.
For two bonds with the same time to maturity, higher the coupon rate, lower the average time of cashflows and the sensitivity to interest rate changes.

(c)

(i) Explain the relationship between the convexity of Bond B and the convexity of Bond C at issue.

(ii) Describe the considerations for selecting a bond to match the insurance liabilities.

Commentary on Question:
Candidates performed below average on this section. While most candidates were able to identify the impact of coupon cashflows on convexity, few connected dynamic policyholder behavior to higher convexity and recognized the higher convexity and duration profile of bond C. Credits were awarded to candidates who correctly identified characteristics of the liability and proposed appropriate considerations. Some candidates misstated the impact of coupons on the convexity of a bond.

2.   Continued

  (i)   For two bonds with the same time to maturity, higher the coupon rate, the lower the convexity. So bond C will have the higher convexity.

  (ii)   Dynamic policyholder behavior typically increases the convexity of the liability. Because bond C has a higher convexity than bond B, it is likely to be a better match for the liabilities.
  In addition, it has the higher duration, which may or may not be a better match depending on the duration of the insurance liabilities.

(d)   ABC's management is concerned with the risks of large movements in the yield curve and the potential impact on their annuity products. Your colleague proposes using a position of k units of bond B to dollar duration-match a block of annuity products that has a fair value of 120 million and a modified duration of 8 years.

Calculate the position k.

Commentary on Question:
Candidates performed above average on this section. Most candidates were able to correctly calculate the position for bond B. Some candidates used incorrect formulas between DV01 and modified duration. Partial credits were awarded to candidates who identified the correct methodology.

$$k = \frac{ModD_{annuity}*P_{annuity}}{ModD_{Bond}*P_{Bond}} = \frac{8*120}{8.36*92.28} = 1.2451 \Rightarrow \text{Long 124.51M of Bond B}$$

$$\text{Or ...} k = \frac{ModD_{annuity}*P_{annuity}}{DV01_{Bond}*Face_{\ Bond}} = \frac{8*120}{7.71*100} = 1.2451$$

(e)   Describe a key limitation of your colleague's method.

Commentary on Question:
Candidates performed as expected on this section. Most candidates were able to identify the limitation of duration hedging being effective for only small parallel change in interest rates. Many also stated the omitting of convexity and curvature of the change in bond price due to change in interest rates. Full credits were rewarded to candidates who explained how convexity and KRD matching can address the limitations or stated how the limitations can be addressed in general.

Duration hedging omits both convexity and curvature of the change in bond price due to change in interest rates.

It tends to work well with only small parallel change in interest rates, as the error in the approximation using duration only becomes material with large interest rate movements and the approximation only captures the size of the yield sensitivity, but not where the exposure occurs on the curve.

3.

Learning Objectives:

3.   The candidate will understand the credit risk aspects of individual securities, portfolios, and sectors and be able to apply a variety of credit risk theories and models to the investment management process.

Learning Outcomes:

(3a)   Demonstrate an understanding of credit analysis.

(3b)   Demonstrate an understanding of and the ability to apply both the concepts and techniques used in the measurement of default risk of individual securities.

(3c)   Understand and apply various approaches for managing credit risk in a portfolio setting, including the use of Credit Default Swaps.

Sources:

Handbook of Credit Quantitative Enterprise Risk Management, M. Hardy & D. Saunders Ch. 12 Credit Risk.

Commentary on Question:

Overall, the candidates performed below average on this question. Detailed comments were provided for each of the sections below.

Solution:

(a)   Calculate the following for Company A over a one-year horizon:

(i)   The real-world probability of default

(ii)   The risk-neutral probability of default

Commentary on Question:

The candidates performed below average on this section. Most candidates were able to identify the use of μ and r for calculating real-world or risk neutral probability of default, respectively. Some candidates made minor mistakes such as using $\frac{\sigma}{2}$ instead of $\frac{\sigma^2}{2}$ in the calculation of d_1 and d_2. Partial credits were given to the correct formula for Z and the correct values for each of the parameters.

(i)

$$PD^{RW} = \Pr[A < L] = \Pr\left[\frac{A}{A_0} < \frac{L}{A_0}\right]$$

$$= \Phi\left(\frac{\log\left(\frac{L}{A_0}\right) - \left(\mu - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}\right) = \Phi\left(\frac{\log\left(\frac{100}{115}\right) - \left(0.05 - \frac{0.1^2}{2}\right) * 1}{0.1\sqrt{1}}\right)$$

$$= \Phi(-1.84762) = 3.23\%$$

3. **Continued**

(ii)

$$\text{PD}^{\text{RN}} = \Phi(-d_2) = \Phi\left(\frac{\log\left(\frac{L}{A_0}\right) - \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}\right) = \Phi\left(\frac{\log\left(\frac{100}{115}\right) - \left(0.02 - \frac{0.1^2}{2}\right) * 1}{0.1\sqrt{1}}\right)$$

$$= \Phi(-1.54762) = 6.09\%$$

(b) Calculate the risk-neutral expected rate of recovery, conditional on default of the bond.

Commentary on Question:
The candidates performed poorly on this section. Most candidates were not able to identify the relationships between the bond price and the recovery rate. Partial credits were given to candidates who identified the use of risk-neural probability of default.

Let Y be the expected rate of recovery, conditional on default
The bond price V is equal to

$$V = e^{-rT}L((1 - PD^{RN}) + PD^{RN} \times E_Q\left[\frac{A_T}{L} | A_T < L\right]$$

Hence,

V = 100*((1-PD^{RN}) *1+ PD^{RN}*Y)
V = 100*((1-0.0609) *1+ 0.0609*Y)
Y = (V/100 - 0.9391) / 0 .0609
Y = (0.9778-0.9391)/0.0609
Y = 0.0387/0.0609
Y = 63.5%

(c) Describe the two general model types into which credit risk models are often divided.

Commentary on Question:
The candidates performed as expected on this section. Most of the candidates were able to correctly identify the two types of models and contrasted these two models. Partial credits were given to candidates who identified the correct model types but were not able to describe and differentiate the two models.

A structural model attempts to model the underlying process that generates defaults, such as modelling corporate securities as contingent claims on the underlying assets of a firm and conditions for default.

3. Continued

In contrast to structural models, reduced form models simply try to replicate the empirical properties of default behavior, without any attempt to incorporate underlying causes or events. Nonetheless, reduced form models have been very successful in modelling credit risk and are particularly popular in the pricing of credit derivative securities.

(d) Critique the risk team's choice of this model, including its advantages and disadvantages.

Commentary on Question:
The candidates performed poorly on this section. Most of the candidates were only able to identify the advantages and disadvantages of the single factor Gaussian Copula. To receive full credits, candidates were expected to critique the use of this model for credit risk modeling in the context of this question (e.g., how does the model impact determination of capital charges for Company C).

Under this model, because the systematic losses are co-monotonic, the VaR of the portfolio is the sum of the VaRs of its constituents. If VaR is used to calculate capital charges, then the capital required for any given position should only depend on the risk of that position and not on the portfolio it is added to. This simplifies aggregation and provides consistency when comparing capital charges for different well-diversified portfolios. This property is portfolio invariance.

However, this property simplifies the decomposition of risks with either systematic or idiosyncratic risk, so any aspects of sector or industry concentrations in the credit portfolio are ignored.

For Bank C, the capital charge on a position in a copper mining company should be higher than that of a well-diversified bank, as Bank C is more exposed to the idiosyncratic risk of company A and mining sector risk, since the credit portfolio only contains several names and is highly concentrated in one sector.

4.   **Learning Objectives:**

2.   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
- Commodities
- Hedge Funds
- Distressed debts

Learning Outcomes:

(2a)   Demonstrate an understanding of the investment strategies and portfolio roles that are characteristic of various types of equity and alternative investments.

(2c)   Explain the basic active equity selection strategies including value, growth and combination approaches, and compare techniques for characterizing investment style of an asset manager.

(2d)   Recommend and justify an optimal portfolio allocation in a risk-return framework.

Sources:

Managing Investment Portfolios (Chapter 1)

Managing Investment Portfolios (Chapter 3)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a)   Recommend the use of accumulated benefit obligation (ABO) or projected benefit obligation (PBO) to calculate the funding ratio.

> **Commentary on Question**:
> *The candidates performed as expected on this section. Most candidates did well recommending PBO, but almost no candidate brought up the specific point that PBO is a reasonable measure of the pension liability for a going concern that does not anticipate terminating its DB plan.*

> The ABO is effectively the present value of pension benefits, assuming the plan terminated immediately such that it had to provide retirement income to all beneficiaries for their years of service up to that date (accumulated service). The PBO projects future compensation increases if the benefits are defined as being tied to a quantity such as final average pay.

4. Continued

The PBO is a reasonable measure of the pension liability for a going concern that does not anticipate terminating its DB plan.
Should use PBO due to above explanation.

(b) Explain why the split between retired-lives and active-lives is important when assessing the funding status of the DB pension plan.

Commentary on Question:
The candidates performed as expected on this section. Most candidates identified that retired lives cause the pension fund's liquidity requirements to go up. But many candidates did not note that a plan with a greater percentage of retirees has a shorter average duration of future pension liabilities.

Because retirees are currently receiving benefits, the greater the number of retired lives, the greater the cash flows out of the fund each month, and thus the higher the pension fund's liquidity requirement.
A plan with a greater percentage of retirees generally has a shorter average life or duration of future pension liabilities.

(c) Describe the implications of the above information for the plan's risk objective.

Commentary on Question:
The candidates performed as expected on this section. Most candidates made the association of lower debt ratio to higher risk tolerance correctly, but many candidates did not identify the last factor below.

Workforce characteristics: the workforce age is relatively old, so the duration of plan liability is shorter, and the plan has less risk tolerance.
Funding status: plan is underfunded ($300/$400 = 75%), which implies a lower risk tolerance.
Financial status: Lower debt ratio implies greater risk tolerance.
Common risk exposure: The plan's portfolio and the company's operating results are correlated, which limits the risk tolerance.

(d) Recommend an updated return objective.

Commentary on Question:
The candidates performed below average on this section. Most candidates made the suggestion to increase the objective return. However, almost no candidate noted that a well-funded plan can be in a position of generating negative pension expense.

Recommend increasing the objective return. The plan is now overfunded, and the younger workforce age reduces the liquidity risk. A well-funded plan can be in a position of generating negative pension expense as the senior management expects.

4. **Continued**

(e)   Describe strategies that could address management's concerns.

Commentary on Question:
The candidates performed below average on this section. Most candidates suggested using ALM or liability driven investment approach as an appropriate objective. However, many candidates did not mention diversifying risk as a strategy to address management's concerns.

Pension portfolio should diversify risk relative to the sponsor's operating activities. In this specific scenario, the plan should invest more in non-energy related sectors.
Because pension plan liabilities are interest rate sensitive, pension plan sponsors emphasizing an ALM approach tend to make more intensive use of interest-rate-sensitive securities (in particular, bonds) than would otherwise be the case.

5.

Learning Objectives:
6. 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:
(6a) Construct and manage portfolios of fixed income investments relative to the liabilities that they support.

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

Sources:
QFIP-142-19: Ch. 10 of Modern Investment Management: An Equilibrium Approach, Litterman

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a) Justify, based on the Sharpe Ratio, which portfolio is preferable in the asset-only asset allocation strategy?

Commentary on Question:
Candidates performed brilliantly on this question. Most candidates got full marks.

The Sharpe Ratio of portfolio 1 is:
$$\frac{\mu_i - R_f}{\sigma_i} = \frac{2.46\% - 1.5\%}{1.71\%} = 0.561$$

The Sharpe Ratio of portfolio 2 is:
$$\frac{\mu_i - R_f}{\sigma_i} = \frac{2.09\% - 1.5\%}{0.78\%} = 0.7564$$

Hence, portfolio 2 is preferable.

(b) Describe the shortcomings of the Sharpe ratio in measuring the trade-off between risk and return in an asset-liability framework.

Commentary on Question:
Candidates performed above average on this question. Most candidates were able to identify that the Sharpe Ratio ignores the presence of liability. Many candidates were able to identify that the Sharpe Ratio is a one-period measure.

The Sharpe Ratio considers only the risk and return of assets and ignores the presence of any liability stream. In other words, it ignores the ability of the portfolio hedge against changes in the value of liabilities.

5. **Continued**

Sharpe Ratio is a theoretically well-founded concept only in a one-period model.

Assuming that a pension fund cares only about the distribution of assets (or the surplus) at one future point in time is inappropriate.

It unclear how to choose the future date.

A pension fund will care about funding characteristics in intermediate periods.

(c) Recommend which portfolio should be selected in the asset-liability management framework based on the Risk Adjusted Change in Surplus (RACS).

Commentary on Question:
Candidates performed below average on this question. Many candidates were able to identify the correct formula, but only a few candidates obtained the correct RACS values.

The RACS of portfolio 1 is:

$$\text{(Mean return)/(Standard Deviation)} = \frac{E[S_{t+1} - S_t\,(1+R_f)]}{\sigma[S_{t+1} - S_t\,(1+R_f)]} = \frac{0.58}{1.47} = 0.39$$

The RACS of portfolio 2 is:

$$\text{(Mean return)/(Standard Deviation)} = \frac{E[S_{t+1} - S_t\,(1+R_f)]}{\sigma[S_{t+1} - S_t\,(1+R_f)]} = \frac{0.18}{0.52} = 0.35$$

Hence Portfolio 1 is preferable.

(d) Calculate the correct minimum percentage asset allocation to the portfolio selected in part (c) based on the correct mean portfolio return.

Commentary on Question:
Candidates performed below average on this question. Many candidates were able to identify the correct formula, but only few candidates obtained the correct result. Some candidates obtained the correct result for portfolio 2 and received partial credits.

The expected return of the portfolio is higher than the bond return. Thus the portfolio can be treated as an "equity" in this analysis. The minimum allocation of the portfolio is given by Formula (10.A.16) in the formula sheet. ($\alpha = \frac{\mu_B\left(\beta\frac{L_t}{A_t}-1\right)+\frac{L_t}{A_t}[R_f(1-\beta)]}{\mu_E-\mu_B}$)

5. **Continued**

Based on the analyst's calculation, we get $3\% - 1.8\% = \mu_E - \mu_B = 1.2\%$, and:

(The numerator of Formula (10.A.16))/1.2 $= \dfrac{\mu_B\left(\beta\frac{L_t}{A_t}-1\right)+\frac{L_t}{A_t}[R_f(1-\beta)]}{3\%-1.8\%} = 3.04\%$,

hence

(The numerator of Formula (10.A.16)) $= \mu_B\left(\beta\frac{L_t}{A_t}-1\right)+\frac{L_t}{A_t}[R_f(1-\beta)] =$
0.000365217.

The correct percentage is therefore $\alpha = \dfrac{0.000365217}{2.46\%-1.8\%} = 5.53\%$

For portfolio 2:

$$\alpha = \frac{0.000365217}{2.09\% - 1.8\%} = 12.59\%$$

Alternative Solution:

The expected return of the portfolio is higher than the bond return. Thus the portfolio can be treated as an "equity" in this analysis. The minimum allocation of the portfolio is given by Formula (10.A.16) in the formula sheet. ($\alpha = \dfrac{\mu_B\left(\beta\frac{L_t}{A_t}-1\right)+\frac{L_t}{A_t}[R_f(1-\beta)]}{\mu_E-\mu_B}$)

$\beta = \dfrac{14}{10} = 1.4$, so the numerator of Formula (10.A.16) is $\mu_B\left(\beta\frac{L_t}{A_t}-1\right)+$
$\frac{L_t}{A_t}[R_f(1-\beta)] = 0.000365217$

The correct percentage is therefore $\alpha = \dfrac{0.000365217}{2.46\%-1.8\%} = 5.53\%$

(e) Explain how the minimum percentage in part (d) changes if the liability value is unchanged but the asset value is $90.

Commentary on Question:
Candidates performed above average on this question. Most candidates correctly identified that the minimum allocation should become larger.

5. **Continued**

From the formula $\alpha = \dfrac{\mu_B\left(\beta\frac{L_t}{A_t}-1\right)+\frac{L_t}{A_t}[R_f(1-\beta)]}{\mu_E-\mu_B}$, we see that if A_t decreases while L_t is unchanged, $\dfrac{L_t}{A_t}$ becomes larger.

So α becomes larger as well.

Alternative solution:

In this case, the fund becomes underfunded. For an underfunded fund, the deficit will grow on average if the allocation of the portfolio is too low.

Therefore, the minimum allocation needed to prevent the fund surplus from shrinking becomes larger.

6. **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)   Demonstrate an understanding of various fixed income investments considering:
- cash flow characteristics,
- markets in which they trade, and
- underlying risks such as interest rate, credit and event risks

Sources:
Miller & Geltner, Commercial Real Estate Analysis and Investments, 3rd Edition, Chapter 16, pg 381

Miller & Geltner, Commercial Real Estate Analysis and Investments, 3rd Edition, Chapter 16, pg 389-392

Miller & Geltner, Commercial Real Estate Analysis and Investments, 3rd Edition, Chapter 16, pg 395-396

Miller & Geltner, Commercial Real Estate Analysis and Investments, 3rd Edition, Chapter 20, pg 482-483

Miller & Geltner, Commercial Real Estate Analysis and Investments, 3rd Edition, Chapter 20, pg 486-492

Commentary on Question:
This question tested candidates' understanding of mortgages and commercial mortgage-backed securities.

Solution:
(a)   Describe three differences between residential and commercial mortgages.

Commentary on Question:
Candidates performed above average on this question. Many candidates received full credit for identifying and briefly describing three differences between residential and commercial mortgages. Candidates that provided one or two differences received partial credit.

Residential and commercial mortgages have several differences, which include:

1. Residential mortgages are typically smaller loans on average and more numerous than commercial mortgages.
2. Residential loans are typically owner occupied and generate no income by themselves. Commercial mortgages loans are serviced by the income generated from their use.

6. Continued

3. Residential mortgages borrowers are not typically financial or business professionals and have a wide spectrum of financial knowledge. Commercial mortgages borrowers are usually much more sophisticated and have more expertise with financial products.

(b)   Identify four typical mortgage covenants.

Commentary on Question:
Candidates performed below average on this question. A few candidates received full credit for their responses. Some candidates received partial credit for listing fewer than four covenants.

Four typical mortgage covenants include:

1. Promise to Pay Covenant
2. Due-on-Sale
3. Good Repair Clause
4. Acceleration Clause

(c)   Describe the borrower's put option in a non-recourse mortgage.

Commentary on Question:
Candidates performed as expected on this question. Some candidates received full credit for their responses. A common mistake was not describing the put option correctly.

In a nonrecourse mortgage, the borrower's put option is the ability of a borrower to default on a loan and effectively sell the underlying property at a price equal to the outstanding loan balance. The lender rids themselves of a liability equal, at least in book value, to the outstanding loan balance, and the lender loses an asset with this same book value.

(d)   Describe the securitization process of commercial mortgage-backed securities, specifically identifying how the following roles are involved:

- Investment Bankers
- Rating Agencies
- Investors
- Servicers

Commentary on Question:
Candidates performed brilliantly on this question. Many candidates received full credit for identifying and describing each step of the securitization process. A common mistake was inaccurately describing certain of the roles.

6. Continued

1. Investment Bankers pool together mortgages owned by borrowers and then packaged into CMBS with different tranches.
2. Rating agencies review each tranche of the CMBS and assign a credit rating reflecting the riskiness of each tranche.
3. Investors with different risk appetites purchase all or portions of the tranches.
4. Servicers maintain contact with the borrowers and administer collection of the loan payments distribute cashflows collected to the tranches. Servicers also deal with defaults or other payment issues

(e) Explain why you should not invest in Tranche X

Commentary on Question:
Candidates performed as expected on this question. Most candidates received partial credit for describing the characteristics and risks of the IO tranche. A common mistake was not tying the IO tranche back to XYZ Assurance and the lack of prepayment penalties with the CMBS.

The IO tranche only provides returns on the interest portion of the mortgage pool payments, and since borrowers are allowed to prepay without penalty there is a risk of these payments being reduced quickly.

The IO tranche is good for short term variable rate liabilities and apply to niche investors. Term and UL do not fit in that category, and since these are the only two product offered by XYZ Assurance I cannot recommend Tranche X as an investment.

(f) Recommend an alternative tranche.

Commentary on Question:
Candidates performed below average on this question. A common mistake was providing a recommendation without providing sufficient justification. Some candidates received partial credit for the reasoning provided for recommending Tranche B.

Tranche A provides a stable return while being protected from default by tranche B, which will absorb any default losses first. Due to prepayments, duration of the tranches could decrease so XYZ Assurance should also be aware of re-investment risk.

6. Continued

Tranche A can be appropriate for 10 year Term as it is a shorter duration liability and it provides steady reliable income.   As UL is a longer term liability, there is some risk that the CMBS may not have sufficient duration, particularly if prepayments are high. Neither tranche may be appropriate to back the UL product in this case, although since XYZ has only recently started to write UL this may not be problem at the moment.

7.   **Learning Objectives:**
2.   The candidate will understand the credit risk aspects of individual securities, portfolios, and sectors and be able to apply a variety of credit risk theories and models to the investment management process.

Learning Outcomes:
(2a)   Demonstrate an understanding of credit analysis.

(2b)   Demonstrate an understanding of and the ability to apply both the concepts and techniques used in the measurement of default risk of individual securities.

Sources:
Geltner & Miller. Commercial Real Estate Analysis and Investments, Geltner & Miller, 3rd Edition, 2014. Ch. 12, 14

QFIP-131-19. Addressing Built-in Biases in Real Estate Investment (including Appendix)

Commentary on Question:
This question is concerned with real estate investment and behavioral finance implication.

Solution:
(a)   Contrast the valuations of REIT and direct investing from both the micro and the macro perspectives.

Commentary on Question:
The candidates performed poorly on this section. Most candidates received partial credit for mentioning of differences as to cash flow and liquidity of REIT. Successful candidates were able to contrast key elements for each perspective. The key reasonable explanation was the magnitude of the difference in cash flow income and the time frame at the micro-level and the price valuation considerations of REIT at the macro-level.

The difference between REIT and direct/property are:

At the micro-level, differences are possible in:

Cash flow expectations and estimation of cost of capital. However, such differences tend to be small and short-lived, and averaged out in the long run; Risk in the asset, not in the investor; Relevant OCC for evaluating a given property which reflects the risk of that property. REIT has more liquidity.

7. Continued

At the macro level, valuation difference exists *with* REIT because share prices reflect their:
REIT price over NAV varies over time;
REIT share price reflects existing in-place asset and entity-level capital structure;
REIT price also reflects the future growth opportunities and
ability to make positive NPV with acquisitions, development and dispositions.

(b) Explain the challenges related to behavioral finance in real estate investment when compared to equity market investment.

Commentary on Question:
The candidates performed below average on this section. Many candidates received partial credit from only providing a list of challenges without then also providing a reasonable explanation and for explaining the irrational emotion associated with physical assets. The candidates that performed well were able to explain the misunderstanding of the investor's perception of the contribution magnitude of capital gain and income in the investment return.

The misunderstanding by investors of investment in real estate for capital gain despite the fact that income drives majority of the returns.

Since real estate is a real, physical real asset and a valuable physical asset this can inspire irrational emotions.

(c)

(i) Explain how each bias affects real estate investing.

(ii) Describe workarounds for each bias.

Commentary on Question:
The candidates performed above average on part (i) of this section. Most candidates received credit for providing relevant explanation for home bias and framing bias. Successful candidates received credit by mentioning the influence of trendsetters associated with herding bias.

The candidates performed as expected on part (ii) of this section.
Most candidates received credit for giving consideration to the underlying drives as tenant risk and leasing risk associated with the framing bias. Successful candidates considered the level and sustainability of assets' rental income in a portfolio of investments.
Most candidates received credit for describing the need for geographical diversification in regards to home bias.

7.   **Continued**

Most candidates received credit for mentioning the urge to follow the trend in regards to herding bias. Successful candidates received credit for recognizing the focus on the long-term view of the real estate investment.

(i)   Bias
Framing bias
- The way we explain the choices are structured such they can influence the decision-making process. The real estate properties are usually categorized accordingly to the industry sector or geographic descriptions which are not necessarily the greater influence.
- Property-specific factors as tenant risk and lease structure often wield far greater influence on real estate than regional or sector trends.

Home bias
- Within real estate the tendency to allocate a significant proportion of the portfolios to home country investment is evident across all asset classes.
- This bias is encouraged by familiarity but also discouraged due to perceptions of higher illiquidity, higher transaction cost and greater information asymmetry.

Herding bias
- The urge to conform to established patterns or follow the lead of perceived authority figures or trendsetters.
- The strong urge to follow the crowd lures many real estate investors into chasing the market, buying high at the 'bubble' and selling low at the 'bust'.

(ii)   Workaround

Framing
- Investors should place particular emphasis on the level and sustainability of assets' rental income.
- Also diversify a portfolio primarily on the basis of tenant risk and lease structure.
- Then give greater consideration to the underlying drives of real estate performance and not only on geographic location.

7. **Continued**

Home Bias
- Ensure that portfolios are diversified across geographies.
- Diversify income streams to ensure the sustainability of cash flow.
- Look abroad for more attractive valuations, take advantage of the difference in the investment cycle among different regions.

Herding
- Resist the urge to act impulsively in a downturn market.
- Take a long-term view of real estate investment.
- Consider a contrarian approach since the real estate market tends to overreact, be prepared and save your resources to buy low. (Keep dry powder to buy low).
- Avoid the impulsion to chase market trends.

(d) Your colleague made the following statements:

Statement A: "REIT A has an average cost of capital of 10%, REIT B has an average cost of capital of 12%. This implies REIT A can afford to pay more for property X than REIT B."

Statement B: "Income contributes the bulk of the total returns on real estate investment, as well as most of the volatility."

Critique your colleague's statements.

Commentary on Question:
The candidates performed as expected in regards to statement A. Most candidates correctly justified the price of the property on the basis of the property risk and not the REIT's cost of capital. Successful candidates distinguished the REIT's cost of capital from the risk at the property level.
The candidates performed above average in regards to statement B. Most candidates received credit for justifying the income as the main component of the return. Candidates that were able to explain the main contribution of capital gain to the volatility of return received full credit.

For statement A

While the risk resides with the property and shall be mostly defined by the characteristic of the property.

REIT's historical cost of capital at the firm level does not imply that it can afford to pay more for the property X since REIT's COC reflects the average risk in its current firm level assets.

7.   Continued

This implies REIT A cannot afford to pay more for property X than REIT B.

For statement B

It is true that income contributes to the bulk of total return on the real estate and tends to be relatively stable but it is not true on its contribution to the volatility of the return.
On the contrary, the capital gains contribute to the majority of the volatility of real estate return.

8. **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.

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

Sources:

Managing Investment Portfolios, Chapter 12: Evaluating Portfolio Performance

Commentary on Question:

This question tests a candidate's knowledge and understanding in investment portfolio performance attribution, specifically on the capability in applying performance measurement methodologies to asset portfolios, and in assessing and interpreting performance attribution metrics for a given portfolio.

Solution:

(a) Describe macro and micro performance attribution.

Commentary on Question:

The candidates performed below average on this section. Many candidates received credit for providing key decision variables involved in the two types of attribution. Those candidates that correctly identified the different levels at which they are conducted received full credit.

Macro attribution is conducted on the fund sponsor level, whereas micro attribution is conducted on the investment portfolio manager level. The distinction relates to the specific decision variables involved. While it is unlikely that an investment manager would be in a position to carry out macro attribution, one can easily envision situations in which a fund sponsor may wish to conduct both macro and micro attribution.

(b)

    (i) Define Normal Exposure

    (ii) Explain the differences between normal exposure and portfolio exposure in the chart above.

Commentary on Question:

The candidates performed poorly on this section. While some candidates made conceptual reference to a "benchmark portfolio" in describing the normal exposure, very few candidates correctly linked it to the normal portfolio or the manager's historical performance.

A normal portfolio refers to a portfolio with exposures to sources of systematic risk that are typical for an investment manager, using the manager's past portfolios as a guide. Normal exposure is a normal portfolio's exposure to sources of systematic risk, where portfolio exposure is the portfolio's actual exposure to sources of systematic risk.

(c)   Calculate the attribution of the active impact into market timing, fundamental risk factors, and economic sectors.

Commentary on Question:
The candidates performed below average on this section. Some candidates, of those that provided an answer, received full credit for their answers.

Total active exposure = -1.7546%. Attribution is as given below:

(%)	Portfolio Exposure (a)	Normal Exposure (b)	Factor Return (Beta)	**Active Exposure (c) = (a) – (b)**	**Active Impact =(c)*Beta**
Market					
Normal Portfolio					
Cash Timing	2.05	0.05	-0.05	2.00	-0.1
Beta Timing	1.04	1.00	2.00	0.04	0.08
-- Total Market Timing					**-0.02**
Growth	1.23	0.51	-0.55	0.72	-0.396
Size	-0.50	0.86	0.57	-1.36	-0.7752
Yield	-0.90	-0.54	2.44	-0.36	-0.8784
-- Total Fundamental Risk Factors					**-2.0496**
Basic Industry	35.23	41.00	-0.04	-5.77	0.2308
Financials	40.12	37.00	0.01	3.12	0.0312
Consumer	24.65	22.00	0.02	2.65	0.053
-- Total Economic Sectors					**0.315**

(d)   Calculate the portfolio return predicted by this model.

Commentary on Question:
The candidates performed poorly on this section. A few candidates, of those that provided an answer, received full credit for their answer.

Predicted return = normal portfolio return + active impact = 3.1954%

9.

Learning Objectives:

3. The candidate will understand the credit risk aspects of individual securities, portfolios, and sectors and be able to apply a variety of credit risk theories and models to the investment management process.

Learning Outcomes:

(3a) Demonstrate an understanding of credit analysis.

(3b) Demonstrate an understanding of and the ability to apply both the concepts and techniques used in the measurement of default risk of individual securities.

(3c) Understand and apply various approaches for managing credit risk in a portfolio setting, including the use of Credit Default Swaps

Sources:

Handbook of Credit Risk Management Ch 1, 4, 5 and 13.

Commentary on Question:

This question tests candidates' ability to identify the embedded credit risks associated with the investment strategies as well as the ability to apply relevant credit risk management functions.

Solution:

(a)

    (i) Identify the source of credit risk, if any, inherent in each element of ABC Life's current approach.

    (ii) Assess qualitatively the degree of credit risk in each element.

    Commentary on Question:
    Candidates performed as expected on this part. Most candidates received credit for pointing out the credit risks associated with each investment strategy. However, some candidates erroneously stated that the S&P500 funds have credit risk, while the risk of the fund is mostly market risk.

    (i)
- Credit risks stem from reinsurer unable to pay the obligated claims.
- Credit risk stem from FGH bank unable to meet the obligation of the swap terms
- Credit risk stem from the mortgagee unable to make payments
- Credit risk stems from foreign sovereign downgrades or unable to make bond payments
- No credit risk, market risk only

9. Continued

(ii)
- The exposure to the reinsurer is small and the reinsurer has a high rating. Credit risk is small.
- The exposure is 100M * 1% per year = 1M. The credit risk is small due to low exposure
- The mortgage is secured by the real estate as collateral. The credit risk is usually small, since the net exposure is small due to collateral.
- Invest $100M in government and municipal bonds from emerging markets carries the most credit risk since the emergent market sovereign and municipal credit ratings is usually low and the recovery rate is also low.

(c) Describe three key functions of the credit portfolio management team.

Commentary on Question:
Candidates performed as expected on this part. Most candidates received credit for recalling the necessary functions of Level 1 credit risk management. Some candidates received some credit for listing the names of the function but did not elaborate on the actual functions.

(i) Aggregation – Measuring the accumulation of risks from each counterparty, aggregating GE, NE, AE.
(ii) Reporting – Provide frequent and regular updates on the content of the credit portfolio, allows the readers to quickly assess key exposure metrics
(iii) Credit Limit – Creating and setting credit limits that are applicable to each counterparty, set in advance and changed infrequently, enforced, subject to judgement and review, set for multiple metrics
(iv) Surveillance – Monitoring the performance of the transaction and counterparty after deals have been closed.
(v) Mitigation - firms originating credit exposures may want to transfer the credit risk they took on a counterparty to another firm.

(c) Explain three additional key functions that need to be implemented in order to achieve this goal and the importance of each function.

Commentary on Question:
Candidates performed as expected on this part. Many candidates received credit for only providing the name of the function. Candidates that elaborated on the actual details received full credit.

Quantification of Capital at Risk – Develop quantification of capital needed to absorb the credit risks in order to protect the firm from the risk of insolvency.

9. Continued

Allocation of Capital and profitability at individual transaction level – Allocate the aggregated level of capital to each individual transaction. This is useful in pricing the transaction where the cost of capital forms part of the price of the transaction.

Stress Testing – Evaluating the economic consequences of unexpected but plausible events that may impact the performance of the counterparties.

Hedging strategy – Some positions can be hedged. Implement a hedging strategy that is defensive in nature.

Rebalancing transactions – Actively aim to minimize the amount of capital deployed an degenerate the highest return on the capital. Given the credit limit, the CPM team rebalances the credit portfolio such that the highest return is achieved.

10.

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)   Demonstrate an understanding of various fixed income investments considering:
- cash flow characteristics,
- markets in which they trade, and
- underlying risks such as interest rate, credit and event risks

Sources:
Handbook of Fixed Income Securities, Fabozzi, F.J., 9th Edition, 2021, Chapter 60: Financing Positions in the Bond Market

Handbook of Fixed Income Securities, Fabozzi, F.J., 9th Edition, 2021, Chapter 15: Inflation Linked Bonds

Commentary on Question:
This question tests the candidates' understanding of repurchase agreements, securities lending agreements, and TIPS.

Solution:
(a)   Describe how you would construct a repurchase agreement. You contract with manager Z to borrow the funds needed.

   Commentary on Question:

   The candidates performed below average on this section. Many candidates correctly identified the borrower and lender. Many candidates correctly noted the need to buy back the collateral at a specified repurchase price. Very few candidates discussed the investment of the borrowed funds or the fact that manager Y pays you the interest income from the security issuer. No candidates mentioned that the amount earned from the repo is uncertain or can be negative.

- You are the borrower of funds using the 20-year Treasury Notes as collateral.
- Manager Y is the lender of funds you need.
- You invest the cash received from manager Y and at the repurchase date pays interest to manager Y based on the repo rate.
- Manager Y pays you any interest income that you would have received from the issuer of the security.
- The amount earned by you from the repurchase agreement is uncertain and, in fact, can be negative.
- At the repurchase date (3 days later), you buy back the US Treasury Note from manager Y at the repurchase price (which includes interest).

10. Continued

(b)   Describe how you would construct a securities lending agreement.

Commentary on Question:
The candidates performed below average on this section. Many candidates correctly identified the borrower and lender. Many candidates correctly noted the need to buy back the collateral at a specified repurchase price. Some candidates correctly described the rebates and interest income from the security issuer. No candidates mentioned that the amount earned from the repo is uncertain or can be negative.

- You are the security lender (beneficial owner of 20-year Treasury Note securities).
- Manager Z is the security borrower.
- You invest the cash received from manager Z, and at the end of the transaction, you rebate part of the income earned to manager Z.
- The amount earned by you from security lending is uncertain and, in fact, can be negative.
- Manager Z pays you any interest income that you would have received from the issuer of the security.
- At some future time, you request the return of 20-year Treasury Note securities and return the cash collateral to manager Z.

(c)   Calculate the risk premium embedded in the bonds.

Commentary on Question:
The candidates performed as expected on this section. Nearly all candidates earned either full credit or no credit on this section. A few papers received partial credit either due to calculation error or simply listing an appropriate formula without performing any calculation. Full credit was awarded to candidates who used one of the two methods shown below and arrived at the corresponding final answer.

- Risk adjusted break-even inflation rate = Break-even inflation rate – Inflation risk premium
- Break-even inflation rate = (1 + conventional nominal yield) / (1 + TIPS real yield) – 1
- Risk adjusted break-even inflation rate = (1 + Conventional nominal yield) / (1 + TIPS real yield) – 1 – Risk premium
- 3.1% = (1+7%) / (1+ 3%) – 1 – Risk premium
- Risk premium = 1.0388 – 1 – .031 = .0078 (78bps)

- Or, alternatively, Risk premium = Conventional nominal yield – TIPS real yield – Risk adjusted break-even inflation rate = 7% – 3% – 3.1% = 0.9%.

10. Continued

(d)   Explain why the portfolio manager would consider the TIPS bonds over the US Treasury notes.

Commentary on Question:
The candidates performed below average on this section. Nearly all candidates correctly noted that TIPs are a defensive hedge against inflation. Partial credit was awarded for each appropriate justification provided. The full list of explanations provided below was not necessary to receive full credit for this section.

- TIPS are a defensive hedge against inflation.
- Investors speculate on changes in inflation and interest rates.
- TIPS have fixed real yield, low correlation to traditional financial assets and muted volatility. They can help achieve long term goals.
- High correlation with Treasuries
- Modest correlation with other asset classes
- Portfolio manager seeking higher returns without increased risk
- Defensive allocation to preserve past gains
- Strategic decision in an ALM context
- Investor may have return objective identified in real terms

11.

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
 - Commodities
 - Hedge Funds
 - Distressed debts

Learning Outcomes:

(3a)   Demonstrate an understanding of the investment strategies and portfolio roles that are characteristic of various types of equity and alternative investments.

(3b)   Use different types of equity and alternative investments available for an investor's growth allocation in portfolio construction, considering portfolio design, risk management, liquidity management, manager selection, and implementation.

(3d)   Recommend and justify an optimal portfolio allocation in a risk-return framework.

Sources:
Maginn and Tuttle 3rd Edition, Chapter 5, sections 3 & 6

Commentary on Question:
This question tests the candidate's knowledge of the use of corner portfolios in asset allocation and of asset allocation considerations for endowments, insurance companies, and banks.

Overall, candidates performed below average on this question. Many candidates did not provide comprehensive explanations, and, thus, only earned partial credit on each part. Most candidates did not demonstrate an understanding of the risk tolerance of an endowment fund.

Solution:

(a)   Recommend a strategic asset allocation (asset class weights) for the CDF Fund that satisfies the return requirements and risk objectives.

11. Continued

> **Commentary on Question**:
> *Candidates performed as expected. While many candidates were able to correctly recommend allocations to portfolios 4 and 5, some did not provide numerical justifications on the expected return and standard deviation of the combined portfolios. Some candidates incorrectly calculated the portfolio weights or did not recommend portfolio weights altogether.*

A linear combination of the adjacent corner portfolios 4 and 5 will provide the minimum variance while satisfying the return requirement utilizing a 23.1% of portfolio 4 and 76.9% of portfolio 5.
w x 9% + (1-w) x 6.1% = 6.77%, w = 23.1% to portfolio 4, (1-w) = 76.9% to portfolio 5
These portfolio weightings satisfy the return requirement of 6.77%
Based on these weightings, the portfolio standard deviation is 7.86% using the approximation or 7.56% using an exact approach considering the correlation, which is less than the 8% requirement.
Has the highest expected Sharpe ratio among the efficient portfolios that meet the return objective. Although portfolio 6 has a higher Sharpe ratio, its return is below the target return.

(b) Explain why real estate should be included in the current portfolio.

> **Commentary on Question**:
> *Candidates performed as expected. Most candidates only explained that real estate has low correlation with fixed income, providing risk diversification. Very few candidates explained that real estate contributes to risk reduction and virtually no candidates mentioned that real estate is in the medium corner portfolios.*

Real estate has low correlation with the safe assets (bonds) and Asian equities, which makes it a very efficient diversifier of risk.
Having real estate in the portfolio maximizes the risk reduction objective while contributing to the minimum return requirement.
Real estate is in the medium risk corner portfolios.

(c) Calculate the values of the parameter R_A for which the fund would prefer portfolio 4 to portfolio 3.

> **Commentary on Question**:
> *Candidates performed below average. Some candidates only calculated the R_A but did not specify when the fund would prefer portfolio 4 to portfolio 3.*

11. Continued

$$U_3 = E(R_3) - 0.50 R_A \sigma^2_3 < E(R_4) - 0.50 R_A \sigma^2_4 = U_4$$

.1020 - .5*R_A(.1572)^2 < .09 - .5*R_A(.1256)^2

(.1020-.09)/(.5*.1572^2-.5*.1256^2) < R_A

2.686 < R_A

(d) Explain whether choosing portfolio 4 over portfolio 3 would be consistent with the expected risk aversion of an endowment fund.

Commentary on Question:
Candidates performed poorly. Most candidates were not able to identify that endowment funds have a low risk tolerance.

Portfolio 4 would be preferred over portfolio 3 at risk levels above 2.686, which would be consistent with the expected risk tolerance of an endowment fund. Risk tolerance of an endowment fund is driven by a need to commit to set a spending limit each year. There is a high penalty for failing to hit the spending limit. Thus, the risk tolerance is fairly low as there is a high degree of certainty required to hit the targets.
Low risk aversion is characterized by a low risk level (1-2) and high risk aversion is characterized by (6-8)

12. **Learning Objectives:**

2. The candidate will understand the credit risk aspects of individual securities, portfolios, and sectors and be able to apply a variety of credit risk theories and models to the investment management process.

Learning Outcomes:

(2a) Demonstrate an understanding of credit analysis.

(2b) Demonstrate an understanding of and the ability to apply both the concepts and techniques used in the measurement of default risk of individual securities.

Sources:

Mark J. P. Anson, *Handbook of Alternative Assets*, 2nd Edition, Chapter 17

Commentary on Question:

This question tests the concept of Leveraged Buyout and its difference from Venture Capital.

Solution:

(a) Define leveraged buyouts (LBOs).

Commentary on Question:

Candidates did above average on this section. Most were able to describe buying a company's stock. Some came up short by not explicitly mentioning taking the company private.

Leveraged buyouts are a way to take a company with publicly traded stock private, or a way to put a company in the hands of the current management.

(b) Calculate the annual compounded return for this investment.

Commentary on Question:

Candidates performed below average on this section. Some were able to calculate the first or second part of the solution and received partial credit. Common mistakes were incorrect rates in the first part or the wrong equity financing value in the second part.

Value of long-term cash flow = EBITDA after LBO / (Discount Rate - Long-Term Growth Rate)
$200million/(0.12 − 0.04) = $2.5billion

Total Return = (Value of Long-Term Cash Flow / Equity Financing) ^(1/years) - 1
 [$2.5billion/$100million]1/9 − 1 = 43.0%

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12. Continued

(c)   Identify four methods that the management of the company can use to realize the value of the LBO deal.

Commentary on Question:
Candidates performed below average on this section. Many candidates were able to list some ways to realize value but were not able to identify all four methods. Many mentioned management improving efficiency or unlocking the entrepreneurial mindset, but the focus of the question is how the value of the deal can be directly realized.

- The management can sell the company to a competitor or another company that wishes to expand into the industry.
- An initial public offering.
- Another LBO.
- Straight refinancing

(d)   Recommend an LBO candidate to the firm.

Commentary on Question:
Candidates performed above average on this section. Most were able to identify the correct company, but three reasons were needed to attain full credit. Candidates did not need to calculate any metrics to receive full credit.

Recommend Company B.
1. A history of profitability with steady profit margins.
   - The operation and net margins for Company B is 13% and 7%
   - The operation and net margins for Company C is 9% and 4%
2. Strong free cash flows to service additional debt levels
   - Company B generates a significant free cash flow after interest and taxes. This shows the ability to support and service a higher debt ratio.
3. Balance sheet is not already overburdened with a high debt level
   - Company B debt equity ratio is 51%. This would allow Company B to take on additional debt in a leveraged buyout
   - While Company C debt equity ratio is 76%. The balance sheet is already overburdened with a high debt level.
4. A strong balance sheet with a large cash/current asset balance.
   - Company B, 61% of its assets identified as current assets
   - Company C, only 45% of its assets identified as current assets
5. A weak stock price.
   - Price per share of Company B has languished

12. Continued

(e)   Identify four benefits of LBOs to both corporate management and investors.

Commentary on Question:
Candidates performed below average on this question. Many candidates were able to identify some benefits but were not able to list four relevant ones. Several mentioned management improving efficiency or unlocking the entrepreneurial mindset. However, the focus of the question is the direct benefit to management, such as equity share and freedom, which will then incentivize management to make efficiency improvements.

From the perspective of corporate management, the benefits of a buyout are:
- The use of leverage whose interest payments are tax deductible.
- Less scrutiny from public equity investors.
- Freedom from a distracted corporate parent.
- The ability of the management of the company to become significant equity holders and to enjoy the upside of building the business.

From the investor side:
- The bid price for their shares is typically at a large premium compared to the market price.

(f)   Compare two private equity strategies: venture capital and leveraged buyouts.

Commentary on Question:
Candidates performed as expected on this section. Most candidates received partial credit for differences in investment strategy and differences in return/risk. However, most did not discuss that the nature of control is different between VC and LBO.

- Equity stake. A venture capital firm will typically acquire a significant, but minority position in the company.
- Control is not absolute. Conversely, in a leveraged buyout, all of the equity is acquired, and control is absolute.
- Target internal rate of returns. Venture capital target IRRs are higher. There is more risk funding a nascent company with brand new technology than an established company with regular and predictable cash flows.
- Investment strategy. Venture capital finance new but unproven technology. Conversely, leveraged buyouts look to see where they can add operating efficiencies or expand product distribution.

13. **Learning Objectives:**

2. The candidate will understand the credit risk aspects of individual securities, portfolios, and sectors and be able to apply a variety of credit risk theories and models to the investment management process.

Learning Outcomes:

(2a) Demonstrate an understanding of credit analysis.

(2b) Demonstrate an understanding of and the ability to apply both the concepts and techniques used in the measurement of default risk of individual securities.

Sources:

Mark J. P. Anson, *Handbook of Alternative Assets*, 2nd Edition, Chapter 3

Commentary on Question:

This question tests the concept of hedging a convertible bond. Candidates achieved full credit by recognizing the amount of shares needed to short to hedge the bond and correctly calculating the profit made in the scenario given. Candidates lost points by using the par value of the bond instead of it's current market value and failing to calculate the impact on the profit margin under a leverage situation in part c.

Solution:

(a) Calculate the position and shares of underlying stock for the manager to hedge the equity exposure of the convertible bond.

Commentary on Question:

Candidates performed as expected on this portion of the question, often recognizing that a short position of 90 shares is needed. Occasionally, candidates lost points for using the par value of the bond in their conversion ratio instead of its market price.

The conversion ratio is 900/40=22.5 at the current bond market price, therefore we need to short 90 shares = 10 bonds x 22.5 x 40% of the underlying stock to be 40% hedged.

(b) Calculate the profit for this arbitrage strategy over the holding period of Year 1.

Commentary on Question:

Candidates performed as expected on this portion of the question, often getting full credit using their answer from part a. Points were lost by candidates failing to account for the bond interest or short rebate.

We get a gain of 1,262 = 10 x [(950-900) + 1,000 x 6%] + 90 x $40 x 4.5% from the bond coupon, appreciation, and the short rebate and lost 450 = 90 x (40-45) from the stock appreciation, for a net gain of 812.

13. Continued

(c)   Assume that the manager uses a leverage ratio of 2:1 in the purchase of the convertible bonds and borrows the additional investment capital from his prime broker at a prime rate of 4%.

Calculate the total return on capital for this arbitrage.

Commentary on Question:
Candidates performed below average on this portion of the exam, often due to failing to answer this part. Candidates often lost points by calculating that $3,000 of capital is needed instead of $4,500.

We borrow ½ of the $9,000 in capital needed, or $4,500, and pay 180 = 4.0% x $4,500 in interest. The total return drops from 812 to 632 = 812 -180, dividing by the $4,500 in capital used gives a return of 14.04%