

RET RPIRM Model Solutions

Spring 2024

1. Learning Objectives:

2. The candidate will recognize and appropriately reflect the role of plan investments in managing plan sponsor risk and make recommendations.

Learning Outcomes:

- (2d) Apply and evaluate strategies and techniques for asset/liability management.

Sources:

Study Note: RPIRM 148-17

Commentary on Question:

Overall, candidates did fairly well on this question. Most understood how to calculate the liability duration and were able to describe at least some of the challenges requested in Part (c). Results on the key-rate portion of the question varied.

Solution:

- (a) Calculate the duration of the liabilities of the pension plan.

Commentary on Question:

Many candidates received full credit on this portion of the question; calculations of Effective, Modified, and McCauley durations were all accepted, as were cashflow timings of Beginning, Middle, and End of year.

Following is a summarized calculation of the McCauley duration assuming Beginning of Year cashflow timing:

Numerator Formula:

$$\text{Cashflow} \times [(1 + \text{DR}\%)^{-(\text{Time}-1)}] \times \text{Time}$$

Denominator Formula:

$$\text{Cashflow} \times [(1 + \text{DR}\%)^{-(\text{Time}-1)}] = \text{Numerator} / \text{Time}$$

1. Continued

Truncated Calculation:

Time	Numerator	Denominator
1	$967,095 \times [(1 + 1.50\%)^{-(1-1)}] \times 1 =$ 967,095	$967,095 / 1 =$ 967,095
2	$994,926 \times [(1 + 1.50\%)^{-(2-1)}] \times 2 =$ 1,960,445	$1,960,445 / 2 =$ 980,223
...		
75	$860,574 \times [(1 + 3.50\%)^{-(75-1)}] \times 75 =$ 5,061,318	$5,061,318 / 75 =$ 67,484

Sum of Numerator: 759, 045,748

Sum of Denominator: 31,611,005

McCaulay Duration = $759,045,748 / 31,611,005 = 24.01$

- (b) Calculate key-rate durations D1, D2 and D3 for the fixed income investment.

Commentary on Question:

While some candidates were unable to recall the formula for this calculation, the most common mistakes were either using the liability value instead of the asset value in the formula ("P" should be the asset value) or using a duration other than Effective Duration to calculate D3.

Two formulae were required:

$$P^* - P = -P \times D1 \times d1 + -P \times D2 \times d2 + -P \times D3 \times d3$$

$$D1 + D2 + D3 = \text{Effective Duration (total)}$$

where:

P = Current Fixed Income Value

P* = New Fixed Income Value

Note this means $P^ - P = \text{Change in asset value for scenario}$*

Dx = Key Rate Duration @ x

dx = Interest Rate Shift @ x

Also, candidates should have noted the duration relationship between assets and liabilities; the modified duration of fixed income and liabilities is equal, thus the liability impacts can be treated as equal to the fixed income impacts, and the effective duration of liabilities can be assumed equal to the effective duration of assets.

1. Continued

Plugging into the formula:

$$-528,000 = [-8,800,000 \times 0.01 \times D1] + [-8,800,000 \times .005 \times D2] + [-8,800,000 \times 0 \times D3]$$

And

$$792,000 = [-8,800,000 \times 0.0075 \times D1] + [-8,800,000 \times -.0075 \times D2] + [-8,800,000 \times 0 \times D3]$$

Solving this system of equations gives:

$$\mathbf{D1 = 0}$$

$$\mathbf{D2 = 12}$$

Recall also that liability effective duration = asset effective duration, thus:

$$D3 = \text{Liab. Eff. Dur} - 0 - 12 = \text{Liab. Eff. Dur} - 12$$

The effective duration of the liability, which some candidates chose to calculate in part A was 23.11, which can be calculated by discounting the liability cashflows based on the provided yield curve and timing to produce the following:

Baseline PV = PV(0): 31,611,005

Interest Rate -100bps PV = PV(1): 40,236,087

Interest Rate +100bps PV = PV(2): 25,625,426

Shift Amount = D = 100bps = 1%

$$\text{Effective Duration} = -[PV(1)-PV(2)]/(2 \times D \times PV(0)) = 23.11$$

Now D3 can be determined:

$$\mathbf{D3 = 23.11 - 12 = 11.11}$$

- (c) Describe the challenges associated with a cash flow matching strategy.

Commentary on Question:

Results on this portion of the question were mixed, with most candidates failing to identify and describe 4 challenges, which was required to achieve full credit.

1. Continued

- **Curve Mismatch**
 - Deficiencies in the hedge can occur due to nonparallel movements in the yield curve.
 - Convexity mismatch can result when the timing of future expected payments is not well-aligned
 - The amount of the mismatch can be measured by calculating the key rate durations of both assets and liabilities

- **Basis Mismatch**
 - The yield used as a discount rate for liabilities is nearly always based on an asset different from those in the investment portfolio
 - Longevity and/or demographic risks can lead to imperfect cashflow tracking

- **Liquidity**
 - The ability to buy and sell investments easily is valuable because the expected pension payments will change to some degree as time passes
 - A portfolio of individual bonds, particularly corporate bonds, may be fairly illiquid. It may be difficult and expensive to adjust as changes in expected cash flows

- **Cost**
 - The return on a portfolio that adopts cash flow matching strategy usually trails its liability. The lower the return, the better the result.
 - It may sometimes be desirable to accept a less precise asset-liability match if the trade-off is additional yield.
 - Any expected pension cash flow can be matched very precisely with a portfolio of Treasury STRIPS, but less precise matches using corporate bonds or longer-duration bonds. However they might be considered more effective because of their additional yield.

2. Learning Objectives:

3. The candidate will understand how to evaluate the stakeholders' financial goals and risk management with respect to their plan.

Learning Outcomes:

- (3d) Understand and apply the principles of financial economics with respect to pension plan investing.

Sources:

The Actuary Journal p.25-28

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Compare and contrast the calculation of market liability and budget liability from the financial economics perspective for the following two assumptions:
 - (i) Default rate
 - (ii) Discount rate

Commentary on Question:

This question was generally well answered by candidates. The idea was to highlight how market and budget liabilities calculations differ or coincide for each of the two assumptions.

	Market	Budget	Comparison / Contrast
i. Default Rate	Assumes default rate exists (or assumes there is a risk that payments are not made)	Assumes default rate exists (or assumes there is a risk that payments are not made)	Same
ii. Discount Rate	Does not include risk premium	Includes Risk (or equity) Premium	Different

2. Continued

(b)

Commentary on Question:

As there was a significant issue with the wording of this part of the question which made the question unanswerable, it was not graded and the total number of possible points for the exam was reduced from 40 to 35.

3. Learning Objectives:

2. The candidate will recognize and appropriately reflect the role of plan investments in managing plan sponsor risk and make recommendations.

Learning Outcomes:

- (2d) Apply and evaluate strategies and techniques for asset/liability management.
- (2e) Provide advice and analysis to plan sponsors regarding the mitigation of investment risks.

Sources:

RPIRM-147-17 : Charting the Course: a framework to evaluate pension de-risking strategies

RPIRM-149-17 : Practical De-Risking Solutions: Asset Duration and Interest Rate Risk

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Describe the benefits of implementing a glide path liability-driven investment (LDI) strategy.

Commentary on Question:

Candidates were expected to list and describe each benefit.

- **Objective decision framework:** formal investment policy decision that is a function of a predefined set of circumstances that are both logical and tangible.
- **Reduces point-in-time risk:** De-risking occurs incrementally based on pre-established triggers, effectively mitigating the risk of mistiming or second-guessing a decision. Locking-in gains as they occur. Don't need to sacrifice too much return because de-risking is done gradually (reasonable compromise between lost upside and undesirable downside).
- **Avoids inaction:** Formal commitment to de-risk, backed by a systematic process that will ensure it actually happens, helps staying away from ambiguity (e.g. sponsor wants to de-risk when more favorable circumstances arise – circumstances that are often vaguely defined, and ultimately never occur).
- **Manages regret risk:** Removes emotions from the equation and avoids being distracted by short-term noise, constant reminder of long-term risk management goals.

- **Ease of customization:** Each solution can be tailored to the circumstances and objectives of the plan sponsor, taking into consideration plan's maturity, status, funded position, risk tolerance, ... Examples of parameters that can be customized: end state, trigger points, triggers distance and monitoring frequency.
- **Interest rate risk mitigation:** Risk must be addressed regardless of current interest rate levels to preserve long-term sustainability of a DB pension plan. Closes gap between asset and liabilities duration. If interest rates go down, pension plans can represent significant cost to the sponsor, etc.

(b) Recommend one of the following LDI strategies considering Company ABC's primary objective.

Justify your recommendation.

	Option 1	Option 2
Initial asset allocation	No immediate change	35% Equity / 65% Bonds
Triggers	Interest rate level (long term bond index) increases by 0.50%	Funded status improves by 2%
Monitoring frequency	Quarterly	Monthly
% of equity replaced with bonds when a trigger is reached	15%	5%
Duration of bonds added to the portfolio	14.9 years	7.2 years
End state objective	Hedge ratio = 100%	Funded status = 100%

Commentary on Question:

Candidates were expected to pick an option and describe how it meets Company ABC's objectives. Full credit was available for both options. Candidates were not required to perform calculations, but could, to help them justify their recommendation. Partial credit was awarded when a candidate did not make a clear recommendation.

Sample answer for Option 1:

- Initial asset allocation
 - No immediate restructuring = avoid massive allocation shift that can be done at an inopportune time

3. Continued

- Triggers:
 - Triggers are easy to understand and simple to monitor (no need to perform any calculations)
 - Interest rate increases means that the funded status would improve as well (which is the Company ABC's main objective): the current hedge ratio is 25%, meaning that when the liabilities decrease by \$100, the asset will only decrease by \$25
 - Hedge ratio = $86\% \times 40\% \times 7.2 / 9.8 = 25\%$
 - This type of glide-path would therefore lock-in improvements in funded status by purchasing bonds and increasing the hedge ratio only when the sponsor feels comfortable extending duration
 - Note: The distance between triggers (0.50%) might be too big and could result in inertia (i.e. never being able to reach the next trigger if interest rates don't increase enough) so would probably be better to have an increment of 0.25%
- Starting Point of the Asset Allocation:
 - The risk-seeking asset allocation could help improve the funded status of the plan if stock market performs well
- Monitoring Frequency:
 - Potential reduction of costs associated with the strategy (fewer trades, therefore lower transaction costs, lower costs associated with monitoring)
 - Note: Monitoring frequency is a bit low, which could lead to missed opportunities to capture gains
- Duration of Bonds Added to the Portfolio
 - The bonds currently held in the portfolio have a shorter duration than the plan's liabilities, so the bonds that will be added to replace equity will help achieve a better asset-liability match (increase the hedge ratio) more quickly which is suitable giving the short investment horizon (5 years)
- End State Objective:
 - Increasing the hedge ratio means that we are reducing risk and thus the funded status volatility before termination occurs
 - The plan sponsor wants to terminate the plan in 5 years, so a hedge ratio of 100% would protect the funded status from unexpected interest rate swings right before termination

3. Continued

Sample answer for Option 2:

- Starting Point of the Asset Allocation:
 - Immediate restructuring of the plan's asset allocation would help to partially lock in the plan's financial position (funded status = 86%)
 - The interest rate hedge ratio is low (25%) so if the interest rates decrease, the plan's financial position will be significantly affected if the plan assets are not immediately reallocated
 - Hedge ratio after the immediate restructuring = 41% ($86\% \times 7.2 \times 65\% / 9.8$)
 - The risk-seeking asset could create a large deficit if the stock market does not perform well, and the investment horizon is short (5 years) so it's best to protect the current assets
 - But this option still leaves enough exposure to equity (35% in risk-seeking assets) to close the funded status gap

- Triggers:
 - Consistent with the end-state objective and Company ABC's main objective to increase the funded status and to stay fully funded until termination occurs
 - The distance between triggers is reasonable (2%): the triggers can be realistically reached
 - Sponsor has a certain control over the triggers (can make special contributions to increase the funded status)

- Monitoring Frequency:
 - Not too low and not too high, would result in a reasonable number of trades without missing good opportunities to capture gains
 - Reduce timing risk as we will move towards bonds more gradually than with Option 1

- Duration of Bonds Added to the Portfolio
 - At the end of the glide-path, assuming that the duration of the liability will remain the same, the hedge ratio will be 73% which would protect the funded status from unexpected interest rate swings right before termination
 - That said, since the plan is closed and frozen, the duration of liability will likely decrease over time

- End State Objective:
 - Consistent with Company ABC's primary objective which is to become fully funded and reduce cost at termination

4. Learning Objectives:

1. The candidate will understand the issues facing retirement plan sponsors regarding investment of fund assets.

Learning Outcomes:

- (1g) Solve for a measure of investment performance relevant to a given benchmark.

Sources:

Modern Investment Management, Litterman, Robert, 2003; page 268

Modern Investment Management, Litterman, Robert, 2003; page 275

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) List the four main objectives of performance measurement tools.

Commentary on Question:

This question tested candidates' knowledge of the uses of performance measurement tools. Successful candidates listed most of the four main objectives of performance measurement tools and delineated between the ability to determine whether returns were sufficient to compensate for the risk assumed and identifying those managers who generate high-quality excess risk-adjusted returns. Common items left out were comparison to benchmark, peer group, and high-quality excess returns.

1. To determine whether a manager generates consistent excess risk-adjusted performance compared to a benchmark.
 2. To determine whether a manager generates superior risk-adjusted performance compared to their peer group.
 3. To determine whether the returns achieved are sufficient to compensate for the risk assumed in cost/benefit terms.
 4. To provide a basis for identifying those managers whose processes generate high-quality excess risk-adjusted returns.
- (b) Identify the strengths and weaknesses of using risk-adjusted return ratios for performance measurement.

4. Continued

Commentary on Question:

This question tested candidates' ability to distinguish between the strengths and weaknesses of risk-adjusted return ratios. Successful candidates understood the methodology behind risk-adjusted return calculations and how they can be used to evaluate performance. Successful candidates also addressed both strengths and weaknesses. Common mistakes included not including strengths and weaknesses, confusing strengths for weaknesses and vice-versa, and contradicting answers.

Strengths	Weaknesses
They can be used to measure relative performance by identifying managers/portfolios which generate superior risk-adjusted excess returns.	They may require data which may be difficult to obtain, especially for other managers/portfolios.
The statistics can be applied both at the portfolio level as well as for individual industrial sectors and countries.	Often an insufficient history to be conclusive about attractiveness of risk-adjusted performance results.
They test whether the manager has generated sufficient excess returns to compensate for the risk assumed.	If using achieved/actual risk instead of potential/modeled risk, the ratios' relevance depends, to some degree, on whether the environment is friendly to the manager.
Easy to calculate, understand and communicate to investment committees / investors for risk management.	

- (c) Calculate the Dollar-Weighted and Time-Weighted rates of return for each of the three portfolios.

Draft Solution in Corresponding Excel Spreadsheet

- (d) Calculate the Sharpe Ratio for portfolios 1 and 2 assuming a risk-free rate of 2.50% and using the Time-Weighted return calculated in c) above.

Draft Solution in Corresponding Excel Spreadsheet

5. Learning Objectives:

3. The candidate will understand how to evaluate the stakeholders' financial goals and risk management with respect to their plan.

Learning Outcomes:

- (3a) Compare the interests of plan sponsors, employees, shareholders, taxpayers and other stakeholders related to the financial management of a retirement plan.
- (3f) Provide advice and analysis to plan sponsors and other stakeholders regarding the mitigation of pension plan risks.

Sources:

RPIRM-123-13: Risk Management and Public Plan Retirement Systems (Appendices background only)

Commentary on Question:

In general, candidates did not perform well on this question. Many candidates did not respond with enough information to earn full points.

Solution:

- (a) Describe the considerations when defining a public pension plan's objectives for the purpose of establishing a risk management framework.

Commentary on Question:

A common mistake in part a) was describing the considerations for private pension plans instead of focusing on public pension plans.

- Management risk – risk from managing benefit levels, contribution policy, and investment policy, especially when one or more are fixed.
- Sustainable – a sustainable plan has consistent plan costs from year to year and from generation to generation.
- Equitable – equitable costs will link plan costs directly from the taxpayers who receive the services to the benefits for the public employees who deliver the services.
- Appropriate funding – a plan should have predictable funding resulting in a reasonable well-funded status but should not be too overfunded. The costs should not be too high.
- Benefit Design – benefits should be high enough to attract and retain workers. Ancillary benefits should reflect the needs of public employees.
- Governance – should mediate the competing objectives of the stakeholders. Should include risk disclosures.

5. Continued

- (b) Describe the factors that contribute to distortions in the feedback loop for public pension plans.
- Time horizon – the time horizon for public pension plans is very long, and it could take decades before mismanagement is discovered absent a negative market event.
 - Dysfunctional control structure – there is no single stakeholder that has the authority to make significant changes to the plan or compel contributions. Stakeholders making short term decisions to increase benefits or decrease contributions could place cost burden on future generations.
 - Lack of regulatory standard – no single regulator with authority to compel certain disclosures. Most plans provide GASB disclosures but less regulation on calculating results versus the private sector.
 - Economic and demographic cycles – During economic downturns, plans may need increased contributions when tax revenues decline. In addition, plan demographics can drive contributions.

6. Learning Objectives:

1. The candidate will understand the issues facing retirement plan sponsors regarding investment of fund assets.

Learning Outcomes:

- (1c) Given a context, analyze a Statement of Investment Policy.
- (1e) Describe the regulatory restrictions on retirement plan assets.

Sources:

RPIRM-103-15, and RPIRM-132-14

Commentary on Question:

This question aimed to assess if the candidate understands how a statement of investment policies can address certain risk of pension plans, and if a candidate can evaluate what is appropriate in a SIPP with respect to a pension plan.

Solution:

- (a) Critique the elements provided above of Company XYZ's SIPP.

Objectives:

- Asset allocations should be considered at an individual plan level, and the two divisions should have their own SIPP.
- The plan's main objective should focus on participants' benefits with improvement of XYZ's balance sheet as a secondary objective instead.

Investment strategies:

- Meets duty to diversify potentially, but should ensure diversification within the categories
- Holding petroleum stocks can stem concentration risks for the company. For example, in a hypothetical downturn of the petroleum industry, it would cause a drop in the company's profit and its retirement asset prices simultaneously.
- Residential and commercial real estate investments will protect the plan from inflation risk. Exchange traded funds help mitigate the liquidity risk that is present in investing directly in real estate.
- Bonds should not be duration matched on an aggregate basis. Instead, it should be matched on a plan basis, and liquidity must be considered at a plan level to ensure stable payouts of retirement benefits for both plans.

Plan administrator:

- XYZ should consider delegating (outsourcing) the administration, if it doesn't have the expertise to carry out that task to meet their fiduciary responsibilities.

6. Continued

Plan Assets:

- Holding more than 10% of the plan's assets in any single investment/security is risky (and in some cases may not even be permitted). Company XYZ should diversify the investments it is holding in Company W stock.

Investments:

- It would be more appropriate to have multiple managers within each asset class as opposed to having only a single manager, especially for stocks, bonds, and hedge funds in XYZ's case.
- Hiring investment managers solely based on low fees may not be a prudent approach. It would be beneficial to hire managers based on the best cost benefit tradeoffs instead.

Rebalancing:

- Annual rebalancing is less costly than more frequent rebalancing, but assets may fall outside the target asset allocation during the year.

Monitoring:

- Investment monitoring should be conducted by personnels with proper credentials or experience. Given that the plan sponsor's expertise is not in finance, external consultants should be hired.

- (b) Company XYZ is considering hiring an outsourced chief investment officer (OCIO) for both Division A and Division B plans.

Describe the advantages and disadvantages of the above consideration.

Advantages:

- Given the plan sponsor's expertise is in Petroleum and not in finance, XYZ may not be able to manage the plan with fiduciary standards of care. By delegating the management of such plans, they can focus their resources back on the business instead.
- By delegating to an OCIO, they can have access to the expertise of pension investment specialists to help them manage the risks linked to the plans.

6. Continued

Disadvantages:

- Time and costs to the Company for the evaluation to select the OCIO, and additional costs from delegation and performance monitoring of the third party will be incurred. The plan sponsor will need to make sure the selected third-party administrator will meet the pension plans' objectives and must investigate qualification of the investment managers, provide all necessary information, and ensure reliance on third party advice is reasonably justified.
- Delegation of the management of the plan to an external party does not mean the fiduciary responsibility of the plan sponsor is gone. In fact, monitoring of the external party is still required to make sure care and prudence is applied.