

RET RPIRM Model Solutions

Fall 2020

1. Learning Objectives:

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

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 pension plan risks.

Sources:

RPIRM-148-17: Key Rate Durations: Measures of Interest Rate Risks

Commentary on Question:

Most candidates performed well. The most common mistake was to solve part (a) using the information provided in the question as if it was for a shift in key rates D2 and D4 instead of D2 and D3. Even if the key rates found in (a) were incorrect, points were awarded in part (b) using the information provided by the candidate in part (a).

Solution:

- (a) Calculate the key rate durations D2 and D4.

$$\begin{aligned}P^* - P &= -P \times D2 \times d2 + -P \times D3 \times d3 \\P \times D3 \times d3 &= -28,000,000 \times .005 \times 3.4 = -476,000 \\D2 &= ((P^* - P) - (P \times D3 \times d3)) / (-P \times d2) \\&= (-1,200,000 + 476,000) / (-28,000,000 \times 0.1)\end{aligned}$$

$$\mathbf{D2 = 2.6}$$

Effective duration = sum of key durations

$$\text{Effective duration} = D1 + D2 + D3 + D4 + D5$$

$$D4 = 17 - 1.7 - 2.6 - 3.4 - 5.2$$

$$\mathbf{D4 = 4.1}$$

- (b) Calculate the effect of the following yield curve shifts on the liabilities

$$P^* - P = (-P \times D1 \times d1) + (-P \times D2 \times d2) + (-P \times D3 \times d3) + (-P \times D4 \times d4) + (-P \times D5 \times d5)$$

1. Continued

| Effect of shift 2 | | | | | | |
|-------------------|------------|------------|------------|------------|------------|-----------|
| | D1 | D2 | D3 | D4 | D5 | Total |
| Liability | 28,000,000 | 28,000,000 | 28,000,000 | 28,000,000 | 28,000,000 | |
| Duration | 1.7 | 2.6 | 3.4 | 4.1 | 5.2 | |
| Shift 1 | -0.10% | -0.05% | 0.00% | 0.00% | +0.15% | |
| Impact | 47,600 | 36,200 | - | - | (218,400) | (134,600) |
| Effect of shift 2 | | | | | | |
| | D1 | D2 | D3 | D4 | D5 | Total |
| Liability | 28,000,000 | 28,000,000 | 28,000,000 | 28,000,000 | 28,000,000 | |
| Duration | 1.7 | 2.6 | 3.4 | 4.1 | 5.2 | |
| Shift 2 | 0.00% | +0.15% | +0.15% | +0.05% | 0.00% | |
| Impact | - | (108,600) | (142,800) | (57,600) | - | (309,000) |

- (c) Compare and contrast investing in the following fixed income portfolios for the purpose of implementing an LDI strategy for XYZ pension plan:
- (i) A portfolio matching the effective duration; and
 - (ii) A portfolio matching the key rate durations

Compare:

- Both provide protection about interest rate risk.
- Both protect against parallel shift of the yield curve.

Contrast:

- Key rate duration matching will provide protection against the following curve movements: Level, steepness, and curvature. (i.e. any shift including parallel shifts) whereas effective duration protects only against parallel shift of the yield curve.
- Effective duration is well established in portfolio management.
- Key rate duration matching is more complex to implement than matching the effective duration.
- If the key rate durations of the liabilities are matched, the liabilities will be fully immunized to change in interest rates. This is not the case if the effective duration is matched.

2. Learning Objectives:

1. The candidate will understand how to analyze the issues facing retirement plan sponsors regarding investment of fund assets and make recommendations.

Learning Outcomes:

- (1a) Assess the different types and combinations of investment vehicles for providing retirement benefits given the particulars of the stakeholders' financial circumstances, philosophy, industry, work force and benefit package.
- (1d) Assess the potential effects of various investments and investment policies on all of the stakeholders, including tax implications.

Sources:

RPIRM-143-17: Attracting Pension Plan Assets

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Describe the additional risks that pension plan would be exposed to

Commentary on Question:

Most candidates scored really well on this section. There was opportunity for numerous points

Illiquidity:

- Reduces possibility for quick exit by investors
- Managers will have a lock-up period

Assets are hard to value

Strategy risk such as:

- Deviations from stated strategy
- Manager straying from area of expertise
- Lower diversification of overall pension portfolio

Counterparty risk

- Issue for hedge funds and private equity funds due to, in part, their use of leverage and/or OTC trading transactions

2. Continued

Additional Commentary: *Other risks/topics receiving points, include but are not limited to:*

- *Market risk such as equity risks, interest rate risks, foreign exchange and commodity risks*
- *Operational risks when inadequate internal control environments exist such as:*
 - *Back-office systems and controls*
 - *Appropriate segregation of duties among personnel*
 - *Execution accountability*
 - *Legal review*
 - *Regulatory readiness*
- *Assets are not covered by mutual fund protections*
- *Sub-advisor risk*

- (b) Describe ways investment managers can mitigate the risks listed in part (a)

Commentary on Question:

Candidates generally did less well on this part. Candidates did not provide sufficient detail.

Illiquidity:

- *After initial lock-up period offer investors monthly or quarterly redemption rights*
- *Offer investors managed account or fund-of-one structure*
- *Diversification of funds or stacking strategies*

Assets hard to value:

- *Determine if fund has rigorous valuation practices in place (including ASC 820)*
- *Policies reviewed regularly by independent governance review board*
- *Audit reports of valuation processes*

Strategy risk:

- *Monitor transactions to identify instances of drift*
- *Plan sponsors can identify drift by doing benchmark analysis*

Counterparty risk:

- *Implement risk controls such as:*
 - *Position limits*
 - *Counterparty credit limits*
- *Show plan sponsors how can access a fund's use of leverage historically to show sponsor how fund controls counterparty risk*

3. 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.
- (3f) Provide advice and analysis to plan sponsors and other stakeholders regarding the mitigation of pension plan risks.

Sources:

RPIRM 162-19 Use of Financial Economics in Pension Actuarial and Investment Practice

Pension Actuary's Guide to Financial Economics and Pension Arbitrage Example

Commentary on Question:

Generally this question was completed well.

Solution:

- (a) Describe how to measure the following items from a financial economics perspective.
 - (i) Market Value of Assets; and
 - (ii) Liabilities

Commentary on Question:

Most candidates received full credit for this part.

- (i) Market value of assets is the current fair value of assets of the pension portfolio.
It should not include smoothing adjustments, which would mislead investors as to the actual funds available to secure member benefits.
 - (ii) Liabilities from a financial economics perspective should be marked-to-market.
They should be measured without salary projections and at discount rates based on the prevailing corporate yield curve.
- (b) Calculate the impact of the new portfolio on your after-tax returns by filing out the tables in Excel.

3. Continued

Commentary on Question:

Some candidates had difficulty in the calculation of pre-tax income – in particular how to apply the corporate tax rate.

| Table 1: Individual Investor Portfolio Return (60/40 Portfolio) | | | | |
|--|------------------------------|---------------------------|---------------------|-----------------------------|
| Pension Plan: 60% Equity / 40% Bonds | Investor Holdings | Pre-tax Income | Personal Tax | After-tax Income |
| Indirect holdings through corporate pension plan | | | | |
| Equity | 195,000 | 13,650 | | |
| Bond | 130,000 | 3,900 | | |
| Total indirect holdings | 325,000 | 17,550 | 2,632.50 | 14,917.50 |
| Investors direct holdings | | | | |
| Equity | 4,805,000 | 336,350 | -50,452.50 | 285,897.50 |
| Bond | 4,870,000 | 146,100 | -58,440 | 87,660 |
| Total direct holdings | 9,675,000 | | | 373,557.50 |
| Total portfolio | 10,000,000 | | | 388,475 |

| Table 2: Individual Investor Portfolio Return (Bond Portfolio) | | | | |
|---|------------------------------|---------------------------|-------------------------|-----------------------------|
| Pension Plan: 100% Bonds | Investor Holdings | Pre-tax Income | Personal Tax | After-tax Income |
| Indirect holdings through corporate pension plan | | | | |
| Equity | 0 | 0 | | |
| Bond | 325,000 | 9,750 | | |
| Total indirect holdings | 325,000 | 9,750 | -1,462.50 | 8,287.50 |
| Investors direct holdings | | | | |
| Equity | 5,000,000 | 350,000 | -52,500 | 297,500 |
| Bond | 4,675,000 | 140,250 | -56,100 | 84,150 |
| Total direct holdings | 9,675,000 | | | 381,650 |
| Total portfolio | 10,000,000 | | | 389,937.50 |

- (c) Explain why shifting the pension plan's asset allocation to bonds represents an arbitrage opportunity.

Commentary on Question:

Most candidates understood and explained the concepts well, but sometimes there was a lack of completeness.

3. Continued

Bonds held in your portfolio are taxed at the individual bond tax rate of 40%.
Bonds held indirectly through the corporate pension plan are taxed at the individual equity tax rate of 15% since they increase the value of the company shares.

The bond investment return is therefore taxed at a lower level if held through the corporate pension plan

The greater the return on bonds, the greater the arbitrage opportunity

The greater the difference in individual tax rates on bonds vs equity, the greater the arbitrage opportunity

Return on the equity investments do not impact the arbitrage opportunity since they're taxed at 15% in all scenarios

4. Learning Objectives:

1. The candidate will understand how to analyze the issues facing retirement plan sponsors regarding investment of fund assets and make recommendations.

Learning Outcomes:

- (1a) Assess the different types and combinations of investment vehicles for providing retirement benefits given the particulars of the stakeholders' financial circumstances, philosophy, industry, work force and benefit package.
- (1d) Assess the potential effects of various investments and investment policies on all of the stakeholders, including tax implications.

Sources:

Modern Investment Management, Litterman Ch. 24

Commentary on Question:

Commentary listed underneath question component.

Solution:

- (a) Describe the risks associated with investing in fixed income.

Commentary on Question:

To achieve full credit, successful candidates correctly identified and described at a minimum six (6) risks associated with fixed income investing. Points were not awarded to candidates who only listed each risk without descriptions. A full list of acceptable answers are detailed below.

- **Interest rate risk** – risk that the yield of a bond will change due to changes in the otherwise risk-free bond with the same cash flows.
- **Yield curve risk** – risk that a portfolio's value will change due to a change in the shape of the yield curve.
- **Sector risk** – risk due to yield changes derived from changes in spread between the sector and the baseline yield curve.
- **Credit risk** – risk that the issuer is unwilling or unable to pay the agreed upon cash flows.
- **Volatility risk** – the portfolio's value is impacted by how much interest rates move or are expected to move in either direction.
- **Prepayment risk** – risk that the borrower of a mortgage-backed security can prepay their mortgages at face value and replace them with other mortgages at a lower rate.
- **Currency risk** – risk investor faces by investing in fixed income that is not in the investor's base currency.
- **Security specific risk** – risk due to the specific security that cannot be explained by any other fixed income risk factors.

4. Continued

- (b) Describe methods that active managers use to mitigate the risks described in (a).

Commentary on Question:

To achieve full credit, successful candidates correctly described ways to mitigate the risks they identified in the previous section. Candidates who provided risk mitigation strategies for risks unrelated to fixed income or the previous section were not given points. A full list of acceptable answers are detailed below.

- **Duration timing strategy** – market timing strategy where a portfolio manager has a longer or shorter average duration than the benchmark.
- **Yield curve positioning** - the portfolio manager overweights the contribution to duration (CTD) of one or more multiple parts of the yield curve and offsets these long positions with underweights of other parts of the yield curve.
- **Sector allocation strategy** – the manager overweights and underweights positions in the various fixed income sectors relative to the benchmark. For example, holding more corporate bonds than the benchmark portfolio.
- **Security selection strategy** – the manager selects individual securities within each of the sectors in which the portfolio is being invested.
- **Country allocation strategy** – the manager takes active long and short positions in bonds prices off the yield curve of one country vs. another country.
- **Currency allocation strategy** – allows managers to implement views on exchanges rates between one currency and another.

- (c) Compare and contrast each constraint of Portfolio A versus Portfolio B for addressing Company XYZ’s goal.

Commentary on Question:

To achieve full credit, successful candidates compared Portfolios A and B against their respective portfolio constraints and were able to identify its contribution to minimizing interest rate risk and/or achieving a greater-than-benchmark return. Solutions comparing and contrasting the portfolios without stating a conclusion were not given full points.

- Portfolio A has a fixed duration and will mitigate interest rate risk. The duration for Portfolio B is not constrained and therefore it may not meet the goal of mitigating interest rate risk.
- The duration of the liabilities of the pension plan may not match the benchmark portfolio duration of 15. Therefore, Portfolio B might do a better job of mitigating interest rate risk if Portfolio B’s duration is closer to the liabilities of the pension plan.
- Portfolio A’s higher quality credit requirement will minimize credit risk. Portfolio B can provide potentially higher returns than the benchmark by allowing a small percentage in lower quality bonds.

4. Continued

- Portfolio B has a higher possibility of excess return over benchmark since the target allocation is more flexible.
- Portfolio B will permit another sector (mortgage backed securities) and thus could have extra returns.
- Portfolio B will permit mortgage back securities and thus could introduce prepayment risk.
- Portfolio A can obtain higher returns with foreign bonds, but they become exposed to currency risk and country risk.
- Portfolio A using currency forward contracts does not reduce interest rate risk and will not provide extra expected return.

5. Learning Objectives:

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

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 pension plan risks.

Sources:

RPIRM-110-13
RPIRM-111-13
RPIRM-112-13
RPIRM-147-17
RPIRM-149-17
Litterman Ch. 2
Litterman Ch. 27-28

Commentary on Question:

Part (a) was testing how a candidate can apply their understating of the duration of the fixed income and discount rate and how it affects the assets/liabilities of a pension plan.

Part (b) was testing a candidate's knowledge of different strategies that a plan's sponsor may use to reduce volatility of the funded ratio without reducing the expected return on the assets.

Solution:

- (a) Calculate the impact on the funded ratio of a 20 basis point reduction in both the fixed income yields and the liability discount rate.

Show all work.

Commentary on Question:

Most candidates did well on this question. The concept that caused some difficulty was on how to use the interest hedge ratio to calculate the duration of the liabilities.

Given:

Current funded ratio = $100/125 = 80\%$

20 bp drop by EOP (end of period)

EOP equity = 60, assumed to be unchanged, since not otherwise indicated

$$(1) \text{ EOP bonds} = 40 * [1 + (7.7/100)*(20/100)] = 40.62$$

$$(1) \text{ EOP assets} = 60 + 40.62 = 100.62$$

5. Continued

$$\text{EOP Liabilities} = 125 * [1 + (\text{liability duration}/100)].$$

To find liability duration, we rearrange the formula for interest rate hedge ratio (the proportion of change in liabilities, due to a change in interest rates, that are covered by a change in assets):

$$(2) \text{ Liability duration} = \text{FI allocation} * \text{FI duration} * \text{funded ratio} / \text{interest rate hedge ratio}$$

$$(1) \text{ Liability duration} = 40\% * 7.7 * 80\% / 0.1643 = 15$$

$$(1) \text{ EOP Liabilities} = 125 * [1 + 0.15*(20/100)] = 128.75$$

$$(2) \text{ EOP Funded ratio} = 100.62 / 128.75 = 78.15\%$$

- (b) Describe potential changes to the investment strategy that achieve the plan sponsor's objective.

Commentary on Question:

A full credit was given to candidates who named two distinct solutions and described how each strategy achieves the plan sponsor's objective. Many candidates failed to provide more than one distinct strategy which resulted in a partial credit. The answer below provides three such strategies; we note that any two strategies would be accepted for full credit.

Possible changes to the investment strategy include:

I. Add duration to assets:

- Increase duration of bonds without changing allocation
 - Assuming longer duration bonds have equal or greater expected return
- Leverage the fixed income (one option is to use derivative overlay strategies) to reduce interest rate risk while maintaining or increasing allocation to equities

II. Diversify growth allocation

- A mix of alternative asset classes could reduce the market risk of the portfolio without reducing expected return
 - For example, a combination of a high return / high risk asset class (e.g. private equity) with a low return / low risk asset class (e.g. certain hedge funds)

5. Continued

III. Buy-in annuities for retirees

- Purchasing a buy-in annuity for all or a portion of retirees using all or a portion of the bond allocation reduces the volatility of the funded status because the risk of both interest rate and mortality experience is shifted to the insurer.
- If the insurer can invest at a higher yield than the current bond allocation, the total return of the portfolio may remain unchanged, even after reflecting the premium charged by the insurer

6. Learning Objectives:

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

Learning Outcomes:

- (3f) Provide advice and analysis to plan sponsors and other stakeholders regarding the mitigation of pension plan risks.

Sources:

RPIRM-141-16

Commentary on Question:

Candidates did not do particularly well in this question. Many candidates failed to answer the question, which was, for each item listed, to explain how risks (or a specific risk) were addressed, and not simply to describe the item in question.

Solution:

- (a) Explain how each of the following addresses risks for defined benefit pension plans:
 - (i) Prudent person rules;
 - (ii) Minimum funding regulations;
 - (iii) Guarantee funds; and
 - (iv) Accounting standards.

- (i) Prudent person rules (PPR) address the risk of holding risky assets within the pension plan. They do so by ensuring that there is both adequacy of assets and an appropriate level of risk. PPR does not focus unduly on the risk and liquidity of individual assets, but accounts for the fact that, at the portfolio level, both default risk and price volatility can be reduced by diversification.

- (ii) Minimum funding regulations address shortfall risk (i.e. the risk of the plan not meeting its financial obligations because of a funding shortfall) by forcing plans sponsors to contribute a minimum amount to the pension plan and thus ensuring a certain "safety" of benefits in case the employer cannot meet its future obligations to the plan. Different approaches are used to define minimum contributions, but notably "solvency" rules ensure plans are funded on the basis on the economic value of the benefits in case the plan is terminated.

6. Continued

- (iii) Guarantee funds address the risk of bankruptcy of the plan sponsor by guaranteeing benefits will be paid in that event. There are usually contributions by plan sponsors using the principle of insurance and maximum benefits that can be provided by the fund.
 - (iv) Accounting standards address the risk that financial statements do not adequately reflect the plan assets, obligation or both, thus misleading investors and/or creditors in their evaluation of the plan sponsor's financial situation (i.e. risk to investors and creditors). They do so by providing standard rules for presenting pension obligation and assets. Accounting standards use mostly mark-to-market approaches to assets and liabilities, meaning that the focus is increasingly on the current financial situation. Standards also require certain disclosures that enhances transparency for pension plan accounting obligation.
- (b) Explain how each of the following addresses risks for defined contribution pension plans:
- (i) Prudent person rules;
 - (ii) Limits on fees charged to plan members; and
 - (iii) Incentives to annuitize.
- (i) Prudent person rules (PPR) address the risk of plan members holding risky assets within their defined contribution account. For defined contribution plans, this translates in requiring plan sponsors offer a diverse range of investment options, thus allowing plan members to invest according to their risk profile and to diversify. PPR also apply to the plan's default option which should be designed to so that member's investments reflect their risk profile and use diversification.
 - (ii) Limits of fees charged address the risk of inadequate returns and hence retirement benefit. They do so by ensuring fees charged are reasonable, and thus, do not unduly reduce the investment return.
 - (iii) Incentives to annuitize address the risk of outliving pension assets (i.e. longevity risk or risk of living longer than expected when decided how much to save and how to decumulate assets). They do so by facilitating the purchase of annuities (either by securing group prices or simply by providing the option within the plan), which by design insure against longevity risk or the risk of outliving pension assets.