RET RPIRM Model Solutions
Spring 2018

1. 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.

(1f) Identify and assess the sources of investment risk applicable to retirement fund assets.

Sources:

RPIRM-145-17: An Introduction to Infrastructure as an Asset Class

RPIRM-143-17: Attracting Pension Plan Assets: what alternative investment managers need to know

Commentary on Question:

This question is preparing candidates to talk to clients about plan assets rather than focusing on the liability side. As plan sponsors are looking for ways to earn more investment return in their pension plans, be prepared to think out of the box and give them sufficient information to make a decision.
Candidates did fairly well on this question. One comment is that Part A of this question asked to describe the advantages and risks. Full points were not given if the candidate only lists the items requested. There has to be some detail provided also

Solution:

(a) Describe the advantages and risks of investing pension plan assets in infrastructure.

Commentary on Question:

No points granted for simply naming the risk in a "describe" question. Extra points may be granted for a risk with a strong explanation or example. Other reasonable risks may be granted credit

1. Continued

Advantages

- Provides enhanced diversification for existing pension plan portfolios due to low correlation with traditional asset classes, allowing it to play a role in risk-return optimization. *[Commentary: must mention optimization for full credit]*
- Offers reliable long-term predictable cash yields to match up with long-term liability cash flows.
- Offers inflation protection.
- Long operational lives and high operation margins.

Risks

- Patronage/demand risk: certain infrastructure assets (e.g. transportation) have patronage/demand that varies with the business cycle which increases correlation with other assets types.
- Regulatory risk: Regulatory structure may be governmental or may be through long-term agreement. Political and business climate may impact regulation and therefore growth opportunities.
- Contractual/credit risk: long term contracts for large projects expose counterparties to risk.
- Operational/construction risk: from large, complicated infrastructure projects. Potential for cost overruns, injuries/death, etc.
- Financial/inflation risk: Leverage involved in financing exposes investors to the costs of debt and refinancing risk. The value of future cash flows may also be influenced by inflation.
- Fund manager risk: Manager must have in-depth sector knowledge, strong transactional capabilities, and deep asset-level operational experience.

(b) Compare investing pension plan assets in infrastructure to investing in:

(i) Fixed income

(ii) Real estate

(iii) Private equity

1. Continued

(i) Fixed income

Similarities to Infrastructure

- Long-term, predictable cash yield
- Low market risk

Differences from Infrastructure

- Infrastructure generally has inflation hedge features
- Infrastructure investments are only indirectly exposed to interest risk

(ii) Real estate

Similarities to Infrastructure

- Cash yield is significant part of return
- Location is important

Differences from Infrastructure

- Infrastructure has higher barriers to entry
- Infrastructure has less exposure to valuation cycles

(iii) Private equity

Similarities to Infrastructure

- Management control over investments
- Converging/similar investment techniques

Differences from Infrastructure

- Infrastructure has lower exposure to economic cycle
- Infrastructure has longer investment horizon with return less driven by exit strategy

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:

(1e) Describe the regulatory restrictions on retirement plan assets.

Sources:

RPIRM-132-14 CAPSA Guideline No. 6 – Pension Plan Prudent Investment Practices Guideline

Commentary on Question:

This question was to test candidates' recall of prudent investment principles, specifically under CAPSA Guideline No. 6.

Candidates that did well gave valid responses specific to the question as asked. Other candidates gave general principles of prudence that may or may not have been mentioned in the note.

Solution:

Describe five prudent investment principles under CAPSA Guideline No. 6 – Pension Plan Prudent Investment Practices Guideline.

Prudent Person Rule

A fiduciary is expected to discharge its duties with the care, skill, prudence and diligence a prudent person acting in a like capacity would use.
The Prudent Person Rule focuses on behaviors and processes rather than solely on outcomes.

Prudent Delegation

If the plan administrator determines it does not have the structures, processes, resources, skills, knowledge and expertise in place, it would be prudent for the plan administrator to delegate these tasks to parties with sufficient skills, knowledge and expertise.

The plan administrator must be prudent when delegating functions, as the plan administrator remains responsible for the delegated activities and should monitor and review the delegated activities to ensure they have been appropriately and prudently carried out.

Risk Tolerance

Risk should be managed by taking into consideration the plan's investment and funding objectives when setting and implementing the investment policy, and evaluating ongoing performance of the fund and effectiveness of the investment policy.

2. Continued

Some of the risk factors to be managed include but are not limited to investment risk, interest rate risk, foreign exchange rate risk, credit risk, liquidity risk, market risk, funding risk, demographic risk, longevity risk and legislative/regulatory risk.

Investment Policy/Statement of Investment Policies and Procedures
The investment policy, which may include the SIP&P, guides investment decision making and sets out how the plan administrator is to comply with investment principles that:
Identify the kinds of investments that could be held;
Indicate the allocation between different kinds of investments;
Identify expected return on investments.

Monitoring
To monitor the pension plan and fund for compliance with statutory requirements and policies that have been adopted by the plan administrator, sufficient information should be provided to appropriate individuals, and an effective reporting and disclosure regime is needed.

Appropriate mechanisms should be in place to monitor an activity, transaction or investment. Investment activities should also be monitored to ensure policies are being followed.

3. Learning Objectives:

2. The candidate will recognize and appropriately reflect the role of plan investments in retirement plan design and valuation.

Learning Outcomes:

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

Sources:

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

Commentary on Question:

Most candidates performed well on this question.

Solution:

(a) Describe the advantages of key rate duration as a measure of interest rate risk.

Commentary on Question:

Most candidates performed well on this question. Full credit was obtained for listing and describing at least three advantages.

Some of the advantages of key rate duration (KRD) as a measure of interest rate risk are:

- KRDs identify price sensitivity on each segment of a spot yield curve.
- KRDs recognize that yield curve movement is driven by multiple market factors.
- It is easy to use a replicating portfolio of a bond with embedded options using zero coupon bonds and identifying key risk factors.
- KRDs can estimate the impact of non-parallel shifts in the yield curve.

(b) Calculate the total effective duration and key rate durations of the asset portfolio.

Show all work.

Commentary on Question:

Generally, candidates did fairly well on this straightforward question.

Total effective duration = (35M * 5 + 5M * 14 + 5M * 28)/(35M + 5M + 5M+5M) = 7.7M.

Short-term D(1) = (35M * 5 + 5M * 2 + 5M * 0)/(35M + 5M + 5M +5M) = 3.7

Medium-term D(2) = (35M * 0 + 5M * 10 + 5M * 0)/(35M + 5M + 5M +5M) = 1.0

Long-term D(3) = (35M * 0 + 5M * 2 + 5M * 28)/(35M + 5M + 5M +5M) = 3.0

3. Continued

(c) Calculate the dollar durations of the assets and liabilities.

Show all work.

Commentary on Question:
Most candidates did not answer this question.

Liability dollar duration = $50M * 14/100 = $7M

Bond dollar duration = ($35M * 5/100 + $5M * 14/100 + $5M * 28/100) = $3.85M

◦ Alternatively, the candidate can use the answer from (b): 7.7/100 * ($35M + $5M + $5M + $5M) = $3.85M

(d) Calculate the dollar change in liabilities and bonds for a parallel shift down in the yield curve of 50 basis points for both portfolios.

Show all work.

Commentary on Question:
Several candidates showed only the change in either the current or proposed portfolio.

Liability change: $50M * ((1 + 14/100)^.5 – 1) = $3.39M
(or $3.5M = $50M * 0.5*14/100)

Portfolio A: bond change: $35M * ((1 + 5/100)^.5 – 1) + $5M * ((1 + 14/100)^.5 – 1) + $5M * ((1 + 28/100)^.5 – 1) = $1.86M
(or $1.925M = $35M * (0.5*5/100) + $5M (0.5*14/100) + $5M * (0.5*28/100)

Portfolio B: bond change: $3M * ((1 + 5/100)^.5 – 1) + $40M * ((1 + 14/100)^.5 – 1) + $2M * ((1 + 28/100)^.5 – 1) = $3.05M
(or $3.155M = $3M * (0.5*5/100) + $40M * (0.5*14/100) + $2M * (0.5*28/100))

(e) Calculate the dollar change in liabilities and bonds given that the long-term rates decrease by 50 basis points but all other rates remain constant for both portfolios.

Show all work.

Commentary on Question:
Some candidates only showed the change for either the current or proposed portfolio. Some candidates only calculated the change for the assets and not the liabilities.

3. Continued

Liability change: $50M * ((1 + 4/100)^.5 – 1) = $0.99M
(or $1.0M = $50M * (0.5*4/100))

Short-term bonds: no change.

Med-term and Long-term bonds, Portfolio A: $5M * ((1 + 2/100)^.5 – 1) + $5M * ((1 + 28/100)^.5 – 1) = $0.71M
(or $0.75M = $5M * (0.5*2/100) + $5M * (0.5* 28/100))

Med-term and Long-term bonds, Portfolio B: $40M * ((1 + 2/100)^.5 – 1) + $2M * ((1 + 28/100)^.5 – 1) = $0.66M
(or $0.68M = $40M * (0.5*2/100) + $2M * (0.5*28/100))

(f) Recommend either the Current Portfolio or the Proposed Portfolio in light of this objective.

Justify your recommendation.

Commentary on Question: *To receive full credit, the candidate had to make a clear recommendation and justify their answer using accurate statements that reflect the specific scenario. Most candidates got credit for recommending portfolio B (which matches bond duration to liability duration), however some candidates received credit for recommending portfolio A if a compelling reason was provided (e.g., supporting a tactical view of long-term rates falling for example, as shown in part (e) of this problem). Candidates that made a clear recommendation with an accurate and logical reasoning for how it would reduce the company's interest rate risk received full credit.*

Some candidates did not make a clear recommendation and received partial credit if reasoning was provided for how the portfolios would potentially reduce the company's interest rate risk.

Some candidates made a recommendation but did not provide specific information from the question (just made lists) and received partial credit.

The recommended portfolio is the Portfolio B.

- Overall, the effected duration of the proposed portfolio (12.62) is much closer to the liability duration (14) than the current portfolio (7.7)
- For portfolio A, the short and long term KRDs exceed the same KRDs for portfolio B, which means that in a period of falling short term or long term rates, portfolio A could be more effective at reducing interest rate risk.
- Portfolio B would better hedge interest rate risk if there is a parallel shift in the yield curve, or falling medium term rates.

4. 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:

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

RPIRM 124-13: Bader and Gold's Rebuttal to The Case for Stock in Pension Funds

RPIRM 121-13: The Case for Stock in Pension Funds

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Explain how the shareholder value perspective applies to pension plans.

Commentary on Question:

Some candidates did not recognize "shareholder value perspective" from the "Pension Actuary's Guide to Financial Economics"; others did not discuss the relationship between shareholders and the pension plan beyond the tax arbitrage effect.

A pension plan is not a self-standing entity, but a pass-through entity. A pension plan is a vehicle used by shareholders to compensate employees for their services. Analyses that focus on the pension plan alone are unable to reflect the shareholder value perspective. Pension plans cannot be managed on a time horizon that differs from that of the shareholder.

From a financial perspective, shareholders own the assets and owe the liabilities of the plans they sponsor. The asset and liability risk of the plan passes through to the shareholders.

The debt/equity mix of pension plan assets does not affect shareholder value on a first order basis. Shareholders can adjust their personal portfolios to reflect the pension plan's holdings. The debt/equity mix of pension plan assets does matter to shareholder value on a second order basis. Second-order issues typically consist of taxes, agency costs and surplus ownership.

4. Continued

(b) Describe the impact of this change on the following:

(i) Shareholders' portfolios

(ii) Shareholders' after-tax income

Commentary on Question:
On part (b)(i), some candidates stated that the shareholders rebalance without describing how they rebalance. Candidates scored better on part (b)(ii).

(i) Since our investors want to maintain their overall portfolio to contain equal amounts of equity and bond investments, they will adjust their portfolios outside the pension plan to reflect the change. Shareholders' indirect holdings through corporate pension plan will change from 100% equity to 100% bonds. Shareholders' direct holdings will shift from bonds to equity by the same amount that the indirect holding changes. Shareholders' combined holdings remain 50% equity/50% bonds.

(ii) We see that moving the pension assets to bonds increased the investors' after-tax income. Shareholders' after-tax income increases by the dollars in the pension plan times the tax spread times the bond rate of return times one minus the corporate tax rate.

(c) Critique the following statement: "Financial economics implies pension plans should invest 100% in bonds."

Commentary on Question:
Many candidates agreed with the 100% bonds statement without a significant critique; few responded based on "The Case for Stock in Pension Funds."

Arguments against 100% Bonds
Financial economics doesn't imply that all pension plans should invest in all-bond portfolios. This is a myth. Financial economics dictates that a portfolio of assets that matches the cash flows in all scenarios will eliminate economic risk. The matching portfolio may include stock to the extent that stock matches the risk of the cash flows. When the benefit contains economic risk, using a portfolio entirely consisting of bonds would increase the risk of the pension plan by mismatching assets and liabilities. Moore and Young show how an optimal investment strategy may involve as much as 40 percent equity, not 100 percent bonds – even in the case with a fixed series of cash flows.

4. Continued

Assumptions used to develop the all bonds assumption may be weak or even false:
Transparency - shareholders cannot see pension assets/liabilities; Accounting rules (smoothing) mute the risk of holding equity investments in the pension plan
Valuation - company that invests in assets with high expected returns is more highly valued than company investing pension 100% in bonds
Risk - shareholders may not include shift of pension assets to bonds in their valuation of a company
Default - PBGC put option can argue for investing in equities

Arguments for 100% Bonds
Potential employee claims on surplus may lead to prefer minimal risk in the pension fund. If fully responsible for pension fund losses but receive only a fraction of the gains, they will prefer to take their equity exposure directly and their bond exposure in the pension fund.

Equity investment, with its higher expected returns, invites the underpricing of pension liabilities.

Taking into account the special tax treatment afforded pension trusts, financial economics argues that shareholders are better off on an after-tax basis if the pension plan holds higher-taxed investments (bonds under U.S. and Canadian tax code) and shareholders hold lower-taxed investments (equity under U.S. and Canadian tax code) in their individual portfolios.

5. Learning Objectives:

2. The candidate will recognize and appropriately reflect the role of plan investments in retirement plan design and valuation.

Learning Outcomes:

(2a) Evaluate the interaction of plan investments with plan design, valuation, accounting and funding.

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

Sources:

RPIRM-134-14: Liability-Responsive Asset Allocation, Russell Research

RPIRM-138-16: FSCO's IGN 001 – Buy in Annuities for Defined Benefit Plans

RPIIRM-146-17: The pension risk transfer market at $260 billion

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

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Critique each option with respect to the CFO's objectives.

Option 1:

- Glide paths balance strategic policy positioning with tactical implementation – they define the strategic objective while moving towards it as opportunities arise. Will reduce volatility of the accounting funded status as well as volatility of funded status on termination basis
- Glide paths provide an objective decision framework: Risk/funded status volatility reduction becomes a formal investment policy decision that is a function of a predefined set of circumstances that are both logical and tangible.
- Objective is vague as it does not define for which funded status the sponsor wants to reduce volatility. Option 1 reduces volatility of accounting funded status, which is not in line with second objective of terminating the plan.
- Even when fully funded, there remains equity risk since there is still 15% of assets invested in equities. As funded position improves, risk/reward tradeoff of return-seeking assets decreases; glide path does not fully reflect this.
- Sponsor keeps interest rate risk even as funded position improves since not 100% fixed income and duration of fixed income of 9.0 likely lower than duration of liability

5. Continued

- If accounting status is currently less than 80%, there would be a reduction in fixed income allocation compared to current allocation, which would go against the first objective.
- Design doesn't address whether re-risking is permitted, which would go against objective 1 if permitted.

Commentary on Question:
Option 1 was generally well critiqued by candidates. Most candidates acknowledged the following:

1. *Glide path should be based on plan termination funded status*
2. *Glide path does not appropriately address the interest rate mismatch between the assets and the liabilities*
3. *The equity exposure may or may not be appropriate, depending on whether there are members accruing benefits*
   Few candidates acknowledged that glide paths provide an objective decision making framework to dial down risk in the pension plan as the funded status improves

Option 2:

- Annuity buy-in for $60M would increase the duration of the assets since the duration of the annuities would be equal to the duration of the retiree liabilities, hence reducing the volatility of the funded status.
- For the same amount of annuity buy-in, duration of assets could potentially be increased by insuring $10M of deferred members liability (duration of 18) and $50M of retiree liability (duration of 12), reducing the funded status volatility.
- Would eliminate the funded status volatility for retirees, but active and deferred liabilities would be covered by $10M in equities, which leaves a lot of interest rate risk and funded status volatility for the remaining group
- By locking in $60M in assets in annuity buy-in, it only leaves $10M in equities to improve the funded status to 100% and terminate the plan, which is highly unlikely.
- Since it is unlikely that the funded status would improve from investment return, second objective would likely only be met through company contributions.
- Eliminates the longevity risk for retirees, which reduces the funded status volatility
- If funded status reaches 100%, wind-up would be simpler as buy-in contracts usually have a buy-out option.

5. Continued

Commentary on Question:
Candidates critiqued this option reasonably well, with most getting credit for the following:

1. *Annuity buy-in would only hedge interest rate and longevity risk for the selected group*
2. *The annuity buy-in can be turned in to a buy-out with relative ease*
3. *Large contributions would be required to fully fund the unfunded liability for the remaining group*
4. *The remaining group is exposed to a lot of interest rate risk as they are invested 100% in equities*

Some candidates incorrectly indicated that funded status volatility of the plan would increase. Although the funded status volatility of a portion of the plan would increase (invested assets and active/deferred members), the funded status volatility of the total plan would decrease.

(b) Recommend an alternative strategy to better address the CFO's objectives. Justify your recommendation.

Commentary on Question:
Candidates got credit for a wide variety of strategies as long as they appropriately supported them, and tied the expected result back to the CFO's objectives. Below are some valid examples:

1. *Borrow to fund approaches to get accelerated tax deduction and convert floating rate debt (pension obligation) to fixed rate debt (bond issue)*
2. *Use of leverage/derivatives to hedge interest rate risk and continued investment in equities to close funding gap*
3. *Use of revised glide path based on plan termination status and longer duration fixed income allocation*

If recommendation involves a glide path, here are some desirable characteristics:

- Design should be clear as to the end state, and be linked to CFO's objectives of terminating the plan at 100% funded.
- Design should address whether there is an immediate change at implementation time.
- Design should address the fact that duration of assets is currently much shorter than duration of liabilities.
- Design can be based on different triggers, such as interest rate level, funded status, time, combination. Triggers should be linked to objectives/end state, in this case funded ratio

5. Continued

- Trigger distance: The distance between triggers and the frequency at which they will be monitored are very important practical considerations. If the increments between triggers are too small, the glide path could induce an unnecessarily large number of trades, resulting in excessive transaction costs. Conversely, if the increments are too large, good opportunities to capture small gains could be missed.

- Design should take into account the fact that the plan is currently closed to new members
- Should address whether or not re-risking is permitted when funded status deteriorates
- Design should be clear as to what de-risking asset/investment type is used and should address annuity buy-ins or buy-outs as a de-risking tool as funded ratio improves, especially given the CFO's objective of terminating the plan

6. Learning Objectives:

2. The candidate will recognize and appropriately reflect the role of plan investments in retirement plan design and valuation.

Learning Outcomes:

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

Sources:

RPIRM-112-13: Asset/Liability Modeling and Asset Allocation for Pension Plans

Commentary on Question:

This question tests the candidate's knowledge of ALM studies. Plan sponsors are increasingly aware of and attempting to mitigate the risks associated with asset-liability mismatch. Candidates should be prepared to discuss the basic outline of an ALM study that may be performed to determine a client's exposure to associated risks.

Candidates did fairly well on this question as a whole. Points that were missed generally resulted from incorrect calculations performed in Part C.

Solution:

(a) Describe the inputs for an ALM study.

Commentary on Question:

Candidates who recalled the three categories of ALM study inputs did well. Those who did not generally received partial credit for disclosing a subset of ALM study inputs.

ALM study inputs are as follows:

- Asset Assumptions
  - **Returns:** assumed returns by asset class
  - **Volatility:** variability of asset class returns
  - **Correlation:** connection between returns of different asset classes
- Liability Assumptions
  - **Valuation Assumptions:** initial liability calculation basis
  - **Assumption Changes:** future liability calculation basis
  - **Sensitivity:** liability behavior to assumption changes
  - **Experience Assumptions:** new entrants, retirements, terminations, and other demographic inputs
- Financial Assumptions
  - **Contribution Policy:** level on timing of future contributions
  - **Accounting Policy:** determination of pension expense
  - **Investment Policy:** asset allocation and rebalancing strategy

6. Continued

(b) Describe the outputs of an ALM study.

Commentary on Question:
Candidates who successfully identified inputs tended to also successfully identify outputs. Most received at least partial credit for identifying and describing some outputs.

ALM study outputs include:
- **Contributions:** funding requirements as dollars or cumulative average
- **Pension Expense:** as dollars or cumulative average
- **Funded Status:** as percentage or absolute dollar amount
- **Benefit Payments:** expected streams of cash flows

(c) Calculate the standard deviation of the bond portfolio that matches the duration of the liabilities.

Commentary on Question:
Calculation errors in Part C are the primary reason for candidates not being awarded full credit. Partial credit was granted for correct intermediate calculations and appropriate formulas. However, a correct final answer was necessary for full credit.

Calculate portfolio weights
Total Portfolio Duration = a * Duration(X) + (1-a) * Duration (Y)
16.1 = a * (18.2) + (1-a) * (6.4)
a = 0.822
1 – a = 0.178

Therefore, portfolio weights are as follows:
- **Portfolio A = 82.2%**
- **Portfolio B = 17.8%**

Calculate portfolio standard deviation
Portfolio StdDev = StdDev(a * X + (1-a) * Y)
= [(a * StdDev(X)) ^ 2 + ((1-a) * StdDev(Y)) ^ 2 +
2 * a * (1-a) * Correlation(X,Y) * StdDev(X) * StdDev(Y)] ^ 0.5
= [(.822 * 0.13) ^ 2 + (0.178 * 0.65) ^ 2 +
2 * 0.822 * 0.178 * 0.75 * 0.13 * 0.65] ^ 0.5
= [0.0114 + 0.0134 + 0.0185] ^ 0.5
= [0.0434] ^ 0.5
= 0.2082

Therefore, portfolio standard deviation is **0.2082**