RET RPIRM Model Solutions
Spring 2019

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.

(1b) Distinguish the various strategies, approaches and techniques used to manage retirement fund assets.

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

Sources:

RPIRM 156-18 Practical De-Risking Solutions: Low Volatility Equity Strategies
McGill, Chapter 26

Commentary on Question:

This question sought to test candidates' understanding of the motivations for a change in asset allocation, and potential issues with pursuing a low volatility equity strategy as a component of that change. On the whole, most candidates did well on this question.

Solution:

(a) Describe the objectives that ABC may have that would justify the change.

Commentary on Question:

Generally, candidates performed well on part (a) by inferring some motivations for the change in each asset class. Those that offered more than one potential motivation (or supporting detail) for each change were able to earn higher marks than those that offered only one.

ABC may be attempting to reduce the high risk associated with regular global equities without sacrificing much (if anything) in expected return.

By shifting to long bonds, ABC is lengthening the duration of its asset portfolio, thus decreasing the mismatch in duration between its assets and its liabilities. This should also reduce the magnitude of any potential losses that could occur in a declining interest rate environment.

1. Continued

By adding real estate as an asset class, ABC is diversifying its portfolio, because real estate has a relatively low correlation with equity markets. Also, real estate has the potential to serve as an inflation hedge through higher-than-average returns.

(b) Describe what a plan sponsor should consider prior to adopting a low volatility equity strategy.

Commentary on Question:
Candidates that performed well on part (b) tailored their answer to considerations related to a potential change to a low volatility equity strategy (specifically), rather than general considerations that apply to a sponsor considering any change in investment strategy.

Impact on Expected Returns
Despite their recent favorable experience, returns for a low volatility equity strategy should be expected to be lower than general equities, as a tradeoff for lower equity risk

Expected Impact on Total Portfolio Risk and Return
Lower equity risk may free the firm's capacity to use more of its 'risk budget' elsewhere in the portfolio, for potentially greater returns

Allocation within the Equity Portfolio
ABC should consider what proportion of its equity allocation should be moved to the low volatility strategy – all of it, or just some?

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.

(1b) Distinguish the various strategies, approaches and techniques used to manage retirement fund assets.

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

Sources:

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

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Describe four uses of key rate durations.

Commentary on Question:

Most candidates provided at least 2 uses of key rate duration. Partial credit was awarded where less than four valid uses were provided. Many candidates provided the definition of key rate duration and compared it to effective duration, which was not the question and no credit was awarded for such responses.

- Key rate durations can be used to identify the price sensitivity of a bond to each segment of the yield curve.
- Key rate durations can be used to create a replicating portfolio of a bond with embedded options using zero-coupon bonds
- Key rate durations can provide valuable insight into option-embedded bond behavior
- Key rate durations are useful in analyzing more complex option-embedded securities such as principal-only mortgage strips
- Key rate durations can be used to quantify interest rate bets for the manager
- Key rate durations can be used to provide a procedure to control interest rate risk exposure

2. Continued

(b) Calculate the effect of the following yield curve shifts on the plan's financial position:

	Short-term D_1	Medium-term D_2	Long-term D_3
Shift 1	+50 bps	+50 bps	+50 bps
Shift 2	-30 bps	+10 bps	-30 bps

Show all work.

Commentary on Question:
Overall, candidates performed well on this question. Candidates who did not calculate the impact on the plan's financial position were awarded partial credit.

A) Initial surplus: $47.5M - $45M = $2.5M

Shift 1:

Impact on liabilities: 0.5% * 15 = 7.5%
7.5% * $45M = $3.375M decrease
New liability = $41.625M

Impact on assets: 0.5%*18 = 9%
9% *$37.5M= $3.375M decrease
New assets=$44.125M

Surplus after shift: $44.125M-$41.625M=$2.5M
Impact of shift: $0

Shift 2
Impact on liabilities:
Short-term: -0.3% * 2 = -0.6%
$45M*0.6%=+$270,000
Medium-term: 0.1%*8=0.8%
$45M*-0.8%=-$360,000
Long-term: -0.3%*5=-1. 5%
$45M *1.5%=+$675,000
Total liabilities: $45,000,000+$270,000-$360,000+$675,000=$45,585,000

Impact on assets:
Short-term: -0.3%*1=0.3%
$37.5M*0.3%=+$112,500
Medium-term: 0.1%*15=1.5%
$37.5M*-1.5%=-$562,500

2. Continued

Long-term: -0.3%*2=-0.6%
$37.5M *0.6%=+$225,000
Total assets: $47,500,000+$112,500-$562,500+$225,000=$47,275,000

Surplus after shift: $47,275,000-$45,585,000=$1,690,000
Impact of shift: decrease of $810,000

(c) Recommend changes to the current portfolio that will minimize the impact of yield curve changes on the plan's financial position.

Justify your recommendation.

Commentary on Question:
Calculations of actual asset amounts allocated to short term fund, mid-term fund, long term fund and equity investment to receive full marks. Most candidates provided explanation on shifting asset allocation without providing calculation support.

B) Need to find a combination of funds that will minimize the financial position's sensitivity to yield curve changes.

To do this, invest the amounts that will provide the same $ movements for shifts in each term using a ratio of the key rate durations.
Start with medium term fund since it is impacted by all three shifts terms
Amount needed in medium term:
$45M * 8 / 15 = $24M
Medium term fund has exposure to short-term yields
$24M with key rate duration of 1
Amount needed in short term fund:
($45M * 2-$24M *1) / 6 = $11M
Medium term fund also has exposure to long term yields

$24M with key rate duration of 2
Amount needed in long-term fund:

($45M * 5- $24M * 2) / 25 = $7.08M

2. Continued

Amount in equities:

$47.5M - $11M-$24M-$7.08M = $5.42M
Summary:

- $11M in short term fund
- $24M in medium term fund
- $7.08M in long term fund
- $5.42M in equities

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:

(3a) Compare the interests of plan sponsors, employees, shareholders, taxpayers and other stakeholders related to the financial management of a retirement plan.

(3b) Describe how the retirement plan financial and design risks integrate with the sponsor's risk management strategy.

Sources:

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

RPIRM-115-13: Pensions in the Public Sector, Chapter 9.

Commentary on Question:

Most candidates performed average or below average on this question. Parts a and b were list types of questions and part c was trying to identify the elements of a good risk management policy by critiquing the draft policy.

Solution:

(a) Compare and contrast the priorities of taxpayers and plan members with respect to public pension plans.

Commentary on Question:

Most candidates provided several relevant compare and contrasts statements.

- **Taxpayers**

Tax payers want to support a system that will provide a benefit structure to attract and retain qualified workers at a predictable cost, that does not impinge on the other public services and does not overcompensate public servants.

Taxpayers have a short-term range of thinking and prefer to minimize their taxes short term.

Taxpayers do not typically have the understanding to evaluate how their actions in the short-term impact the long-term risk.

Taxpayers want a contribution holiday when there is a surplus.

3. Continued

- **Plan Members**

Members want to have secure retirement benefits with no surprises in benefit levels when they approach retirement.

They do not want (negative) surprises with regard to benefit levels as they approach retirement.

Those not covered by Social Security are particularly dependent on public pension plan benefits for income security in retirement.

Incentives: To pay the least amount (as a percentage of their compensation) for the highest level of benefits.

Plan members want benefit increases when there is a funding surplus.

(b) Describe two challenges that public pension plans face in effectively monitoring risk.

Commentary on Question:
A valid description of two relevant challenges was needed to be awarded full credit. Most of the candidates focused on the challenges of time horizon, lack of control structure and lack of effective regulatory standard. We observe that very few elected o comment on the economic and demographic cycles or the fact that pension liabilities cannot be exactly hedged in capital markets.

- **Time horizon**:

  It can take a long time to uncover poor management decisions since the feedback process is very long.

  Once mismanagement is discovered, it may be too late to utilize cost effective risk management strategies.

- **Lack of control structure**:

  There is no single person responsible for/has the authority to make pension plan decisions.

  Plans can be mismanaged in the short-term with long-term consequences. For example, using surplus for funding contribution holidays.

3. Continued

- **Lack of effective regulatory standard**: There is no single regulator to compel certain disclosures (like the IRS in private plans), including disclosing information on a comparable basis.

  GASB standards exist for accounting, but more leeway in how information is disclosed than the private sector. The discount rate can be based on the EROA which can understate the liability.

  They are more susceptible to political pressures, increasing complexity and long-term costs in exchange for short term accommodation.

- **Economic and demographic cycles**: Impact the need for cash contributions. For example, during a market downturn more contributions may be required to go in a pension plan, but this may happen when tax revenues decline.

  Also, the need for contributions can be affected by plan demographics – plans with more active participants can contribute more in than plans with a greater percentage of retirees. Also, the ability to fund is also dependent on the tax base demographics

- **Pension liabilities cannot be exactly hedged in the capital markets:**

  At any point in time there will be a perceived shortfall or surplus in the fund.

  Public pension plans represent an extremely long bond obligation that is poorly understood and backed by an enormous pool of assets.

(c) Below are three provisions in a risk management policy of a public pension plan:

(i) The following funded statuses of the plan will be disclosed in an actuarial report issued once per year:
- ongoing (or going concern) basis using a best estimate discount rate
- risk-free basis

(ii) The impact on the plan's funded status and future contributions assuming either an immediate increase or decrease of 20% in the asset value will be disclosed once per year.

(iii) If the plan falls below 70% funded on a risk-free basis, action is required to bring the funded percentage up to 70% within a 2-year period through a combination of increased contributions from taxpayers and/or lowering benefit amounts.

Critique the three provisions described above.

3. Continued

Commentary on Question:
Candidates commented on several of these points, but most received partial credit. Candidates generally understood the value of having two liability measures and that sensitivity testing was important, but some candidates did not understand that extreme scenarios were important. Many did not comment on the restrictions of increasing contributions or decreasing benefits.

- Critique on (i)
    - Including an additional liability measure based on a risk-free discount rate in addition to the expected rate of return illustrates the amount of risk the plan is taking through the investments.
    - Other liability measures could include using a discount rate based on high quality bonds to provide a market based measurement of liability
    - Reporting should be done at least on an annual or regular basis to monitor progress.
    - The actuarial report should show statistics regarding the plan demographics (benefit payments, payroll) in order to gauge the maturity level of the plan.
- Critique on (ii)
    - In addition to showing projections based on the expected return on assets, showing the impact on funded status and contributions using different market return scenarios, including the extreme scenarios (for example a -20% return or +20%) is helpful in order to plan actions to be taken if these scenarios occur.
    - Should consider sensitivity testing to other assumptions such as discount rates.
    - Stochastic testing could be useful in addition to one scenario.

3. Continued

- Critique on (iii)
    - A risk budget should be established with hard measurements and what actions need to be taken if it is exceeded.
    - However, this is unrealistic since the plan participant's contributions remain unchanged, the taxpayers may not tolerate such an increase and it may not even be possible within a two-year period.
    - Should consider how much more revenue the taxpayers can allocate within a reasonable time frame.
    - The actuary should check to see if there are any constraints for lowering benefit amounts. For example, if the benefits are guaranteed by law.

4. Learning Objectives:

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

Learning Outcomes:

(2c) Model the effect on setting investment strategy of factors including, cash flow requirements, various plan designs and various economic environments.

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

Sources:

RPIRM-146-17: The Pension Risk Transfer Market at $260 Billion

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

RPIRM-140-16: OSFI's Policy Advisory #2014-002- Longevity Insurance and Longevity Swaps

RPIRM-136-15: Longevity Risk Management: New Tools for Defined Benefit Pension Plans

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

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Compare and contrast the following pension risk transfer solutions

(i) Annuity buy-in

(ii) Annuity buy-out

(iii) Longevity risk transfer

Commentary on Question:

Most candidates performend well on this part. On the contrast portion, most candidates listed the same items such as settlement accounting, premium payment timing. There were other possible contrast items such as cost volatility and regulatory approval that most candidates did not address.

4. Continued

Comparing:

- All transfers pension risk away from the plan sponsor to an insurance company
- Can cover only select group of plan members
- All require plan sponsor to be prudent to select best insurers
- All solutions are alternatives to using design/financial/investment risk reduction techniques

Contrasting:

- Year-to-year Plan Expenses:
  - Buy-in and Longevity Risk Transfer (LRT) retain liabilities for still have administrative expenses, including PBGC premiums
  - Buy-out removes liabilities and thus eliminates administrative, actuarial, and investment management expenses
- Accounting Impact
  - A buy-out removes assets and liabilities off the balance sheet and thus results in settlement charge
  - Since a buy-in and LRT are considered a plan asset still in the plan, there is no settlement accounting necessary.
- Cost Volatility
  - Buy-in and LRT minimizes accounting and funding volatility
  - Buy-out results in short-term cash and expense volatility
- Types of Risks Transferred
  - Buy-out and buy-in covers all financial and demographic risks
  - LRT covers longevity risk only

(b) Recommend an appropriate pension risk transfer solution for a defined benefit pension plan with the following characteristics:

- The plan has over 9,000 retired lives
- 90% funded status
- Asset allocation of 70% fixed income 30% equities
- Objective is to de-risk the plan gradually as funded status improves
- Increases in contributions in the short term are to be avoided

Justify your response.

4. Continued

Commentary on Question:
The plan statistics were taken directly from a study note that recommended a longevity risk transfer. However, points were awarded for a buy-in recommendation with appropriate justification. Some candidates recommended and justified a glide-path solution; however, that is an investment risk reduction strategy where this question specified a pension risk transfer solution. Credit was not awarded for "glide-path" type responses.

The recommendation would be to use a longevity risk transfer for the following reasons:

- The pension scheme can pay for the de-risking over time with a longevity risk transfer
- With an LRT the plan sponsor can retain some risk in order to achieve full funded status
- The plan sponsor can use the investment income from their fixed-income portion of their portfolio to pay for LRT premiums. In essence, it is matching the LRT liability with asset income.
- Does not cause settlement charges
- Result in some stabilization of future cash contribution/accounting charges

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:

(3b) Describe how the retirement plan financial and design risks integrate with the sponsor's risk management strategy.

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

(3e) Provide advice and analysis to stakeholders regarding the economic assumptions used in the valuation of their retirement plans.

Sources:

RPIRM-115-13: Pensions in the Public Sector, Ch. 9

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

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

Commentary on Question:

This question focused on the candidate's understanding on the financial economics perspective on pension plans. Overall, candidates did not perform well on this question.

Solution:

(a) The financial economics viewpoint suggests that, in most cases, company-sponsored pension plans should only be invested in bonds.

Describe the four assumptions underlying this viewpoint.

Commentary on Question:

Most of the candidates simply listed four assumptions without further description on how these assumptions are invalid. Some candidates provided a description of the assumptions but the descriptions provided were false.

1. Shareholders can always see the plan assets and liabilities

- Transparency is assumed to exist between shareholders and pension funds. In reality, shareholders cannot see the pension plan assets, liabilities or cash flows on a timely basis.
- Even though asset and liability values are disclosed at fair or market value, pension expense is based on smoothed asset values with gains and losses further smoothed.

5. Continued

2. Shareholders can value corporations economically by reference to the capital markets

- The value of the corporation would be determined independently of the value of the pension plan. The exception would be to include the service cost as a current operating expense for the core business.
- The surplus or deficit, adjusted for taxes may be added to the value of the company.

3. Rational investors will adjust their own portfolio to their desired level of risk

- Investors aim to maximize their returns for a given level of risk for their investment portfolios. However, unlike the corporate finance view, shareholders will not always perform value-adding transactions in their valuation of a company. Shareholders would only shift pension assets to bonds if they believe that other market participants will soon perceive the transaction as an additional value.
- One possibility is that the smoothing mechanisms in current contribution and accounting calculations mute the risk of holding equity investments in the pension plan. Investors do not immediately experience the gains or losses of investment risk, so their perception of the risk is less than the pension finance model would indicate.

4. Promised benefits will be paid by the plan because it remains sufficiently funded and/or the corporation is strong enough to make up any pension deficits

- The pension finance model does not anticipate an entity like the PBGF (or PBGC). PBGF can serve as a floor so that the plan sponsors can invest more aggressively. When the PBGF is added to the pension finance model, the circumstances differ from case to case.

(b) Critique the following statement from a financial economics perspective

"Pension plan liabilities should only be discounted at the risk-free rate."

Commentary on Question:
Most of the candidates mentioned that the expected return of a cash-flow matching portfolio should be used to discount pension liabilities. However very few candidates discussed the restrictions to apply this methodology. Some candidates proposed choosing the discount rate solely based on plan liabilities instead of considering plan assets.

5. Continued

- From a financial economics perspective, pension liabilities should be discounted at the expected return of assets in a cash-flow matching portfolio.
- Pension liabilities could be discounted at the risk-free rate only if the cash-flow matching portfolio is 100% risk-free bonds.
- Pension funds cannot be invested in 100% risk-free bonds because there are insufficient long-term risk-free bonds to replicate ongoing pension plan liabilities.
- Pension payments are not fixed and are more variable than bonds. Therefore, it's hard to achieve cash-flow matching with investment in 100% risk-free bonds.
- Pension plan liabilities in the above statement is not defined. Different types of pension plan liabilities should be discounted using different discount rates for valuation

- Market liability of a pension plan should be determined by looking at how the financial markets price similar cash flows. Financial economics looks to the discount rate inherent in the debt markets to determine pension liability market values.
- Solvency liability is determined as the market value of a portfolio with certain payments that are comprised of risk-free traded securities. In this case, therefore, pension plan liabilities might be discounted at the risk-free rate.
- Budget liability refers to the traditional actuarial accrued liability. Discount rate should be based on the long-term expected return on the pension assets.

6. 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:

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

Sources:

Modern Investment Management, Litterman, Ch. 2

Commentary on Question:

This question focused on the candidates' knowledge of the risk/return relationship of a portfolio. Candidates generally performed well on part (a), but most struggled with at least one part of the remaining question.

Solution:

(a) Calculate the standard deviation of the portfolio.

Commentary on Question:

Candidates successfully recalled the correct standard deviation formula and applied the appropriate values provided by the question.

$$\text{StdDev} = (d^2 \times \sigma_d^2 + f^2 \times \sigma_f^2 + 2df\sigma_d\sigma_f\rho)^{0.5}$$
$$= (0.5^2 \times 0.08^2 + 0.5^2 \times 0.09^2 + 2 \times 0.5 \times 0.5 \times 0.08 \times 0.09 \times 0.65)^{0.5}$$
$$= 0.07723$$

(b) Calculate the marginal contribution to portfolio risk of:

(i) Domestic equities

(ii) International equities

Commentary on Question:

Candidates struggled to recall the correct formula representing marginal contribution to risk. Partial credit was awarded where the formula was largely correct with only a minor error resulting in incorrect results.

$$\Delta_d = (d \times \sigma_d^2 + f \times \sigma_d \times \sigma_f \times \rho) / \text{StdDev}$$
$$= (0.5 \times 0.08^2 + 0.5 \times 0.08 \times 0.09 \times 0.65) / 0.07723$$
$$= 0.07173$$

$$\Delta_f = (f \times \sigma_f^2 + d \times \sigma_f \times \sigma_d \times \rho) / \text{StdDev}$$
$$= (0.5 \times 0.09^2 + 0.5 \times 0.09 \times 0.08 \times 0.65) / 0.07723$$
$$= 0.08274$$

6. Continued

(c) Calculate how many units of international equity the investor must purchase to retain the same level of risk in the portfolio.

Commentary on Question:
Results were mixed for determining how to retain the same level of risk when altering the portfolio allocation. Successful candidates recognized the ratio of the results from Part B would yield the correct answer. Common mistakes involved switching the numerator/denominator relationship or comparing the risk to return relationships between the two asset classes.

Selling 1 unit of domestic equity requires Δ_d / Δ_f units foreign equity to be purchased to maintain equal risk.

International Equity = Δ_d / Δ_f
= 0.07173 / 0.08274
= 0.867

(d) Calculate the change in the portfolio expected excess return.

Show all work.

Commentary on Question:
Struggles with earlier parts of the question compounded into struggles with Part D. Many candidates did not attempt a solution. Partial credit was granted where minor errors such as using absolute returns in lieu of excess returns when calculating the change.

e_d = excess return of domestic equity
= expected return on domestic equity less risk-free rate
= 0.065 – 0.02
= 0.045

e_f = excess return of foreign equity
= expected return on foreign equity less risk-free rate
= 0.06 – 0.02
= 0.04

Change in return = $(\Delta_d / \Delta_f) \times e_f - e_d$
= 0.867 x 0.04 – 0.045
= -1.032%