

## MACROECONOMIC MODELS: THE MISSING LINK IN PENSION FUND INVESTMENT EVOLUTION?

The traditional approach to pension fund investing has been to calculate the familiar efficient frontier, which is used to determine the "optimal" asset mix by assessing the fund's risk tolerance. The investment managers would be typically evaluated against standard indexes of their respective asset classes. This approach is appropriate for the plan sponsor who wishes to maximize the return on the assets in the pension fund, trading that off against the volatility of the fund's return.

### Stabilize Funding Ratio

Since the purpose of the assets is to fund the pension liabilities, it makes more sense to be concerned with the ratio of the assets to the liabilities, or the funding ratio. In this framework, we would attempt to maximize the growth of the funding ratio while minimizing its volatility. We will explore how macroeconomic models may help to create more stable funding ratios. For our purposes, the liability that we will work with is the PBO since that is considered more appropriate for ongoing plans.

### Match Duration of Assets and PBO

Interest rate changes have a major impact on both the pension assets and the PBO. Therefore, one way to stabilize the funding ratio would be to match the duration of the assets with that of the PBO. This would require accurate duration estimates for the PBO and the assets (fixed income and equities). These estimates are generally available for the PBO and the fixed income portfolios; estimating equity duration is not as easy (a macroeconomic model may help do this).

It is usually the case that the duration of the PBO is much greater than that of the assets. There are two ways to remedy this: extend the duration of the fixed income portfolio (which would increase expected return), or substitute long bonds for equities (which would decrease expected return). Since substituting long bonds for equities involves giving up some expected return, this action must be carefully evaluated. It is also important to be aware of how sensitive the actuarial assumptions are to market interest rates, since that has a direct impact on the "duration" of the PBO.

### Additional Factor – Unexpected Inflation

In order to stabilize the funding ratio, we want to explore all the possible ways to synchronize the behavior of the assets and the PBO. We therefore want to look at all the economic factors that affect the assets and the PBO (interest rates, inflation, and wage increases), and try to determine how these factors affect both the assets and the PBO. The relationships between the economic factors and fixed income/equity securities can be determined empirically since there is plenty of data available. The relationships with respect to the PBO must be derived theoretically (since data is not available).

It can be shown that the only economic factors that significantly impact both the assets and the PBO are interest rates and unexpected inflation. We will therefore focus on the relationships between these two economic factors and the components of the funding ratio (the PBO, fixed income securities, and equities). By incorporating unexpected inflation into the

analysis, we obtain a more accurate estimate of the PBO duration and we substantially reduce the unexplained variability of the PBO.

### **Economic Relationships**

The PBO decreases 8-10% for each 1% increase in interest rates, and increases 1% for each 1% increase in unexpected inflation. About 70-80% of the variability of the PBO is attributed to interest rates, and about 10-20% to unexpected inflation.

Fixed income securities have a wide range of values for duration, and usually over 90% of their variability is attributable to interest rates. They are minimally affected by unexpected inflation.

Equities have a modest range of values for duration and a wide range of sensitivities (both positive and negative) to unexpected inflation. Only a small portion of an individual issue's price variability is explained by these factors. At the portfolio level, the explanatory value can be increased by combining issues with similar sensitivities.

### **Alternative Benchmark/Investment Process**

The problem with using traditional indexes (like the S&P 500 and Lehman Aggregate Bond Index) as benchmarks is that they will typically have much lower sensitivities to interest rates and unexpected inflation than the PBO. If the investment managers are measuring their risk relative to these indexes (as is usually the case), there will be a mismatch between the economic factor sensitivities of the assets and the PBO.

This mismatch could be alleviated by creating a "PBO Index" as a benchmark. This index, which could be initialized at 1.00, would be adjusted quarterly to reflect changes in interest rates and unexpected inflation. It would be recalculated annually (as the actual PBO is) to reflect demographic changes. This index would track the actual PBO best when the demographic changes are minimized, which tends to be the case for the larger plans.

In order to create a situation where the assets are tracking a benchmark like a PBO Index, a different investment process would be required. The investment managers would need to track economic factor benchmarks, so that in the aggregate they have the same sensitivity to the economic factors (interest rates and unexpected inflation) that the PBO does. The economic sensitivities for individual securities would also need to be made available to the managers; some kind of a macroeconomic model would probably be required. This would allow the managers to maximize expected return while minimizing active economic factor exposures.

### **Results**

If no asset/liability matching is performed and the traditional 60/40 mix is used, the funding ratio volatility will be approximately 13%. If a duration-matching strategy is implemented by lengthening the fixed income portfolio, the funding ratio volatility would decrease to about 11%. If the sensitivities for both interest rates and unexpected inflation are matched, this volatility would then be about 10%. The primary reason for such modest improvements is the large portion of equity variability that is not explained by either interest rates or unexpected inflation. Unless an equity portfolio can be constructed whose performance is more "explained" by these factors, the volatility of the funding ratio may not be able to be lowered that much more.

## **Issues to be addressed**

- **Shift focus to funding ratio stability**
- **Establish link between assets and liabilities**
  - Become more familiar with liability
  - Identify relevant economic factors
  - Determine key relationships
- **Quantify results**

## **Traditional approach**

- **Develop efficient frontier**
- **Determine risk tolerance, asset mix**
- **Evaluate managers against standard benchmarks**
- **Standard risk/return tradeoffs**

# Interest rate immunization

- Interest rates affect assets and PBO
- Match duration
  - Actuary estimates duration of PBO
  - Investment managers estimate duration of assets

## Typical problem:

- Duration of assets < Duration of PBO
- Investment solutions
  - Extend duration of bonds (increase expected return)
  - Substitute long bonds for equity (decrease expected return)

## Effect of actuarial assumptions

- Dampen volatility of assumed discount rate
- Shorten duration of PBO
- Not expected to be as prevalent in future (SEC)

## **Establish key relationships**

- **Economic factors vs. assets**
  - Data available
  - Empirical
- **Economic factors vs. PBO**
  - Data not available
  - Theoretical
  - Need to understand PBO calculation

## **PBO for retiree**

- **PV of future pension payments**
- **Discounted for interest and mortality**

## **PBO for active employee**

- **PV of future pension payments**
- **Discounted for interest and mortality**
- **Accrued as of valuation date**
- **Must estimate pension payment in future**
  - Wage increase assumption

## **Demographic factors**

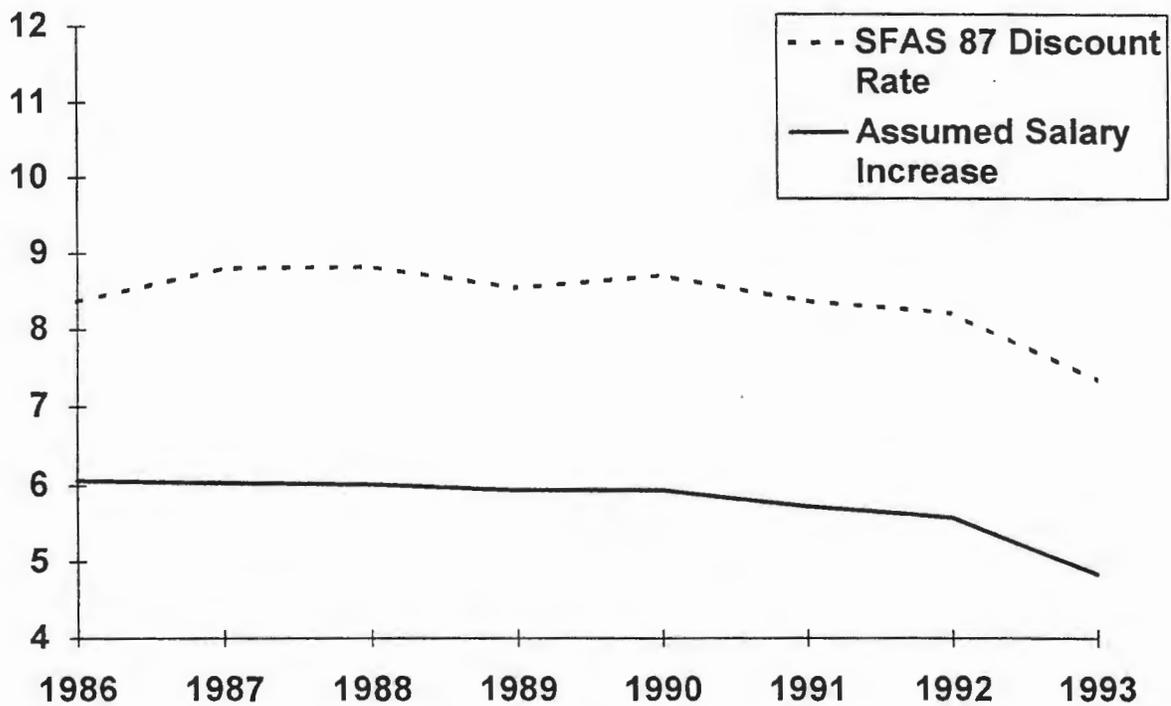
- **Mortality, termination, retirement, disability rates**
- **No relation to assets**
- **Tend to be small percent for large plans**

## **Wage increases**

- **Unexpected wage increases**
- **Changes in expected wage increases**

$$\text{Wage increase} = \text{Inflation} + \text{Real wage increase}$$

- **Unexpected inflation**
- **Change in expected inflation**
- **Unexpected real wage increases**
- **Change in expected real wage increases**



## Key relationships

Between:

- Interest rates
- Unexpected inflation

and:

- PBO
- Fixed income securities
- Equities

## **Benefits of using unexpected inflation**

- **More accurate estimate of PBO duration**
- **Large reduction in unexplained variability of PBO**

## **Problems with traditional indexes**

- **Lower sensitivity to economic factors than PBO**
- **Managers define risk relative to benchmark**
- **Economic factor mismatch between assets and PBO**

## **Different investment process**

- **“Factor” benchmarks for managers**
- **Sensitivities for individual securities**
- **Maximize expected returns**
- **Minimize active economic factor exposures**

## **Quantify results for different strategies**

- **No asset/liability matching**
  - Traditional 60/40 mix
  - Equity volatility = 17%
  - Fixed income volatility = 7%
  - PBO volatility = 11%
- **Funding ratio volatility 13%**

# Alternative approach

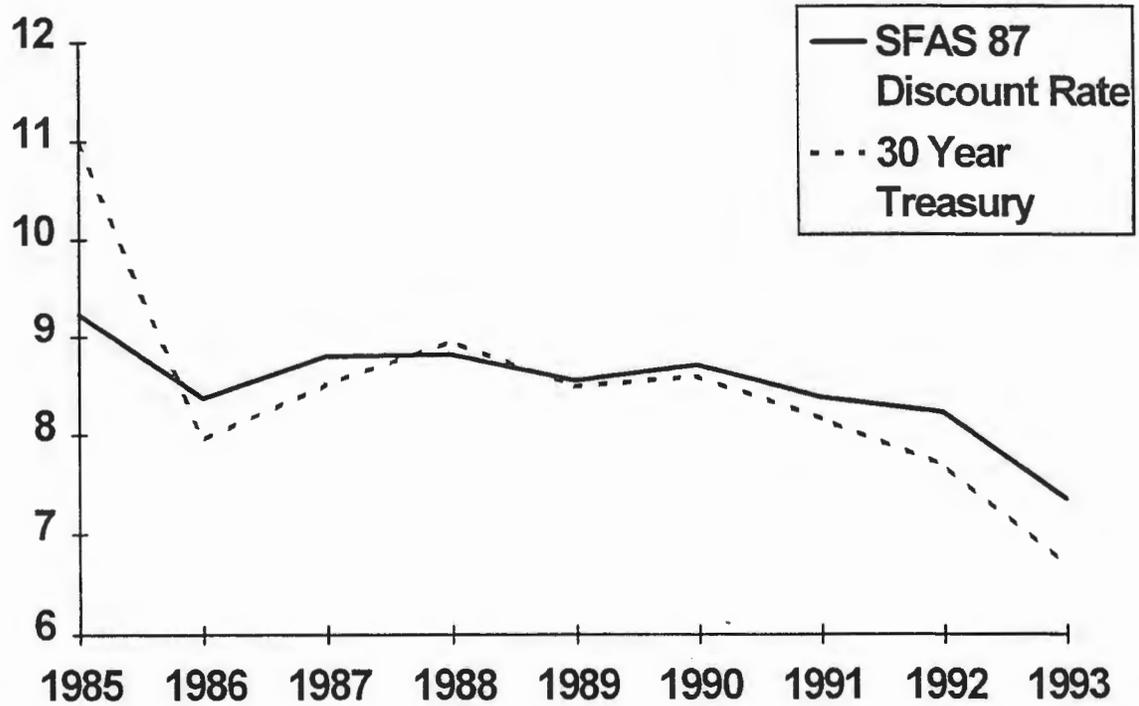
- **Purpose of assets: fund liabilities**
- **Funding Ratio = Assets / Liabilities**
  - Accepted measure of plan's financial health

## Which liability?

- **ABO (termination)**
- **PBO (ongoing)**
- **Other?**

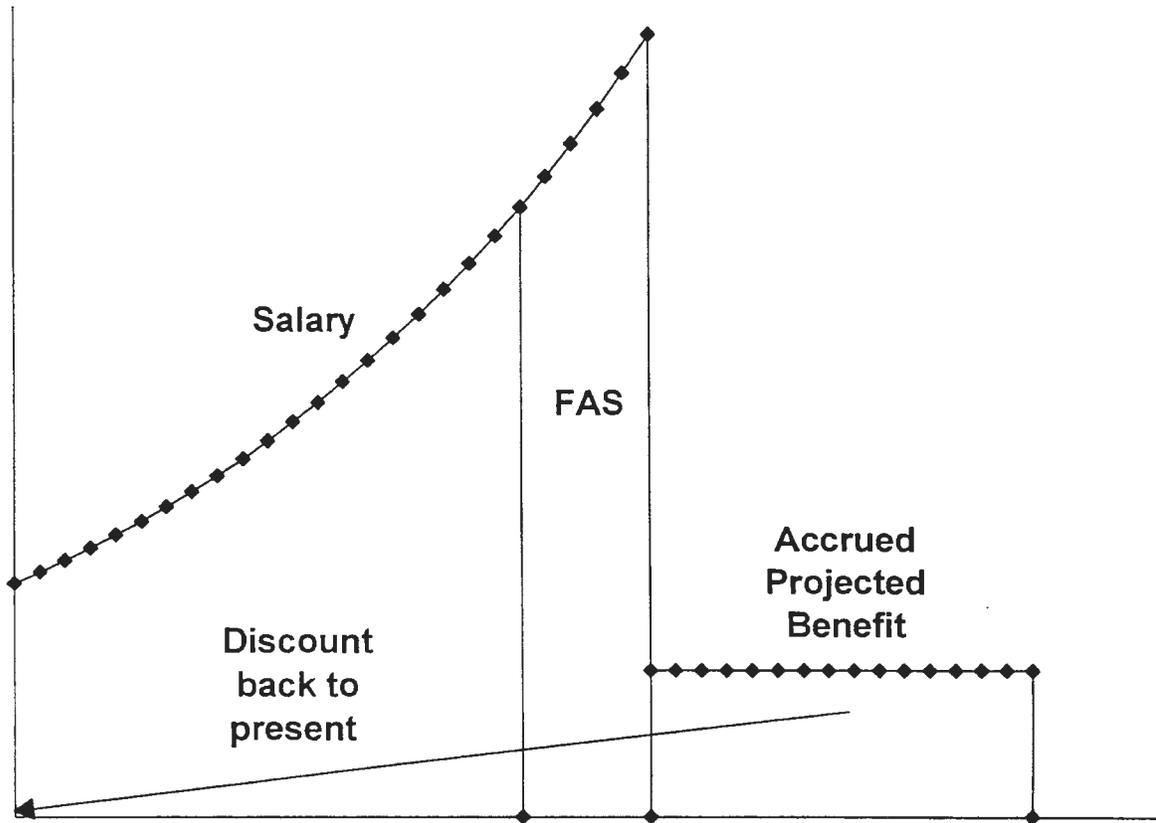
## Comparison of strategies

- **Traditional**
  - Maximize asset growth
  - Minimize asset volatility
- **Alternative**
  - Maximize funding ratio growth
  - Minimize funding ratio volatility



## Stabilize Funding Ratio

- Synchronize behavior of assets and PBO
- Identify factors which affect assets and PBO
  - Interest rates
  - Inflation
  - Wage increases



## Factors which affect PBO

- Interest rates
- Wage increases
- Demographics
- Cost-of-living increases?

## **Factors which affect both PBO and assets**

- **Change in interest rates**
- **Unexpected inflation**
- **Change in expected inflation**
- **Unexpected real wage increases**
- **Change in expected real wage increases**
- **Demographic**

## **Expected inflation**

- **Tends to follow interest rates**
  - **Consistent with stable real return expectations**
  - **Verified empirically**

# PBO

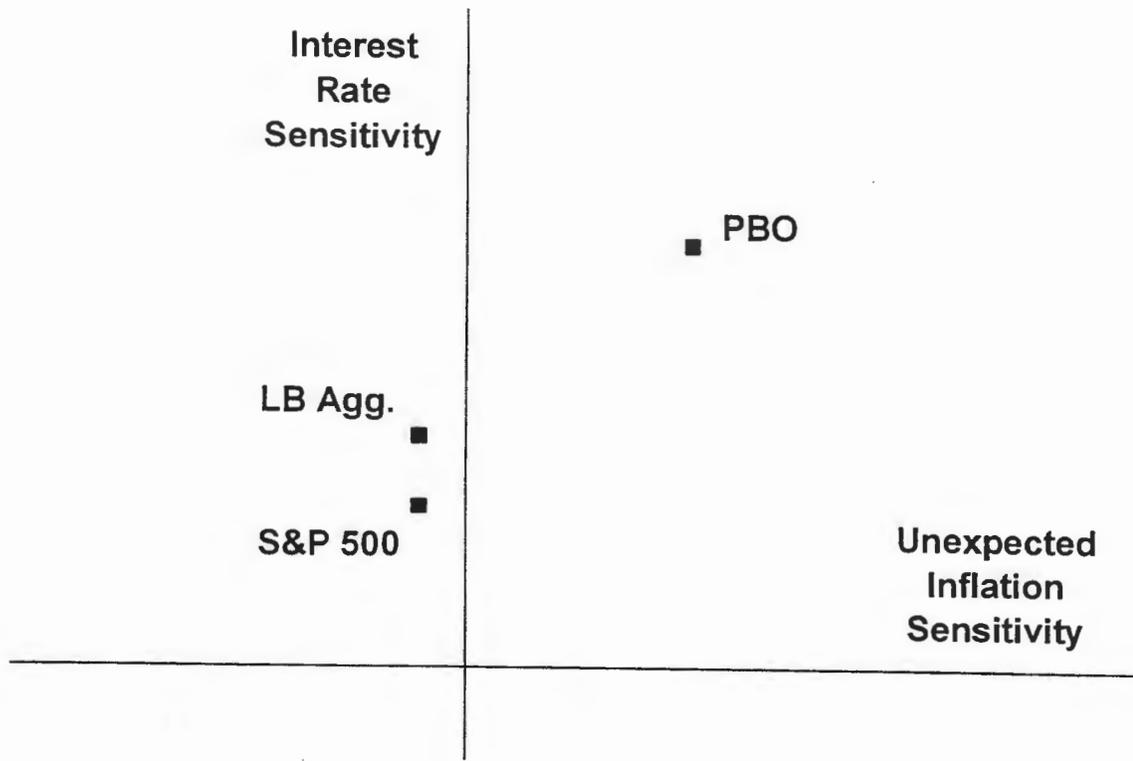
- PBO decreases 8-10% for each 1% increase in interest rates
- 70-80% of variability is attributed to interest rates
- PBO increases by 1% for each 1% increase in unexpected inflation
- 10-20% of variability is attributed to unexpected inflation

## Fixed income securities

- Wide range of values for duration
- Over 90% of variability is attributed to interest rates
- Minimally affected by unexpected inflation

## Equities

- Modest range of values for duration
- Wide range of sensitivities (positive and negative) to unexpected inflation
- Relatively small portion of individual issue variability explained by these factors
  - Can be increased by combining “like” issues



## “PBO Index” as benchmark

- Initialize at 1.00
- Adjust for interest rates and unexpected inflation every quarter (actuary)
- Recalculate (adjust for demographic changes) annually
- Tracks actual PBO best when demographic changes are smallest (large plans)

- **Duration matching**
  - Extend duration of bonds
  - 30% of equity variability explained by interest rates
  - 90% of fixed income variability explained by interest rates
  - 75% of PBO variability explained by interest rates
- **Funding ratio volatility 11%**
- **Using interest rates and unexpected inflation**
  - 5% of equity variability explained by unexpected inflation
  - 5% of fixed income variability explained by unexpected inflation
  - 15% of PBO variability explained by unexpected inflation
- **Funding ratio volatility 10%**

## Summary

- **Stable funding ratio**
- **Link assets and liability (PBO)**
  - Interest rates (“assumptions” effects)
  - Unexpected inflation
- **Benefits of macroeconomic models**
  - Excellent for fixed income, PBO
  - Less for equities