How Should Public Pension Plans Invest?

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How public pension plan assets should be invested is an important but unsettled question. Alicia H. Munnell and Mauricio Soto (2007) find that the share of state and local (S&L) plan assets held in equities has grown over time largely in parallel with private sector practices, from an average of about 40 percent in the late 1980s to about 70 percent in 2007. This exposure led to a loss of an estimated $1 trillion dollars following the decline of the stock market from October 2007 to October 2008 (Munnell et. al., 2008). Nevertheless, some observers endorse the standard practice of investing heavily in higher yielding but riskier equities, reasoning that the higher average returns will reduce future required tax receipts and also help to reduce under-funding over time. Others advocate a more conservative approach that reduces the volatility of funding levels and the likelihood of severe shortfalls during economic downturns when government resources are already constrained (e.g., Lawrence N. Bader and Jeremy Gold, 2007).

The accounting rules for public pensions create a perverse incentive to invest in stocks: since projected liabilities are discounted at the expected return on assets[1] rather than at a rate that reflects the generally lower risk of liabilities, investing the assets in the stock market leads to a higher allowed discount rate for the liabilities, which in turn lowers the accounting-based measure of liabilities and lowers required pension contributions. This choice of discount rate contradicts the valuation principle that the risk of the quantity under consideration determines the appropriate discount rate. Robert Novy-Marx and Joshua Rauh (2008) estimate that if liabilities were discounted at a tax-adjusted muni rate instead of at the 8 percent rate commonly used by S&L pension plans, measured 2005 liabilities would increase from $2.2 to $3.1 trillion.

[1] Government Accounting Standards Board (GASB) ruling 25, and Actuarial Standards of Practice (ASOP) item 27.

Determining optimal asset allocation requires us to specify who bears the risks and returns and how risks and returns are traded off, i.e. a budget constraint and an objective function.[2] We solve a simple model that illustrates the asset allocation problem facing a public fiduciary who seeks to minimize the welfare cost of distortionary taxes, subject to a funding constraint. We demonstrate that there is a tradeoff between the higher average return on equities that lowers average taxes and the greater risk of equities that increases expected tax distortions. We also incorporate the idea first exposited by Black (1989) that if there is a positive correlation between stock returns and pension liabilities over longer horizons, then holding some equities can serve as a partial hedge against liabilities, providing an additional reason for equity holdings. We consider the sensitivity of the conclusions about optimal asset allocation to the degree of initial underfunding, to the expected level of future taxes, and to the stochastic properties of pension liabilities. Although we do not model them formally, we discuss other considerations beyond minimizing tax distortions that can influence the optimal asset allocation in S&L pension plans, which together seem to point toward a policy of matching pension assets and liabilities.

To compare theory with practice, we examine the asset allocation behavior of state and local pension plans. We find little variation in investment strategies across plans, and that differences are not easily explained by economic factors such as whether a plan has a larger share of active workers or the degree of underfunding.

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[2] There has been little formal analysis of the appropriate pension asset allocation in the state and local context, although more has been written about the tradeoffs for private sector plans. Some considerations affecting private sector plans, such as increasing the option value of PBGC insurance, are not relevant for state and local governments.

I. Modeling Optimal Asset Allocation for Public Pensions

A natural starting point is with a reminder that in a completely frictionless market, asset allocation is irrelevant. The Modigliani-Miller theorem implies that taxpayers will take the risks and returns of pension assets and liabilities fully into account when forming their private portfolios, and can therefore undo any allocation of government pension assets by making offsetting changes in their own portfolios. Further, Ricardian equivalence says that the timing of non-distorting tax collections is irrelevant because taxpayers only face a lifetime budget constraint; they can save, borrow and lend to offset any effect of tax policy on the timing of consumption. In the same spirit, Dennis Epple and Katherine Schipper (1983) point out that to the extent that underfunded S&L pension liabilities are reflected in lower local land values, the cost of current worker services is borne by current residents, mitigating concerns about fairness to future generations of taxpayers.

These benchmarks make clear the need to be explicit about the frictions that can cause asset allocation to be relevant. In this analysis, we maintain the Modigliani-Miller assumption but relax the Ricardian equivalence assumption by incorporating a cost of distortionary taxes.

I.A Liabilities

The costs and risks passed on to taxpayers are based on the difference between plan inflows and outflows. Therefore optimal asset allocation will depend on the risks and returns of the asset-liability gap rather than on the properties of assets alone.

The typical S&L defined-benefit pension plan promises retired workers a life annuity that is calculated as a function of the worker’s years of service and final salary. The benefit is often but not always indexed to inflation. Unlike in the private sector, it is illegal to change plan terms for existing workers, and benefits are often protected by state constitutions.

Measured liabilities are sensitive to the assumed discount rate, which should reflect the systematic risk of the liabilities. As emphasized by Munnell and Soto (2007) and Jeffrey Brown and David Wilcox (2008), S&L pensions offer retirees a very safe stream of income in the sense that there are strong contractual and legal protections against default on promised benefits. However, both plan participants and S&L plan sponsors bear considerable risk arising from uncertainty about the future salaries that will determine contractual benefits.

Assessing liability risk, both to determine the correct discount rate and for hedging purposes, is not easy. Although the short-run correlation between stock returns and the growth in average aggregate labor earnings is low, there is theoretical support and empirical evidence that supports higher long-run correlations. Lucas and Zeldes (2006) show that when labor earnings growth and stock returns are positively correlated over longer horizons, obligations to older workers and retirees are more like bonds and can be valued and hedged as such, but because of future salary risk, obligations to younger workers have risk and return characteristics that are more like stocks.[3] Geanakoplos and Zeldes (2007) apply these ideas to the valuation of Social Security obligations, and show that taking priced liability risk into account has a significant effect on present value estimates. In the model below, the risk associated with pension liabilities affects the optimal allocation of pension assets, and is incorporated via the assumption of a positive correlation between equity returns and pension obligations.

[3] In assessing the risk and return characteristics of future pension liabilities, a subtle issue is the extent to which future benefit accruals are offset by lower future base wages since total compensation should always equal the marginal product of labor in a spot labor market. To the extent that the offset between benefits and base wages is incomplete, or when total compensation is correlated with stock returns and benefits are a stable share of compensation, future liabilities will be sensitive to future base wages and to the correlation between long-term wages and asset returns.

Optimal asset allocation will also depend on whether liabilities after retirement are fixed in real or nominal terms, as stocks may be a better long-run hedge against inflation than nominal bonds, although they are not as good as inflation-indexed bonds. In the model, we abstract from the effects of inflation and indexing.

I.B A Simple Asset Allocation Model

The model is related to the deterministic analyses of Epple and Schipper (1981) and Stephen D'Arcy et. al. (1999) who consider the optimal level of underfunding for S&L pension plans in the presence of distortionary taxes. We posit a simple two-period asset allocation model where the objective of the pension fund is to minimize the expected present value of the costs of distortionary taxes. These costs are a quadratic function of the tax rate, creating an incentive to smooth taxes across time and states of nature. Behind the reduced form objective function is the idea that dynastic families maximize expected discounted utility over consumption and leisure, subject to the constraint that initial wealth and lifetime earnings pay for lifetime consumption and taxes. Consumption and leisure are additively separable. Distortionary taxes on labor income discourage work effort and reduce output. Capital markets are complete, implying that the prices of all financial claims are based on equilibrium stochastic discount factors. Pension plan asset allocation does not affect individual consumption risk in a complete market because people can take offsetting positions in their personal portfolios.

The simplest representation of social welfare that captures the interaction of asset allocation with distortionary taxes is with a discounted quadratic loss function. Pension assets, A_i, can be invested in two types of securities, equities and bonds. An optimizing fiduciary chooses the fraction of pension assets invested in stocks, λ, to minimize:

$$E\left[(T_1 + \omega/2\, T_1^2) + \beta(T_2 + \omega/2\, T_2^2)\right] \qquad (1)$$

subject to a present value budget constraint, where T_i is total taxes paid in period i (equal to pension contributions C_i plus other taxes θ_i), β is a subjective discount rate, and ω is a curvature parameter.[4] Bonds earn the constant risk-free rate, r_f, while stock returns are stochastic with an expected return of $E(r_s)$ and standard deviation $\sigma(r_s)$.[5] We define L_i as pension liabilities[6] and assume that future pension liabilities are stochastic with an expected growth rate, $E(\gamma)$, and standard deviation of growth, $\sigma(\gamma)$. The growth of liabilities has a correlation ρ with the stock market. Initial underfunding, $L_1 - A_1$, is decreased by contributions, C_i, net of benefit payments, B_i, so underfunding at the start of time 2 is $L_1(1+\gamma) - (A_1 + C_1 - B_1)[(1 + r_f + \lambda(r_s - r_f)]$.[7] Any difference between terminal assets and terminal liabilities must be absorbed by incremental taxes C_2. Hence $C_2 = L_1(1+\gamma) - (A_1 + C_1 - B_1)[(1 + r_f + \lambda(r_s - r_f)]$.

[4] Implicitly we assume that the marginal tax rate is proportional to total tax collections, since it is the marginal rate that causes distortions in labor supply.

[5] We abstract from interest rate risk, which would induce a positive correlation between the prices of long-term bonds and the value of pension liabilities.

[6] Most public pension plans measure liabilities in one of two ways (so called "entry-age normal" or "projected unit cost") each of which at least partially incorporates future salary changes into the current liability measure.

[7] In practice, there are typically regulatory minimum funding requirements imposed. Required minimum contributions are usually based on amortizing current underfunding over 30 years and also include "normal costs" arising from current accruals. These more complex intermediate funding requirements cannot be captured in a two period model, and it remains an unanswered question as to how they would influence asset allocation.

Taking the initial tax bill, initial level of fund assets and liabilities, and current contributions into the pension fund as given, the resulting first order condition over asset allocation implies:

$$\lambda = \frac{\frac{E(r_s) - r_f}{\omega} + E\left[\theta_2 (r_s - r_f)\right] + E\left[\theta_1 (1+\gamma)\left(r_s - r_f\right)\right] - X(1 + r_f)\left[E(r_s) - r_f\right]}{X\left[E(1 + r_s)^2 - (1 + r_f)^2\right]}. \qquad (2)$$

where invested funds are given by $X = A_1 + C_1 - B_1$. From (2), it follows that the share held in stock increases with the equity premium, and with the correlation between future pension liabilities and stock returns through the term $E(\gamma r_s)$. With a positive equity premium, it also increases with anything that is positively related to future total tax rates, including the average size of other future tax and pension liabilities. This reflects the increased benefit of the equity premium in the presence of high future distortionary taxes. The share of stock decreases in the volatility of stock returns, via the term $E(1 + r_s)^2$, and in the level of initial pension assets.

The correlation between other distortionary taxes and stock returns also affects the optimal equity share. If states of the world in which equity returns are low (e.g. economic downturns) tend to correspond to states of the world in which government resources are particularly scarce (leading to higher required tax rates) and/or tax distortions (at a given tax rate) are particularly high, this will reduce the optimal equity share, possibly pushing it negative.

In sum, with a quadratic objective function it is generally optimal to hold some stock because of the equity premium. The optimal share of stock decreases in the curvature parameter ω. It is optimal to invest exclusively in risk-free assets only if there is a strong negative correlation between other tax distortions and equity returns, or, assuming other tax distortions are uncorrelated with equity returns, if risk aversion approaches infinity, future other tax liabilities are zero, and the plan is fully funded. A caveat to this analysis of tax effects is that arguably it makes more sense to equate the marginal cost of tax levies through the rest of the tax code, rather than through the pension funding mechanism. It should also be noted that under a fully optimal policy, asset allocation and initial period contributions (and thus initial underfunding) would be determined simultaneously. We leave this for future work.

I.C Other Factors That Influence Desired Asset Allocations

We have not taken into account other potentially important factors that are more difficult to model formally. Many suggest a lower optimal allocation to equities. First, unexpectedly high or low asset returns may not be efficiently allocated by the political process. Peskin (2001) argues that the asymmetry in the receipt of returns, whereby pension recipients are likely to receive at least some of the surpluses in the plan that arise from high asset returns, while taxpayers must cover the deficits caused by losses, should lead pension funds to choose assets to match liabilities as closely as possible.[8] Second, Bader and Gold (2007) argue that since state and local taxes are often deductible from federal taxes, assets invested in pension plans on behalf of taxpayers offer a tax advantage that is maximized by investing pension assets in the most highly taxed asset, namely taxable bonds.

There are also omitted factors pointing toward a higher equity share. First, some taxpayers may find it prohibitively costly to participate directly in equity markets. In this case it may be efficient for local governments to hold equities on taxpayers' behalf through pension fund investments. In addition, if there is a lack of intergenerational connections between taxpayers, there may be scope for pension funds to engage in intergenerational risk-sharing,

[8] We think that this would be less of an issue if the arrangement were fully transparent and spelled out by contract, because it could then be offset with lower average benefits or higher employee contributions. An example of this is that some plans explicitly tie the receipt of a COLA for retirees to the performance of the investment fund.

effectively exposing future generations to current equity returns. On balance, however, the combination of all of the other factors omitted from the model seem to point toward a policy of matching assets and liabilities, even if it means forgoing the equity premium.

II. Empirical Evidence

Using data collected by the Center for Retirement Research (CRR) at Boston College for 2006, we describe the asset allocations for a large sample of state and local plans, and consider plan characteristics that might explain the differences across plans. The CRR dataset[9] contains extensive information on 109 state and 87 local pension plans, including assets; liabilities; asset allocation (equities, bonds, real estate, cash and short term, alternative investments, and other); assumed asset returns, inflation rates, and wage growth; the type of COLA clause if any, governance indicators; the number of active, retired and inactive members; and other actuarial assumptions. Combined plan assets total $2.6 trillion. Local plans are much less likely to report detailed information, limiting the inferences that can be drawn about those plans.

II.B Results

On average, in 2006 S&L plans held 60 percent of pension assets in equities, 24 percent in bonds, 6 percent in real estate, 3 percent in alternatives, 2 percent in cash, and 5 percent in other assets.[10] There is remarkably little variation in equity shares, with about 3/4 of all plans holding between 50 and 70 percent of their assets in equities.[11] As previous studies have noted, plans tend to be underfunded, with state plans on average 81 percent funded, and local plans 85 percent funded, both with a standard deviation of about 20 percent.

9 Importantly, the CRR data adjusts reported assets for the effects of smoothing rules to produce actual asset values. The complete data and documentation can be found at: http://crr.bc.edu/frequently_requested_data/state_and_local_pension_data.html

10 These averages are weighted by plan size. Unweighted results are almost identical.

11 Equity holdings have a standard deviation of 11.1 percent for state plans and 12.6 percent for local plans.

The analysis suggests that the equity share should be positively related to the percentage of active participants, due to the long-run correlation between salaries and stock returns. But in the data we find no statistically significant evidence of this in a univariate regression with state and/or local plans.[12] We also ran a multiple regression of the equity share on a number of economic and actuarial variables (these were run only for state plans due to data constraints). The coefficient on share active was positive, but statistically insignificant. The coefficient on the actuarial funding ratio was positive and significant, which is at odds with the idea that more underfunded plans seek higher expected returns.[13] Overall, the results suggest that variation in the equity share is not well explained by variables that theory suggests should be important for asset allocation.

Interestingly, there is almost no correlation between the equity share and the assumed rate of return on plan assets (equal to the discount rate used for liabilities), even though theory indicates that there should be a higher expected return for plans holding more equities. In a regression of the assumed return on all of the asset shares (omitting cash), the coefficients were all positive, but only the coefficients on real estate and alternatives were statistically significant. A raw plot of the distribution shows the assumed rate of return on assets clusters tightly around 8 percent, and previous studies have shown these have persisted for many years despite large changes in nominal interest rates over that time. On the other hand, casual time series evidence does suggest a relationship: for example, both assumed portfolio returns and discount rates were low in the 1960s and high in the 1990s. In addition, there is no correlation between the assumed

[12] In these regressions the coefficient was negative but insignificant for state plans, local plans and the pooled set.

[13] This may be an artifact of the accounting practice of discounting liabilities at the expected return of the assets, so that all else equal plans with higher equity shares will appear better funded. The equity share was also positively related to a dummy for the use of projected unit cost actuarial method, and negatively related to the presence of a separate investment council; each of these results were statistically significant. We also ran regressions based on broader measures of the risky asset share, including alternatives and in some cases real estate and other assets, and the results were similar in all cases.

inflation rate and the assumed nominal return on assets (and a strong negative correlation between assumed inflation and implied real return on assets) indicating that those plans assuming a high inflation rate tend to assume a lower real return on assets.

III. Conclusions

Our analysis of the asset allocation problem facing S&L pension plans suggests two distinct reasons, each related to tax smoothing, for holding a portion of pension assets in higher returning equities. First, in the presence of distortionary taxes, the equity premium produces higher average returns that reduce the need to raise revenues in the future through distortionary taxes, even though with a convex loss function the volatility associated with equities reduces welfare by increasing the volatility of taxes. Note that the effects of the higher equity share in the pension fund on individual consumption dynamics would tend to be offset by a lower equity share in taxpayers' private portfolios. Second, the optimal share in equities increases in the correlation between risky asset returns and future liabilities – the higher is this correlation the greater is the role for stocks as hedge against liability risk.

While these considerations do suggest a positive share of stocks in the portfolio, they do not rationalize the clustering of observed equity shares around 60 percent. They also do not justify the GASB rule that allows projected liabilities to be discounted at the expected return on plan assets. Economic logic dictates using a discount rate for liabilities that reflects the risk of those liabilities, and which is invariant to plan asset allocation. To the extent that future pension obligations co-vary positively with market returns, however, the appropriate discount rate will include a risk premium.

Although the formal model emphasizes distortionary taxes, there are other considerations that may be equally important in determining the optimal policy. The tight distribution of observed allocations around 60 percent equity suggests that in practice allocation decisions are based on other criterion than those emphasized here. One leading possibility is that the accounting rules that allow state and local plans to discount liabilities at the expected return on assets creates an incentive to invest in high risk–high return assets in order to lower accounting shortfalls.

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