

# Public Employee Defined Benefit Pension Systems: The Impact of Explicit Surplus Sharing Contracts and Stakeholder Influence on Investment Strategies

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## **Abstract**

The riskiness of state employee pension plan portfolios – as measured by the ratio of equities to fixed income assets – varies substantially from state to state. We investigate whether this variation is related to how the public employees and taxpayers share the excess earnings on the pension fund accounts. We construct a theoretical model with two principal determinants of the equilibrium asset mix of defined benefit plans: (1) whether a surplus-sharing contract is specified; and (2) the relative influence of public employees and taxpayers on the plan administrator's asset allocation. We empirically test our theoretical results. In both our theoretical and empirical analyses, we find that if the surplus sharing rule has been set in advance of the investment decision and known by the taxpayer and public employee, plans adopt a more aggressive investment allocation. In our empirical analysis, we also find that greater employee influence leads to a less aggressive investment allocation. This latter empirical result corroborates our theoretical results that the influence effect can be complex. Specifically, in our theoretical model, we demonstrate that under certain conditions greater public employee influence produces a more risky asset mix, while under other conditions the greater influence yields a less risky mix.

*(Pensions, Contracts)*

# 1 Introduction

It is generally believed that, in aggregate, state and local pension plans in the U.S.: (1) invest their funds more conservatively than do their private sector counterparts, and as a result (2) earn a lower overall rate of return. Recent studies contributing to this consensus include Useem and Mitchell (2000) and Coronado, Engen and Knight (2003).<sup>1</sup> A significant feature of these studies is that in addition to presenting evidence to support these basic conclusions, they also investigate why this is the case. They focus on the institutional characteristics of the governance and oversight structures of the boards that oversee these plans, and analyze measures such as size and membership composition of the board and whether there are constitutional or legislative constraints on investment decisions. Not surprisingly they find that at least in some instances these features make a difference. Such empirical results are important because they provide insight into how enacting changes in governance structures and the design of contracts might improve investment performance and thereby either lower the fiscal burden to taxpayers or perhaps increase the benefits to beneficiaries.

We expand the focus of this line of inquiry to include the issue of who is the residual claimant of a pension fund account surplus (i.e., excess earnings) and who is responsible to fund a deficit (i.e., earnings shortfall). In particular we consider whether asymmetry or uncertainty among alternative claimant rules contributes to the observed conservative investment strategies of state administered plans. If this is indeed the case, then one way to improve investment performance would be to enact policies that implement an

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<sup>1</sup>We note that not all analysts agree that public plans earn less. For example Munnell and Sunden (2001) suggest that “Today, public plans appear to be performing as well as private plans.” (p. 154)

appropriate surplus-sharing rule and reduce or eliminate this uncertainty.

Issues of pension plan design and reform are as important in Europe as in the U.S. European public sector pension plans offer generous benefits but face serious demographic pressures. Factors that influence pension plan investment strategies need to be better understood (see Disney (2000, 2003)).

## 1.1 Identifying the Residual Claimant

The exclusive benefits rule of the U.S. internal revenue code holds that with regard to pension funds “no part of plan assets may be used for purposes other than the exclusive benefit of employees and beneficiaries.”<sup>2</sup> Although this sounds like a prudent constraint we believe that it, when combined with the benefit guarantee available to public sector employees, introduces a moral hazard problem that has an impact on the amount of risk displayed in the allocation of pension fund assets.

In U.S. state employee pension plans, the combination of defined-benefit plans and the employee ownership of plan surpluses provides public employees with the essence of a free call option. The employee receives a guaranteed defined retirement benefit if the plan is in deficit. Although this guarantee is implicit inasmuch as defined benefit pension promises are backed by the full faith and taxing power of their sponsoring governments, we know of no instance where even a fiscally distressed state government has actually reneged on such a pension promise.<sup>3</sup> The situation when a fund is in surplus is more complex. Despite the U.S. internal revenue code statement about the employee right to pension-fund surpluses,

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<sup>2</sup>Pension plan fiduciary duties are required by the IRS in Sec. 401(a)(2) and Sec. 503 – as indicated by Rajnes, 2001, p. 8

<sup>3</sup>It is interesting to note that public employees may fear the loss of promised pension benefits in the future despite the lack of renege precedent. For example, two New Jersey public sector unions objected to a proposal of the governing council for the state’s funds to shift to a more aggressive investment strategy and threatened legal action if the proposal was implemented (*New York Times*, November 9, 2004, C2)

in reality taxpayers can also share - or perhaps even fully appropriate - a surplus when it occurs. For sharing to occur at least part of the surplus must be distributed to public employees as enhanced benefits.

The issue of what to do with fund surpluses is complicated by the long term nature of pension funds. Actuarial estimates of the present value of a defined benefit plan's liabilities are quite sensitive to assumptions about the interest rate that the fund's assets will earn and the rate of increase in salary for remaining work life of current employees. Even when annual contributions are adjusted to maintain actuarial full funding, differences on a year-to-year basis between the realized values and the assumed values for these key parameters can move the plan's status from fully funded to a surplus or an unfunded liability, depending on the direction of the deviation.

Figure 1 illustrates this phenomenon. The middle track in Panel A shows how a plan's assets can grow over time as the plan matures and annual contributions are made to fully fund the promised defined benefits. The lower track shows how plan assets might grow if annual contributions did not match accruing liabilities. In this case taxpayers would be required to increase contributions to cover liabilities when the plan matured. The upper track shows how plan assets might grow if annual contributions exceed accruing liabilities. In this case a strict application of the exclusive benefits rule would require an adjustment to increase the actual benefits of the plan's retirees. Under such a scenario rational taxpayers, faced with some uncertainty about the actual growth in a plan's assets, might well choose to err on the side of underfunding annual contributions.

Panel B of the figure illustrates the more realistic case where a plan's managers adjust annual contributions to maintain full funding, but realized interest rates and salary growth

deviate from the values assumed by actuarial estimates of the fund's future liabilities. In this case even a well managed fund will experience periods of surplus and unfunded liability. While it may seem reasonable to suggest that all parties should simply take a long term view of a fund's financial status, we must remember that decisions about state and local pension plans take place in the political arena. It is possible that in certain time periods - such as the bull market of the late 1990s - public sector defined benefit pension plans might experience prolonged periods during which even a zero current period contribution will result in a continuing fund surplus. Even in the absence of the IRS exclusive benefit rule this would likely result in significant political pressure to use at least part of this surplus to enhance retirees' benefits.<sup>4</sup> Perhaps variations in how plans deal with the uncertainty of surplus sharing can provide some insight into why some plans invest more heavily in risky assets than do others.

In what follows we present a model that shows that an equilibrium asset mix must reflect more than the wishes of the public employee. The interests of other parties must also be taken into account. The (representative) taxpayer's preferred mix is not necessarily the same as that of the employee. We also add a public choice element to our model by recognizing that someone must mediate between the interests of the public employee and the taxpayer. In our model it is an elected official, the legislator, that performs this function.

In brief our model takes into account the power of the public employee relative to that of the taxpayer to influence the investment decisions of the legislator and whether or not the legislator has not only determined the size of the employee's defined benefit in

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<sup>4</sup>This was certainly the case when the Pennsylvania State Legislature substantially increased the defined benefit of teachers and state employees - including members of the legislature - in 2001.

retirement, but also how any surplus in the trust fund will be shared between the taxpayer and employee. The model allows us to see when taxpayer and employee interests are in harmony and when they are not with respect to the preferred degree of risk in the trust fund's asset mix.

Most importantly, we will show that whether or not the surplus shares are specified (i.e., whether the surplus sharing is implicit or explicit) before the portfolio mix is chosen, a consideration so far neglected in the pension fund literature, is likely to help explain variations in the asset allocations of the state employee pension plans.

A brief overview of the pension design is presented in Section 2. Section 3 contains our theoretical model and our empirical model is in Section 4. Section 5 contains a description of our data. The empirical results are in Section 6. Section 7 concludes.

## **2 Pension Design**

There are two basic types of pension plans: the defined contribution (DC) plan and the defined benefit (DB) plan. The DC plan is easy to understand. The employer or the employee makes regular payments into an account in the employee's name. The funds are placed in trust and invested.

Defined contribution plans are, by definition, always fully funded because the worker's pension is determined by what has been accumulated. But who should determine how the assets should be invested? In a DC plan the employer's obligation is fulfilled by making the periodic contributions.<sup>5</sup> Thus, it would seem that the worker, who actually owns the assets, should have an important say in how they are invested.

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<sup>5</sup>There are many variations on the theme. Employers can, for example, contribute stock and therefore influence the choice. See EBRI, 1997, Chapters 6, 7.

But pension fund design has been more imaginative than simply relying on the individual's propensity to save. Employers in both the private and public sectors have put into place DB plans that promise a pension based on a formula that takes into account years of service, an annual pension credit, and the level of salary achieved. (For example, if the plan offered two percent of final pay for every year worked, a person who worked for 30 years and reached a salary level of \$100,000 would be entitled to a pension of \$60,000 per year.)

While being fully funded (i.e., a condition where pension assets equal pension liabilities) in a DC plan is a trivial accomplishment, in a DB plan it is a work of art. The future earnings of the workers, the turnover of the workforce, the mortality of the pensioners and the rate of return on the accumulating assets must all be estimated. On the basis of crucial assumptions the actuary calculates the accrued liability of the plan and the necessary periodic contribution to a trust fund. If the actuary's estimates are perfectly correct the plan remains fully funded. But the plan may experience unanticipated losses or gains and therefore move into an underfunded or overfunded position. While the need for a trust fund seems non-controversial, a question remains as to how the pension fund assets should be invested. That is to say, whose risk preference should be satisfied, the employer's or the worker's?

What are the benefits and costs to the employer of pursuing a high-risk strategy? High risk offers the chance of a high rate of return and thereby a lower annual contribution rate. If the strategy fails, the firm must divert additional otherwise productive expenditures to refinancing the level of benefits promised. In the worst case, the firm in the private sector would default on its promise and shift the obligation to the PBGC. Sharpe (1976) has

pointed out that this reduced downside risk to employers of private DB plans creates a moral hazard. Specifically, the private employer has an incentive to pursue a high-risk investment strategy.

For the worker, high risk taking only makes sense if excess gains can be claimed in the form of pension benefit enhancements. And the worker must recognize that if the strategy fails, the pension fund might fail and then his benefits are reduced to those offered by the PBGC which in most cases is less than that promised by the firm. In these private sector DB plans, it would appear that since workers have more to lose and less to gain than do the firms that they would be less likely to favor a risky investment strategy.

State and local pension plans which are, for the most part, DB plans are subject to a moral hazard problem not present in private sector DB plans. The problem arises because these pension promises are backed both by the full faith and credit of the public sector and the assets accumulated in the trust funds of these plans.

Currently all states attempt to prefund their plans.<sup>6</sup> So once again we need to ask about the investment strategy for the trust fund assets. Do we expect the worker and the public employer (i.e., taxpayer) to exhibit the same degree of risk aversion? What are the gains and losses to the employer? The more risky portfolio offers a chance of a higher rate of return on assets and thus potentially lower future contribution rates. This means there can be a lower current tax rate. However, if the strategy fails the taxpayers must make up the difference with higher future tax rates. What about the employee? A risky portfolio offers a chance of producing an overfunded trust fund and the opportunity to claim

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<sup>6</sup>Although the Employee Retirement Insurance Security Act (ERISA, 1974) does not apply to public sector plans, state and local governments generally require some sort of funding scheme that takes account of accrued liabilities.

enhanced benefits on the basis of the exclusive benefits rule. And what happens if the strategy fails and the trust fund is, at the extreme, empty? The employee is still guaranteed the DB pension. Thus, a moral hazard has been created. Since there is no real penalty for failure, it is to the benefit of the employee to induce those who manage the pension plan to take on some added risk. Our model considers the asset mix preferences of both the employee and the taxpayer and explains how they are reconciled in a public choice setting.

### 3 Theoretical Model

We examine two determinants of the asset mix of the pension trust fund: the relative influence of the public employees and the taxpayers; and whether surplus-sharing rules are specified before the investment decision is made. The relative influence of the public employee is both direct and indirect. The direct influence is straightforward. We show that if the public employee has more power to influence the investment decision, then the result will be relatively more invested in the risky asset. The indirect influence is subtle. It is implicit in our model that the public employee can influence both the size of the defined benefit and the surplus shares. We demonstrate that increases in either the defined benefit or the surplus shares of the public employees *ceteris paribus* results in a relatively smaller investment in the risky asset. Therefore, the effect on the asset mix of an increase in the public employees' influence is ambiguous.

We identify two reasons why leaving the surplus shares unspecified at the in time when the investment decision is made results in a smaller investment in the risky asset. First, if the surplus shares are left unspecified when the investment decision is made, and specified only after a surplus is known to exist, then at this point in time the public employees are in

a relatively better position to capture greater shares of a surplus. With greater surplus shares going to the public employees, relatively less is invested in the risky asset so as to generate smaller surpluses.

Second, with the surplus shares unspecified at the time the investment decision is made, the public employees have an additional source of uncertainty about their retirement wealth and the taxpayers have an additional source of uncertainty as to their future required contributions. To reduce the uncertainty about the surplus shares, the legislature can either specify the surplus shares up front, before the investments are made, or invest less in the risky asset. Comparing the cases in which the surplus shares are specified up front and in which the surplus share are left open, we demonstrate that less will be invested in the risky asset if the surplus shares are left open.

### **3.1 The Participants, Portfolios, and Utility Functions**

#### *The Participants*

Our model is built on the behavior of three participants: a representative public employee ( $p$ ) who receives a pension, a representative taxpayer ( $t$ ) who is responsible for funding the pension plan and a representative legislator ( $l$ ) who enacts the law needed to create the plan and who is also responsible for setting – or at least overseeing – the asset mix of the trust fund. In practice fund administration involves several people such as pension board officials or selected managers. In our theoretical analysis the legislator carries out these functions.

#### *Setting the Surplus Sharing Rule*

The public employee's initial defined benefit, denoted as  $f$ , is given. Since the pension plan can experience overfunding (i.e., the value of the pension assets is greater than the value of

the pension liabilities) a surplus sharing rule must be set. Let  $\beta$  denote the public employee's share of any surplus earnings and  $(1 - \beta)$  the taxpayer's share. The shares can be set prior (*ex ante*) to the legislator's choice of the asset mix, in which case we denote the shares as  $\beta_0$ , or after (*ex post*) the surplus has been recognized, in which case we denote the shares as  $\beta_1$ .

The funding of the plan is the responsibility of the taxpayer, and the legislator administers the plan and sets the asset mix. Our hypothetical trust fund portfolio is composed of at most two assets: one risk-free, denoted as  $A$ , and the other risky, denoted as  $B$ . The taxpayer must make an up-front contribution necessary to purchase these assets.

That the portfolio can produce a surplus or a deficit creates an asymmetry between the taxpayer and the employee. If the pension account is in deficit, the taxpayer must make up the loss by making an additional contribution. If, however, the plan produces a surplus, the gain will be divided between the employee and the taxpayer.

#### *Trust Fund Portfolio Composition and Returns*

In our hypothetical trust fund, let  $\alpha_A$  represent the amount invested in the risk-free asset and  $\alpha_B$  the amount invested in the risky asset. Let  $R_A$  and  $R_B$  denote the gross return per dollar invested in the risk-free and risky asset. We normalize the returns on the assets to the return on the risk-free asset. Let  $r_A = 1$  and  $r_B = R_B/R_A$  represent the normalized gross return on the risk-free and risky asset respectively. (Hereafter, we refer to "normalized gross return" as "return.") Of course, the return on the risky asset may differ from the expected return. Let  $\bar{r}_B$ , where  $\bar{r}_B > 1$ , denote the expected return per dollar invested in asset  $B$ , and let  $\hat{r}_B$  denote the return less the expected return. Specifically,  $\hat{r}_B = r_B - \bar{r}_B$ . Let  $G(\hat{r}_B)$  represent the probability distribution function on  $\hat{r}_B$ . From the

definition of  $\hat{r}_B$ ,  $\int \hat{r}_B dG(\hat{r}_B) = 0$ . Finally, the notation  $\bar{s}_B$  represents the expected surplus per dollar invested in the risky asset. Specifically, this expected surplus equals the probability that  $\hat{r}_B > 0$  times the expected value of  $\hat{r}_B$  given  $\hat{r}_B > 0$ :

$$\bar{s}_B = \int_{\hat{r}_B > 0} \hat{r}_B dG(\hat{r}_B). \quad (1)$$

Expression (??) is useful when characterizing the optimal trust fund portfolio.

### *The Pension Contract* <sup>7</sup>

The pension contract has two crucial features. First, the contract sets the size of the defined benefit,  $f$ . The benefit is guaranteed in the sense that after the parties learn the return on the risky asset, if the pension account is in deficit, the taxpayer must also pay the residual,  $f - (\alpha_A + \alpha_B r_B)$ . The second feature is the surplus-sharing factor. The contract either states a factor,  $\beta_0 \in [0, 1]$ , or the contract states that the surplus-sharing factor will be determined later, in which case,  $\beta_0 = \emptyset$ , and the factor  $\beta_1$  is set after the parties realize a surplus.

With the contract in place, we can write the surplus share,  $\beta$ , as

$$\beta = \begin{cases} \beta_0 & \text{if } \beta \text{ is specified in the contract;} \\ \beta_1 & \text{if } \beta \text{ is not specified in the contract.} \end{cases}$$

At the point in time when the legislator chooses the portfolio mix of the trust fund, the parties may be uncertain as to the value of  $\beta$ . We let  $\rho : [0, 1] \rightarrow \mathfrak{R}$  denote the probability density function on  $\beta$ , and  $\mathcal{P} : [0, 1] \rightarrow [0, 1]$  denote the corresponding probability distribution function. Note that if  $\beta = \beta_0$ , then

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<sup>7</sup>In our theoretical model, we leave open the issue of the optimal design of the pension plan, the types of issues addressed in the contracting literature (see Bolton and Dewatripont, 2005, for an overview), from the seminal papers on the principal-agent problem (see Hölmstrom 1979) to the hold-up problem (see Che and Hausch 1999) and the optimal specificity of the contracts (i.e., whether the surplus shares should be specified up-front or left open) (see Hart and Moore 1999).

$$\mathcal{P}(\beta) = \begin{cases} 0 & \text{if } \beta < \beta_0 \\ 1 & \text{if } \beta \geq \beta_0. \end{cases}$$

*The Actuarial Budget Balancing Condition*

To analyze the asset allocation decision, we need to characterize the set of feasible portfolios. By feasible we mean that the legislator must choose a portfolio mix which is actuarially balanced. Hence, the defined benefit must equal the expected (gross) return on the portfolio. Specifically:

**Definition.** The *actuarial expected budget balancing* condition is

$$f = \alpha_A + \alpha_B \bar{r}_B. \tag{2}$$

A budget-balancing portfolio can be expressed in terms of the amount invested in the risky asset,  $\alpha_B$ . From equation (??),

$$\alpha_A = f - \alpha_B \bar{r}_B. \tag{3}$$

Adding  $\alpha_B$  to both sides of (??) produces the taxpayer's up-front contribution in a budget-balancing portfolio:

$$\alpha_A + \alpha_B = f - \alpha_B(\bar{r}_B - 1) \tag{4}$$

The right-hand side of (??) indicates that taxpayer can minimize the amount of his up-front contribution by investing solely in the risky asset.

*The Realized Value of the Portfolio*

The actual return on the risky asset,  $r_B$ , determines whether the pension fund has accumulated enough value to fund the pension liabilities. Let  $x$  denote the difference

between the value of the assets and liabilities of the pension plan:

$$x = \alpha_A + \alpha_B r_B - f. \quad (5)$$

and since  $\hat{r}_B = r_B - \bar{r}_B$ ,

$$x = \alpha_B \hat{r}_B. \quad (6)$$

Equation (6) tells us that the pension trust fund is in surplus if  $\hat{r}_B > 0$  and is in deficit if  $\hat{r}_B < 0$ .<sup>8</sup>

### *Wealth and The Utility Functions*

The taxpayer's ( $t$ 's) wealth prior to entering the pension fund arrangement is denoted as  $W_{t_0}$ , and his wealth upon the employee's retirement is denoted as  $W_{t_n}$ . Specifically, the taxpayer's wealth at the point of retirement is

$$W_{t_n} = \begin{cases} W_{t_0} - f + \alpha_B \hat{r}_B + \alpha_B (\bar{r}_B - 1) & \text{if } \hat{r}_B < 0; \\ W_{t_0} - f + (1 - \beta) \alpha_B \hat{r}_B + \alpha_B (\bar{r}_B - 1) & \text{if } \hat{r}_B > 0. \end{cases}$$

In this wealth expression, if the plan is in deficit (i.e.,  $\hat{r}_B < 0$ ), then the taxpayer's wealth is the sum of his initial wealth, the deficit (which he must pay to bring the plan back into balance), and the reduction in his initial contribution from investing in the risky asset.

Given the budget-balancing portfolio requirement, the taxpayer's expected utility, evaluated at the point in time when the legislator sets the asset mix, is a function of the taxpayer's initial wealth,  $W_{t_0}$ ; the defined benefit,  $f$ ; the investment in the risky asset,  $\alpha_B$ ; the surplus sharing rule that is in place when it is time to share the surplus  $\beta$ ; and the

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<sup>8</sup>It follows from the definition of  $\hat{r}_B$  and the budget-balancing condition that the expected surplus equals the expected deficit. Specifically, the expected value of  $x$ ,  $E[x]$  is

$$E[x] = \int_{\hat{r}_B > 0} \alpha_B \hat{r}_B dG(\hat{r}_B) - \int_{\hat{r}_B < 0} \alpha_B \hat{r}_B dG(\hat{r}_B) = 0.$$

probability distribution function on this final surplus-sharing rule,  $\mathcal{P}$ . (Recall that if  $\beta = \beta_1$ , then  $\mathcal{P}$  indicates that the parties know  $\beta$  with probability one.)

The taxpayer's (weakly) concave utility of his final wealth function is  $V_t(W_{t_n})$ .<sup>9</sup> If the surplus-sharing factor is specified *ex ante*,  $\beta_0$ , the taxpayer's expected utility function, evaluated before the pension fund portfolio is chosen, is

$$U_t(W_{t_0}, f, \alpha_B, \beta_0, \mathcal{P}) = \int_{\hat{r}_B < 0} V_t(W_{t_0} - f + \alpha_B \hat{r}_B + \alpha_B(\bar{r}_B - 1)) dG(\hat{r}_B) \\ + \int_{\hat{r}_B > 0} V_t(W_{t_0} - f + (1 - \beta_0)\alpha_B \hat{r}_B + \alpha_B(\bar{r}_B - 1)) dG(\hat{r}_B).$$

If, on the other hand, the surplus sharing rule is specified after the surplus is realized,  $\beta_1$ , the taxpayer's expected utility function, evaluated before the pension fund portfolio is chosen, is

$$U_t(W_{t_0}, f, \alpha_B, \beta_1, \mathcal{P}) = \int_{\hat{r}_B < 0} V_t(W_{t_0} - f + \alpha_B \hat{r}_B + \alpha_B(\bar{r}_B - 1)) dG(\hat{r}_B) \\ + \int_{\hat{r}_B > 0} \int_0^1 V_t(W_{t_0} - f + (1 - \beta_1)\alpha_B \hat{r}_B + \alpha_B(\bar{r}_B - 1)) d\mathcal{P}(\beta_1) dG(\hat{r}_B).$$

The public employee's wealth prior to entering the pension fund arrangement is denoted as  $W_{p_0}$ , and his wealth at the point in time of the public employee's retirement is denoted as  $W_{p_n}$ . Specifically, the public employee's final wealth is

$$W_{p_n} = \begin{cases} W_{p_0} + f & \text{if } \hat{r}_B < 0; \\ W_{p_0} + f + \beta \alpha_B \hat{r}_B & \text{if } \hat{r}_B > 0. \end{cases}$$

The public employee's (weakly) concave utility of final wealth function is  $V_p(W_{p_n})$ . If the surplus-sharing factor is specified *ex ante*,  $\beta_0$ , the public employee's expected utility function, evaluated before the pension fund portfolio is chosen, is

$$U_p(W_{p_0}, f, \alpha_B, \beta_0, \mathcal{P}) = \int_{\hat{r}_B < 0} V_p(W_{p_0} + f) dG(\hat{r}_B) + \int_{\hat{r}_B > 0} V_p(W_{p_0} + f + \beta_0 \alpha_B \hat{r}_B) dG(\hat{r}_B).$$

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<sup>9</sup>To avoid the analysis of borrowing and lending, so as to simplify the model, we assume the taxpayer and public employee consume after the public employee receives the retirement benefit and the taxpayer has made all necessary contributions to fund the public employee's pension. Also, in Section 3.2.2, the taxpayer and public employee are assumed to be risk neutral; and in Section 3.2.3, we consider two cases – on in which the taxpayer and public employee are risk neutral and the other in which they are risk averse.

If, on the other hand, the surplus sharing rule is specified after the surplus is realized,  $\beta_1$ , the public employee's expected utility function, evaluated before the pension fund portfolio is chosen, is

$$U_p(W_{p_0}, f, \alpha_B, \beta_1, \mathcal{P}) = \int_{\hat{r}_B < 0} V_p(W_{p_0} + f) dG(\hat{r}_B) + \int_{\hat{r}_B > 0} \int_0^1 V_p(W_{p_0} + f + \beta_1 \alpha_B \hat{r}_B) d\mathcal{P}(\beta_1) dG(\hat{r}_B).$$

The legislator makes the only decision in the model; he chooses the budget-balancing portfolio. We assume that the legislator's objective is to stay in power. To maximize his probability of remaining in power, the legislator maximizes the weighted sum of the natural log of the public employee's and taxpayer's expected utilities. In the legislator's utility function, we let  $k$  represent the relative weight that the legislator attaches to the public employee's expected utilities. Specifically, the legislator chooses a portfolio to maximize

$$U_l = (1 - k) \ln(U_t) + k \ln(U_p). \quad (7)$$

We choose this utility function to represent the legislator's preferences for two reasons.

First, we view the legislator as responding to the influence of both the public employee and the taxpayer. The root of this influence could be the degree to which the public employee and taxpayer groups are organized, how they respond to policy decisions in their voting behavior, or simply the number of public employees and taxpayers. The degree of influence of the public employee on the legislator's portfolio decision is represented by  $k$ , and the degree of influence of taxpayer by  $(1 - k)$ . Second, we choose the natural log of the utilities to represent diminishing marginal returns to the legislator of increasing the utilities of the public employee and taxpayer. <sup>10</sup>

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<sup>10</sup>Furthermore, although we model the legislator's choice problem as an expected utility maximization problem, alternatively, we could model the asset allocation as the outcome of a negotiation between the

## 3.2 Theoretical Analysis

In Section 3.2.1, we examine the effect of changes in public employee and taxpayer influence,  $k$ , the size of the defined benefit,  $f$ , and the *ex ante* specified surplus sharing rule,  $\beta_0$ , on the legislator’s asset allocation. To isolate the effect of these variables –  $k$ ,  $f$ , and  $\beta_0$  – from the effect of risk aversion on the asset mix, we assume both the employee and the taxpayer are risk neutral. In Section 3.2.2, we examine the effect on the asset allocation decision of leaving the surplus sharing rule undetermined. We consider two cases: the taxpayer and public employee are risk neutral; and they are risk averse.

### 3.2.1 Influence and the Portfolio Allocation

We begin by considering a defined-benefit contract in which the taxpayer is the “residual claimant” to the returns on the portfolio. That is,  $\beta_0 = 0$ . After examining this base case, we examine cases in which  $\beta_0 > 0$ .

#### *The Entire Surplus Goes to the Taxpayer*

With  $\beta_0 = 0$ , Lemma 1 characterizes the optimal asset allocation. The important point of Lemma 1 is that if the taxpayer reaps the full value of the surplus (i.e., the taxpayer is the residual claimant of the trust fund), then optimal asset allocation dictates that the legislator invest the entire portfolio in the asset with the greatest expected return.

If  $\beta_0 = 0$ , the legislator’s optimization program in the determination of the asset mix is:

$$\max_{\alpha_B} (1 - k) \ln(U_t(W_{t_0}, f, \alpha, 0, \mathcal{P})) + k \ln(U_p(W_{p_0}, f, \alpha, 0, \mathcal{P})). \quad (8)$$

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public employee and taxpayer. With a negotiation process, one reasonable solution is the non-symmetric Nash bargaining solution of the public employee and taxpayer axiomatic bargaining game. The non-symmetric Nash bargaining solution of an axiomatic game with the reversion point is  $(U_p, U_t) = (0, 0)$  is identical to the solution of the legislator’s expected utility maximization problem. Hence, our model yields the same results as this bargaining model. See Myerson, 1991, Section 8.6, for a characterization of the non-symmetric Nash bargaining solution.

**Lemma 1.** *Suppose the taxpayer and public employee are risk neutral. If the taxpayer is the residual claimant of the trust fund account (i.e.,  $\beta_0 = 0$ ), the legislator will choose the Pareto optimal asset portfolio of all risky assets,  $\alpha = (\alpha_A, \alpha_B) = (0, f/\bar{r}_B)$ .*

**Proof of Lemma 1.** See Appendix.

### ***The Public Employee Gets At Least Part of the Surplus***

Theorem 1 characterizes the effects of the degree of surplus sharing,  $\beta_0$ , the size of the defined benefit,  $f$ , and the public employee's relative power,  $k$ , in influencing the portfolio allocation decision.

Before presenting Theorem 1, we state the legislator's optimal portfolio mix, which is the solution to the legislator's optimization program:

$$\max_{\alpha_B} (1 - k) \ln(U_t(W_{t_0}, f, \alpha_B, \beta_0, \mathcal{P})) + k \ln(U_p(W_{p_0}, f, \alpha_B, \beta_0, \mathcal{P})). \quad (9)$$

The legislator's optimal portfolio mix, i.e., the solution to (9), is

$$\alpha_B^* = \begin{cases} 0 & \text{if } \hat{\alpha}_B < 0 \text{ and } (\bar{r}_B - 1) - \beta_0 \bar{s}_B < 0; \\ \hat{\alpha}_B & \text{if } 0 < \hat{\alpha}_B < f/\bar{r}_B \text{ and } (\bar{r}_B - 1) - \beta_0 \bar{s}_B < 0; \\ f/\bar{r}_B & \text{if either } \hat{\alpha}_B > f/\bar{r}_B \text{ or } (\bar{r}_B - 1) - \beta_0 \bar{s}_B > 0; \end{cases} \quad (10)$$

where

$$\hat{\alpha}_B = \frac{\beta_0 \bar{s}_B (f - k w_{t_0}) - (1 - k) f (\bar{r}_B - 1)}{\beta_0 \bar{s}_B ((\bar{r}_B - 1) - \beta_0 \bar{s}_B)}$$

The solution to (9) has two corners: one in which legislator invests in only the risk-free asset,  $\alpha_B = 0$ ; and the other in which the legislator invests in only the risky asset,  $\alpha_B = f/\bar{r}_B$ . The legislator places the entire trust fund in the risky asset if both the employee and taxpayer prefer to invest the entire portfolio in the risky asset. Certainly, the

employee prefers to invest the entire portfolio in the risky asset, but the taxpayer prefers to do so only if

$$(\bar{r}_B - 1) - \beta_0 \bar{s}_B > 0. \quad (11)$$

We can view expression (??) as the benefit minus the expected cost to the taxpayer per dollar invested in the risky asset. The benefit of each dollar invested in the risky asset instead of the risk-free asset is  $(\bar{r}_B - 1)$ . The taxpayer's expected cost is that he must share a trust fund account surplus with the public employee. Specifically, the expected cost per dollar invested in the risky asset is  $\beta_0 \bar{s}_B$ . Hence, if the benefit is greater than the expected cost (i.e., expression (??) holds), then the taxpayer prefers to invest in the risky asset.

We are now ready to state Theorem 1.

**Theorem 1.** *Suppose the taxpayer and public employee are risk neutral. If the public employee has a positive surplus-sharing factor,  $\beta_0 > 0$ , then the equilibrium ratio of the risky to the risk-free asset,  $\alpha_B^*/\alpha_A^*$ , is non-increasing in size of the defined benefit,  $f$ , non-increasing in the public employee's surplus share,  $\beta_0$ , and non-decreasing in the public employee's relative influence on the asset allocation,  $k$ .*

**Proof of Theorem 1.** See Appendix.

Theorem 1 outlines the effects of changes in three determinants – the defined benefit, the surplus shares, and the relative influence of the public employee – on the legislator's asset allocation decision. An increase in the defined benefit has a negative effect on the amount invested in the risky asset. To understand this effect, fix the public employee's and taxpayer's ability to influence the legislator's investment decision and also increase the public employee's defined-benefit factor. With this particular influence held constant, the

legislator is unwilling to give the public employee the double increased benefit of a greater defined benefit and a greater expected surplus. So, the legislator reduces the investment in the risky asset.

Theorem 1 shows that an increase in the public employee's share of a realized surplus,  $\beta_0$ , has a negative effect on the amount invested in the risky asset. As with the case of an increased defined benefit, with an increased surplus share, the legislator is unwilling to give the public employee the increased benefit of a greater expected surplus as well as an increased surplus share. As a result, the legislator reduces the investment in the risky asset. With regard to a change in the public employee's relative influence on the legislator's choice of an asset mix, the greater is  $k$ , the greater is the legislator's investment in the risky asset.

### ***Numerical Example***

Figure 2 shows the effects of the public employee's surplus share ( $\beta_0$ ) and his relative influence ( $k$ ) on the legislator's portfolio decision. It is constructed on the basis of the following numerical example.

While many sets of numerical values can generate a figure qualitatively like Figure 2, we choose the following values. The expected return on the risky asset is  $\bar{r}_B = 1.07$ , roughly equal to the historic average on the expected return of U.S. stocks. We set the initial wealth levels and defined benefit so that, ignoring the surplus, the public employee's retirement wealth,  $w_{p_0} + f$ , equals the taxpayer's retirement wealth,  $w_{t_0} - f$ . The initial levels of are  $w_{t_0} = \$20$  and  $w_{p_0} = \$0$ ; and the defined benefit is  $f = \$10$ . We set the probability of a surplus at 0.5; and the expected surplus per dollar invested in the risky asset is  $\bar{s}_B = 0.65$ . The values  $\beta_0$  and  $k$  vary between 0 to 1. Substituting these values into

equation (??), we have the legislator's investment in the risky asset:

$$\alpha_B^* = \begin{cases} 0 & \text{if } \frac{1.54(\beta_0 6.5(2k-1)+0.7(1-k))}{\beta_0(0.65\beta_0-0.07)} \text{ and } (0.07 - \beta_1 0.65) < 0; \\ \hat{\alpha}_B = \frac{1.54(\beta_0 6.5(2k-1)+0.7(1-k))}{\beta_0(0.65\beta_1-0.07)} & \text{if } 0 < \frac{1.54(\beta_0 6.5(2k-1)+0.7(1-k))}{\beta_1(0.65\beta_0-0.07)} < 9.34 \\ & \text{and } (0.07 - \beta_0 0.65) < 0; \\ f/\bar{r}_B = 9.34 & \text{if either } \frac{1.54(\beta_0 6.5(2k-1)+0.7(1-k))}{\beta_0(0.65\beta_1-0.07)} > 9.34, \\ & \text{or } \frac{1.54(\beta_0 6.5(2k-1)+0.7(1-k))}{\beta_0(0.65\beta_0-0.07)} < 0 \text{ and } (0.07 - \beta_0 0.65) > 0. \end{cases} \quad (12)$$

Figure 2, which plots values of  $k$  on the horizontal axis and values of  $\beta_0$  on the vertical axis, displays the legislator's optimal investment in the risky asset, as specified in expression (??). There are three noteworthy features about the location of legislator's optimal asset mix. First is the interpretation of the positively-sloped black lines. These are iso-risky-asset lines. Each line to the right represents a relatively more of the risky asset. As part of the proof of Theorem 1, we demonstrated that in the  $(k, \beta_0)$  space, the iso-risky-asset investment lines have positive slopes. Second, the amount invested in the risky asset is non-decreasing in  $k$  and non-increasing in  $\beta_0$ . Third, the legislator invests the entire trust fund in the risk-free asset if the public employee has little power to influence the investment decision ( $k$  is small) or great power to capture the surplus ( $\beta_0$  is large); and the legislator invests the entire portfolio in the risky asset if the public employee's ability to influence the investment is large or power to capture the surplus is small. This last result leads us to discuss the opposing effects on the legislator's investment decision of the public employee's power to influence his surplus-sharing factor and his power to influence the legislator's investment decision.

### ***Influence and Opposing Effects***

In reality, the defined benefit,  $f$ , the public employee's share of the surplus,  $\beta_0$ , and the relative amount invested in the risky asset,  $\alpha_B/\alpha_A$ , are all determined by the public employee's relative influence in the policy arena. In Figure 2, the influence parameter,  $k$ , is limited to measuring the relative ability of the public employee to influence the investment decision. If we were to model the three types of relative influence - influences to determine the defined benefit, surplus share, and asset allocation - as Theorem 1 indicates, we would find that the defined-benefit and surplus-share effects are opposite of the effect of the asset allocation influence.

Presumably, the public employee's ability to influence his share of the surplus is positively correlated with his ability to influence the legislator's investment decision, i.e.,  $\beta_0$  and  $k$  are positively related. The counteracting effects of increases in  $\beta_0$  and  $k$  on  $\alpha_B/\alpha_A$  imply that the effect of an increase in public employee's ability to influence his surplus share and influence the investment strategy on  $\alpha_B/\alpha_A$  is indeterminate. Whether  $\alpha_B/\alpha_A$  increases with an increase in both  $\beta_0$  and  $k$  depends on which effect dominates: the *surplus-share effect* (as measured by an increase in  $\beta_0$ ) or the *direct-influence effect* (as measured by an increase in  $k$ ). We have that the *direct-influence effect* dominates the *surplus-share effect* if and only if

$$\frac{\partial \alpha_B}{\partial k} dk > \frac{\partial \alpha_B}{\partial \beta_0} d\beta_0. \quad (13)$$

The arrows in Figure 2 show the relative strength of the two effects. The solid arrow shows the surplus-share effect dominating the direct-influence effect. As public employee power increases, the legislator invests less in the risky asset. The dashed arrow shows the direct-influence effect dominating the surplus-share effect. As public employee power

increases,  $k$ , the legislator invests more in the risky asset.

### 3.2.2 The Timing of Specifying the Surplus Share

We now consider the impact on  $\alpha_B/\alpha_A$  of the point in time when the legislator sets the surplus shares. In Theorem 2, we demonstrate that specifying the surplus shares before the investment decision is made results in a (weakly) greater ratio  $\alpha_B/\alpha_A$ .

**Theorem 2.** *Suppose the public employee and taxpayer are risk neutral. The ratio of the risky to risk-free asset is (weakly) greater if the surplus shares are specified before the asset allocation is made than if the surplus shares are left open. That is,*

$$\frac{\alpha_B^*(f, k, \beta_0^*, \mathcal{P}(\beta_0^*))}{\alpha_A^*(f, k, \beta_0^*, \mathcal{P}(\beta_0^*))} \geq \frac{\alpha_B^*(f, k, \beta_1^*, \mathcal{P}(\beta_1^*))}{\alpha_A^*(f, k, \beta_1^*, \mathcal{P}(\beta_1^*))}.$$

**Proof of Theorem 2.** See Appendix.

If the surplus shares are specified after a surplus is realized, then the legislator knows that a deficit has not occurred. Alternatively, if the surplus shares are specified before the legislator makes the investment decision, then the legislator takes into account the possibility of a deficit and accordingly the negative impact on the taxpayer's utility. In fact, by the budget-balancing condition, the expected surplus equals the expected deficit. With the expected deficit equal to the expected surplus and the legislator setting the surplus shares before making an investment decision, the legislator assigns a smaller *ex post* payment to the public employee. With this result of a greater *ex post* payment to the public employee, the legislator accordingly invests less in the risky asset.

We now demonstrate that our Theorem-2 result is strengthened by a risk-averse public employee and taxpayer. In Theorem 3, we consider the case in which the  $\beta_0$  equals the

expected value of  $\beta_1$ . That is,  $\beta_0 = \int_0^1 \beta_1 d\mathcal{P}_1(\beta_1)$ . Hence, in this comparison, we demonstrate that the loss in expected utility due to the risk of leaving the surplus share open, and not the the greater public employee share (if specified in period 1) drives the decreased investment in the risky asset.

**Theorem 3.** *Suppose the public employee and taxpayer are risk averse and that*

*$\beta_0 = \int_0^1 \beta_1 d\mathcal{P}_1(\beta_1)$ . The ratio of the risky to risk-free asset is (weakly) greater if the surplus shares are specified before the asset allocation is made than if the surplus shares are left open. That is,*

$$\frac{\alpha_B^*(f, k, \beta_0, \mathcal{P}(\beta_0))}{\alpha_A^*(f, k, \beta_0, \mathcal{P}(\beta_0))} \geq \frac{\alpha_B^*(f, k, \beta_1, \mathcal{P}(\beta_1))}{\alpha_A^*(f, k, \beta_1, \mathcal{P}(\beta_1))}.$$

**Proof of Theorem 3.** See Appendix.

### 3.2.3 From the Theoretical Results to the Empirical Analysis

Our analysis showed that the *direct-influence* and *surplus-sharing* effects work in opposite directions. If the *direct-influence* effect dominates the *surplus-sharing* effect (as specified in expression (??)), then  $\alpha_B/\alpha_A$  is increasing in influence. Otherwise,  $\alpha_B/\alpha_A$  is decreasing in influence. That is, by Theorem 1:

$$\begin{array}{l} \text{If the public employees have} \\ \text{greater influence} \end{array} \Rightarrow \begin{array}{l} k \uparrow \Rightarrow \alpha_B^*/\alpha_A^* \uparrow \\ \beta \uparrow \Rightarrow \alpha_B^*/\alpha_A^* \downarrow \end{array}$$

While determining which of these effects dominates is an empirical issue, in our empirical analysis, we do not disentangle the *direct-influence* and *surplus-sharing* effects. Rather, we investigate the combined effects, specifically whether one effect dominates the other.

Our analysis also suggests that the *ex ante* specification of surplus shares (i.e.,  $\beta_0$  instead of  $\beta_1$ ) unambiguously leads to a weak increase in  $\alpha_B/\alpha_A$ . Theorems 2 and 3 tell us:

$$\text{If } \beta \text{ is set } \textit{ex ante} \quad \Rightarrow \quad \alpha_B^*/\alpha_A^* \uparrow$$

Finally, in our theoretical model, we did not analyze the determinants of whether the surplus shares are specified up-front or left open. Our conjecture is that the public employee will push to specify the surplus shares *ex ante*. Hence, we believe that the up-front specification of the surplus shares is positively correlated with public employee influence.

## 4 Empirical Model

Our analysis focuses on two important, and potentially related, choices involved in administering a public employee defined benefit pension plan. The first involves whether a sharing rule for excess earnings is negotiated *ex ante*, and the second relates to the asset mix of the trust fund. We examine whether negotiations between plan administrators and beneficiaries lead to an explicit *ex ante* sharing rule for any excess earnings that a fund may realize, how the relative power of the negotiating parties will impact whether an *ex ante* rule is established, and ultimately whether the adoption of an explicit sharing rule influences the fund's investment strategy. We now proceed to an empirical test of the model.

To examine the conjectures derived in the theoretical section, we specify the following treatment model (as described in Greene, 2003, pp 787-789). In the asset allocation

equation, the percent of a pension fund invested in equities,  $\%Equity_i$ , is a function of control variables,  $x_i$ , together with the treatment, which is whether an explicit *ex ante* sharing rule,  $ShareRule_i$ , has been adopted:

$$\%Equity_i = x_i'\beta + \delta ShareRule_i + e_i \quad (14)$$

The principal focus of our analysis is how the relative power of the plan members influences whether an *ex ante* sharing plan is adopted and also how this relative power influences the strategy for investing the plan's assets. We, therefore, include (as the measure of primary interest among the control variables) a binary variable, *Majority*, equal to one if the fraction of the plan's board of directors or trustees who are themselves plan members exceeds 0.5, and is zero otherwise. We also include as a control variable the total value of the plan's investments, *Assets*, on the notion that larger pension funds may adopt a more aggressive investment strategy.

This asset allocation equation (??) relates to our theoretical analysis: whether the direct-influence combined with the indirect-influence effects of greater public employee power, as measured by *Majority*, lead to a greater percentage of the pension fund invested in equities (Theorem 1); and whether an explicit *ex ante* sharing rule results in a greater percentage of a plan's assets being invested in equities (Theorems 2 and 3). It is important to stress that the relationship between  $\%Equity_i$  and *Majority* in the asset allocation equation captures both the *direct-influence* and *surplus-sharing* effects (which we characterized in Section 3.2.1 and discussed in Section 3.2.3). Based on our theoretical analysis, these combined effects mean that the relationship is ambiguous. Hence, in the empirical analysis we measure which of the two effects dominates the other.

We specify the selection equation for whether an *ex ante* sharing rule has been agreed upon:

$$ShareRule_i^* = z_i' \gamma + u_i;$$

and

$$ShareRule_i = \begin{cases} 1 & \text{if } ShareRule_i^* > 0; \\ 0 & \text{otherwise.} \end{cases}$$

where the variables in  $z_i$  that explain the latent measure,  $ShareRule_i^*$ , include all the variables in  $x_i$  as well as identifying variables. The identifying variables should be measures that impact the decision whether or not to adopt an explicit *ex ante* sharing rule but do not necessarily influence a fund's subsequent investment strategy. Our identifying variables are:

Vesting - the number of years required before a member's benefits are vested;

Dependency Ratio - ratio of the number of a plan's annuitants to the total number of plan members, active and annuitants; and

ADA Senate Index - the average 2001 Americans for Democratic Action voting index of the two U.S. Senators from the state in which the plan is located.

A longer time required for member's benefits to be vested suggests a more conservatively administered pension plan and perhaps a lower likelihood that members will have been able to negotiate an *ex ante* sharing rule for any excess earnings that the fund may realize. A higher dependency ratio indicates a more mature pension plan, so that a longer time has been available for negotiations to lead to an *ex ante* sharing rule. The ADA Senate Index is higher for states that elect more liberal United States Senators. A liberal political

climate may indicate a greater likelihood that public employee pension plan members are able to negotiate an *ex ante* sharing rule.

If the error terms from the two equations are normal and are correlated, then

$$E[\%Equity_i | ShareRule_i = 1, x_i, w_i] = x_i' \beta + \delta + \rho \sigma_e \lambda_i(-w_i \gamma) \quad (15)$$

and

$$E[\%Equity_i | ShareRule_i = 0, x_i, w_i] = x_i' \beta + \delta + \rho \sigma_e \frac{-\phi(w_i \gamma)}{1 - \phi(w_i \gamma)} \quad (16)$$

The parameter  $\lambda_i$  in (15) is the inverse Mills ratio, while the normal distribution and cumulative normal are referenced in the ratio at the end of (16) .

## 5 Data

The principal source of data used to test our model is “Characteristics of 100 Large Public Pension Plans,” published in 2002 by the National Education Association. This volume contains information on both administrative and financial features of the enumerated plans. Included among these plans are the large state pension programs. Most states operate separate pension plans for state employees and teachers, respectively. Some states, however, operate a single plan for employees and teachers. Other states operate a separate plan for employees of the state’s higher education system. Also included in these 100 large public pension systems are plans that cover public employees and/or teachers in a few large cities not included in statewide plans.

Because our analysis focuses on defined benefit pension plans we do not include any of the 100 large plans that have defined contribution structure. In several states, the

investment funds of more than one plan are managed jointly, so that the financial characteristics, such as asset allocation, are identical. When this occurs, we combine the plans into a single observation for the empirical analysis using a weighted average, when necessary, to determine the plan's administrative characteristics (e.g., majority membership on the plan's board). Finally we omit the few plans which have missing data for any administrative or financial feature that serves as a variable in the empirical model.

The valuation date for which we determine each plan's asset allocation depends upon the plan's fiscal reporting period and varies between June 2000 and January 2002 for the 83 plans in the estimating sample. The largest pension plan included in the sample is the California Public Employee Retirement Systems with assets of \$156 billion and the smallest is the Omaha OSERS plan which covers teachers and education support personnel with assets of \$800 million.

Data for the political climate control measure are from the Americans for Democratic Action web site. Table 1 presents summary statistics for all variables included in the model.

## 6 Results

Column 1 of Table 2 presents OLS estimates for the asset allocation model as a single equation, ignoring the endogeneity of an *ex ante* explicit sharing agreement decision. We present these results strictly for the purpose of comparison to our more general model. Notice that the estimated coefficients for neither the size of the pension fund's assets nor the binary variable indicating whether plan members comprise a majority of the plan's board are statistically significant. The coefficient of the binary variable indicating the existence of an *ex ante* sharing rule is positive and statistically significant with a point

estimate of 0.05.

Column 2 of Table 2 presents maximum likelihood estimates of the treatment model. In states that operate more than one public employee pension plan the error terms for observations within the same state may not satisfy the standard independence assumption. Column 3 of the table therefore presents maximum likelihood estimates of the treatment model with robust standard errors adjusting for clustering of observations by state. The results in Columns 2 and 3 are quite similar, except for the effect of the dependency variable in the first stage which exhibits statistical significance only when the estimated standard errors are adjusted for clustering. Our discussion of the results therefore will focus on the estimates presented in Column 3.

The direction of effect for all variables in the selection equation explaining which pension plans have adopted explicit *ex ante* sharing arrangements are consistent with our expectations. The presence of a majority of plan members, active and retired, on a state's pension board increases the probability that a sharing agreement is adopted. This is consistent with our conjecture that annuitants are more likely to be able to negotiate a fixed share of the excess interest earnings when members of the plan exert more power in decision making process. Plans that require a longer time period before members' benefits are vested, presumably signaling more parsimonious plan oversight, are less likely to have an explicit sharing agreement. Plans with a higher dependency ratio of beneficiaries to active members are more likely to have a sharing agreement, possibly because more mature plans have had a longer period in which to work out such an arrangement. And explicit sharing agreements are more likely in states that elect U.S. senators with liberal voting records.

Perhaps the most interesting result from the first stage equation is the coefficient for the selection correction variable. The estimate for this coefficient is negative and statistically significant at the one percent level. And the Wald equation test of independence rejects at the  $\alpha < 0.01$  level the null hypothesis that the error terms of the two equations are not correlated. These results suggest that, when examining empirically the determinants of public pension fund asset allocations, it is critical to first consider explicitly the process of selecting into an *ex ante* sharing agreement as does our theoretical model. We now turn to the second stage of the empirical model and examine the determinants of a pension plan's asset allocation.

The total value of the plan's investments, *Assets*, is positive and statistically significant at the one percent level in explaining the equity share of a public pension plan's investment allocation. This suggests that larger plans pursue a more aggressive investing strategy, a result that seems plausible intuitively.

Investigating the validity of Theorems 2 and 3 of our theoretical analysis, the variable of most interest in the asset allocation decision is whether or not an explicit *ex ante* sharing agreement has been put in place for any excess earnings that the plans investments may realize. The estimated coefficient, 0.12, for this variable is positive and significant at the one percent level. Just as importantly its economic magnitude appears considerable. The mean value for the equity share of the asset allocations in our sample is 0.57 and the standard deviation is 0.08. Thus, the presence of an *ex ante* sharing agreement increases the equity share in a plan's allocation by one and half standard deviations. Notice that the point estimate of the sharing rule coefficient controlling for its endogeneity is more than twice as large as the simple OLS estimate of Column 1.

The coefficient of Majority is negative and significant at the ten percent level. Its magnitude, however, is relatively small. This negative empirical relationship suggests that the *surplus-sharing* effect, as highlighted in Section 3.2.3, dominates the *direct-influence* effect. Again, in the *surplus-sharing* effect, as demonstrated in Theorem 1, means that greater public employee power results in a greater defined benefit, which in turn results in less invested in equities. The *direct-influence* effect, also characterized in Theorem 1, means that greater public employee power directly leads to greater investment in equities. In terms of Figure 2, with increased public employee influence, the investment strategy follows the solid arrow and not the dashed arrow.

Furthermore, it is worth pointing out that in the model estimated by Useem and Mitchell (2000) a variable measuring the percentage of a board's members who were themselves members of the plan also had a negative coefficient, though not statistically significant, in explaining the share of the fund's assets invested in equities. Our theoretical analysis, however, provides some insight into this otherwise apparent anomaly. Recall the ambiguity about the relationship between employee influence and asset allocation discussed in section 5.2.3. In our empirical results we find that greater employee influence (Majority) leads to a greater likelihood of an *Ex Ante* Earnings Share Rule. The existence of such a rule, in turn, significantly increases the allocation of risky assets. This effect countervails the direct effect of Majority in the asset allocation equation. In this regard our empirical results are consistent with those derived from our theoretical model.

## 7 Conclusion

The observed asset mix of a public sector defined benefit pension plan is the result of a complex set of forces. The preferences and goals of taxpayers, beneficiaries and those responsible of administering the plan must somehow be reconciled and this must be accomplished with ground rules given in the law. Taxpayers, because they are ultimately responsible for making good on the pension promise might prefer a cautious investment strategy; beneficiaries, on the other hand, who realize they have a guaranteed pension payment and the protection of the "exclusive benefits rule" might favor a more adventuresome strategy in hopes of reaping some extra gain from a potential investment surplus. Plan managers (in our study legislators) must make their decisions as "prudent" people but, of course, also wish to satisfy their constituencies. They may want to keep current tax rates low but they also want to stay in power.

We have laid out a theoretical model to capture some of the forces at work. Specifically, we show the potential impact on the asset mix of two important factors, the ability of the taxpayer and the beneficiary to influence the decision of the plan administrator (i.e. the legislator) and whether or not the sharing between the taxpayer and beneficiary of any excess investment earnings has been established prior to the earnings experience or left to be decided after the earnings have been recognized.

Previous research has concentrated on documenting the low rate of return on state and local pension fund assets. Governance procedures and constitutional or legislative legal constraints can explain a lot. Our empirical analysis shows that the low rate of return may also reflect a rational taxpayer's willingness to invest relatively more in less volatile fixed

income instruments (bonds) rather than variable return assets (stock) when the gains as well as the pension promised may go to beneficiary. But most importantly we also show that when the surplus sharing rule is set in advance and known by both taxpayer and beneficiary rather than left to chance, the mix of trust fund assets becomes more aggressive.

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## APPENDIX

**Proof of Lemma 1.** We take the partial derivative of the legislator’s utility with respect to the amount invested in the risky asset:

$$\frac{\partial U_l}{\partial \alpha_B} = \frac{(1-k)(\bar{r}_B - 1)}{E[W_{t_1}]} > 0.$$

Since both the numerator and denominator are positive, the derivative is positive.

Hence, regardless of the amount invested in risky asset, the legislator prefers to put more into risk. As a result, the legislator's optimal portfolio choice is

$(\alpha_A, \alpha_B) = (0, f/\bar{r}_B)$ . With risk neutral parties,  $(\alpha_A, \alpha_B) = (0, f/\bar{r}_B)$  is the Pareto optimal portfolio. Q.E.D.

**Proof of Theorem 1.** If  $\alpha_B^* \neq \hat{\alpha}_B$ , then changes in  $k$ ,  $\beta_0$ , and  $f$  have no effect on  $\alpha_B^*$ . In the remainder of the proof we consider the case in which  $\alpha_B^* = \hat{\alpha}_B \in (0, f/\bar{r}_B)$ . The effect of a change in  $f$  on  $\hat{\alpha}_B$  is

$$\frac{\partial \hat{\alpha}_B}{\partial f} = \frac{\beta_0 \bar{s}_B - (1-k)(\bar{r}_B - 1)}{\beta_0 \bar{s}_B((\bar{r}_B - 1) - \beta_0 \bar{s}_B)} < 0.$$

Next, we characterize the effect of a change in  $k$  on  $\alpha_B$ :

$$\frac{\partial \hat{\alpha}_B}{\partial k} = \frac{f(\bar{r}_B - 1) - \beta_0 \bar{s}_B w_{t_0}}{(\bar{r}_B - 1) - \beta_0 \bar{s}_B} > 0.$$

To determine the effect of a change in  $\beta_0$  on  $\hat{\alpha}_B$ , we begin by taking the total differential of the first-order condition,  $\partial U_l / \partial \alpha_B$ , and setting it equal to zero:

$$\frac{\partial U_l^2(\alpha_B, \beta_0, k)}{\partial \alpha_B^2} d\alpha_B + \frac{\partial U_l^2(\alpha_B, \beta_0, k)}{\partial \alpha_B \partial \beta_0} d\beta_0 + \frac{\partial U_l^2(\alpha_B, \beta_0, k)}{\partial \alpha_B \partial k} dk = 0.$$

Next, set  $d\hat{\alpha}_B = 0$  and rearrange the total differential to derive:

$$\left. \frac{d\beta_0}{dk} \right|_{d\hat{\alpha}_B=0} = - \frac{\partial^2 U_l / \partial \alpha_B \partial k}{\partial^2 U_l / \partial \alpha_B \partial \beta_0}. \quad (\text{A-1})$$

We now establish that (??) is positive. To do so, we begin by signing the numerator.

We rewrite this numerator as

$$\frac{\partial^2 U_l}{\partial \alpha_B \partial k} = \frac{\beta_0 \bar{s}_B}{f + \beta_0 \bar{s}_B} - \frac{(\bar{r}_B - 1) - \beta_0 \bar{s}_B}{w_{t_0} - f + \alpha_B((\bar{r}_B - 1) - \beta_0 \bar{s}_B)}. \quad (\text{A-2})$$

In the last term of (??), the numerator is negative and the denominator is positive.

Therefore, (??) is positive.

Next, we evaluate the denominator of (??). We rewrite this denominator as

$$\frac{\partial^2 U_l}{\partial \alpha_B \partial \beta_0} = \frac{k \bar{s}_B}{f + \beta_0 \bar{s}_B} - \frac{(1-k) \bar{s}_B}{w_{t_0} - f + \alpha_B ((\bar{r}_B - 1) - \beta_0 \bar{s}_B)}. \quad (\text{A-3})$$

We now establish that expression (??) is negative. To do so, we write the first-order condition to the legislator's optimization program:

$$\begin{aligned} \frac{\partial U_l}{\partial \alpha_B} &= \beta_0 \left( \frac{k \bar{s}_B}{f + \beta_0 \bar{s}_B} - \frac{(1-k) \bar{s}_B}{w_{t_0} - f + \alpha_B ((\bar{r}_B - 1) - \beta_0 \bar{s}_B)} \right) \\ &+ \frac{(1-k) \bar{s}_B}{w_{t_0} - f + \alpha_B ((\bar{r}_B - 1) - \beta_0 \bar{s}_B)} = 0. \end{aligned} \quad (\text{A-4})$$

Notice that the first line of (??) contains expression (??). Hence, because the last term of (??) is positive and expression (??) itself equals zero, we have that expression (??) is negative. We now have that the numerator of expression (??) is positive and the denominator is negative. Hence, (??) is positive.

We can also write the derivative,  $\frac{d\beta_0}{dk} \Big|_{d\hat{\alpha}_B=0}$ , in expression (??) as

$$\frac{d\beta_0}{dk} \Big|_{d\hat{\alpha}_B=0} = - \frac{\partial \hat{\alpha}_B / \partial k}{\partial \hat{\alpha}_B / \partial \beta_0} > 0. \quad (\text{A-5})$$

In expression (??), we established at the beginning of this proof that  $\partial \hat{\alpha}_B / \partial k$  is positive. Therefore, since expression (??) is positive,  $\partial \hat{\alpha}_B / \partial \beta_0 < 0$  is negative. Q.E.D.

**Proof of Theorem 2.** If  $\beta$  is chosen in period 0, the legislator chooses  $\beta_0$  to maximize (??); and if  $\beta$  is chosen in period 1, the legislator chooses  $\beta_1$  to maximize the same objective function, (??). The solutions to these optimization programs are the following. If the surplus share is specified in period 0,

$$\beta_0^* = \frac{k(w_{t_0} + \alpha_B(\bar{r}_B - 1)) - (1 - k)w_{p_0} - f}{\alpha_B \int_{\hat{r}_B > 0} \hat{r}_B dG(\hat{r}_B)}; \quad (\text{A-6})$$

and if the surplus share is specified in period 1

$$\beta_1^* = \frac{k(w_{t_0} + \alpha_B(\bar{r}_B - 1)) - (1 - k)w_{p_0} - f + k\alpha_B\hat{r}_B}{\alpha_B\hat{r}_B}. \quad (\text{A-7})$$

From (??) and (??), the total share payments are

$$\beta_0^* \alpha_B \int_{\hat{r}_B > 0} \hat{r}_B dG(\hat{r}_B) = k(w_{t_0} + \alpha_B(\bar{r}_B - 1)) - (1 - k)w_{p_0} - f; \quad (\text{A-8})$$

and

$$\beta_1^* \alpha_B \hat{r}_B = k(w_{t_0} + \alpha_B(\bar{r}_B - 1)) - (1 - k)w_{p_0} - f + k\alpha_B\hat{r}_B. \quad (\text{A-9})$$

Notice that the if the surplus shares are specified after a surplus is realized, then the legislator knows that a deficit has not occurred. As a result, the legislator knows that in assigning surplus shares, there is no possible negative impact of a deficit on the taxpayer's utility. Alternatively, if the surplus shares are specified before a surplus or deficit is realized, then the legislator takes into account the possibility of a deficit and accordingly the negative impact on the taxpayer's utility. As a result, if the legislator sets the surplus shares after a surplus is realized, then the legislator assigns a greater share to the public employee.

The total surplus payment to the public employee is greater if the surplus shares are specified in period 1 than if they are specified in period 0. That is, for any  $\hat{r}_B > 0$ ,

$$\beta_1^* \alpha_B \hat{r}_B > \beta_0^* \alpha_B \int_{\hat{r}_B > 0} \hat{r}_B dG(\hat{r}_B). \quad (\text{A-10})$$

By (??) and Theorem 1, we have that  $\alpha_B^*(f, k, \beta_0^*, \mathcal{P}(\beta_0^*)) \geq \alpha_B^*(f, k, \beta_1^*, \mathcal{P}(\beta_1^*))$ .

Q.E.D.

**Proof of Theorem 3.** The public employee's utility function  $U_p$  is strictly concave in  $W_{t_1}$  and the taxpayer's utility function  $U_t$  is strictly concave in  $W_{p_1}$ . Hence, if

$\beta_0 = \int_0^1 \beta_1 d\mathcal{P}_1(\beta_1)$ , by Jensen's inequality, for any  $\alpha_B$ ,

$$U_t(W_{t_0}, f, \alpha_B, \beta_0, \mathcal{P}(\beta_0)) > U_t(W_{t_0}, f, \alpha_B, \beta_1, \mathcal{P}(\beta_1)) \quad (\text{A-11})$$

and

$$U_p(W_{p_0}, f, \alpha_B, \beta_0, \mathcal{P}(\beta_0)) > U_p(W_{p_0}, f, \alpha_B, \beta_1, \mathcal{P}(\beta_1)). \quad (\text{A-12})$$

Hence, both the taxpayer and public employee are better off if the surplus share is set up front, before the asset allocation decision is made, than if it is left open until after the surplus is realized. Therefore, if the surplus shares are set up front, by (??) and (??), both the taxpayer and public employee prefer some  $\alpha_B$  that is greater than  $\alpha_B^*(f, k, \beta_1, \mathcal{P}(\beta_1))$ . Therefore, we have

$$\frac{\alpha_B^*(f, k, \beta_0, \mathcal{P}(\beta_0))}{\alpha_A^*(f, k, \beta_0, \mathcal{P}(\beta_0))} \geq \frac{\alpha_B^*(f, k, \beta_1, \mathcal{P}(\beta_1))}{\alpha_A^*(f, k, \beta_1, \mathcal{P}(\beta_1))}.$$

Q.E.D.

TABLE 1. DESCRIPTIVE STATISTICS

	<i>Mean</i>	<i>Std. Dev.</i>	<i>Minimum</i>	<i>Maximum</i>
<i>ENDOGENOUS</i>				
% Equity	57.0%	8.0%	22.0%	73.0%
Share Rule	0.16	0.37	0.00	1.00
<i>EXOGENOUS</i>				
Assets (\$ billion at market)	\$22	\$28	\$8	\$156
Majority	0.54	0.5	0	1
Vesting	5.9	2.5	0.0	10.0
Dependency Ratio	31%	10%	0%	100%
ADA Senate Index	0.55	0.34	0.00	1.00

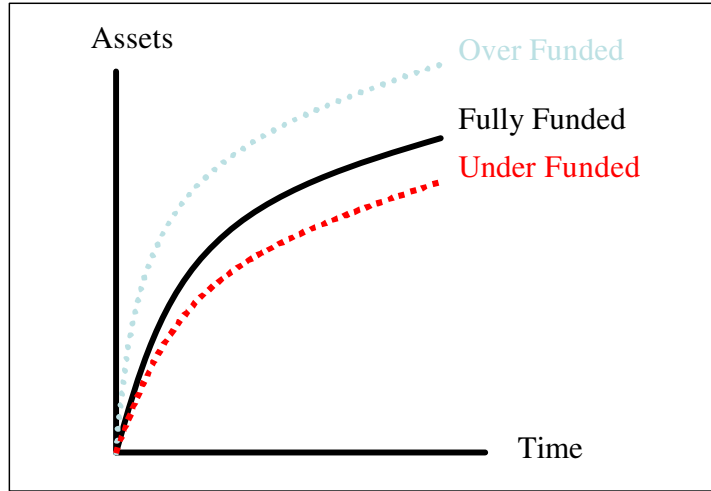
*N*=83

Data Sources: Characteristics of Large Public Pension Plans, National Education Association, November 2002, Americans for a Democratic Action web site ([www.adaction.org](http://www.adaction.org)).

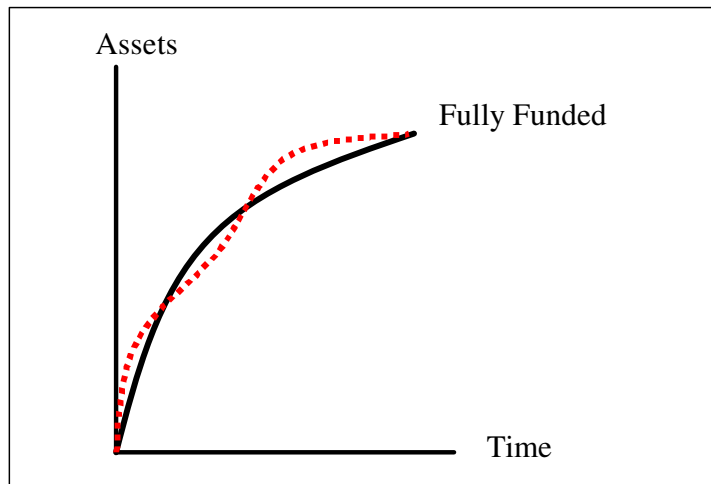
TABLE 2. MODEL ESTIMATES

	<i>Single Equation OLS</i>	<i>No Clustering</i>	<i>Cluster by State</i>
<i>Second Stage – % Equity</i>			
Constant	0.57 [34.6]	0.525 [26.3]	0.525 [23.3]
Assets	0.000261 [0.80]	0.00124 [3.32]	0.00124 [3.78]
Majority	-0.018 [0.97]	-0.03 [-1.73]	-0.03 [-1.71]
ShareRule	0.051 [2.11]	0.116 3.51]	0.116 [4.11]
<i>First Stage – ShareRule</i>			
Constant		-1.77 [-2.06]	-1.77 [-1.97]
Assets		-0.00116 [-0.13]	-0.00116 [-0.15]
Majority		0.779 [1.94]	0.779 [1.70]
Vesting		-0.218 [-2.62]	-0.218 [-2.08]
Dependency Ratio		1.27 [0.7]	1.27 [2.94]
ADA Senate Index		1.78 [2.62]	1.78 [2.27]
Selection Correction Parameter		-0.039 [2.28]	-0.042 [3.55]
<i>Observations</i>	83	83	83

Note: Numbers in brackets are the  $t$  values for the null hypothesis of no association.



Panel A



Panel B

Figure 1: Under or Over Funding.

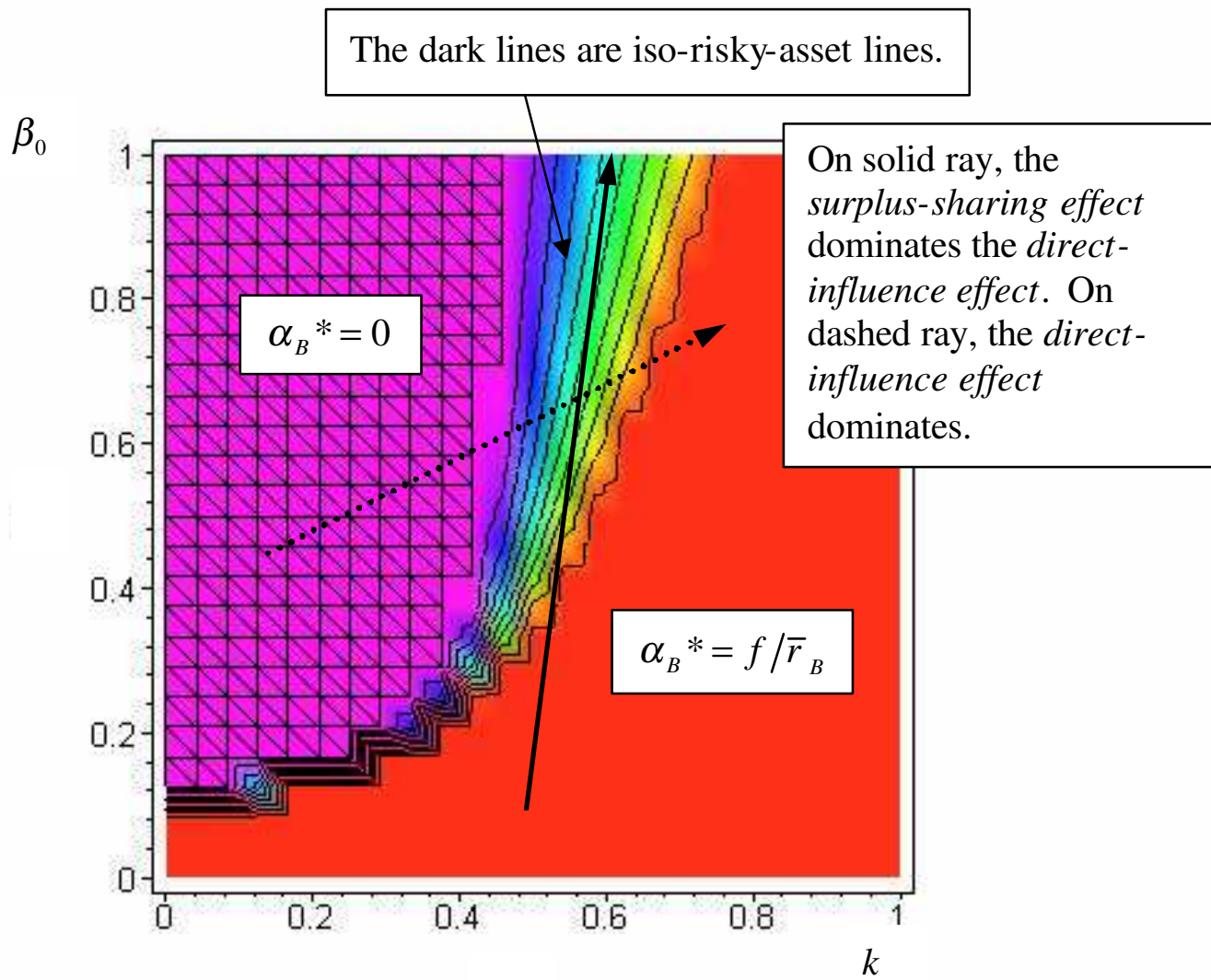


Figure 2: The investment in the risky asset in terms of public employee's influence in capturing surplus and the size of the public employee's surplus share.