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

J. Richard Aronson
James A. Dearden
Vincent G. Munley
David H. Myers

College of Business and Economics
Rauch Business Center
Lehigh University
621 Taylor St.
Bethlehem, PA 18015

August 8, 2006

*The authors thank the TIAA-CREF Institute for financial support. The authors greatly benefited from comments by workshop participants at Binghamton University, National University of Ireland, Galway, University of Buckingham, the University of York, and the Public Economic Theory Meetings. Mike Wickens and Eoghan Garvey provided particularly helpful suggestions. We thank Stan Wisniewski for providing us with the NEA data in electronic format.

†Contact: J.R. Aronson. tel. 610-758-3411 email. jral@lehigh.edu
Public Employee Defined Benefit Pension Systems: The Impact of Explicit Surplus Sharing Contracts and Stakeholder Influence on Investment Strategies

August 8, 2006

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 confirms 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.
1 Introduction

It is generally believed that, in aggregate, state and local pension plans: (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). 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 inquiry to include the issue of who is the residual claimant of a pension fund account deficit (i.e., earnings shortfall) or surplus (i.e., excess earnings). 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 appropriate surplus-sharing rule and reduce or eliminate this uncertainty.

---

1We 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)
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.”\(^2\) 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.\(^3\) 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, in reality taxpayers can also share - or perhaps even fully appropriate - a surplus when it

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

\(^3\)It is interesting to note that public employees may fear the loss of promised pension benefits in the future despite the lack of reneg 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)
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 of the figure 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.\textsuperscript{4} 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 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
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

\textsuperscript{4}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.
harmony and when they are not with respect 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. Sections 3 and 4 contain our theoretical model and an empirical test of some of the results of the model. Our conclusions are summarized in Section 5.

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. Thus, it would seem that the worker, who actually owns the assets, should have an important say in how they are invested.

In a DC plan the worker assumes the investment risk. If the final level achieved is disappointing the beneficiary will have to live with it. And in the event that the assets

\[5\]  There are many variations on the theme. Employers can, for example, contribute stock and therefore influence the choice. See EBRI, 1997, Chapters 6, 7.
grow to a value higher than anticipated, the excess accumulation without question belongs to the employee. Thus, although the investor can make mistakes, there is no moral hazard problem. The investor knows his own self interest and the costs of his failure are not shifted to the employer.

But pension fund design has been more imaginative than simply relying on the defined contribution concept. Employers in both the private and public sectors have put into place DB plans. In this scheme the employee is promised 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.) What advantage is there to such a system? The DB approach gives the appearance of freeing the worker of investment risk. Appearance, however, may not be reality. How does the employer meet his pension obligation? Under a pay-as-you-go (PAYG) system the employer meets the obligations as they come due. This can be particularly dangerous in the private sector because a private firm can fall on hard times and even cease to exist. No wonder that in 1974 the U.S. Congress passed ERISA (Employee Retirement Income Security Act) legislation. Among other things this law established standards and regulations concerning financial reporting, fiduciary responsibility and vesting. ERISA also required that pension assets be kept separate from the firm’s general assets and that single employer DB plans make at least a minimum contribution to a trust fund equal to the normal cost of the plan plus an amortized amount to fund any past service liabilities (EBRI, 1997, pp. 45-46). ERISA also established the Pension Benefit Guarantee Corporation (PBGC) to insure the benefits of workers whose
firms could not meet their obligations. 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. This is the work of actuaries. On the basis of crucial assumptions the actuary calculates the accrued liability of the plan and the periodic contribution to a trust fund needed to meet that liability. 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? On this matter employers and workers might not see eye to eye.

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. This frees funds for other productive investment. But, the strategy might fail. In this case the firm must divert additional otherwise productive expenditures to refinancing the level of benefits promised. In the worst case, the firm would default on its promise and shift the obligation to the PBGC, but this amounts to a Chapter-11 reorganization. Sharpe (1976) points out that this reduced downside risk to employers of private DB plans creates a moral hazard. Specifically, the private employer has a greater 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 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.

A moral hazard problem also arises in the pension funds of state and local governments 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. State and local pension plans are, for the most part, DB plans. Although these plans are exempt from ERISA regulations state law has generally eschewed PAYG financing in favour of full funding of these obligations.

Currently all states attempt to fully fund their plans. Just as for private plans, estimates must be made for employee turnover, vesting, mortality, longevity and the rate of return on assets. So once again we need to ask about the investment strategy for the trust fund assets. Do we expect the worker and the employer 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 lower tax rate or an improved provision of social services. 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 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 also 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.

If the surplus shares are left unspecified, we characterize two reasons why the investment decision will result in smaller investments in the risky asset. First, if the surplus shares are specified when a surplus is known to exist, then 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.

In our analysis, 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 Hölstrom 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).

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 \( r_B \), where \( r_B > 1 \), denote the expected return per dollar invested in asset \( B \), and let \( \hat{r}_B \) denote the return less the expected return. Specifically, \( \hat{r}_B = r_B - \tau_B \). 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 \( \tau_B \) 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 \( \hat{r}_B > 0 \):

\[
\tau_B = \int_{\hat{r}_B > 0} \hat{r}_B dG(\hat{r}_B).
\] (1)

Expression (1) is useful when characterizing the optimal trust fund portfolio.

**The Pension Contract**

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

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

---

6In 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 Holmstrom 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).
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 $\rho : [0, 1] \rightarrow \mathbb{R}$ 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

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

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

$$
f = \alpha_A + \alpha_B \tau_B. \tag{2}
$$

A budget-balancing portfolio can be expressed in terms of the amount invested in the risky asset, $\alpha_B$. From equation (2),

$$
\alpha_A = f - \alpha_B \tau_B. \tag{3}
$$

Adding $\alpha_B$ to both sides of (3) produces the taxpayer’s up-front contribution in a budget-balancing portfolio:

$$
\alpha_A + \alpha_B = f - \alpha_B (\tau_B - 1) \tag{4}
$$

The right-hand side of (4) 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:

\[
x = \alpha_A + \alpha_B r_B - f.
\]  

(5)

and since \( \hat{r}_B = r_B - \tau_B \),

\[
x = \alpha_B \hat{r}_B.
\]  

(6)

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

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

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

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.

\footnote{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

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

14}
Given the budget-balancing portfolio requirement, the taxpayer’s expected utility, evaluated at the point in time when the legislator sets the asst 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 probability distribution function on this final surplus-sharing rule, $P$. (Recall that if $\beta = \beta_1$, then $P$ indicates that the parties know $\beta$ with probability one.)

The taxpayer’s (weakly) concave utility of his final wealth function is $V_t(W_{t_n})$. 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

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

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

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

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

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

8To 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, they are considered risk averse.
The public employee’s (weakly) concave utility of final wealth function is $V_p(W_p)$. If the surplus-sharing factor is specified \textit{ex ante}, $\beta_0$, the public employee’s expected utility function, evaluated before the pension fund portfolio is chosen, is

$$U_p(W_{p0}, f, \alpha_B, \beta_0, \mathcal{P}) = \int_{\hat{r}_B < 0} V_p(W_{p0} + f) dG(\hat{r}_B) + \int_{\hat{r}_B > 0} V_p(W_{p0} + f + \beta_0 \alpha_B \hat{r}_B) dG(\hat{r}_B).$$

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

$$U_p(W_{p0}, f, \alpha_B, \beta_1, \mathcal{P}) = \int_{\hat{r}_B < 0} V_p(W_{p0} + f) dG(\hat{r}_B) + \int_{\hat{r}_B > 0} \int_{\hat{r}_B > 0} V_p(W_{p0} + f + \beta_1 \alpha_B \hat{r}_B) d\mathcal{P}(\beta_1) dG(\hat{r}_B).$$

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

$$U_I = (1 - k)\ln(U_t) + k\ln(U_p).$$

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.  

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 \textit{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

\footnote{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 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.}
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:

$$\max_{\alpha_B} (1-k)\ln(U_t(W_{t0}, f, \alpha, 0, P)) + k\ln(U_p(W_{p0}, f, \alpha, 0, P)).$$

(7)

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, $\alpha = (\alpha_A, \alpha_B) = (0, f/\tau_B)$.

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:

$$\max_{\alpha_B} (1-k)\ln(U_t(W_{t0}, f, \alpha_B, \beta_0, P)) + k\ln(U_p(W_{p0}, f, \alpha_B, \beta_0, P)).$$

(8)

The legislator’s optimal portfolio mix, i.e., the solution to (8), is

$$\alpha_B^* = \begin{cases} 
0 & \text{if } \hat{\alpha}_B < 0 \text{ and } (\tau_B - 1) - \beta_0 \bar{s}_B < 0; \\
\hat{\alpha}_B & \text{if } 0 < \hat{\alpha}_B < f/\tau_B \text{ and } (\tau_B - 1) - \beta_0 \bar{s}_B < 0; \\
f/\tau_B & \text{if either } \hat{\alpha}_B > f/\tau_B \text{ or } (\tau_B - 1) - \beta_1 \bar{s}_B > 0;
\end{cases}$$

(9)

where

$$\hat{\alpha}_B = \frac{\beta_0 \bar{s}_B (f - kw_{t0}) - (1-k)f(\tau_B - 1)}{\beta_0 \bar{s}_B ((\tau_B - 1) - \beta_0 \bar{s}_B)}.$$
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
\[
(\bar{r}_B - 1) - \beta_0 \bar{s}_B > 0. \tag{10}
\]
We can view expression (10) 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 (10) 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 $\tau_B = 1.07$, 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, $w_{p0} + f$, equals the taxpayer’s retirement wealth, $w_{t0} - f$. The initial
levels of are $w_{h_0} = 20$ 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 $\sigma_B = 0.65$. The values $\beta_0$ and $k$ vary between 0 to 1. Substituting these values into equation (9), we have the legislator’s investment in the risky asset:

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

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 (11). 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

$$ \frac{\partial \alpha_B}{\partial k} dk > \frac{\partial \alpha_B}{\partial \beta_0} d\beta_0. $$

(12)

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.

**Influence and the Retirement Benefit**

Our model of influence focuses on the public employee’s relative influence on the legislator’s investment decision. However, in actuality, the public employee can influence the size of the defined benefit and the surplus share as well. In exerting influence, the public employee’s ultimate objective is to increase his (expected) retirement wealth, $E[W_{tn}]$. This result leads to an important observation that is relevant to our empirical analysis:

**Observation 1.** If the public employee has increased influence on the process of setting the defined benefit, $f$, the surplus share, $\beta$, and the amount invested in the risky asset, $\alpha_B$, then the public employee’s expected retirement wealth, $E[W_{tn}]$, increases. Therefore, with these increases in public employee influence, either $f$, $\alpha_B$, $\beta$, or any combination of these three variables must increase.

### 3.2.2 The Timing of Specifying the Surplus Share

In Theorem 1, we demonstrated that the ratio $\alpha_B / \alpha_A$ is affected by the magnitude of $\beta_0$. We now consider the impact on $\alpha_B / \alpha_A$ of setting the surplus shares only after a surplus has been discovered. To determine this impact, we begin with Lemma 2, where we compare the equilibrium surplus shares, $\beta^*_0$ and $\beta^*_1$. If the surplus shares are specified in period 0, given the defined benefit, $f$, that is in place, the legislator’s optimal defined benefit is

$$\beta^*_0 = \frac{k(w_{t_0} + \alpha_B(\tau_B - 1)) - (1 - k)w_{p_0} - f}{\alpha_B \int_{r_B > 0} r_B dG(r_B)}; \quad (13)$$
and if the surplus share is specified in period 1

\[ \beta_1^* = \frac{k(w_t + \alpha_B(\tau_B - 1)) - (1 - k)w_p - f + k\alpha_B\hat{\tau}_B}{\alpha_B}\hat{\tau}_B. \]  

(14)

From (13) and (14), the total share payments are

\[ \beta_0^*\alpha_B \int_{\hat{\tau}_B > 0} \hat{\tau}_B dG(\hat{\tau}_B) = k(w_t + \alpha_B(\tau_B - 1)) - (1 - k)w_p - f; \]  

(15)

and

\[ \beta_1^*\alpha_B\hat{\tau}_B = k(w_t + \alpha_B(\tau_B - 1)) - (1 - k)w_p - f + k\alpha_B\hat{\tau}_B. \]  

(16)

Lemma 2. Suppose the public employee and taxpayer are risk neutral. The defined benefit in the pension plan is \( f \). The relationship between total share payments, as determined by \( \beta_0^* \) and \( \beta_1^* \) is

\[ \int_{\hat{\tau}_B > 0} \int_0^1 \beta_1^*\hat{\tau}_B dP(\beta_1)dG(\hat{\tau}_B) = \bar{s}_B(\beta_0^* + k) > \bar{s}_B\beta_0^* \]

Proof of Lemma 2. The proof follows directly from (15) and (16). Q.E.D.

The key point of Lemma 2 is that 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.
With Lemma 2 in place as well as the Theorem 1 result that the legislator’s optimal investment in the risky asset, $\alpha_B$, is decreasing in the public employee’s surplus share, $\beta$, we have

**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,

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

**Proof of Theorem 2.** The proof of Theorem 2 follows directly from Lemma 1 (the surplus share specified in period 1 is always greater than the surplus share specified in period 0) and Theorem 1 ($\frac{\alpha_B}{\alpha_A}$ is decreasing in $\beta$). Q.E.D.

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, $\beta_0 = \int_0^1 \beta_1 dP_1(\beta_1)$. 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 $\beta_0 = \int_0^1 \beta_1 dP_1(\beta_1)$. 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,

$$\frac{\alpha_B^*(f, k, \beta_0, P(\beta_0))}{\alpha_A^*(f, k, \beta_0, P(\beta_0))} \geq \frac{\alpha_B^*(f, k, \beta_1, P(\beta_1))}{\alpha_A^*(f, k, \beta_1, P(\beta_1))}.$$
**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 (12)), then $\alpha_B/\alpha_A$ is increasing in influence. Otherwise, $\alpha_B/\alpha_A$ is decreasing in influence. That is, by Theorem 1:

$$
\text{If the public employees have greater influence} \quad \Rightarrow \quad k \uparrow \Rightarrow \quad \frac{\alpha^*_B}{\alpha^*_A} \uparrow
$$

$$
\beta \uparrow \Rightarrow \quad \frac{\alpha^*_B}{\alpha^*_A} \downarrow
$$

Determining which of these effects dominates is an empirical issue.

Although the effect of overall influence on $\alpha_B/\alpha_A$ is ambiguous, Observation 1 suggests that the public employee’s (expected) retirement benefit is increasing in his influence. Our empirical analysis provides a test of whether $f$, $\alpha_B/\alpha_A$, or $\beta$ is increasing in the public employee’s relative overall power. 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:

$$
\text{If } \beta \text{ is set } \textit{ex ante} \quad \Rightarrow \quad \frac{\alpha^*_B}{\alpha^*_A} \uparrow
$$

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 theoretical analysis focused primarily on the effect of both the political influence and the timing of the determination of the surplus-sharing rule on the asset mix of the plan. While not the focus of our theoretical model, it is obvious that political influence is also perhaps an important determinant of both the size of a plan’s defined benefit and whether the sharing rule is explicitly specified in a pension contract. For this reason, our empirical analysis specifies a three-equation model, where political influence is a key right-hand-side variable in each of the three equations.

The first equation of our empirical model concerns the benefit factor. While our theoretical model specifies the defined benefit, $f$, as a lump sum payment, in practice the benefit provided to members at retirement has two distinct dimensions. The first involves specifying the initial annuity payment, typically established as a function of the employee’s final salary, often averaged over her or his final few years at work, and a multiple of the number of years in which the employee has been a member of the plan. For example, the annuity that an employee receives might be expressed as:

$$(2\%) \times (\text{number of years worked}) \times (\text{average of final three years salary}).$$

The second dimension involves determining how, if at all, an employee’s retirement annuity will be adjusted for inflation. Typical adjustments include cost of living allowances (COLAs), often capped at a maximum adjustment per annum, ad hoc adjustments over time, or increases that depend on the annual interest earnings that a plan obtains as a
result of its investment strategy.

Given the importance of the surplus sharing rule in our theoretical analysis, we are particularly interested in whether there is an explicit ex ante arrangement for inflation adjustments to be tied directly to a positive experience for the fund’s earnings. The second equation of our empirical model concerns whether COLA adjustments, in the form of an ex ante surplus sharing rule, are specified in the pension contract.

Our third equation involves how to invest the plan’s assets, in particular how to allocate the assets between equities and investments more of a fixed income, and is related to our theoretical model. To test empirically the results of our theoretical model as well as examine other other relationships which we discuss below, the three equations of our empirical model are:

\[
\text{Benefit Factor} = \gamma_0 + \gamma_1 \text{ Majority} + \gamma_2 \text{ Soc Sec} \\
+ \gamma_3 \text{ Ex Ante Surplus Sharing Rule} \\
+ \gamma_4 \text{ ADA Senate Index} + \varepsilon_1 
\] (17)

\[
\text{Ex Ante Surplus Share Rule} = \delta_0 + \delta_1 \text{ Majority} + \delta_2 \text{ Benefit Factor} + \gamma_3 \text{ Vesting} \\
+ \gamma_4 \text{ Std Dev of ADA House Index} + \varepsilon_2 
\] (18)

\[
\text{Equity Ratio} = \zeta_0 + \zeta_1 \text{ Total Plan Assets} + \zeta_2 \text{ Majority} \\
+ +\zeta_3 \text{ Benefit Factor} \\
+ \zeta_4 \text{ Ex Ante Surplus Share Rule} \\
+ \zeta_5 \text{ Dependency Ratio} + \varepsilon_3 
\] (19)

where \(\gamma_i, \delta_i, \text{ and } \zeta_i\) are parameters of the model to be estimated, and \(\varepsilon_i\) are random error
terms.

The endogenous variables within the system of equations are:

**Benefit Factor** - the factor by which number of years membership in the plan and final salary are multiplied to determine a member’s annuity at retirement;

**Ex Ante Surplus Sharing Rule** - a binary variable equal to one if post retirement benefit increases depend on the plan’s interest earnings and zero if they are specified as a cost of living allowance, including when capped, or on an ad hoc basis;

**Equity Ratio** - the ratio of the percentage of a fund’s investments in stocks, both domestic and international, to the percentage invested in fixed income securities, money market and other short term funds and real estate and mortgages.

Exogenous variables include both characteristics of an individual pension plan and measures intended to capture potentially important characteristics of the political environment within which decisions about a plan’s financial parameters are determined.

The characteristics of a pension plan included in the empirical model are:
Total Plan Assets - total value of the plan’s assets;

Majority - a binary variable equal to one if the proportion of members of the plan’s board of directors or trustees who are themselves plan members exceeds 0.5;

SocSec - binary variable equal to one if the pension plan is integrated with the Social Security system;

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.

Our theoretical analysis focused on equation (19) - the relationship between the Equity Ratio and Majority (which is a proxy for relative employee influence), Benefit Factor (the size of the public employee’s benefit), and Ex Ante Surplus Share Rule (whether the employee’s share was predetermined). We expand this focus in the empirical model to investigate public choice determinants of the structure of the defined benefit. Specifically, we expand the theoretical analysis to include equations (17) and (18).

Given the results of our theoretical analysis, in each of the three equations our primary focus is on two principal items. The first is the political power of the plan’s membership, measured as whether members of the plan, active or retired, comprise a majority of the plan’s governing board. The second is the effect that each of the endogenous variables exerts when they appear on the right hand side of an equation.

Some explanatory variables that represent characteristics of a particular pension plan are included in one of the equations because, putatively, there appears a rationale to do so.
Perhaps the best example of this is the inclusion of SocSec in equation (17). Because the beneficiaries of public pension plans that also are part of the social security system pay for and receive social security benefits, the Benefit Factor of the public pension need not be as large as for those plans for which the public plan makes up a retiree’s entire pension. We include the Dependency Ratio in the equation that explains asset allocation on the premise that a high dependency ratio, other things being equal, may prompt fund managers to feel the need to adopt a more aggressive investment strategy. We similarly include Total Assets in the asset allocation equation on the supposition that larger plans may likewise be more aggressive investors.¹⁰

A secondary consideration in determining which variables to include in each estimating equation arises from the need to identify the system of equations for estimation purposes. We discuss below the chronological nature of the plan structure determination and investment portfolio allocation and the estimation strategy that we adopt to account for this. We include Vesting in equation (18) not because we have an a priori reason to believe that this plan characteristic should be more closely related to the determination of the Benefit Factor than the Ex Ante Earnings Share Rule, but rather because it exhibits statistical significance only in explaining the former. We, therefore, exclude this variable from equation (17) for the purpose of econometric identification. We exclude SocSec from equation (18) for the same reason.

The political ideology proxy variables are included solely for the purpose of satisfying conditions of *ceteris paribus*. The Americans for Democratic Action (ADA) index assigns values between zero (conservative) and one (liberal) based on the voting records of

¹⁰We tried including other plan characteristics, most notably the plan’s funding ratio, in the estimating equations but none exhibited statistical significance.
members of Congress. The correlation between the mean value of the voting index for a state’s two senators and its house delegation is, not surprisingly, positive and significant. We include the standard deviation of a state’s house delegation index as a way of capturing the heterogeneity of political ideology within a state as well as a mean value. Because we include these measures only for the purpose of controlling for any underlying political ideology that might play a role within the policy arena where decisions about public employee pension plan features are made, their placement in the equations simply reflects where they contribute the greatest explanatory power. We include only one measure in each equation, again consistent with our intent to identify the set of simultaneous equations as fully as possible.

In interpreting the effect of Majority in each of the equations it is important to recognize that these data represent the boards that oversee the administration of a pension plan. The actual value for Benefit Factor and whether or not there is an a priori earnings share arrangement are typically determined by a state’s legislature. There is substantial variation across public employee pensions plans in how asset allocation and investment strategy decisions are made (Useem and Mitchell, 2000). Pension fund investment decisions may be the direct responsibility of the plan’s board of directors or trustees or a subcommittee of this board. Alternatively this decision may be the responsibility of a specially appointed board or even the sole fiduciary responsibility of an elected official such as a state’s treasurer. The opinion of the board of directors or trustees of the plan should weigh significantly as an advocacy voice throughout the policy decision-making process, however, and this is the context for it inclusion in all three equations.

Because the level of benefits that a plan’s annuitants receive through retirement depends
upon both the factor that establishes the initial payment and subsequent increases in this payment over time, we must allow for the possibility that the determinations of these two components are interrelated. Moreover, there may be a trade-off in the design of a pension plan’s structure between the generosity of the initial benefit level when a member retires and the certainty of increases in this benefit if the fund’s investment performance is positive. We thus include the dependent variables for each of the first two equations as a right-hand-side variable in the other equation.

The third equation considers the investment strategies of public employee pension plans and is, therefore, of greatest interest. Our theoretical analysis suggests that if the pension contract states that annuitants are certain to benefit directly from a pension account surplus, then a fund is likely to invest more heavily in equities. If this is the case the coefficient for *Ex Ante* Earnings Share Rule in this equation should be positive. Other factors, however, may also impact decisions. A more generous pension formula may necessitate a more aggressive investment strategy, hence the inclusion of Benefit as a potential explanatory variable. Similarly, a high Dependency Ratio may place financial pressure to obtain a greater return on fund assets. Finally, because it is conceivable that larger funds may simply be more aggressive players in the market, we include the total value of a fund’s assets in this equation as well.

The chronology of the decision process has an important implication for the specification of the structural empirical model. The legislature first determines the pension plan’s benefit structure. The potential for a trade-off between a more generous initial level of the annuity, Benefit Factor, and establishment of an *Ex Ante* Earnings Sharing Rule is apparent. We therefore estimate equations (17) and (18) simultaneously. To accomplish
this we estimate equation (17) by OLS. Because the dependent variable of equation (18) is binary, we estimate this equation using the probit technique. We then re-estimate both equations using the predicted value of the dependent variables and repeat this procedure until the estimated values of the coefficients of both equations converge.\textsuperscript{11}

A pension fund’s asset manager(s) determines its investment allocation after the fund’s benefit parameters have been established, often altering this allocation on at least an annual basis. The designation of pension fund asset manager varies considerably across states, from fiduciary responsibility assigned to a sole elected official such as the state treasurer to the plan’s board comprising of plan members, active and retired, elected officials, and gubernatorial appointees. It is not clear in this setting whether we should model equation (19) as being simultaneously determined within the policy process with equations (17) and (18) or, rather, as separately determined \textit{ex post}. For this reason, we present two sets of estimates for equation (19). The first includes the predicted values of Benefit Factor and \textit{Ex Ante} Earning Sharing Rule from equations (17) and (18) as right hand side variables, consistent with a public policy arena jointly determined policy. We also estimate equation (19) using the actual values of these variables, consistent with a separate, \textit{ex post} investment decision model.

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

\textsuperscript{11}Four iterations produced stable coefficient values.
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 contribution pension plans we do not include any of the 100 large plans that are defined contribution. 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. 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 our two political climate control measures are from the Americans for Democratic Action web site.
6 Results

Table 1 presents summary statistics of the plan characteristics and political climate variables. Table 2 presents the results of two different estimation techniques for this system of equations. The results are largely consistent with those obtained in our theoretical analysis. In equation (17) the coefficient of Majority is positive, as expected, but not statistically significant. The coefficient of \textit{Ex Ante} Surplus Share is negative and significant at the ten percent level, consistent with the supposition that a trade-off exists between the initial level of benefit upon retirement and the certainty of future increases in this level when the fund’s investments experience excess earnings. The most statistically significant coefficient in (17) is for SocSec, a binary variable equal to one if the pension plan is integrated with the Social Security system, consistent with our a priori expectations. The coefficient of the Standard Deviation in the state’s House delegation’s ADA index is positive and significant at the ten percent level. This suggests that the initial benefit levels for public employee pension plans are more generous in states with a more heterogeneous mix of political ideologies within their House delegation, i.e. states characterized my more regional political diversity.

In equation (18) the coefficient of Majority is positive and significant at the ten percent level. This is consistent with our conjecture that annuitants are more likely to be certain of a direct share of the interest earnings when members of the plan exert more power in decision making process. The coefficient of Benefit Factor is positive surprisingly, but its estimated value is quite small compared to the standard error. The coefficient for Vesting is also negative and significant at the five percent level. A longer time required before a
member’s benefits are vested is suggestive of a conservatively administered pension plan. This may suggest that more conservatively administered plans are less likely to guarantee annuitants a direct share of the fund’s excess interest earnings. Finally, the coefficient for the ADA Senate Index for the state in which the plan is located is positive and significant at the one percent level, suggesting that the annuitants of public pension plans are more likely to be certain of sharing in the fund’s excess interest earnings in states where voters elect liberal senators.

The results for equation (19) are, perhaps, most intriguing. The coefficient of *Ex Ante* Surplus Sharing Rule is positive and significant at the five percent level. The statistical significance of this result holds regardless of whether the actual or predicted value of this variable appears as the right hand side variable and thus the importance of this factor does not depend on the chronological specification of the structural model. The economic magnitude of the result, however, is 2.5 times as great under the specification consistent with the simultaneous determination of benefit parameters and fund asset allocation within the public policy arena. Consistent with Theorem 2, this evidence suggests that plans where members share directly in the excess interest earnings of a fund’s assets adopt a more aggressive investment strategy with a higher share in equities.

What is more surprising, though, especially in light of our results in Theorem 1, is the lack of statistical significance of the other variables in the equation. The magnitude of the initial Benefit Factor seems to exert no effect on how a plan’s funds are invested, regardless of whether the actual or predicted value appears as the right hand side variable. Neither does the Dependency Ratio. And the size of the funds assets also fails to exert any statistical influence on how they are allocated between equities and fixed income.
instruments.

Finally, the coefficient of Majority is negative in both chronological structural specifications of the model. It is significant at the ten percent level in the simultaneous specification while it is significant at only the twenty percent level in the \textit{ex post} asset allocation specification. 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 3.2.3. In our empirical results we find that greater employee influence (Majority) leads to a greater likelihood of an \textit{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"
pople 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.

References


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:

$$\frac{\partial U_l}{\partial \alpha_B} = \frac{(1-k)(\tau_B - 1)}{E[W_t]} > 0.$$

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 

$$(\alpha_A, \alpha_B) = (0, f/\tau_B).$$

With risk neutral parties, $(\alpha_A, \alpha_B) = (0, f/\tau_B)$ 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 $\alpha^*_B = \hat{\alpha}_B \in (0, f/\tau_B)$. The effect of a change in $f$ on $\hat{\alpha}_B$ is
\[
\frac{\partial \hat{\alpha}_B}{\partial f} = \frac{\beta_0 \bar{s}_B - (1 - k)(\tau_B - 1)}{\beta_0 \bar{s}_B((\tau_B - 1) - \beta_0 \bar{s}_B)} < 0.
\]

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

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

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:

\[
\frac{d\beta_0}{dk} \bigg|_{d\hat{\alpha}_B=0} = -\frac{\partial^2 U_l}{\partial \alpha_B \partial k} \frac{d\alpha_B}{\partial U_l/\partial \alpha_B \partial \beta_0}.
\] (A-1)

We now establish that (A-1) is positive. To do so, we begin by signing the numerator.

We rewrite this numerator as

\[
\frac{\partial^2 U_l}{\partial \alpha_B \partial k} = \frac{\beta_0 \bar{s}_B}{f + \beta_0 \bar{s}_B} - \frac{(\tau_B - 1) - \beta_0 \bar{s}_B}{w_{t_0} - f + \alpha_B((\tau_B - 1) - \beta_0 \bar{s}_B)}.
\] (A-2)

In the last term of (A-2), the numerator is negative and the denominator is positive. Therefore, (A-2) is positive.

Next, we evaluate the denominator of (A-1). We rewrite this denominator as

\[
\frac{\partial^2 U_l}{\partial \alpha_B \partial \beta_0} = \frac{k \bar{s}_B}{f + \beta_0 \bar{s}_B} - \frac{(1 - k) \bar{s}_B}{w_{t_0} - f + \alpha_B((\tau_B - 1) - \beta_0 \bar{s}_B)}.
\] (A-3)

43
We now establish that expression (A-3) is negative. To do so, we write the first-order condition to the legislator’s optimization program:

\[
\frac{\partial U_l}{\partial \alpha_B} = \beta_0 \left( \frac{k\bar{S}_B}{f + \beta_0\bar{S}_B} - \frac{(1 - k)\bar{S}_B}{w_{t_0} - f + \alpha_B(\bar{r}_B - 1) - \beta_0\bar{S}_B} \right) \\
+ \frac{(1 - k)\bar{S}_B}{w_{t_0} - f + \alpha_B(\bar{r}_B - 1) - \beta_0\bar{S}_B} = 0.
\]  

(A-4)

Notice that the first line of (A-4) contains expression (A-3). Hence, because the last term of (A-4) is positive and expression (A-4) itself equals zero, we have that expression (A-3) is negative. We now have that the numerator of expression (A-1) is positive and the denominator is negative. Hence, (A-1) is positive.

We can also write the derivative, \(\frac{d\hat{\alpha}_B}{dk}|_{d\alpha_B=0}\), in expression (A-1) as

\[
\frac{d\beta_0}{dk} \bigg|_{d\alpha_B=0} = -\frac{\partial \hat{\alpha}_B / \partial k}{\partial \hat{\alpha}_B / \partial \beta_0} > 0.
\]  

(A-5)

In expression (A-5), we established at the beginning of this proof that \(\partial \hat{\alpha}_B / \partial k\) is positive. Therefore, since expression (A-5) is positive, \(\partial \hat{\alpha}_B / \partial \beta_0 < 0\) is negative.

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

\[
\beta_0 = \int_0^1 \beta_1 dP_1(\beta_1),
\]

by Jensen’s inequality, for any \(\alpha_B\),

\[
U_t(W_{t_0}, f, \alpha_B, \beta_0, P(\beta_0)) > U_t(W_{t_0}, f, \alpha_B, \beta_1, P(\beta_1))
\]  

(A-6)

and

\[
U_p(W_{p_0}, f, \alpha_B, \beta_0, P(\beta_0)) > U_p(W_{p_0}, f, \alpha_B, \beta_1, P(\beta_1)).
\]  

(A-7)
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 (A-6) and (A-7), 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

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENDOGENOUS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit Factor</td>
<td>2.0%</td>
<td>0.3%</td>
<td>1.5%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Ex Ante Surplus Share</td>
<td>0.16</td>
<td>0.37</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Equity Ratio</td>
<td>1.43</td>
<td>0.44</td>
<td>0.29</td>
<td>2.68</td>
</tr>
<tr>
<td><strong>PLAN CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majority</td>
<td>0.54</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Social Security Coverage</td>
<td>0.77</td>
<td>0.42</td>
<td>0.00</td>
<td>1.00%</td>
</tr>
<tr>
<td>Vesting</td>
<td>6.0</td>
<td>2.5</td>
<td>0.00</td>
<td>10.0</td>
</tr>
<tr>
<td>Assets ($billion at market)</td>
<td>$22</td>
<td>$28</td>
<td>$0.8</td>
<td>$156</td>
</tr>
<tr>
<td>Dependency Ratio</td>
<td>31%</td>
<td>10%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>POLITICAL CLIMATE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADA Senate Index 2001</td>
<td>0.55</td>
<td>0.34</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>St Dev ADA House Index 2001</td>
<td>0.31</td>
<td>0.17</td>
<td>0.00</td>
<td>0.60</td>
</tr>
</tbody>
</table>

N=83

# TABLE 2. SEQUENTIAL ESTIMATES

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>Benefit Factor</th>
<th>Surplus Sharing</th>
<th>Equity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.19</td>
<td>-2.51</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>(24.2)</td>
<td>(0.93)</td>
<td>(3.37)</td>
</tr>
<tr>
<td>Majority</td>
<td>0.058</td>
<td>0.78</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(0.99)</td>
<td>(1.81)</td>
<td>(1.29)</td>
</tr>
<tr>
<td>Soc. Sec.</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.74)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ex Ante* Earnings Share Rule

| Actual              | 0.32           |
|                     | (2.40)         |
| Predicted           | -0.31          | 0.77            |
|                     | (1.81)         | (2.20)          |

Benefit Factor

| Actual              | 0.057          |
|                     | (0.34)         |
| Predicted           | 0.46           | 0.28            |
|                     | (0.36)         | (0.77)          |

| Vesting             | -0.20          |
|                     | (2.20)         |

| Total Assets        | 0.11           | 0.03            |
|                     | (0.62)         | (0.18)          |

| Dependency Ratio    | 0.17           | 0.21            |
|                     | (0.37)         | (0.43)          |

| ADA Senate Index    | 0.28           |
|                     | (1.72)         |

| ADA House St. Dev.  | 1.91           |
|                     | (2.48)         |

Note: Numbers in parenthesis are the absolute value of the t-statistic (asymptotic for *Ex Ante* Earnings Share Rule equation) for the null hypothesis of no association.
Figure 1: Under or Over Funding.
The dark lines are iso-risky-asset lines.

On solid ray, the surplus-sharing effect dominates the direct-influence effect. On dashed ray, the direct-influence effect dominates.

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.