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# PENSION FUNDING IN THE PUBLIC SECTOR

Olivia S. Mitchell and Robert S. Smith\*

*Abstract*—This paper explores the determinants of pension funding in the public sector. We formulate and test several hypotheses about the determinants of public employer pension funding practices, using a new data set describing financial and other characteristics of state, local, and teacher plans.

The data show that, on average, public sector pension plans were relatively well-funded during the late 1980s. There were, however, wide variations in funding practices in our sample. Our analysis of these variations suggests that past funding practice tends to be perpetuated, that unionized employers are less likely to fully fund future pension obligations, and that funding is sensitive to fiscal pressure.

## Introduction

STATE and local pension plans now cover 10 million employees and command a substantial fraction of the nation's capital stock, with assets of more than \$720 billion. After a decade of neglect by researchers, the funding of public employee retirement plans is again coming under scrutiny, partly due to revenue shortfalls that public pension funds have been asked to help meet in some states,<sup>1</sup> and partly because contributions for school employee pensions have recently been deferred or canceled in a dozen states and cities.<sup>2</sup> The purpose of this paper is to explore the determinants of public employee retirement system (PERS) funding, so as to better

understand the political economy of these important institutions.

Taxpayers, employees, and government agencies should be concerned about underfunded public employee retirement systems for several reasons. Underfunded systems represent a major form of public borrowing against the future, yet the practice receives little public attention. Though public employee pension system borrowing is kept "off the books," it may nevertheless powerfully affect future revenue-raising potentials of the government agencies in question. In addition, the income security of public sector retirees is critically affected by underfunding, and compensation packages offered to active public sector workers may have to be adjusted to reflect the riskiness of the pension promise. Finally, because the public sector workforce is maturing along with the rest of the population, PERS funding practices take on increasing importance as time passes.

Previous studies of PERS funding have often been descriptive, in part because good data on public plans' financial status have been extraordinarily difficult to obtain.<sup>3</sup> One contribution of our paper is an investigation of new PERS data that offer better and more comparable information on assets and liabilities than heretofore available. A second contribution is that we devise and estimate a structural model of public employers' pension funding behavior, exploring the links between three interrelated outcomes: required annual pension contributions, actual annual pension contributions, and public employee earnings. Our most important conclusion is that variations in funding practices observed across governmental units are at least partially explained by behavioral persistence, the collective bargaining process, and temporary fiscal pressures.

Section I discusses PERS funding, and we present descriptive evidence on funding patterns using a variety of measures. Section II outlines a theoretical model of the determinants of PERS

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<sup>1</sup>In the last five years, almost two-thirds of all states have reportedly reduced budget deficits (at least in the short run) by altering the actuarial assumptions used to compute their public employee pension obligations. For example, New York State pension officials recently agreed to raise the assumed rate of return on pension fund assets from 8% to 8.75% which lowered pension contributions by \$325 million annually and helped balance a state budget deficit (see Verhovek, 1990, and Price, 1991). Similar approaches are being used to cover state deficits in California, Connecticut, Maine, Pennsylvania, and Texas; see Durgin (1991) and Hemmerick (1991).

<sup>2</sup>See the articles in Employee Benefit Plan Review (1991) and Durgin (1991).

<sup>3</sup>Descriptive studies of public pension plan characteristics include Bahl and Jump (1974), Testin (1984, 1986), Taylor (1986), Testin and Snell (1989) and Turner and Beller (1989).

funding and presents hypotheses derived from it. The empirical model and results are described in section III, and a discussion of policy implications is contained in the concluding section.

### I. Funding State and Local Pension Plans

More than 95% of all public employees covered by a pension have a "defined benefit" plan (Turner and Beller, 1989). In this type of pension, the employer specifies a retirement benefit formula that typically varies with the worker's retirement age, final average salary, and years of service.<sup>4</sup> In many cases, these plans index benefits after retirement so the benefit promise is effectively a real, rather than a nominal, one.

Properly funding the defined benefit promise requires setting aside a reserve large enough to ensure that the promised stream can be paid after the worker retires. Actuaries must forecast future benefits and then work backward to determine the time path of contributions required to meet future benefit needs. In the private sector, full reserve funding is now federally required, but it is not in the public sector. As a result, some government sector employers fully fund their pension obligations but others do not.

#### *Valuation of Pension Benefits*

To further clarify the calculation of pension liabilities, it is useful to begin with the information that most public sector pension systems provide in their periodic audit reports—a figure called the plan's actuarial liability (AAL). This figure is whatever the sponsoring plan chooses to report as its future pension obligations to both current retirees and active workers. AAL figures cannot be taken literally, however, because plan obligations differ from one to the other, depending on the actuarial method chosen and assumptions used to calculate future obligations. The variety of actuarial practices employed makes reported AALs noncomparable across plans.

Recognizing the need for more similar figures across plans, the Government Accounting Stan-

dards Board (GASB) in 1987 required plans to begin reporting liability figures using a standardized actuarial computation called the "projected benefit cost method." This approach produces the "pension benefit obligation" (PBO) for each defined benefit plan by grouping prospective pension liabilities into five logical categories:

- (1) those pledged to currently retired employees,
- (2) those to vested terminated employees (based on past service and salary levels),
- (3) those to vested active employees (based on current service and salary),
- (4) those payable to non-vested active employees who may vest in the future, and
- (5) those that will be earned by current workers resulting from future salary increases.

The change in an employer's PBO from one year to the next represents the expected benefit accrual resulting from its operation, and these yearly accruals are termed the plan's "normal cost." To be actuarially sound, an employer's annual contributions must be enough to meet normal cost *and* to amortize past unfunded pension liabilities. That is, if the current stock of pension fund assets is smaller than projected liabilities, proper actuarial practice requires employers to make up this difference over time by making yearly contributions in excess of normal cost.

Most public sector plans now report the PBO liability measure, and having a PBO reported for all public sector plans greatly facilitates comparison of plan liabilities.<sup>5</sup> Nevertheless, even with this projection method in common, liability computations remain very sensitive to several assumptions employed in assessing future pension benefit streams, including salary growth rates, investment rates of return, worker turnover and mortality patterns, and retirement ages. PERS administrators have leeway in the choice of these assumptions, and they can therefore alter the size of anticipated liabilities if they so choose. For

<sup>4</sup> The other type of pension plan is a "defined contribution" plan, in which the employer specifies an annual pension contribution made on behalf of each participating worker. Pension contributions are invested in the capital market, and at retirement the pensioner receives benefits that depend on the outcome of this contribution and investment process.

<sup>5</sup> Some states use an *accrued* benefit cost method rather than the *projected* benefit cost method, where the accrued method indicates smaller liabilities primarily by omitting funding for category 5 listed above. Because we wish to compare funding positions across public sector plans, it is necessary for us to focus on the standardized *projected* method of computation.

instance, a pension plan paying retirees a given fraction of their final pay could show a smaller estimated liability if a lower (real) rate of future salary increase is assumed. Similarly, a computation of future liabilities could be reduced by assuming a higher future real rate of return on pension fund investments. We investigate this issue in some detail later in the paper.

Two perspectives can be taken in measuring how well pension liabilities are funded. The "flow" perspective asks whether an employer is setting aside enough money each year to meet that year's requirements, where required contributions are determined by adding together normal cost and the amount required to amortize past unfunded liabilities. A "stock" perspective, in contrast, measures the ratio of the pension plan's total assets to its total promised obligations.<sup>6</sup> This measure represents the cumulation of both past funding practices and deviations in past investment performance from what was assumed.

#### *Descriptive Findings on Stock Funding*

The information on public sector pension plans used in this study is derived from several different sources, but primarily from a 1989 compilation of pension data published by the National Association of State Retirement Administrators (NASRA) and the National Council on Teacher Retirement (NCTR).<sup>7</sup> The NASRA/NCTR survey consists of a nine-part questionnaire completed by pension plan administrators, and it contains data on active and retired membership, types of workers covered, auditors' reports on plan assets and liabilities, flow and stock funding measures, assumptions used to derive PBOs, benefit formulas and payroll amounts, and investment data. Pension sponsors from 60 plans responded to the basic survey; however, in this study we use the 42 plans that reported a com-

plete set of financial data. The plans examined here covered a total of 4.7 million employees in 31 states; thus, our sample covers about half of all public sector workers enrolled in pension plans. The plans in our sample are of three types: teacher-only (33%), state and local workers only (29%), and hybrid plans that combine teachers and other workers (38%).

Table 1 displays pension plan assets and liabilities reported by plans in our sample. One measure of plan obligation is the reported "actuarial accrued liability" figure (AAL), which averaged \$5.5 billion per plan (line 1). Not surprisingly, the pension benefit obligation (PBO), computed as required by GASB, was some 7% higher at 5.9 billion per plan (line 2). Line 3 indicates assets valued at market;<sup>8</sup> across plans in the sample, reported assets averaged \$4.9 billion.

There are two ways we measure the average stock funding ratio. One, given on line 4, is the median of the ratios across plans; the typical plan in our sample has a stock funding ratio of 91%. The other measure, presented on line 5, is the ratio of the average assets (line 3) to the average PBO (line 2); in effect, this ratio weights observations by size. The fact that this latter ratio is only 84% is indicative that funding is poorer among larger funds. Under either measure, assets typically fell short of liabilities by 9% to 16%.

We conclude that some degree of stock underfunding was common among PERS plans during the late 1980s. However, it remains to describe and analyze the extent to which yearly employer contributions fell short of required contributions during that period. We next turn to an extensive analysis of flow funding.

## **II. Flow Funding Patterns in Public Sector Plans**

The underfunding of pension promises generally arises in two ways. One method of underfunding is to adopt unrealistic assumptions that reduce legally required pension contributions. For example, the spread between the assumed rate of return on pension investments and the rate of assumed wage growth determines, in effect, the

<sup>6</sup> Both stock and flow calculations require accurate valuation of plan assets to arrive at a meaningful number. However, assets in public sector pension plans were traditionally carried at book value, making it difficult to compare funding ratios across plans. This was remedied in the late 1980s by GASB, which urged public sector plans to begin reporting assets at market value for the first time. Calculations reported below report assets at market value.

<sup>7</sup> For a full discussion of these data see National Association of State Retirement Administrators and National Council on Teacher Retirement (1990) and Zorn (1990).

<sup>8</sup> In the past most plans reported fund assets valued at book; see Eppele and Schipper (1981), and Kotlikoff and Smith (1984) for a discussion of public plan funding practices in the 1970s.

TABLE 1.—FUNDING PATTERNS OF PUBLIC SECTOR PENSION PLANS

Stock Pension Funding Measures		
Obligations and Assets (million \$):	Mean	St. Dev.
1. Reported actuarial accrued liability (AAL)	\$5519.99	6723.39
2. Pension benefit obligation (PBO)	5884.93	5760.21
3. Pension assets at market value	4940.11	4814.08
Cumulative Stock Funding Ratios:		
4. Median stock funding ratio across pension plans (Using assets at market value and PBO)	0.91	
5. Ratio of Line 3 to Line 2	0.84	
Flow Pension Funding Measures		
Annual Required and Actual Pension Contributions (\$)	Mean	St. Dev.
6. Required annual contribution per worker	\$2316	1754
7. Actual annual contribution per worker	2069	1450
Annual Flow Funding Ratios:		
8. Median flow funding ratio across plans	1.00	
9. Ratio of Line 7 to Line 6	0.89	

Source: Computed from 1989 NASRA/NCTR data.

real discount rate applied to future pension liabilities. The larger the spread between these two, the lower the present value of calculated pension obligations. The other form of underfunding involves failure of the public sector employer to actually contribute its calculated pension obligation.

#### *Determinants of Required Pension Funding*

In the public sector, retirement benefits are almost always calculated by applying a replacement rate, which depends on the worker's years of service, to the employee's final average salary (often the average of the highest three consecutive years of earnings). Thus, given the pension benefit formula and current salary levels, calculating the actuarially-needed yearly pension contribution requires projecting future retirees' years of service at termination (a function of expected turnover rates and retirement age) as well as anticipated salary growth rates. In addition, contributions needed to fund normal cost are affected by the expected rate of return on pension fund investments. Finally, required employer contributions are affected by the presence of past unfunded liabilities (that is, stock underfunding).

Our data set contains information on two critical assumptions underlying the calculations of normal cost: the expected future rate of wage

growth, and the rate of return anticipated on pension fund investments. The mean rate of wage growth assumed by the plans in our sample was 5.6% per year, while the investment returns assumption averaged 7.6%. The difference between these two rates, commonly called the "spread," effectively serves as a real discount rate in present value calculations of pension liabilities, and the mean difference of 2% is comfortably close to both historic and recent real interest rates in the United States.<sup>9</sup> Further, the standard deviations of these two assumed rates are small relative to their mean values (26% of the mean for salary growth rates and 8% of the mean for investment returns).

Taken together, the mean spread and the small variances suggest that in our late-1980s dataset there were few, if any, instances of egregious misuse of the "spread" for the purpose of reducing employers' pension fund contributions. To corroborate this inference, we conducted extensive empirical analyses of the data, seeking to relate the spread used by each plan to a variety of regional, political, and economic variables. None of these factors proved statistically significant at

<sup>9</sup> Simon (1990) summarizes several historic studies and concluded that a 3% rate is a reasonable estimate of the real rate of return in the long run. Over the last 25 years, however, the real rate of return on 6-month Treasury bills has averaged 1.5% (derived from US President 1991, table B-58 and B-71).

conventional levels in explaining the spread, and in no equation could our composite of variables account for more than 15% of the variance.<sup>10</sup> We therefore conclude that, in this sample and for this period, at least, the assumed rates of wage growth and investment returns were not manipulated for the purpose of making public pension plans appear better-funded than they actually were.

The fact that assumptions about the “spread” used by plans in our sample seem reasonable does not necessarily imply that other critical assumptions, such as those regarding expected future years of service by active employees, were prudent. We have no data on these less visible assumptions, but as detailed in the appendix, we simulated each plan’s reported PBO by varying four assumptions: the average age of active and retired employees, the average years of service accumulated by active employees, and the years remaining before active workers begin to receive pension benefits. Averages for three of the four PBO measures thus derived exceeded reported values by less than 4%; the fourth simulated value was *lower* than the reported PBO by 10%. Because imposing uniform assumptions on all plans virtually guarantees that deviations from reported figures will occur, the fact that the simulated adjustments did not materially increase PBOs is evidence that actuarial assumptions do not appear to have been manipulated for purposes of reducing employers’ pension contributions.

#### *Determinants of Actual Underfunding*

The other way that pension plans can become financially troubled is for employers to fail to contribute the yearly funds calculated as “required” by the plan’s actuaries. At first glance, the data seem to suggest this source of underfunding is not a problem in our data set either. Table 1 (line 8) indicates that the median employer’s “flow funding” ratio in this dataset is 100%, implying that the typical employer made contributions each year equal to those required. However, when one compares average requirements and average contributions (lines 6 and 7,

respectively), the “weighted” ratio of contributions to requirements is only 89%, suggesting that funding is poorer among plans with larger required contributions per worker. In an effort to better understand the determinants of these patterns, we develop and estimate in this section a behavioral model of PERS flow underfunding.<sup>11</sup>

Algebraically, the required per worker annual pension contribution (*REQ*) by employer *i* depends on such observables as employee’s pay level (*AVEPAY*), the pension plan’s benefit replacement rate as a generosity parameter (*BEN%*), the pension plan’s current level of stock funding (*STOCK*), and assumptions about future salary growth (*WDOT*) and investment return projections (*ROR*):

$$REQ_i = f(AVEPAY_i, BEN\%_i, STOCK_i, WDOT_i, ROR_i) + e. \quad (1)$$

Clearly, *REQ* also depends on unobserved facts about each employer’s workforce; hence, equation (1) includes an error term.

We anticipate that the most important determinant of public employers’ *actual* pension contributions is likely to be the *required* obligation, as determined by actuaries. Flow underfunding is common in practice, however, for a variety of reasons captured by the plan’s stock funding ratio. One hypothesis is that each government jurisdiction can be thought of as having a particular political climate, or “culture,” that affects its

<sup>10</sup> Results of these analyses may be obtained from the authors on request.

<sup>11</sup> There are few previous studies of flow funding. For example, Inman (1980) devised and estimated a model of pension funding per capita on a flow basis for police and firefighters, Inman and Albright (1987) examined funding for teacher plans, and Grosskopf et al. (1983, 1985) related pay and stock underfunding for police pension plans in Illinois. Grosskopf et al. (1988) also examined Illinois police pension plans and examined determinants of municipalities’ actual contributions, but did not control on required, nor on past (stock) funding patterns. Looking across these studies, it is fair to conclude that no previous study has examined how actual pension contributions are determined holding constant required contribution patterns, as we do here, and also while controlling on stock funding patterns. Only in this way can one identify the behavioral patterns of interest, while holding constant past practice and formulaic relationships that would otherwise confound the findings. In addition, none of these studies had data on PBOs and the market value of pension assets, and none focused on the large state-level plans that we examine here.

propensity to fund pension obligations.<sup>12</sup> Past practices do not change much, or if they do, change slowly. Thus, one might expect “behavioral persistence” with respect to funding, producing a positive and possibly unitary relationship between current actual and stock funding measures.

An alternative view is that state and local governments may hold to the philosophy that actual contributions should equal required contributions, but not necessarily over a period as short as one year. If so, the long-term relationship between stock and flow funding should reflect “regression to the mean”; that is, a period of underfunding should be followed by one of overfunding. In this case, the empirical stock and actual funding relationship would be attenuated, or even offsetting. More generally, there may be non-correspondence between the time period over which the data are available (one year) and the time period over which government officials might actually seek to balance pension funding.

Another set of influences on pension funding may derive from the public sector collective bargaining process. Influences that work in opposing directions also can be reasonably hypothesized. Unions may function primarily as the informed agents of their members, who may be unaware of the complex issues surrounding actual and required pension funding. Union leaders and their staffs may make it their business to be informed about pension funding and to apply pressure on government agencies to improve funding when it is inadequate. Thus, union strength may be associated with improved flow funding.

Alternatively, unions might themselves be under pressure to produce “results” in the areas about which workers are most informed and most likely to care: namely, pay levels. If union leaders believe that workers care only (or primarily) about wages, but much less about the complexities of funding a rather distant pension obligation, then unions may exert efforts to secure a high wage while tacitly allowing public employers to partially “pay for” that high wage through inade-

quate pension contributions. Under this view, one could hypothesize that funding is less adequate in more heavily-unionized environments.

In addition to the long-term factors that influence flow underfunding, funding is conceivably affected by short-term fiscal pressures, such as unexpected changes in a state’s economic circumstances. For example, imagine a PERS plan that intends to customarily fund  $X\%$  of its actual pension obligation over the long term, where  $X$  is equal to or less than 100%. If the state suddenly faces an unexpected increase in unemployment (and as a consequence an unanticipated reduction in tax revenues), it might contribute less than required (funding less than  $X\%$ ) in the current period. Likewise, if a state experiences unexpected revenue increases, it might fund more than required when times are good (either in anticipation of leaner periods in the future or to make up for deficiencies in the past). Put differently, governmental jurisdictions may seek to “smooth” their spending in the face of unanticipated shocks.

Algebraically, this formulation of the determinants of actual pension plan funding in the public sector can be summarized as follows:

$$ACT_i = f'(REQ_i, STOCK_i, UNEMPD_i, UNION_i) + e'. \quad (2)$$

In addition to the variables already defined, we add: a proxy for unanticipated fiscal pressures ( $UNEMPD$ ), or the difference between a state’s recent unemployment rate (in the last two years) and its longer-term average (averaged over the previous five years); and the percentage of workers in the employing unit who are covered by collective bargaining contracts ( $UNION$ ).<sup>13</sup> A disturbance is postulated to capture other randomly occurring events shaping actual funding patterns.

When translating this model to empirically estimable form, it must be recognized that actual and required pension contributions are simultaneously determined. To elaborate, public sector

<sup>12</sup> For instance, Mummy (1978) hypothesizes that some states are more likely to borrow against the future on a long-term basis than are other states. Inman (1985) suggests that states where residents are homeowners in large numbers will seek to fund pensions more fully since they will be at risk to cover future pension obligations via property taxes.

<sup>13</sup> The NASRA/NCTR survey does not contain the fraction of the active pension-covered employees unionized. Telephone calls were made to each of the pension plan sponsors in the survey (and other relevant parties as necessary) to ascertain the fraction of members covered by collective bargaining. Since some states legislatively prohibit collective bargaining among public sector employees, the percent covered by collective-bargained contracts ranges in our data set from 0 to 100%, with the average being 40%.

pension promises are put at risk when actual pension contributions are less than required, because an underfunded pension fund may run short of money with which to pay promised benefits.<sup>14</sup> If workers or unions perceive underfunding as a threat to their pension promise, then underfunding should lead to a compensating wage differential that drives salaries in the jurisdiction higher than they would otherwise be.<sup>15</sup> This compensating increase in salary will, by itself, tend to increase required pension contributions, because pension benefits in the public sector are a direct function of final average salary. Thus, any estimate of equations (1) and (2) requires a simultaneously estimated system that includes an additional equation explaining salary levels.

Of course, several factors other than pension risk influence the salary that a public sector employer must pay to attract and keep employees.<sup>16</sup> Previous studies have shown that wages of private sector employees in the state ( $W_a$ ) should have a positive effect on PERS workers' wages. This variable captures workers' opportunity wage, but it may also capture "ability to pay" forces that can legitimately influence wage determination when monopolistic elements are present. Public sector pay levels are also likely to respond to imperfectly anticipated fiscal conditions, proxied here by  $UNEMPD$ . An additional factor widely thought to influence public sector pay is the degree of unionization among public sector employees. We hypothesize that in jurisdictions in which workers are more heavily unionized ( $UNION$ ), wages will tend to be higher, other things equal.

<sup>14</sup> To date, pension plan bankruptcy has not been a serious threat for most public employees, but Inman and Albright (1987) note that local employee plans in Michigan and Pennsylvania did declare bankruptcy, and the near-failure of the Cleveland and New York City pension plans have also engendered new worries about the security of underfunded plans. Other plans have also been found close to crisis: the police pension fund in the District of Columbia alone was recently reported to be suffering a \$5 billion underfunding problem, with pension contributions required to cover this shortfall almost equaling police payroll (Shine, 1991).

<sup>15</sup> Smith (1981) discusses the theory and empirical evidence on public sector employees in Pennsylvania; also Inman (1980) examined teacher salaries for risk premiums for underfunded teacher plans. In other cases analysts have adopted proxy variables in compensating differentials studies, when they lack pension funding information; for instance Grosskopf (1988) relates police pay levels to municipalities' pension contributions as a fraction of police pay.

<sup>16</sup> For a review of public sector pay determination see Ehrenberg and Schwarz (1986).

Finally, it must be recalled that wages and employee benefits are substitutes in the compensation package, *ceteris paribus*. To the extent that other differences can be held constant across workers and jobs, we posit that the data will show that jurisdictions offering (and funding) more generous promised pension benefits pay lower cash salaries.

Combining these factors in equation form, we have the following generalized salary model:

$$AVEPAY_i = f''(W_a, UNION_i, REQ_i, ACT_i, UNEMPD) + e'' \quad (3)$$

where  $W_a$  represents average private service-sector salaries in state  $i$ , and other variables are as defined above. It should be noted from the discussion that  $AVEPAY$ ,  $REQ$ , and  $ACT$  are simultaneously determined.

### III. Results: The Basic Model and Sensitivity Tests

In analyzing the causes and effects of pension underfunding, we first estimate a "basic" linearized model of the three-equation simultaneous system developed above. Specifically, we assume all disturbances are normally distributed and apply two-stage least squares (2SLS) to estimate the following model:

$$ACT_i = a_0 + a_1REQ_i + a_2STOCK_i + a_3UNEMPD_i + a_4UNION_i + e' \quad (4)$$

$$REQ_i = b_0 + b_1AVEPAY_i + b_2BEN\%_i + b_3STOCK_i + b_4WDOT_i + b_5ROR_i + e \quad (5)$$

$$AVEPAY_i = c_0 + c_1W_{ai} + c_2UNION_i + c_3REQ_i + c_4ACT_i + c_5UNEMPD + e'' \quad (6)$$

In evaluating the results from this model, we have the following expectations regarding the signs of coefficients:

Equation (5):  $b_1, b_2, b_4 > 0$ ;  $b_3$  and  $b_5 < 0$ .

Equation (6):  $c_1, c_2, c_3 > 0$ ;  $c_4, c_5 < 0$ .

Coefficients  $c_3$  and  $c_4$  in equation (6) represent compensating wage differentials, as argued above.

In equation (4), the behavioral equation of primary interest, we expect  $a_1$  to be positive and



equal to unity if public sector employers tend to fully fund on a flow basis. The coefficient of *UNEMPD*,  $a_3$ , is expected to be negative, because as unemployment rises above its long-term level the accompanying fiscal pressures for "smoothing" may cause states to underfund. The coefficient of the unionization term ( $a_4$ ) has an ambiguous sign prediction, as argued above. Finally, the estimated coefficient on *STOCK* ( $a_2$ ) can help to distinguish the "behavioral persistence" from the "regression to the mean" hypotheses. If behavioral persistence dominates, then a one-percentage point increase in the stock funding ratio should be associated with a one-percentage point increase in the flow funding ratio. To the extent that "regression to the mean" enters the picture, the estimate of  $a_2$  will fall below the magnitude required for a one-for-one percentage-point change.

Results from the basic model appear in table 2. Of most interest is the equation describing actual public sector pension funding patterns. We find that an additional dollar of required pension contributions (*REQ*) is met by 94 cents of actual additional funding, *ceteris paribus*. This point estimate suggests that, on average, public sector employers do not fully fund increases in pension obligations. Nonetheless, the coefficient on *REQ* is not significantly different from unity, so we cannot reject the hypothesis that marginal increases in *REQ* are fully funded, all else constant.

A second finding in the *ACT* equation is the strong, positive relationship between stock and flow pension funding levels. This finding supports the conclusion of behavioral persistence, as hypothesized above, but some caution is required in interpreting the estimated magnitudes. For a

TABLE 2.—DETERMINANTS OF ACTUAL AND REQUIRED PUBLIC PENSION CONTRIBUTIONS AND PAY  
(2SLS, Standard errors in parentheses)

	Sample Mean	<i>ACT</i> Equation (4)	<i>REQ</i> Equation (5)	<i>AVEPAY</i> Equation (6)
<i>ACT</i>	\$2,069			-3.52 <sup>c</sup> (2.54)
<i>REQ</i>	\$2,316	0.94 <sup>a</sup> (0.13)		3.17 <sup>c</sup> (2.01)
<i>AVEPAY</i>	\$22,049		0.24 <sup>a</sup> (0.04)	
<i>STOCK</i>	90.02%	12.99 <sup>b</sup> (6.05)	-13.20 <sup>b</sup> (7.13)	
<i>UNION</i>	33.80%	-11.06 <sup>b</sup> (5.00)		74.46 <sup>b</sup> (35.79)
<i>UNEMPD</i>	-1.92%	-119.84 <sup>c</sup> (83.67)		763.30 (581.56)
<i>ROR</i>	7.61%		-423.19 <sup>c</sup> (281.90)	
<i>WDOT</i>	5.63%		427.02 <sup>a</sup> (104.83)	
<i>BEN%</i>	1.75%		710.49 <sup>c</sup> (442.06)	
$W_a$	\$18,187			0.93 <sup>b</sup> (0.37)
<i>N</i>		42	42	42
<i>R</i> <sup>2</sup>		0.68	0.72	0.55

<sup>a</sup> Significant at 0.01 level, one-tailed test.

<sup>b</sup> Significant at 0.05 level, one-tailed test on all coefficients except on *UNION* in eq. (4).

<sup>c</sup> Significant at 0.10 level, one-tailed test.

*Variable Definitions*

<i>ACT</i>	Actual employer pension fund contribution per worker (\$/year)
<i>REQ</i>	Required employer pension fund contribution per worker (\$/year)
<i>AVEPAY</i>	Annual average salary of public sector workers in state (\$/year)
<i>STOCK</i>	Ratio of pension fund assets (valued at market) to pension benefit obligation (%)
<i>UNION</i>	Fraction of public sector workers covered by a collective bargaining agreement (%)
<i>UNEMPD</i>	Ave. unemployment rate last two years minus ave. unemployment rate previous five years (%)
<i>ROR</i>	Assumed rate of return on pension fund assets (%)
<i>WDOT</i>	Salary growth rate assumed in calculating $R_i$ (%)
<i>BEN</i>	Benefit credit percent per year of service (%)
$W_a$	Average salary of private service-sector workers in state (\$/year).

1-percentage point increase in stock funding to increase *ACT* by 1%, the coefficient on *STOCK* would have to be 20.69; instead, the estimated coefficient is 12.99, with an estimated standard error of 6.05. Thus, the hypothesis that behavioral persistence explains the relationship between *STOCK* and *ACT* cannot be rejected, while the point estimate suggests that persistence is attenuated by some regression-to-the-mean behavior.

There is also evidence in table 1 that economic distress—in the form of unusually high unemployment rates in the state—causes public employers to underfund their pension promises. The coefficient of *UNEMPD* is negative, and its magnitude sensible: the point estimate suggests that a 1 percentage-point increase in a state's unemployment rate above its recent mean level will lead public employers to reduce *ACT* by about \$120 (roughly a 6% reduction in annual per-worker contributions).<sup>17</sup> It is statistically significant at only the 0.10 level, however.

Finally, the results suggest that, other things equal, greater unionization is associated with lower levels of actual pension funding in the public sector. Thus, unions may sometimes exert pressure to improve public plan funding, but their apparent net negative effect, we find, is probably due to the upward pressure on salaries associated with collective bargaining, to which employers respond by reducing pension contributions. Interestingly, our estimates imply that if a public sector employment unit went from being completely nonunion to 100% union, actual employer pension contributions (holding required contributions constant) would fall by approximately 50%.

These results seem credible, but it is also important to examine the findings for the other two equations in the system as well. In the *REQ* equation, all coefficients have their expected signs and are different from zero at the 0.10 statistical significance level or better. The coefficients of *WDOT* and *ROR* are opposite in sign and equal in magnitude, thus conforming to expectations (their difference is effectively the real discount rate, so a 1 unit change in each should not change the present value of future obligations).

<sup>17</sup> Our results thus extend the conclusion of Bumgarner et al. (1991), who find that fiscal distress reduces expenditures for public sector capital and capital-maintenance funds.

Furthermore, a \$1 increase in salary translates into a higher required pension obligation of 24 cents; this finding implies a marginal “replacement value” of plausible size.

The results from the *AVEPAY* equation (6) are also generally plausible. As found in previous studies, public and private sector salaries are positively correlated, and one cannot reject the hypothesis that private sector pay increases are reflected dollar-to-dollar in public sector pay. The estimated union effect on public sector pay levels is positive, as expected, but it implies that going from a nonunion environment to a completely unionized one would increase salaries by about 33%. This point estimate is above the upper end of the previously-established range of estimated union effects in the public sector (16%), but not significantly so.<sup>18</sup> The coefficient on *UNEMPD* is unexpectedly positive, but it is not significantly different from zero.

One interesting result pertains to the estimated coefficients on *ACT* and *REQ* in the public sector workers' pay equation. Both coefficients have their expected signs, are significantly different from zero (at the 0.10 level), and their difference is negative. This is consistent with earlier studies reporting compensating wage differentials for pension underfunding in the public sector.<sup>19</sup> Using our results, it can be seen that public sector wages rise if funding worsens (i.e., if *ACT* falls, holding *REQ* constant); and wages fall if funding improves (i.e., both *REQ* and *ACT* increase together). Despite these reassuring conclusions about the model's performance, the coefficients on *REQ* and *ACT* seem implausibly large taken one at a time. They imply that if required pension contributions per worker were held constant while actual yearly contributions per worker were improved by \$1, the average worker's salary would fall by \$3.50 per year. On the other hand, we cannot reject the hypothesis that the two coefficient estimates on *ACT* and

<sup>18</sup> See Ehrenberg and Schwarz (1986) for a survey of union effects on public sector pay. However, our results are not strictly comparable to those estimated previously since our model controls for both public pension levels and pension funding adequacy, which previous studies do not (pension variables were not typically included in previous analyses).

<sup>19</sup> Other studies finding pension and funding-related compensating wage differentials for public sector employees include those by Ehrenberg (1979), Smith (1981), and Smith and Ehrenberg (1983).

*REQ* are in fact equal in size (though opposite in sign) and hence cannot reject the hypothesis that their difference is zero. Hence if pension funding were to rise by \$1, a one-dollar offset in salaries could result.

A different method of assessing these findings involves testing their sensitivity to alternative model specifications. To this end, variants of the *ACT* equation were examined that included additional control variables for the type of employee covered by the plan, and several variables reflecting the state's political climate. Plan-type controls distinguish teacher-only pension plans, plans with only state and local workers, and hybrid plans. Political variables include the fraction of each state's population voting Democratic in the last presidential election, the political rating given to the state's senators by the AFL-CIO, and an indicator of whether the state had a right-to-work law. Political and plan-type variables control for the possibility that *UNION* is affected by factors that themselves might affect flow funding adequacy. Put differently, this approach allows us to see whether omitted variables bias affects estimated union effects on actual pension contributions.

The extended three-equation simultaneous model yields results qualitatively similar to those given in table 2. Most importantly, the estimated union coefficient in the actual funding equation is of similar magnitude, and the inclusion of the additional variables (while not themselves statistically significant) enhances its significance. Finally, the fact that the plan-type and political/environment controls are not statistically significant at conventional levels suggests that the most important determinants of pension plan actual funding behavior are well-captured by the economic variables included in table 2.

Additional models may be used to explore the sensitivity of *ACT*, actual pension funding, to new formulations. The union effect is further examined by adding a union-fiscal pressure interaction term ( $UNION * UNEMPD$ ) to the basic equation for actual pension funding. This specification posits that responses to fiscal pressures are different in union and nonunion jurisdictions, and we find that the coefficient on the interaction term implies poorer funding in union environments when fiscal pressures mount. The estimated coefficient of this interaction term is larger

than its standard error; however, it is not statistically significant at the 0.10 level. The remainder of the results suggest that other conclusions are fundamentally the same as those described in table 2. It is also possible to make the pension plan's stock funding rate endogenous through the use of the plan-type and state union-political variables, which produces a four-equation simultaneous model. Having done so, we conclude that the coefficients in the *ACT* equation are virtually unchanged, and only one variable (the dummy for a teacher-only plan) is significant in the *STOCK* equation.<sup>20</sup>

A final way we evaluate the credibility of the results appearing in table 2 requires evaluating the assumptions underlying the model. First we test overidentification conditions for the *ACT* and *AVEPAY* equations; the null hypothesis that excluded predetermined variables have zero coefficients cannot be rejected. We also examine the covariance of the error structure across the equation system, and conclude that the only correlated residuals are those for *ACT* and *AVEPAY*, but not for *REQ* (in any event, the basic model's estimates are consistent). These results suggest that our conclusions from extended models are fundamentally the same as those described in table 2, and the basic results are robust to changes in specification.

#### IV. Conclusion

This paper has explored the determinants of public sector pension funding. Using a new survey on public employee pension plans, we investigate several hypotheses about the determinants of flow funding behavior, focusing on a model that permits the simultaneous determination of three interrelated outcomes: required annual pension contributions, actual annual pension contributions, and public employee pay. The empirical work uses a recent survey of public pension plans, a dataset which reports more accurate data

<sup>20</sup> A Hausman test lends further credence to the "basic" model, because it does not reject the hypothesis that *STOCK* is exogenous. In addition to this test and others discussed in the text, we also re-estimated the *AVEPAY* equation interacting  $W_a$  and pension-plan type and with *STOCK* as an explanatory variable; again, the results of major interest are unchanged. Results from these tests are available from the authors on request.

on plans' assets and liabilities than ever available before.

Findings about public pension plan funding practices can be highlighted. Regarding stock funding, which refers to the ratio of the pension plan's total assets to its total promised obligations, data from the late 1980s indicate no instances of egregious misuse of actuarial and economic assumptions for the purpose of reducing employers' pension fund contributions. Nevertheless, public plan funding ratios totalled only 90% of required, on average, not particularly high in light of strong capital markets during the decade of the 1980s. In addition, new challenges face public pension plans of late, and the funding status of public sector pension plans may deteriorate quickly if unprecedented state budget deficits impose new economic pressures on stock funding practices in ways which differ from those of the 1980s.<sup>21</sup>

Regarding flow funding, or the rate at which public sector employers actually contribute what they are required to each year, we find wide variations in behavior. All else equal, our data do not reject the hypothesis that marginal increases in required contributions usually were funded in the latter part of the 1980s. Nonetheless, pension funding "habits" do seem to persist in the public sector, and not all public sector plans fully cover their current obligations. Further, fiscal pressure appears to cause some public employers to reduce their annual contributions below required levels, and growth in employee unionization also reduces flow funding.

Finally, there is some evidence of compensating wage differentials; that is, if the promised pension benefit rise by \$1 per year and this increase is fully funded, salaries would probably fall by about 50 cents per year. This result is not surprising in light of other studies finding partial capitalization of local fiscal conditions.<sup>22</sup> Research to further disentangle these and other

state-specific effects must await the development of panel data on public sector pension plans.

## APPENDIX

### Alternative Valuation Methods for Pension Liabilities

In this appendix we investigate the effects of changing key assumptions underlying estimates of each plan's projected benefit obligation (the PBO). These adjustments are helpful both in making plan liability figures more comparable and in shedding light on whether assumptions are manipulated to make pension underfunding more difficult to detect.

In particular, we evaluate the effects of changing discount rates, salary growth projections, and assumptions regarding worker service and longevity, to show the sensitivity of PBO estimates to varying assumptions. Two valuation methodologies were employed by us to correct for different underlying assumptions: one was proposed by Ippolito in a study of private sector plan liabilities, and a second relied on our own calculations of benefit present values. In both cases, a crucial role was played by the reported interest rate in adjusting the future value of the benefits stream, and both methods converted each plan's reported liabilities to adjusted by employing a common discount rate.

Ippolito's adjustment method, termed PBO-1 in table A1, posits a separate conversion factor for active and retired workers and then combines the two with weights representing the fraction of each type of participant in the plan (Ippolito, 1989, p. 65). This adjustment method assumes that the typical retiree has 12.49 years remaining in which to collect the pension annuity, and that the typical active worker has completed 60% of his potential service. On the assumption that  $i^r$  is the reported discount rate which varies from one plan to the next, and  $i^e$  is the common economic discount rate, the two formulas are as follows:

$$\begin{aligned} \text{for retirees: (Economic liability/Reported liability)} \\ = \exp[-.057(i^e - i^r)]; \text{ and} \end{aligned} \quad (A1)$$

$$\begin{aligned} \text{for actives: (Economic liability/Reported liability)} \\ = \exp[-.077(i^e - i^r)]. \end{aligned} \quad (A2)$$

Thus, for example, liabilities calculated for actives at a 6% discount rate will be 73% as large as they would have been at a 2% rate. Of course, the conversion formula is only an approximation to the precise actuarial calculation required to re-value each plan's liability figures, but as Ippolito says, "as a first order of magnitude it will reveal true economic pension liabilities" (p. 65).

The second method of adjusting reported liabilities allows us to vary both the discount rate assumption and, for active workers, the assumptions about salary growth and the number of years remaining until retirement. The employer's total pension liabilities ( $TPL$ ) can be shown to equal the number of employees ( $J$ ) times the present value of the annuity needed as of retirement age ( $A_j$ ) to finance retirement benefits over the remaining lifetime ( $T$ ), given the number of years until active members separate ( $n$ ) and their years of service at retirement age ( $m$ ). This is expressed as

$$\begin{aligned} TPL &= J * A_j / (1 + i^e)^n \\ &= J * \beta * [(1 + g)^n / (1 + i^e)^n] * \alpha_j \end{aligned} \quad (A3)$$

where  $i^e$  is the common economic discount rate;  $\alpha_j = 1/i^e * \{1 - [1/(1 + i^e)^{T-m}]\}$ ;  $\beta$  is the pension benefit a retiree would receive based on current salary levels, and  $g$  is the projected

<sup>21</sup> *Business Week* recently reported that "governors and legislators are scrambling to tap employee pension funds or cut back on contributions to avoid more painful budget cuts or tax increases," citing as examples West Virginia's use of pension fund loans to finance teacher pay hikes, and Philadelphia's borrowing of \$75 million funds to pay city workers (Schine, 1991).

<sup>22</sup> Capitalization patterns in the non-pension case are discussed by Gyourko and Tracy (1989).

TABLE A1.—STOCK FUNDING PATTERNS UNDER ALTERNATIVE ASSUMPTIONS

Earnings Growth and Investment Return Assumptions Used in Computing Public Pension Plan Liabilities		
	Mean	St. Dev.
Reported wage growth assumption	5.63%	1.44
Reported investment returns assumption	7.61	0.64
Implied real discount rate	1.98	1.44
Alternative Measures of Pension Obligations		
	Mean	St. Dev.
Reported PBO	\$5884.93	5760.21
PBO-1	5867.38	5691.84
PBO-2	5911.08	5731.53
PBO-3	5276.35	5108.83
PBO-4	6090.84	5965.05
Alternative Measures of Pension Stock Funding Ratios (Using market asset values)		
Using reported PBO	90.02%	23.90
Using PBO-1	86.31	22.66
Using PBO-2	91.82	28.70
Using PBO-3	90.11	26.47
Using PBO-4	101.79	31.51

## Notes:

PBO-1: Correction factor as in Ippolito (1986)

PBO-2: Wage growth = 5%, invst. return = 7%,  $m = n = 23$ ,  $T = 37$ PBO-3: Wage growth = 5%, invst. return = 7%,  $n = 18$ ,  $m = 23$ ,  $T = 37$ PBO-4: Wage growth = 5%, invst. return = 8%,  $m = n = 23$ ,  $T = 37$ 

future salary growth rate. The NASRA/NCTR data set reports each public plan's interest rate and projected salary growth rate, which we then vary using equation (A3) along with different assumptions for  $T$ ,  $m$ , and  $n$ . Three calculations that adjust reported PBO figures in this manner are

PBO-2: assumes  $g = 5\%$ ,  $i^e = 7\%$ ,  $m = n = 23$ ,  $T = 37$ ,

PBO-3: assumes  $g = 5\%$ ,  $i^e = 7\%$ ,  $m = 23$ ,  $n = 18$ ,  $T = 37$ ,

PBO-4: assumes  $g = 5\%$ ,  $i^e = 8\%$ ,  $m = n = 23$ ,  $T = 37$ .

In other words, the PBO-2 measure assumes that the "spread" (or the real discount rate) is 2%, the average public sector worker is around 40 years old, has 23 years of work remaining before retirement, and has a life expectancy of 37 years. Low public sector quit rates are reflected in the assumption that  $m = n$ , but this assumption is altered in PBO-3, where  $n$  is set to  $m - 5 = 18$ . The final measure, PBO-4, tests the sensitivity of the liability measure to an assumed spread of 3% rather than 2%.

Table A1 reports these five measures of public employee pension plan obligations, using adjusted wage growth, investment return, and turnover assumptions. Line 1 recapitulates the reported PBO described in the text, while the next four lines present alternative obligation measures PBO-1 through PBO-4. These five PBO measures are used to compute alternative stock funding ratios, which were then used in alternative versions of the basic three-equation model presented in the text. In no case was the pattern of coefficient estimates very different (results available from the authors on request). The similarity in results probably results from the fact that all of the generated PBO measures have a relatively similar distribution to the one reported by the pension systems in our sample.

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