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Funding Defined Benefit State Pension Plans: An Empirical Evaluation

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FUNDING DEFINED BENEFIT STATE PENSION PLANS:
AN EMPIRICAL EVALUATION

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DISSERTATION

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ABSTRACT OF DISSERTATION

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Defined Benefit (DB) state pension trust funds are an integral component of state finances and play a major role in the country's labor and capital markets. The last decade though has seen a substantial growth in unfunded pension obligations and a seeming inability by states to make the contributions needed to cover funding shortfalls. When coupled with even larger unfunded retirement health benefits, the looming threat of insolvent state retirement systems pose both current and long-term fiscal challenges to state governments already struggling with the ongoing economic downturn and billions of dollars in budget deficits. The convergence of these factors have led states to undertake various reform strategies in an attempt to move their respective public pension plans towards a more sustainable funding path.

Using an asset-liability framework to describe the DB plan funding structure and process, this dissertation advances the discussion over major pension reform efforts currently implemented or considered by states. I show analytically the link between various pension reform categories and specific DB plan funding components, and how this in turn, affects DB plan funding outcomes. From this analytical framework, I derive the study's hypotheses on the relationship between DB plan reform-linked funding components and outcomes of interest.

This study looks at three DB-plan reform-linked funding components: (1) plan member employee contributions, (2) plan employer contributions, and (3) retirement benefit payments. Four major funding outcomes are evaluated: (1) the employer contribution rate, (2) flow funding ratio, and (3) stock funding ratio, and (4) relative size of plan unfunded liability.

Utilizing a unique panel dataset of 100 DB state retirement systems from 50 states covering a nine-year period of FY 2002 to 2010, I empirically test the following hypothesized funding relationships: (1) States as DB plan sponsors have underfunded their plans as indicated by their failure to meet annual employer funding requirements;

and (2) Increasing the employee and employer contribution rate and reducing the cost of retirement benefits are associated with higher plan stock funding ratios and lower unfunded pension liabilities.

Results from my fixed-effects (FE) panel regression analyses provide the clearest empirical evidence to date that state DB pension plan sponsors underfunded their required annual employer contributions. The financial condition of a state's budget is also shown to have a significant effect on the amount states are able to contribute into their pension funds. I find empirical support for the crucial function of employer contributions in determining the overall funded status of state pension plans. This finding is further reinforced when I estimate plan stock funding ratios using a dynamic system GMM (sGMM) panel regression model. The results from static FE and dynamic sGMM models suggest no significant effect on overall plan funding levels from changes in the employee contribution rate or the average retirement benefit cost. Lastly, the results lend evidence to the significant influence of past funding levels on current funding levels. It is recommended that future empirical research account for the dynamic nature of public pension funding and related endogeneity issues. This dissertation concludes by discussing the implications of the empirical findings for policy makers seeking to improve the funded status of their respective state DB retirement systems.

KEYWORDS: Public Pensions, State Retirement Systems, Defined Benefit, Pension Reform, Dynamic Empirical Model

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CHAPTER 1

INTRODUCTION

Overview of Public Employee Retirement Systems

This study evaluates the funding of state retirement systems over the period of Fiscal Years (FY) 2002 to 2008. As part of my evaluation, I present a framework for relating employer contribution behavior to the funding process of a typical Defined Benefit (DB) public pension plan. I discuss the results of my research within the context of its implications for selected policy reforms intended to improve the overall funded status of state retirement systems.

While administered separately in a fiduciary capacity from the primary government budget, public employee pension trust funds are an integral component of state finances, and as a sector, play a major role in the country's labor and capital markets (Peng, 2008). In FY 2010, the U.S. Census Bureau estimated there were 3,418 public employee retirement systems (PERS), of which 222 were administered at the state level (Becker-Medina, 2012).[1] Although the number of state pension plans represents only 6 percent of all public pension plans, these state administered retirement systems cover 90 percent of all public sector employee members and 84 percent of retirees and beneficiaries.[2]

Cash and investment holdings of state pension plans, which in FY 2010 totaled $2.2 trillion, historically account for over 80 percent of all assets held by public retirement systems (U.S. Census Bureau, 2012; see also Figure 1-1). To put the size of these asset holdings into perspective – consider that 19 out of the 25 largest U.S. retirement systems in 2010 were state pension plans. The California Public Employee Retirement

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[1] In this study, the terms and acronyms of public pension plans, public employee retirement systems (PERS), and state and local government (SLG) retirement systems, are all equivalent and used interchangeably throughout the text.
[2] The U.S. Census Bureau (2012) estimated in FY 2010 that out of the total 14.7 million active members in US public retirement systems, nearly 13 million were in state retirement systems. During the same period, state plans covered almost 7 million of the 8.2 million total public employee retirees and their beneficiaries.

System (CalPERS) is the largest state DB pension plan with assets valued in 2010 at over $ 214 billion (see Table 1-1).
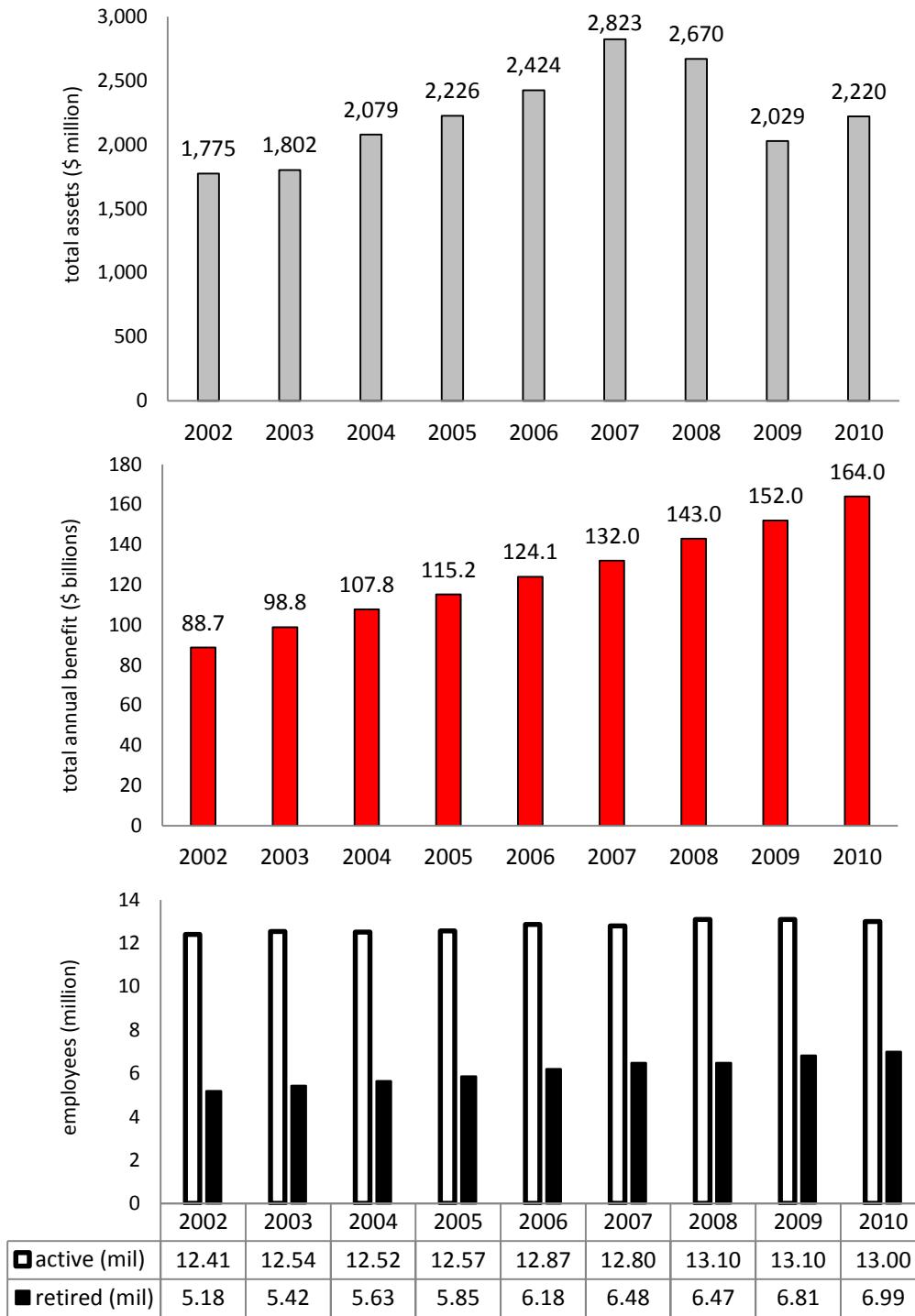
Figure 1-1. Total Annual Assets, Benefit Payments, Active and Retired Membership, All State Retirement Systems, FY 2002-2010 (Source: U.S. Census Bureau)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
active (mil)	12.41	12.54	12.52	12.57	12.87	12.80	13.10	13.10	13.00
retired (mil)	5.18	5.42	5.63	5.85	6.18	6.48	6.47	6.81	6.99

Table 1-1. Largest U.S. Pension Plans in 2010, Ranked by Total Assets (in $U.S. million)

Rank	Plan Sponsor	Assets	Total DB	Total DC	DB Asset Allocation			
					stocks	bonds	cash	other
1	Fed Retirement Thrift	264,013	264,013	---				
2	CalPERS	214,387	213,066	1,321	52%	24%	2%	23%
3	CalSTRS	138,888	138,630	258	53%	23%		24%
4	NY State Common	133,023	133,023	---	55%	26%	1%	18%
5	Florida State Board	123,373	117,802	5,571	61%	25%	1%	13%
6	NY City Retirement	115,204	96,801	18,403	59%	34%	0.1%	8%
7	General Motors	101,541	87,807	13,734	27%	46%	---	27%
8	Texas Teachers	100,280	100,280	---	56%	22%	1%	21%
9	IBM	83,095	49,692	33,403	35%	47%	0%	17%
10	NY State Teachers	80,324	80,324	---	61%	23%	1%	15%
11	Boeing	79,411	48,670	30,741	34%	51%	---	15%
12	WI Investment Board	77,812	75,355	2,457	59%	27%	---	14%
13	AT&T	76,183	46,090	30,093	41%	33%	1%	25%
14	North Carolina	75,314	69,746	5,568	50%	38%	---	12%
15	OH Public Employees	72,157	71,727	430	62%	27%	0.3%	11%
16	New Jersey	70,803	70,230	573	44%	37%	3%	16%
17	WA State Board	61,637	52,035	9,602	37%	21%	1%	41%
18	Ohio State Teachers	61,007	60,587	420	65%	18%	3%	14%
19	General Electric	60,843	42,728	18,115	49%	20%	4%	27%
20	OR Public Employees	55,216	54,152	1,064	44%	26%	---	30%

Note: DB-Defined Benefit; DC-Defined Contribution. Source: Pensions and Investments (February 7, 2011). "2011 P&I Top 1000 Largest Retirement Plans". Accessed March 2011 from www.pionline.com

As highlighted in later chapters, these substantial pension fund investments in financial markets result in public pension plan revenues being highly dependent on market performance.

When combined with local government retirement plans, the economic contributions of public pension plans are not only gauged by the trillion dollars invested annually in the stock market, but also by the pension benefits paid out to retired public employees and their beneficiaries. In FY 2010, public pensions disbursed over $200 billion in retirement annuities, of which 81 percent or $ 164 billion was paid out by state plans to 7 million retirees and their beneficiaries (U.S. Census Bureau, 2012). These pension benefits, which grew by 85 percent from FY 2002-FY 2010 due to the steadily

growing number of retirees, are critical for the welfare of public employees and help create economic multiplier effects for state and local economies (Boivie & Almeida, 2009; see also Figure 1-1).

Retirement income comprises a greater share of public employees' overall compensation compared to their private sector counterparts, and as such, offering retirement benefits that are either competitive or generous relative to the private sector, helps the public sector meet its workforce goals in recruiting, hiring, and retaining skilled and qualified workers (Bender & Heywood, 2010; Franzel, 2009). In particular, guaranteed and statutorily protected DB retirement benefits are highly valued and preferred by public employees, and continue to be the dominant type of pension plan in the public sector covering over 90 percent of state and local government employees (Munnell et al. 2007, 2008b, 2011b). As a result, DB pension plans have been an effective recruitment and retention tool in the public sector (Almeida & Boivie, 2009). Nonetheless, rapidly growing retirement benefit obligations have begun to exert increasing fiscal pressure on states as concerns grow over the current and long-term solvency of state run DB retirement systems (GAO 2010b, 2012a, and 2012b; Russek, 2011).

The Issue of Unfunded Public Pension Liabilities

In a series of widely cited reports, estimates from The Pew Center on the States (2007, 2010a, 2011, 2012) indicate that between FY 2006 to FY 2010, pension liabilities grew by 30 percent from $2.35 trillion to $3.07 trillion while plan assets only rose 16 percent from $1.9 trillion to $2.3 trillion. With the increase in liabilities outpacing asset holdings, the funding gap grew from $361 billion in FY 2006 to $757 billion by the end of FY 2010, representing a 110 percent increase in unfunded pension liabilities. Over this same period, actuarially determined annual employer contributions that state and local governments (SLGs) needed to make in order to cover funding shortfalls and maintain solvency in their respective retirement systems, rose 50 percent from $48.8 billion to $73.7 billion. The problem was that state and local governments were contributing on

average, 17 percent less than the required annual total, thus worsening the funding gap even further.[3] The failure by states to meet their required annual pension contributions is understandable if we consider that states were facing an estimated $230 billion in budget shortfalls and one of the worst fiscal periods in decades due to the economic downturn and slow recovery (see NASBO 2008, 2009, 2010, 2011).

Novy-Marx and Rauh (2011a, 2011b) present an even more dismal assessment of public retirement system funding by reporting even larger estimates than that given by the Pew Center on the aggregate pension liability. They argue that the discount rates used by states, typically around 8 percent, is problematic since it does not realistically reflect the risk of the retirement benefit payments from a taxpayer point of view under different conditions. At a minimum, Novy-Marx and Rauh estimate that the combined total liabilities for state pension plans is anywhere from $3.2 trillion if discounting according to the taxable state-specific municipal yield curve, to $4.4 trillion if using the discount rate given by the Treasury yield curve. When the actuarial procedure of recognizing future service and wage increases is used, the liability estimate goes up to $5.2 trillion.[4]

The Impetus for Reform

The funded status of public employee retirement systems is a major public policy and finance issue largely due to the huge investment losses racked up from two financial crises within the past decade, along with looming increases in the annual total cost of benefit payments as baby boomers begin to retire in large numbers soon. The uneasiness over public pension funding is further heightened when considered in the context of current and growing long-term fiscal challenges faced by states. As the funding outlook deteriorates for state retirement systems coupled with its looming

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[3] Author's calculations using Pew Center on the States aggregate state level data on actual and required employer contributions.
[4] In a series of papers, Novy-Marx and Rauh (2009, 2011a, 2011b) comprehensively examine the issue over the appropriate discount rate for public pensions. For a more summarized overview of the debate, see GAO (2012a, pp. 45-47).

adverse fiscal implications, an increasing number of states are undertaking efforts to reform various aspects of their respective DB pension plans (Mitchell, 2011; Munnell et al., 2011c; GAO, 2012).

Anecdotal evidence of the growing impetus for reforms is noted in GAO (2012a) and The Pew Center on the States (2010a, 2012) which highlight the increasing amount of pension reform legislation passed in recent years. In reviewing annual pension related legislation compiled by the National Conference of State Legislatures, the Pew Center reported more pension reform legislation was passed in 2010 compared to the two previous years combined, and the trend towards more reform continued through FY 2011 and FY 2012 (NCSL; see Snell, 2003-2010; The Pew Center, 2010a; see also Table 1-2). They also found that apart from the reforms related to benefit reductions and contribution increases, more than a third of the states created task forces or commissions to study and explore various solutions and policy initiatives. As part of their review, The Pew Center identified five broad categories of policy reforms for state pension plans (Pew Center 2010a, p. 8), these were:

1. Keeping up with funding requirements;
2. Increasing employee contributions;
3. Reducing benefits;
4. Improving governance and investment oversight; and
5. Increasing employee share of the investment risk.

A direct empirical examination of each reform category may not be feasible due to the lack of data, and as most reforms are just recently implemented. An alternative for policymakers is to have a framework by which to evaluate the rationale and outcomes for each reform category. While such a framework is currently lacking in the public pension literature, it would center on the premise that all reforms have the general objective of improving the overall funded status of their respective retirement systems. Furthermore, despite the different reform categories, the saliency of these reforms reflects the fiduciary role that state governments have in ensuring their respective DB plans are adequately funded. Hence, by design, the state government as plan sponsor is ultimately responsible for covering any pension funding shortfalls through employer

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contributions. This raises the question as to what determines the rate at which states make their actual employer contributions, and to what degree they meet their actuarially determined annual required contributions (ARC). Addressing these questions empirically allow us to test the hypothesis that DB state plans are underfunded largely because states were remiss in fully meeting their annual contribution obligations.

Table 1-2. Selected Pension Policy Reforms Enacted by State Legislatures, 2003-2010

TYPE OF REFORM	2003	2004	2005	2006	2007	2008	2009	2010
Increase employer contributions	CO, CT, FL, KS, NM, NC, OR	AZ, KS, LA, MS, NE, OK, PA, RI	AZ, MN, MT, NM, SC, TX, WA, WY	AK, AZ, CO, CT, IL, IA, KY, MN, NE, NM, WA, WV	CT, MT, NE, NJ, ND, OK, TX	AK, CT, IA, VT, WA, WV	NE, NM, OK	CA, FL, IL, IA, MN, NM, WY
Increase employee contributions	FL, NE, OK	AZ, NE, OK	IA, LA, MN, NE, NM, SC, WA	FL, IA, KY, MN, NE, WA	NJ	AK, IA, NH, NM, VT	AZ, KY, NE, UT, WY, TX	CO, IA, LA, MN, MS, MO, NM, VT, WY
Reduce future benefits	LA	KY, LA, SD, WI	KY, OK	CO, IL, IA, LA, MN, WY	CA, CT, HI, KY, MS, MO, NH, ND	CT, NH, NJ, NY, VT	GA, LA, NV, RI, TX	AZ, CA, CO, IL, IA, LA, MI, MN, MS, NJ, VT, VA
Introduced DC or Hybrid Plan		OR, CO, AK				GA		UT, MI
Approved POBs/GO Bonds; OPEB pre-funding (2007 only)	CA, IL, OR, WI				AL, DE, GA, IA, LA, MD, MO, NV, TN, UT, VT, VA, WV	AK	IL	

Note: Partial list only; a more detailed and comprehensive information of state legislature enacted pension policies can be accessed from the NCSL website as compiled by Ronald Snell at http://www.ncsl.org/?tabid=13399.

Despite the prevalence of articles on public pension underfunding, much of the empirical evidence is limited to descriptive estimates of the aggregate difference between total plan assets and total liabilities. Even more common is research relating overall funding levels and investment performance to governance practices (see for example, Albrecht & Lynch, 2007; Hess, 2005; Schneider, 2005; Schneider & Damanpour, 2002). Studies that do examine public pension employer contributions emphasized state fiscal condition as a primary predictor of state funding effort (e.g., Eaton & Nofsinger, 2004; Munnell et al., 2008d).

This dissertation builds on the existing empirical pension funding literature by constructing a framework by which to link the various pension reform categories to specific DB plan funding components. The framework applies a balance sheet-like approach to describe the state DB funding structure and process. With this framework, I derive hypotheses on the funding relationships between the reform-linked DB plan funding components and DB plan funding outcomes of interest. Specifically, the asset-liability framework is used to evaluate the hypothesis that increasing employer and employee contributions and reducing the annual cost of retirement benefit payments improves a plan's overall funded status.

Using a unique panel dataset of 100 state administered DB pension plans from FY 2002-2010, I empirically test my hypotheses with static Fixed Effects (FE) and dynamic GMM panel regression models. I find evidence that state DB plan sponsors underfunded their annual required employer contributions, and that employer contributions play a critical role in determining the overall plan funded status.

Organization of the Dissertation

The rest of the dissertation is organized as follows. In the next chapter, I review the five major pension reform categories identified by the Pew Center (2010b) by presenting the rationale and providing examples for each reform category. In Chapter 3, I present the asset-liability framework used in this study to describe the DB plan funding structure and process, and evaluate the relationship between the reform-linked DB plan

funding components and improved DB plan funding outcomes. I outline my data and research methods in Chapter 4 and discuss the results of my empirical analysis in Chapter 5. In Chapter 6, I extend the static empirical model from Chapter 5 by taking into account the dynamic adjustments in public pension funding. I report and discuss the results of a dynamic GMM panel regression model of plan stock funding ratios. In the last chapter, I summarize my findings, discuss future research prospects, and conclude by discussing the implications of my results in the context of efforts to reform public pensions given the current fiscal conditions of states.

CHAPTER 2

SELECTED POLICY REFORMS TO IMPROVE STATE DB PENSION

FUNDING OUTCOMES

In the introductory chapter, I highlighted the dismal and worsening financial outlook of DB state retirement systems and the saliency of these funding problems considering the significant role of public pension plans in the country's financial and labor markets. States have increasingly moved to consider and implement reforms to improve the funded status of their respective pension plans. As cited in the last chapter, The Pew Center on the States (2010a) identified five major areas where states are either considering or implementing reforms to address funding shortfalls, control the growth in liabilities, and restore their retirement systems on the path towards long-term solvency. In this chapter, I discuss the rationale behind the reforms and provide examples in each of the reform categories.

Keeping Up With Funding Requirements

As a policy reform strategy, tackling employer contributions involves assessing the plan sponsor's pension funding behavior. Unlike employee contributions, which are fixed by statute, employer contribution rates vary yearly depending on the actuary's assessment of a plan's funded status for a given period (Peng, 2008). Actual employer contributions are evaluated relative to the actuarially determined *annual required contribution* (ARC). This measure is normally expressed as a percentage of the plan's annual covered payroll (ACP) in nominal dollars. The ARC is equal to the amount needed to cover the value of employee services accrued in the current year and an amortization of any unfunded accrued actuarial liability.

Because states can choose to pay more or less than their ARC, the extent to which states meet their actuarially required contributions reflects both plan funding health and the plan sponsor's funding effort from a fiscal standpoint (GAO, 2008; Munnell et al., 2008d; Young, 2009).

The plan's ARC incorporates all the actuarial information including the costing methods and assumptions in measuring the plan's overall funded status and the funding requirement or target that the plan sponsor needs to contribute to maintain a desired funding outcome. Paying the full ARC every year signals that the state has set aside sufficient funds to cover currently accruing benefits and to pay down unfunded accrued benefits carried over from previous years. A failure to make the full ARC payment may reflect a variety of conditions that include the following:

(1) The state government is currently in a weak fiscal position to fully pay the required amount.

(2) The state government is either constrained or legally bound from paying the full ARC due to its funding policy. The most common funding policy requires employer contributions to be determined actuarially and for the full actuarial amount to be paid every year. Peng (2008) identified 34 states that adopted this policy but noted that it did not necessarily guarantee that the full actuarial amount was paid. States such as Alaska, Kansas, Massachusetts, and New Jersey, have actuarially determined employer contribution rates but their actual employer contribution is ultimately subject to various legal provisions such as caps on the rate of increase or legislative approval.

(3) Other states follow a funding policy based on a statutory contribution rate (Munnell et al., 2008d). States may adopt this funding policy for two reasons (Peng, 2008; p. 102): (1) to stabilize contribution rates over time rather than face an actuarial rate that fluctuates according to changes in plan funding; or (2) to correct for severe underfunding caused by historically low employer contribution rates. The latter reason involves raising the statutory contribution rate to bring the plan to a desired level of funding over a certain period. In order to mitigate shocks to the state budget, a gradual rate increase schedule is normally used to raise the contribution rate to the targeted actuarial rate.

(4) When a state contributes far and above its required employer contribution rate or what it contributes historically, it is attributed to either a one-time General

Fund appropriation or government borrowing. Issuing pension obligation bonds (POBs) and using the proceeds to pay off unfunded pension liabilities in one lump can be an attractive policy option for states that have severely underfunded retirement systems. Thomson Reuters Financial estimates state and local governments from 26 states issued a total of 340 POBs between 1993 and 2006 (Davis, 2006). Research on the use of POBs has yielded mixed results, and many of the case studies were limited to underscoring the poor design and mismanagement of POB issuances in the past (Burnham, 2003; McDonald & Cataldo, 2008; Peng, 2004; Williams, 2002).

Using cross-sectional data on 126 DB state and local pension plans from 2006, Munnell et al. (2008b) found that two-thirds of public plan employers fail to pay the full ARC due to legal constraints. They also identified lack of funding discipline, governance issues, and fiscal characteristics as other factors that affect ARC payment.

The NCSL compilation of 2010 state pension legislation shows at least seven states that enacted changes to their state DB plan employer contributions during the recent legislative cycle (Snell, 2010). Some of the changes involved direct increases in the employer contribution rate. For example, Iowa enacted concurrent increases in employer and employee contribution rates for its Peace Officer Retirement System and Public Employees Retirement System (IPERS). In 2010, states such as New Mexico and New York issued provisions to either delay contribution rate increases or introduce new amortization schedules for selected DB plans. Over the same period, differing funding policies were also implemented. For example, Rhode Island removed a statutory obligation of making certain payments to its state employee and teacher retirement systems whereas the Vermont legislature passed a law requiring full funding of its annual actuarial employer contribution requirement.

Increasing Employee Contributions

Unlike their private sector DB counterparts, public sector employees are required to contribute a percentage of their annual salaries to their respective DB plans (Munnell et al., 2007). On average, employee contributions are fixed at a lower rate than employer contributions but as fiscal pressures mount along with increasing employer contribution requirements, states are now looking towards their workers to pay a larger share in order to improve funding outcomes (Pew Center, 2010a, 2010b). Since 2008, half the states have enacted increases in member contributions (GAO, 2012a). In the 2010 legislative cycle alone, nine states enacted employee contribution rate increases compared to only five states in 2008 and 2009 respectively (Snell, 2008, 2009, 2010). A review of NCSL compiled pension legislation passed in 2010 showed that the kind and scope of legislated increases in employee contribution rates varied by state. For example, Minnesota enacted increases in employee contribution rates across the board for its general, public safety, and teacher employee members. In another example, Missouri introduced new contributory tiers for new members of the Missouri Department of Transportation and Highway Patrol Employees' Retirement System (MPERS), the Missouri State Employees' Retirement System and the retirement plan for judges. In their plan, employees hired after January 1, 2011 would make a pre-tax employee contribution of 4 percent of salary. Up until this legislation, Missouri plans were non-contributory.

Other states passed legislation that implements annual increases of the employee contribution rate over a specified period. For example, New Mexico enacted a 0.225% increase over a four-year period from 2005 to 2008 for members of its New Mexico Educational Retirement Fund; this started on July 1, 2005 at 7.675% of salary and increased to 7.9% of salary by July 1, 2008 (Snell, 2005).

Reducing Benefits

In this approach to reforming pensions, reducing the level of employee benefits improves plan funding by reducing the actuarial value of plan liabilities and

correspondingly the funding requirements. In practice though, states can only reduce or change the benefits for newly hired and future employees (GAO, 2010). This is because all states have strong legal protections for their pensions, either by constitutional provision or statute, that prevent benefits accrued by existing employees from being eliminated or diminished (Kaufman, 2007; Moore et al., 2000).

All the same, states are actively implementing changes to their respective defined benefit systems. A review of state pension plan enactments compiled by the NCSL from the 2010 legislative cycle reveals that twelve states reduced benefits for new employees in their defined benefit plans (Snell, 2010). Benefits were reduced through a variety of means that included adjusting the pension benefit formula and raising eligibility requirements such as increasing the retirement age (GAO, 2012a). For example, retirement multipliers were lowered for new employees of CalPERS and four of Louisiana's state DB plans. In Mississippi and New Jersey, provisions for longer service requirements were made. In Minnesota, the early retirement reduction factor was increased for newly hired members of its State Patrol Retirement Plan. In effect, the retirement annuity is reduced by a certain factor upon early retirement for each year that a person is short of normal retirement age. Another way states carry out benefit reductions is through increasing the number of years used in the final average salary (FAS) formula. For example, Iowa recently passed a law requiring the retirement benefits for new IPERS members to be calculated using five years of a member's highest salary instead of the current three years (Snell, 2010).

Post-retirement cost of living adjustments (COLAs) are another type of benefit enhancement that states are also trying to reform. Unlike their private sector DB counterparts, most DB public pension plans offer COLAs to reduce the impact of inflation on retirement benefits, a feature virtually unheard of in the private sector (Munnell & Soto, 2007). Depending on the plan, COLAs are either automatically based on a fixed rate or some percentage of the Consumer Price Index or awarded *ad hoc* at the discretion of the plan's governing body (Harris, 2002). The 2010 NCSL compilation of pension reform legislation identified eight states that dealt with inflation indexation

of retirement annuities (Snell, 2010). States such as Minnesota and South Dakota enacted provisional reductions in the COLA of retirement benefits contingent on the improvement of plan funding ratios. Other states such as Colorado extended the period after retirement before COLAs are allowed to kick-in whereas states such as Illinois removed the compounding feature for such provisions.

Whatever policy reform states undertake to reduce employee retirement benefits, states can expect to face legal challenges from their respective retirement system members and public employee unions (Moran, 2010). For example, Colorado and Minnesota which recently enacted reductions in member COLAs are now facing legal suits claiming that the reduction in benefits were a violation of contract (Snell, 2010).

As a whole, because the majority of policy reforms undertaken by states to reduce retirement benefits are limited to new and future employees, this approach to reforming pensions may not have a considerable impact in reducing the existing unfunded DB plan liabilities. At best, the empirical evidence suggests these reforms probably serve only to lessen the rate of plan funding deterioration. In calculating the financial impact of various benefit reduction strategies, Novy-Marx and Rauh (2011a) estimate that early retirement practices reduce liabilities by only 2 to 5 percentage points, 2 to 4 percentage points if retirement age is increased by one year. They calculate that reducing COLAs by 1 percentage point lowers liabilities by only 9 to 11 percent; and even if COLAs were eliminated altogether, they find that the aggregate unfunded liability would still reach around $1.5 trillion.[5]

Improving Governance and Investment Oversight

These types of reforms address how plan administration and board composition affect investment policies intended to improve plan investment returns and overall portfolio risk. Other issues associated with this policy area include the use of

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[5] In their simulations, the authors assume a baseline level of three trillion dollar in unfunded liabilities (Novy-Marx and Rauh, 2011a).

economically targeted investment (ETI) strategies; the application of ethical practices, reporting transparency; and "prudent investor" rules.

The relationship between plan governance and investment performance is one of the more relevant topics covered in the public pension literature mainly because investment income comprises the largest share of public pension plan revenues.[6] Data from the U.S. Census Bureau's *Survey of State and Local Government Retirement Systems* showed that from 2002 to 2010, half the average annual total revenues of U.S. public pension plans came from investment earnings (see Figure 2-1). The remaining portion of plan revenues came from employer contributions and employee contributions with an average share of 33 percent and 17 percent respectively.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
■ employee contributions	23.0	24.4	26.3	26.8	27.7	29.8	31.6	33.3	97.7
☐ employer contribution	32.1	37.4	49.3	45.7	49.6	57.6	64.1	64.8	64.7
☐ investment earnings	-63.5	68.2	264.1	220.9	248.9	401.0	-39.1	-524.0	290.0
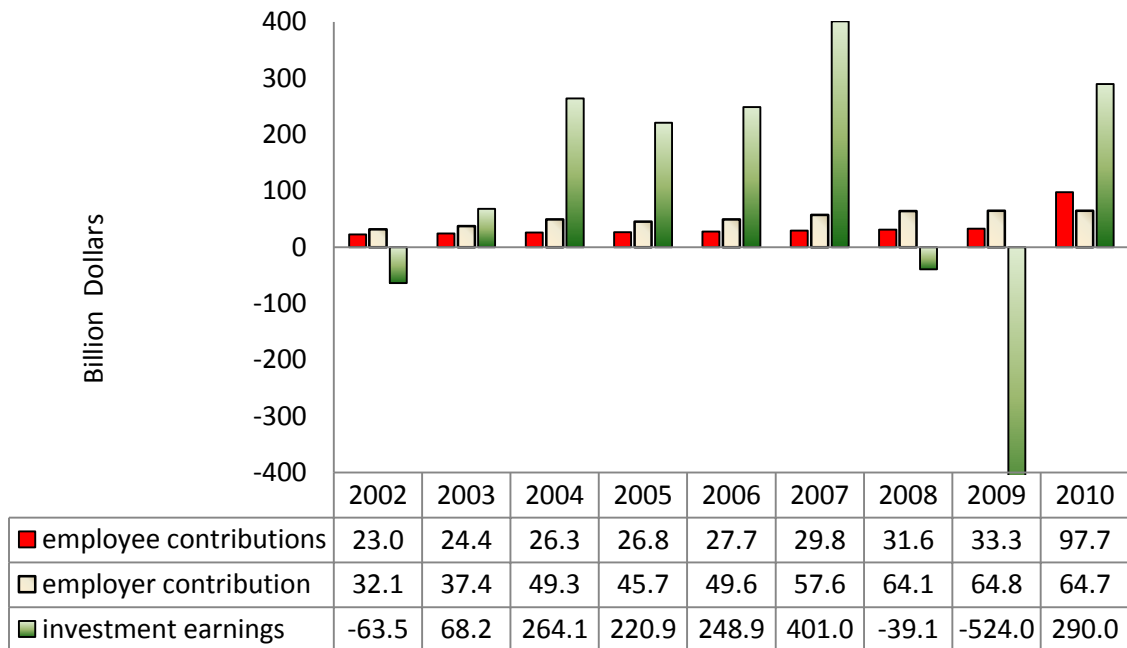
Figure 2-1. Total Annual Revenues for U.S. Public Employee Retirement Systems, by Revenue Source, FY 2002-2010 (Source: U.S. Census Bureau 2011)

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[6] For a comprehensive review of the literature on PERS investment performance, see Schneider (2005). Both Albrecht and Lynch (2006) and Albrecht et al (2007) provide an extensive empirical evaluation of both public pension plan governance and financial performance.

Governance issues can have a significant influence on DB plan funding outcomes because pension boards are directed to make decisions on investments, benefit levels, and actuarial assumptions (Coggburn & Reddick, 2006; Hess, 2005; Schneider, 2005). The way board size and composition determine decisions on investment policy and asset allocation is critical since studies have shown that asset allocation can explain up to 90 percent of the variability in the return on assets over time (Brinson et al., 1991; Ilkiw, 2003). Even so, the empirical literature on the effect of board size and composition on plan funding and investment performance has yielded mixed results (Schneider, 2005). Some studies show that a greater proportion of appointed trustees increases investment performance (e.g., Hess, 2005) and others find a negative, albeit non-significant, relationship (Albrecht & Lynch, 2006). Others such as Mitchell and Hsin (1997) and Murphy and Van Nuys (1994) submit that trustees elected by retired members negatively affect plan performance whereas Doyle (2005) contends retiree elected trustees have no impact on performance. A balanced board would seem to be the ideal arrangement since having a board dominated by one type of trustee (e.g., appointed/ex-officio or member elected) is counterproductive because it may prevent meaningful input from other trustee groups (Hess, 2005).

What is clear though is the definitive contribution of investment policy changes to the considerable growth of asset holdings in the public pension sector as a whole. Studies show that public pension plans with greater equity exposure in their portfolios tend to perform better. For example, controlling for differences in risk tolerances toward equity across plans, Doyle (2005) showed that plans with "a greater appetite for investment risk" (as evidenced by a plan increasing its stock limit policy) exhibited higher investment returns. Doyle argues his finding is consistent with basic finance theory on the positive relationship between risk and return and goes on to cite research showing the extensive impact of the equities market on public fund investment performance. This partly explains why the strong market performance in the 1990s led a growing number of state governments to increase the equity exposure of their plan asset portfolios as a way to solve underfunding problems, such that by 1996, the three

remaining states that banned equity investments lifted their respective prohibitions (Useem & Hess, 2001). By 2000, due to the strong and sustained stock market growth during this period, half of all state retirement systems were fully funded (Pew Center, 2007; Young et al., 2006).

Unfortunately, the period of impressive gains in equity asset values of public pension plans also saw numerous benefit enhancements enacted by state legislatures in the form of shortened vesting and service requirements, increased benefit formula multipliers, reductions in employer and employee contributions, coupled with abusive practices related to boosting employees' final pay earnings (CanagaRetna, 2004; Pew Center, 2010a; Schieber, 2011). A weakening economy that began in 2000 with the dot.com bust followed by the attacks of 9/11 saw the S&P 500 fall 16 and 19 percent in 2001 and 2002, respectively. With falling asset values and upward pressure on liabilities due to the cumulative impact of contribution shortfalls and benefit enhancements taking hold, state DB pension plan funding ratios started to decline along with a marked growth in unfunded pension liabilities. Because most plans apply multi-year asset valuation smoothing, the effect of poor investments returns from the 2001-2002 period were still being felt five years later in the funding levels of several state plans (Pew Center, 2007).[7]

Consecutive years of positive investment returns following the 2001-2002 financial crises help fuel a recovery in pension plan assets and overall funding levels steadily improved until the market once again collapsed in 2008. Munnell et al. (2008a) estimates that between October 2007 and October 2008, the value of equity assets for state and local defined benefit plans collectively declined by around $1 trillion. In response to substantial pension plan investment losses, several states are undertaking efforts to professionalize their investment oversight that include the use of specialized investment bodies separate from the board; selecting board members who have

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[7] Just as it was after the 2001-2002 stock market downturn, the impact of the 2008-2009 financial crisis will also be felt over time as most plans continue to apply asset valuation smoothing methods in order to minimize contribution rate increases that following such funding shortfalls (Munnell et al., 2010).

financial investment expertise and experience; and increasing the competitiveness of the procurement process and performance review of consulting and investing services (Pew Center, 2010).

Sharing the Risk with Employees

This reform category centers on state efforts to transition away from DB type plans toward defined contribution (DC) and *hybrid* pension plans. After experiencing severe investment losses in 2008, several states have considered revisiting this policy option as a way of improving the funded status of their retirement systems (Munnell et al., 2011b; Pew Center, 2010a, 2010b).

DC plans, which are far more prevalent in the private sector, differ from DB plans in several ways and some of their basic differences, along with a hybrid example, cash balance plans, are listed in Table 2-1. In a DB plan, retirement benefits are calculated using a predetermined formula utilizing actuarial evaluations of tenure, retirement age, and salary (Hustead, 2001); regular contributions are made by the DB plan sponsor and members, and fund assets are held in a trust and managed by professional investors (Munnell et al., 2007).

In contrast to DB plans, DC plans involve participants and/or sponsors making pre-specified contributions with the employee participant shouldering the risk of their own investment decisions (CanagaRetna, 2004). The future benefits received under a DC plan is a function of the contribution level and outcomes in the investment choices made by the participants (Munnell et al., 2008b). Proponents calling for public DB plans to shift to DC systems often cite cost containment, portability, and flexibility as a major benefit (CanagaRetna, 2004; Pew Center, 2007; Munnell et al., 2011b).

Other pension plans such as Cash Balance, Deferred Compensation, Deferred Retirement Option Programs (DROPs), or plans that incorporate a combination of DB and DC components, are referred to as *hybrid* systems.[8]

Table 2-1. Defined Benefit, Defined Contribution, and Hybrid Pension Plan Characteristics

	Traditional Defined Benefit (DB) Plans	Defined Contribution (DC) Plans	Common Hybrid Example: Cash Balance Plans
Funding / Contributions	Typically by employer only	Employee determines wage contribution rate; employer may also contribute	Employer
Financial Market Risk Borne By	Employer	Employee	Employer
Benefits Determined By	Formula based on years of service and final or highest average pay	Contributions (based on current wages) and investment returns on those contributions	Pay Credits (based on current wages and interest credits)
Enrollment and Vesting	Eligibility and participation are typically automatic. Participants may need to work up to 10 years for full vesting.	May require waiting for eligibility and sign-up by employee. May need to work up to 6 years to fully vest in employer matching contributions	Varies; depends on plan sponsor arrangement
How Benefits Are Typically Paid at Retirement and general risk associated	Typically payable as life annuities, but may have lump sum option. Annuities lose purchasing power if not indexed to inflation.	Lump Sum; typically by withdrawing from total balances, and must be managed to last throughout retirement.	Annuity or Lump Sum based on account balance of each participant
Access to Funds for Current Workers Prior to Retirement	No	Yes (through loans and hardship withdrawals)	No
Portability	Generally not portable. Sometimes unavailable until beneficiary reaches specified retirement age.	Portable; can be left in plan, rolled over to an IRA, or cashed out	

Source: Adapted from Gale and Orszag (2003); and GAO (2007)

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[8] For an overview of the different type of hybrid pension plans, see Coggburn and Reddick (2006, pp. 431-435). A more detailed discussion of cash balance plans is found in Rappaport et al (1997).

For most hybrid plans, the pension sponsor still retains the investment risk but reduces it in most cases by guaranteeing a relatively low rate of return associated with lower risk investments (Clark & Haley, 2001). In Ohio and Washington, state employees can opt to sign for a combined plan in which employer contributions fund a lower but guaranteed retirement benefit, while employee contributions are invested separately in a defined contribution plan (Pew Center 2007). Oregon adopted a similar hybrid approach to pension plan investing in 2003 when it allowed employees to invest in a portfolio mirroring that of Oregon's own DB plan and to date, 70 percent of Oregon's DC assets are invested this way (Olleman, 2007). According to The Pew Center (2007), Nebraska took note of Oregon's cost savings from the hybrid program and decided to adopt a cash-balance plan, in which employees and the state both make annual contributions and are guaranteed a 5 percent annual return. They found the plan works especially well for risk-averse employees who also prefer the convenience of not having to make their own investment decisions.

The differences between DC, hybrid, and DB plans, along with the debate over shifting away from DB public plans to address underfunding problems, has been extensively covered in the literature.[9] Giertz and Papke (2007) argue though that this debate has generally emphasized extraneous issues, and when actually directed toward underfunding issues, plan type ultimately does not matter because all plans can be modified accordingly. From the policymaker's perspective, the objective essentially is to shift the investment risk from the state government or plan sponsor to the plan member employee. Other factors that determine whether to pursue a DC and hybrid plans related to whether governments can save money by making the transition away from DB plans (Munnell et al., 2011b; Frank et al., 2011). One area where cost savings are expected from requiring new employees to join DC plans is from lower future DB payments as the number of DB plan members begin to diminish upon retirement (Fore

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[9] For a more comprehensive review of DC/Hybrid public pension plans, see Munnell et al. (2011b) and Frank et al. (2011). See also Beshears et al. (2011) for a behavioral economics perspective on the adoption of public sector DC and hybrid systems.

2001). Nevertheless, the empirical evidence from the few cases where states have introduced a DC system is that adopting a DC plan "does nothing to take care of unfunded obligations" (Olleman 2007, p. 5). The Pew Center (2007) similarly argued that shifting to a DC system does not ensure states will start adequately funding their pension plans. Furthermore, the transition away from a DB system brings up a common public sector human resources issue in relation to its impact on recruiting and retaining a quality workforce (Frank et al., 2011).

Consequently, despite the overwhelming private sector trend towards DC plans, DB systems are expected to remain dominant in the public sector due to the public pension regulatory environment and the nature of the public sector workforce (Almeida et al., 2009; Munnell et al., 2008b, 2011b). Compared to the private sector, the public sector workforce is older, more risk averse, less mobile, and more unionized (Munnell et al., 2007).

To date, DC and hybrid systems still make up a very small fraction of state and local pension plans and remain for the most part limited to new employees or as a voluntary or supplemental option for states that do offer them (Beshears et al., 2011; Pew Center, 2012).[10] Apart from Nebraska, which ran a DC plan as its primary retirement system from 1967 to 2002, no state has moved completely away from DB plans (The Pew Center, 2010a). According to Munnell et al. (2011b), since 1996, few states have adopted a primary DC or Hybrid Plan for new hires: Alaska and Michigan have "mandatory defined contribution" plans; five states have "mandatory hybrid" plans (GA, IN, MI, OR, and UT); and another seven states offer new employees a choice between DC or Hybrid as the primary plan. Furthermore, they report that from 2008 onwards, only Georgia, Michigan, and Utah have introduced new hybrid plans in which new employees accrue retirement income under both a DB and DC plan.

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[10] Beshears et al. (2011) cited findings from a 2009 *Pension and Investment* (Volume 38, No. 3, p. 13) survey of the top 1000 U.S. Pension Funds that showed, only 6 percent of total public plan assets were managed under a DC plan. The same survey showed 94 of the 222 largest public pension plans have a DC component, of which 38 were DC plans with over $1 billion in assets.

To date, empirical data on the financial impact of introducing DC/Hybrid plans on the overall funded status of state retirement systems is lacking. This is primarily due to the limited adoption of DC/Hybrid plans and the difficulty in making comparative evaluations across plans given the variety of contribution and investment arrangements. The research so far has failed to establish the willingness of current vested public employees to give up their highly coveted DB plan memberships and the (guaranteed) retirement benefits that accompany it. Additionally, several other factors also contribute to the lack of DC/Hybrid pension plan adoption in the public sector. Some of the more widely identified constraints were related to legal challenges, human resource implications, and the financial illiteracy of public employee participants (Frank, 2012).

Concluding Remarks

My discussion in this chapter of the various public pension reform efforts reflects the states' recognition of the serious fiscal implications if they fail to move their retirement systems on a path to long-term solvency. In reviewing the information provided by the National Conference of State Legislature (NCSL) database of annual enacted legislation summaries, the Pew Center of the States (2010a, 2010b, 2012) suggest a growing momentum for reform among the states based on the increasing number of legislative pension reform related initiatives passed in recent years. As introduced in the previous chapter, the Pew Center (2010a) categorized reform efforts into five broad areas: (1) keeping up with funding requirements; (2) increasing employee contributions; (3) reducing benefits; (4) improving governance and investment oversight; and (5) sharing the investment risk with employees through the adoption of Defined Contribution and Hybrid Plans.

I discussed the rationale behind each reform category and cited recently applied examples from information available in the NCSL database and various reports. The lack of data makes it difficult to evaluate the effectiveness of the reforms largely because

most of the reforms have been enacted fairly recently.[11] For now, most of the analysis

has been limited to studies that simulate the assumed impact of selected reforms in

order to project future funding levels (e.g., Novy Marx & Rauh, 2011b; Munnell et al.,

2010). Despite the simulation-type studies, questions remain about how effective all

the reforms will truly be in addressing the overall public pension funding situation when

the overwhelming majority of the reforms are applied solely to new and future public

employee hires. This is especially true for reform efforts related to reducing benefits and

increasing employee contribution rates which are generally established in state

constitutions or by statute (The Pew Center, 2010a).[12]

I found that apart from the Pew Center and NCSL reports, most of the discussion

over public pension reforms has been limited to presenting anecdotal evidence in case

studies and journalist reporting. When it comes to the related empirical public pension

literature, much of the analysis emphasizes plan funding and investment performance

as a function of plan governance practices and state fiscal factors. This is not surprising

given how overall funding levels of public pensions are largely determined by their

investment income, and the longstanding challenging fiscal environment states have

been operating under.

Granted that a direct empirical examination of each reform category may not be

feasible, a useful alternative for policymakers would be a holistic framework by which to

evaluate the rationale behind each reform category. While such a framework is

currently lacking in the public pension literature, it would be grounded on the premise

that all reforms have the general objective of improving the overall funded status of

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[11] A more feasible approach is to utilize an individual plan-level analysis that looks into a specific
reform and its impact on plan funding levels since a plan's actuary firm will likely have the data
needed to conduct a thorough actuarial valuation of future assets and liabilities. Just as likely
too, is that the state will have already commissioned the actuarial analysis prior to deciding on
initiating the legislative process.
[12] In the same report, the Pew Center (2010a, p. 31) cites Ron Snell, the lead administrator of
the NCSL database, as stating that judges frequently have held that states cannot modify
pension contracts with existing employees. "Once granted, a pension is a contractual obligation
of the employer, so that in most states it is impossible to cut the promise of a future benefit
(Ron Snell, "Pension Tension," State Legislatures, National Conference of State Legislatures,
May, 2008.)"

their respective retirement systems. The framework is used to show analytically how each reform category is linked to a specific DB plan funding component. From there, I derive hypotheses relating each reform category to improved funding levels through changes in the relevant funding components and its impact on selected DB plan funding outcomes. In the next chapter, I outline such an analytical framework that utilizes the DB plan funding structure and process to relate reform-linked-funding components to improved funding outcomes.

CHAPTER 3

USING A SIMPLE ASSET-LIABILITY FRAMEWORK TO EVALUATE STATE

DB PENSION FUNDING

In the last chapter, I discussed how an increasing number of states are enacting reforms in an effort to restore their respective retirement systems on the path towards long-term solvency. These reforms fall into five broad categories and deal with fulfilling employer funding obligations, increasing member contributions, reducing retirement benefits, improving investment performance through better governance, and introducing DC/hybrid plans that apportions more of the risk to the participating employee members. Despite the growing impetus for public pension reforms, implementation is still largely limited to new employees and future hires. Hence, the effectiveness of reform efforts to improve state DB pension funding outcomes is unclear at this point because it does not address the pension liabilities already accrued by the vast majority of vested public employee participants. Another challenge is the lack of empirical data on reform impacts to analyze as most reforms were enacted recently in light of the 2007-2009 financial crises.[13]

In this chapter, I outline a simple asset-liability framework to describe the basic structure and process of funding a typical DB state plan. I use this "balance-sheet like approach" to identify key funding components and incorporate the actuarial concepts and selected measures of pension plan funding. Instead of directly examining the impact of individual pension reform policies, I take the broad categories of reform strategies listed in Chapter 2 and show analytically how each category is linked or addresses a specific funding component. Within this framework, I present my hypotheses of how plan funding outcomes are affected by changes in the various funding components. Of interest is the impact on plan funding from increasing the employer and employee

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[13] Apart from the actuarial valuations, policy simulation studies that present projected funding impacts are more common. For example, see Munnell et al. (2011c) and Novy-Marx and Rauh (2011a).

contributions and reducing retirement benefit payments. Lastly, I highlight the fiduciary role that state governments have in ensuring the solvency of their respective DB retirement systems. Using my asset-liability framework, I model the impact on plan funding when states fail to keep with their employer contribution requirements.

Actuarial Valuation of Plan Assets and Liabilities

Prior to developing my analytical framework, I first give a brief overview of the actuarial valuation process and the relevant funding indicators. Consider first that the objective of DB plan funding is to build up a fund of investment assets from the contributions of both the government employer (plan sponsor) and employees (plan members), so that the income from and capital value of those assets are available to finance pension obligations upon the retirement of an employee (Blake, 2006a; Blake, 2006b). The required size and maturity structure of the fund's assets necessary to match the maturity structure of its liabilities are all determined actuarially.

Since 1994, the actuarial methods used in valuing state DB plan contributions, assets, and liabilities follow the accounting and financial reporting standards established under GASB Statements 25 and 27 (Peng, 2008).[14] GASB 27 details how plan sponsors are to measure and recognize the annual pension cost and unfunded liability and GASB 25 specifies the guidelines for reporting funding information in the financial statement (Peng, 2009). Below is a summary list by Munnell et al. (2008e, p. 3) of the GASB 25/27 guidelines and their corresponding parameters:

(1) Actuarial valuations are performed at least biennially, and present discounted value of future benefits should reflect all pension benefits, including ad hoc cost-of-living increases.

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[14] GASB Statement No. 25 "Financial Reporting for Defined Benefit Pension Plans and Note Disclosures for Defined Contribution Plans" and GASB Statement No. 27 "Accounting for Pensions by State and Local Government Employers" were issued concurrently in November 1994 in order to fill "a void that existed in accounting standards related to accounting and reporting pension costs" (Ruppel 2005, p. 220).

(2) Actuarial assumptions should incorporate actual experience and investment assumptions of expected long-term yield of plan assets.

(3) Annual required contribution (ARC) should include the cost of benefits accrued by plan member employees in the current year ("normal cost") plus an amortized portion of any unfunded actuarial liability.

(4) An acceptable amortization period (originally up to 40 years but reduced to 30 years in 2006) should be consistent with generally accepted accounting principles (GAAP). This amortization period is applied to both the plan's 'initial' underfunding and any subsequent underfunding created by benefit increases attributed to 'past service.'

Under GASB 25 and 27 public pension plan sponsors must recognize and disclose the following information in their financial statement: the fair value of plan assets; plan liabilities; plan net assets and annual changes in net assets; required employer and employee contributions; and historical information on the ratio of actual plan sponsor contributions to the plan sponsor's ARC. To summarize, the GASB 25/27 reporting framework generates two types of information: (1) current financial information about plan assets, and (2) financial activities and actuarial information that provide a long-term outlook on the plan's funded status and the progress in accumulating assets to pay obligations that become due (Peng, 2009; p321-322).

GASB Statement 34, issued in 1999 and widely implemented by FY 2003, further defined the inclusion of public pension plans in the fiduciary fund group by requiring states and local governments to prepare two sets of financial statements for their respective pension plans (Peng, 2009):

(1) A plan's current financial information appears in the Statement of Plan Net Assets and Statement of Changes in Plan Net Assets.

(2) The plan's long-term actuarial position is reported in two required schedules - the *Schedule of Funding Progress* and the *Schedule of Employer Contributions*.

Both sets of statements are prepared on a full accrual basis of accounting with a measurement focus on economic resources; all inflow and outflow of resources are recorded, as long as a monetary value can be attached to them. This means that all transactions occurring in the year having a financial impact on a plan are reported whether or not cash changes hands. This is different from governmental funds where the modified accrual basis of accounting places the measurement focus on current financial resources (Mead, 2000; as cited in Peng, 2009).

Actuarial Measures of Funded Status

Three measures are commonly used to evaluate the funded status of a DB plan derived from the abovementioned actuarial schedules (GAO, 2008). The first measure is the pension plan's funding ratio of plan assets to liabilities; or more formally defined as the ratio of *actuarial value of assets* (present value of accumulated plan assets) to *actuarial accrued liabilities* (present value of accrued plan liabilities). It is the most recognized measure of overall pension fund health or summary measure of funded status - indicating the extent to which a plan has sufficient assets set aside to pay accrued benefits (Mitchell et al., 2001, p. 25). The measure is also referred to as the "stock" funding ratio because it gives a snapshot of the plan's cumulative financial health at a moment in time (Mitchell & Smith, 1994; Yang & Mitchell, 2005). A ratio of one (or 100%) indicates that a pension plan is fully funded whereas a ratio less than one (less than 100%) represent an underfunded status.[15]

The second measure is the relative size of a plan's unfunded obligation for past service or unfunded actuarial accrued liability (UAAL). It is derived from the difference between the actuarial value of assets (AVA) and accrued actuarial liabilities (UAAL= AVA-

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[15] A funded ratio of at least 80 percent or more represents a commonly held normative view of what constitutes a "healthy or responsible" funding level for a public pension plan (e.g. GAO, 2007, Pew Center, 2007). D'Arcy and Dulebohn (1999) develop a simulation model that estimates plan-specific optimal funding levels for state retirement systems as determined by several factors that include the level and growth in pension obligations, the state's current and future tax base and interest rates.

AAL). The UAAL measure is commonly reported as a percentage of a plan's annual covered payroll to take into account the size of the pension plan (Peng, 2008).

A favorable funding ratio and UAAL measure represent the fundamental policy objective of pension reform. Let us suppose a state DB pension plan records some level of underfunding such that the funding ratio is less than 100 percent (AVA - AAL < 0). If the state government responds by enacting pension reform policy, the favorable funding outcome is manifested through an increase in the plan's funding ratio and a lowering of the unfunded liability measure.

The third actuarial measure is a pension plan's flow funding ratio which measures the retirement system's ability to meet its annual required contribution; or in other words, it reports the extent to which a plan sponsor is paying down unfunded obligations and keeping up with benefits as they accrue. This measure first defined for public pensions by Mitchell and Smith (1994) as the ratio of a plan's employer's actual contribution (AC) by the plan's annual required contribution (ARC) gives a "flow" perspective on whether the plan sponsor is "setting aside enough money each year to meet that year's [funding] requirements (p. 280)."[16] A flow funding ratio of less than one (less than 100%) indicates that the actual employer contribution (AC) made by the plan sponsor is less than the amount of their annual required contribution (ARC). In determining how well governments are meeting their plan's annual funding needs, contributing the full ARC each year is key to maintaining a fully funded plan, or in the case of an underfunded plan, necessary for getting the plan back on a path to long-term solvency. In more specific terms, paying the full ARC signifies that the plan sponsor has set aside sufficient funds to cover currently accruing benefits and the amortized portion of any unfunded liability carried over from previous years (Munnell et al., 2008e).

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[16] The term "required" can be misleading because governments can choose to pay more or less than the ARC (GAO, 2008).

Linking Reforms to Key DB Funding Components

Having provided an overview of the relevant GASB guidelines and the major actuarial valuation measures used in public pension accounting and financial reporting – flow funding ratio, stock funding ratio, the UAAL (%ACP) – I proceed to show these three measures, along with the employer contribution rate, serve as the key outcomes evaluated in my study of state DB plan funding. I start by incorporating these measures into an asset-liability framework that I use in describing the basic structure and process in funding a typical state DB plan (see Figure 3-1).
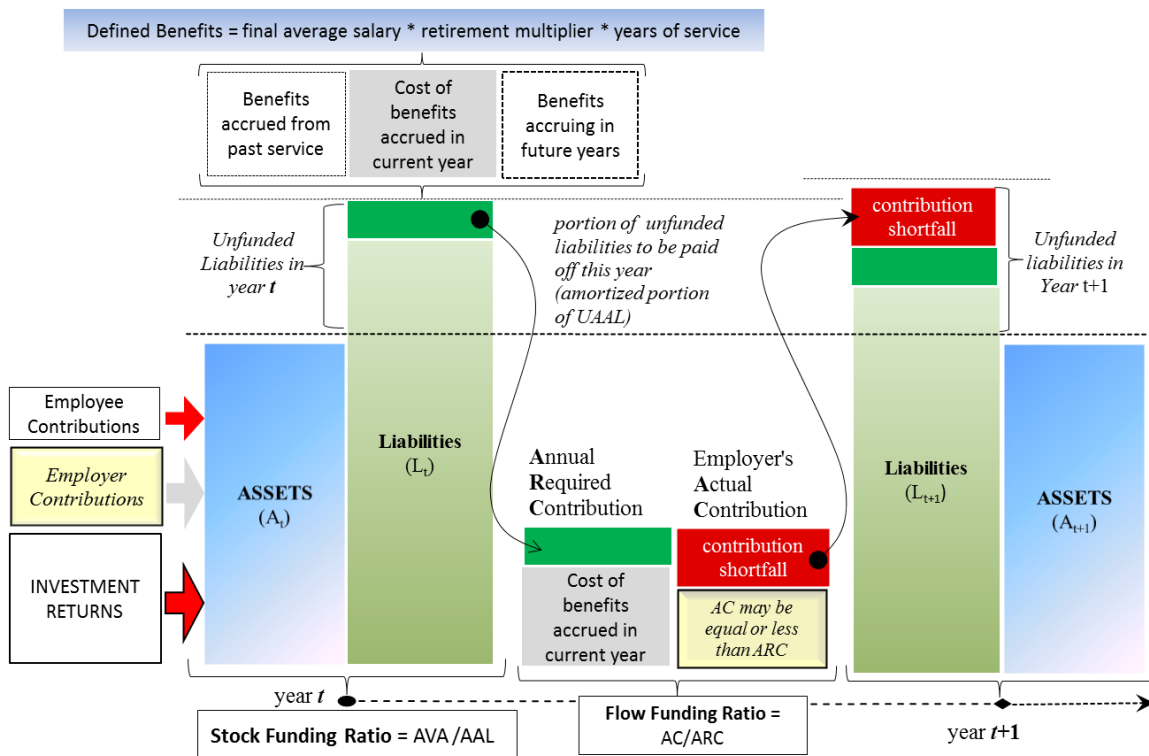
Figure 3-1. Increase in Unfunded DB Plan Liabilities Due to Deficient Employer Contributions (Note: AVA–Actuarial Value of Assets; AAL-Actuarial Accrued Liabilities; AC-employer's Actual Contribution; ARC-annual required contribution)

In summarizing the discussion from the previous chapter and extending it to this chapter, the general policy objective of the various categories of public pension reforms

is to improve state DB plan funding outcomes by accomplishing either increasing annual plan revenues and/or reducing plan expenditures. Data constraints may prevent the direct estimation of the actual impact of specific reforms, but each category of public pension reforms can analytically be tied to a specific DB funding component.

Components of State DB Plan Funding

I use a simple asset-liability framework as illustrated in Figure 3-1 to identify the key funding components of a typical state DB pension plan, and how each component is associated with a category of pension reforms. Using a "balance-sheet like" approach in describing the DB funding structure and process also provides the analytical framework for hypothesizing on funding outcomes due to changes in a specific DB plan funding component when addressed by a selected category of pension reforms.

Starting on the asset side, the three primary sources of annual pension plan revenues for a state DB pension plan are investment returns, employer contributions, and employee contributions. As noted in Chapter 2, investment returns represent the largest and most important source of annual pension fund revenues, a point illustrated in Figure 3-1, where *Investment Returns* is denoted with a much larger rectangular area compared to *Employee* and *Employer contributions*. Given the substantial revenue share from investment income, the overall funded status of public DB plans is tied closely to plan investment performance, which in turn, is a function of the asset allocation decisions made by the DB plan sponsor and the overall condition of the capital markets. State governments that introduce or consider defined contribution or hybrid plans for their new employees, do so as a way of transferring some if not all the risk of investment loss, along with the contribution burden, from the plan sponsor to the plan employee.

Despite all the consideration for introducing DC plans, DB pension plans will continue to dominate in the public sector given the 90 percent of currently employed public employees covered under DB retirement systems. As such, it is more likely that the majority of reforms related to pension investment performance are geared towards improving DB plan governance and investment oversight. The effectiveness of these

reforms will be judged according to the degree they improve plan investment performance given the conditions of the financial market and overall macroeconomic environment.

The annual revenue derived from investment income may be stochastic in nature but the level of employer and employee contributions, and the size of retirement benefits, are much more deterministic. The latter two are mainly defined by statute whereas the former depends on the plan sponsor's contribution behavior. Going back to Figure 3-1 as our illustration, the policy objective of reforms addressing any of the three annual revenue sources is akin to increasing the size of actuarial asset values as represented by the size of both rectangles denoting plan assets, A_t and A_{t+1}. One can see then how the overall funded status of a DB pension plan, as indicated by its stock funding ratio, is improved by implementing reforms related to increasing annual plan revenues. By increasing plan revenues, the size of actuarial asset values increases relative to plan liabilities, and *ceteris paribus*, this results in a higher stock funding ratio and reduces the size of a plan's unfunded liability.

I start defining the liability side of my framework by first considering that a defined benefit retirement system guarantees the plan member a set level of pension benefits calculated from an actuarial formula that includes the years of service, the employee's final average salary, and some pre-determined retirement multiplier (Hustead, 2001).[17] From the plan sponsor's perspective, the annual benefits paid out to plan retirees, usually through life annuities, represent the plan's primary cash outflow or expense in the current period. In FY 2010, retirement benefit payments comprised 94 percent of all public pension plan expenditures (Becker-Medina, 2012). As illustrated by the rectangular areas L_t and L_{t+1}. in Figure 3-1, the total actuarial value of liabilities in current year t includes not only the benefit payments made to current retirees but the

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[17] DB plan commonly employ the *final average* method in which the pension paid is derived from the average of the final 3 to 5 years of employment. A survey study by Brainard (2007) found that the median FAS retirement multiplier rate for DB public pension plans with and without Social Security coverage was 1.9% and 2.2% respectively. Approximately a fourth of public employees do not participate in Social Security, including 40 percent of public school teachers and a majority of public safety personnel (Brainard, 2011).

benefits accrued from past, current, and expected future service of active employees as well. When applied to Figure 3-1, reforms that attempt to reduce the cost of retirement benefits is analytically equivalent to reducing the area of rectangles L_t and L_{t+1}. By extension, just as it was on the asset side, reforms that attempt to reduce the size of a plan's total retirement benefit payments translates into lowering the actuarial value of plan liabilities, which holding plan assets constant, likewise results in a higher stock funding.

However, as often is the case with theory and application, the actual effectiveness of the various public pension reforms is difficult to gauge given the lack of data at this point. Still, if we consider the relatively fixed and smaller annual revenue share of employee contributions compared to investment income, addressing the former will likely be a less effective policy reform option. The effectiveness of improved funding outcomes from reforms related to reducing benefits are also questionable given their strong legal protections that makes it less likely that states will be able to apply these kind of policies beyond new hires. This then leaves us with the category of reforms that address how the plan sponsor fulfills its annual contribution requirements. To highlight the critical function that employer contributions play in DB pension plan funding outcomes, I describe the most common case characterizing DB public pension plans – that of being underfunded.

Applying the Framework to a Two-Period Model of Underfunding

We can use the asset-liability framework illustrated in Figure 3-1 to derive a general hypothesis of retirement system underfunding that relates employer contribution behavior with the overall funded status of a DB public pension plan. Specifically, I show how a failure by the plan sponsor to fully meet its annual employer contributions leads to further deterioration in funding outcomes. Let us assume a single investment horizon from year t to year $t+1$ for an underfunded state DB plan; that is, AVA<AAL and the plan incurs an unfunded liability (UAAL), where t denotes the year in which assets are invested with an interest income earned beginning year $t+1$, and so on. The investment

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income combined with employee and employer contributions constitutes the total pension revenue for the current period.

Now, if the state pays the full ARC for year *t*, *t+1*, and so on, then a portion of the UAAL is paid off each year as part of a series of deficiency payments over a specified amortization period. Paying the full ARC demonstrates that the state has allocated sufficient assets to cover currently accruing benefits along with a portion of any unfunded liability carried over from year *t-p* periods. If the state fails to pay its full ARC in year *t*, a contribution shortfall occurs and gets carried over to the next period; hence, increasing the plan's net pension obligation. Thus, a high ARC value may imply that the cost of benefits are relatively high or signal the cumulative negligence of the plan sponsor in making its annual employer contribution commitment.

Holding investment returns constant and *ceteris paribus*, the state will now have to allocate additional funds on top of its annual contribution. In order for the UAAL to be amortized on schedule along with the interest incurred on any net pension obligation, the employer contribution rate will need to increase in subsequent years starting from year *t+1.* If we extend this asset-liability framework to account for multiple periods, the plan's unfunded liability will likely grow over time if the plan sponsor continues to fail in meeting its full actuarial funding requirement.

An applied test of this framework will allow us to evaluate two empirical questions on the employer contribution behavior of state DB plans. The first is related to how well states have met their annual employer contribution requirements. The second is related to testing the hypothesis that employer contribution behavior is positively related to the overall funded status of state DB plans. Answering both questions might yield new insights into the fiduciary role of state governments as DB plan sponsors.

Concluding Remarks

In this chapter, I outlined a simple asset liability framework that incorporated relevant financial and actuarial concepts to describe the funding structure and process, and evaluate funding outcomes of a typical state DB pension plan. Four key funding

components were identified. The first three components make up the asset side, with investment income and contributions from member employees and the plan sponsor as primary sources of annual plan revenues, whereas the fourth funding component on the liability side is comprised mainly of retirement benefit payments.

This "balance-sheet like" approach to describing the state DB funding structure and process also provides the analytical framework by which to link the various categories of pension reforms with a specific funding component. From here, I derived hypotheses on the outcomes from changes in the funding components affected by selected categories of pension reforms. I showed how the funded status of state DB plans, as indicated by the stock funding ratio and the relative size of unfunded liabilities, is positively related to increases in the employee and employer contribution rate and reductions in retirement benefit payments. Lastly, I applied this framework to model the impact of employer contributions on the overall funded status of a DB plan. I showed how the overall funded status of a plan can deteriorate over time if the DB plan sponsor, in this case, the state government, fails to make the full ARC payment each year. In the next chapter, I present the empirical methods for testing these hypothesized DB plan funding relationships.

CHAPTER 4

RESEARCH METHODS

In the previous chapter, I presented a simple asset-liability framework for describing the structure and process of state DB retirement system funding with key components and outcomes identified. The framework was used to develop the study's hypotheses for relating the effect of increasing employer and employee contributions and reducing benefits on key DB plan funding outcomes. In this chapter, my empirical analysis for testing these hypothesized funding relationships is divided into two parts. The first part takes into consideration the fiduciary responsibility of states in ensuring the solvency of their respective retirement systems. How well the state government fulfills this responsibility is reflected by its actual employer contributions relative to the annual required contributions (ARC) as determined by system actuaries. I present an empirical model that evaluates the determinants of employer contribution rates and flow funding ratios, and test the hypothesis that states have underfunded their annual employer contributions. The second part of my analysis draws from my analytical framework that considers the three general categories of pension reform efforts related to key DB funding components, specifically, increases in employer and employee contributions and reductions in retiree benefits. I discuss my empirical model for testing the hypothesized relationship between these funding components and the funded status of a plan as indicated by the stock funding ratio and size of unfunded actuarial accrued liabilities.

In the last part of this chapter, I describe the construction of my panel dataset and sample of state DB pension plans. I provide an overview of the panel regression methods, present summary statistics, and discuss general trends in my models' dependent and explanatory variables of interest.

Empirical Model

In this study, I examine four funding outcomes of state DB retirement systems: (1) the employer contribution rate, (2) the flow funding ratio, (3) the stock funding ratio, and (4) the size of a plan's unfunded actuarial liabilities. For each outcome, I specify a panel regression model that takes the general form:

$$funding_{i,t} = \alpha + \beta \boldsymbol{k}_{i,t} + \gamma \boldsymbol{C}_{i,t} + \lambda T_t + \eta_i + \varepsilon_{it}$$ (eq. 4-1)

Where i=1,2,…,100 refers to each of the 100 state pension plans in my panel dataset; t=2002,2003,…,2010 denotes the time period in years covered in my analysis, resulting in a panel with dimensions $N \times T$, where N=100 and T=9; $\boldsymbol{\kappa}_{i,t}$ is the matrix of explanatory variables observed for plan i in year t; $\boldsymbol{C}_{i,t}$ contain the control variables comprised of selected plan-level characteristics and state fiscal measures respectively; and $funding_{i,t}$ is the DB state funding outcome or the dependent variable of the specified model.

The term $\eta_i + \varepsilon_{i,t}$ represents the composite error $\mu_{i,t}$, where $\varepsilon_{i,t}$ is an independently distributed error term with $E[\varepsilon_{i,t}]$=0 for all i and t, and refers to all the unobserved factors affecting plan funding outcomes that change across time as well as across plans; η_i captures all unobserved time-invariant factors that affect a plan's funding outcome. Since i denotes a unique pension plan, we also call η_i the plan fixed effect. Finally, T_t is a vector of year dummy variables to capture year effects common to all state DB plans. In other words, my models control for any unmeasured universal time-related shocks or national factors that may have influenced all state DB plans over the study period.

I direct the first half of my empirical analysis on the determinants of state DB pension employer funding behavior. To test the hypothesis that states have underfunded their annual employer contributions, a panel regression model of employer contribution rates (Model 1, see eq.4-2) and a model of flow funding ratios (Model 2) are specified in eq. 4-2 and eq. 4-3 respectively:

Model 1: the dependent variable is the employer's actual contribution rate ($ac\_acp_{i,t}$), expressed as a percentage of the plan's annual covered payroll

$$ac\_acp_{i,t} = \beta_0 + \beta_1 (memcon\_acp_{i,t}) + \beta_2 (lnaveben_{i,t}) + \beta_3 (stock_{i,t})$$
$$+ \beta_4 (arc\_acp_{i,t}) + \gamma C_{i,t} + \lambda T_t + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 4-2)}$$

Model 2: the dependent variable is the plan's flow funding ratio ($flow_{i,t}$)

$$flow_{i,t} = \beta_0 + \beta_1 (memcon\_acp_{i,t}) + \beta_2 (lnaveben_{i,t}) + \beta_3 (stock_{i,t})$$
$$+ \beta_4 (arc\_acp_{i,t}) + \gamma C_{i,t} + \lambda T_t + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 4-3)}$$

where $memcon\_acp_{i,t}$ is the employee contribution rate expressed as a percentage of the annual covered payroll; $lnaveben_{i,t}$ is the logarithm of a plan's average benefit payment; $stock_{i,t}$ is the plan's stock funding ratio and $arc\_acp_{i,t}$ is the annual required contribution rate expressed as a percentage of annual covered payroll. For this part of the empirical analysis, we are interested in evaluating the estimated coefficient result for $arc\_acp_{i,t}$ to see if there is evidence for our hypothesis that states have underfunded their employer contributions.

In the second part of my analysis, I specify another two panel regression models (see eq. 4-4 and eq. 4-5) to examine the relationship between the key funding components of a DB state plan and its overall funded status as indicated by the stock funding ratio (Model 3) and unfunded actuarial accrued liabilities (Model 4):

Model 3: - the dependent variable is the plan's stock funding ratio ($stock_{i,t}$)

$$stock_{i,t} = \beta_0 + \beta_1 (memcon\_acp_{i,t}) + \beta_2 (lnaveben_{i,t}) + \beta_3 (ac\_acp_{i,t})$$
$$+ \beta_4 (made\_arc_{i,t}) + \gamma C_{i,t} + \lambda T_t + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 4-4)}$$

Model 4: the dependent variable is the relative size of a plan's unfunded actuarial accrued liability ($uaal\_acp_{i,t}$), expressed as a percentage of the plan's annual covered payroll

$$uaal\_acp_{i,t} = \beta_0 + \beta_1 (memcon\_acp_{i,t}) + \beta_2 (lnaveben_{i,t}) + \beta_3 (ac\_acp_{i,t})$$
$$+ \beta_4 (made\_arc_{i,t}) + \gamma C_{i,t} + \lambda T_t + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 4-5)}$$

Where $ac\_acp_{i,t}$ is the employer contribution rate; and $made\_arc_{i,t}$ is a dummy variable to indicate whether the plan made its full annual required contribution;

memcon_acp$_{i,t}$ and *lnaveben$_{i,t}$* are the same explanatory variables used in Models 1 and 2. Additionally, all four empirical models use the same set of control variables $C_{i,t}$ comprised of selected plan-level characteristics and state fiscal measures, respectively. These include *actret$_{i,t}$*, a control for plan member composition between active and retired plan members; *assumedret$_{i,t}$* the selected discount rate used in the actuarial asset valuation; and *historicalret$_{i,t}$* the one year actual rate of return on investments.

Here, the empirical strategy builds on the proposition derived from my analytical framework that we can evaluate the funding of certain categories of pension reforms by first associating each type of reform with a specific DB funding component. Through this approach, I test the hypotheses that reforms related to increasing employee and employer contributions positively affect state DB plan stock funding ratios and reduce plan unfunded liabilities, and that the same effect, is expected from reforms that reduce the size of retirement benefit payments.

Dependent Variables

In this section, I review the empirical literature behind the dependent variables specified in my panel regression models; where each of the four dependent variables represents a key DB funding outcome as described in Chapter 3.

Employer Contribution Rate and Flow Funding Ratio

Model 1 is used to analyze the determinants of employer contribution behavior. The dependent variable is the plan sponsor's annual actual *employer contribution rate*, expressed as a percentage of the plan's payroll. To obtain this variable, I first collect data on the total employer contribution amount made for each state DB plan as indicated in the CAFR *Statement of Changes in Plan Net Assets* section. I then divide this amount by the plan's annual covered payroll to scale it according to plan size and standardize it according to the ARC measure as defined under GASB 25.

The public pension funding study by Mitchell and Smith (1994), who analyzed cross-sectional 1989 data on per-worker actual and required employer contributions of 42 public pension plans from 31 states, is the only known empirical evaluation which directly looks at the determinants of actual employer contributions. Mitchell and Smith

(1994) hypothesized that actual employer contributions are characterized by either behavioral persistence or regression-to-the-mean funding behavior. The former implies that past long-term funding behavior produces a positive unitary relationship with flow funding. The latter predicts periods of underfunding and overfunding follow each other, resulting in an offsetting or non-significant relationship between stock funding and employer contribution efforts. They also found that while stock funding positively affects current employer funding, it is not a unitary relationship. They suggested that employer funding in public pension plans exhibit some form of behavioral persistence attenuated by a regression-to-the-mean funding behavior.

Young (2008) provides a more recent discussion of PERS employer contribution rates as defined in this study. Employer contribution rate volatility is traced to the failure of governments to make the necessary annual required contributions; unfunded and ad-hoc retirement benefit increases; and the pursuit of higher risk and higher return asset allocation strategies. [18] Young (2008) goes on to discuss examples of strategies and practices carried out to mitigate rate fluctuations. These include spreading or smoothing asset gains and losses over longer periods; requiring minimum contribution rates; and restricting rate changes. Nevertheless, Young (2008) argues that despite efforts to limit employer contribution rate volatility, "as long as investments by public retirement systems continue to emphasize higher-risk, equity asset classes, some volatility will remain" (p. 83).

As employer contributions make up one of three major sources of annual pension fund revenues, the employer contribution rate is specified in Models 3 and 4 as an explanatory variable of stock funding and unfunded plan liabilities, respectively. On the surface, greater employer contributions should translate into higher funding levels. This positive relationship was posited by Doyle (2005) who used a pooled five-year cross-sectional dataset of SLG pension plans but found instead that an increase in the

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[18] Young (2008) gives examples of governments who instituted contribution holidays during periods of above-average investment returns.

employer contribution rate was associated with a lower stock funding ratio.[19] Although

Doyle (2005) fails to discuss their result, it suggests that the funding relationship

between the employer contribution rate and stock is more of an endogenous process in

which the plan sponsor contributes more in order to cover any funding shortfall as

indicated by a lower stock funding ratio.

Building on the first dependent variable, the flow funding ratio is the second

dependent variable analyzed. As defined in the Chapter 3, it is simply the ratio of a

plan's actual employer's actual contribution (AC) to its annual required employer

contribution (ARC). To obtain this measure, I first get my ARC data from the state or plan

CAFR *Required Schedule of Employer Contributions* section, which will often include

information as well on the actual employer contribution and/or the flow funding ratio or

percentage contributed as required under GASB 25 (Peng 2008). This "flow" pension

funding measure was first defined in Mitchell and Smith (1994), and Mitchell and Hsin

(1997) were the first to empirically examine its determinants. The authors used a cross-

sectional survey of 269 SLG pension plans from 1991 and specified a model of flow

funding with explanatory variables covering five categories: pension board composition,

board management practices, investment practices, reporting requirements, and

assumptions. Their results showed that only board member liability insurance coverage

and board authorized actuarial assumptions were found to significantly affect the flow

funding ratio.

In their review of the empirical pension funding literature, Yang and Mitchell (2005)

noted that most of the studies analyzed cross-sectional data using single equation

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[19] The dataset used by Doyle (2005) to evaluate stock funding is commonly referred to as the "PENDAT" files, made up of a series of periodic surveys conducted by the Public Pension Coordinating Council (PPCC) to determine the funded status of SLG pension plans from the following years: 1990, 1991, 1992, 1994, 1996, 1998 and 2000 (Harris, 2002). When pooled, the PENDAT files formed an unbalanced panel dataset that ranged from a sample of 124 plans surveyed in FY 1990 to as many as 228 plans surveyed in FY 1996. Doyle's PENDAT sample consisted of the following fiscal years (1992, 1994, 1996, 1998, and 2000). The Public Pension Coordinating Council was a confederation of three national associations serving state and local government retirement plans: The National Association of State Retirement Administrators (NASRA), The National Conference on Public Employee Retirement Systems (NCPERS), and The National Council on Teacher Retirement (NCTR).

models. They argued that prior studies failed to account for endogeneity of plan funding and investment performance such that funding results in one year may be related to lagged funding measures. According to Yang and Mitchell (2005), they address these econometric issues by running pooled OLS on seven years of PENDAT survey results using the same flow funding and stock funding model from Mitchell and Hsin (1997).[20] Yang and Mitchell (2005) found that a one percentage point increase in the stock funding ratio was associated with a 0.45 percentage point increase in the flow funding ratio. They suggested that the positive but less-than unitary relationship between stock and flow funding lends support to Mitchell and Smith's (1994) conclusion that public pension funding persistence is attenuated by mean reversion effects. Yang and Mitchell also found a positive relationship between flow funding plans that assumed a longer amortization period for accrued liabilities; and plans having more retirees as board members, and states having a dedicated tax for financing pension contributions, have a negative effect on flow funding.

   Using the same PENDAT dataset, Eaton and Nofsinger (2004), as part of their analysis of flow funding ratios, proposed an adjusted flow funding measure that standardized the required employer contributions to account for differences in the actuarial asset valuation assumptions used by the public pension plans in their sample.[21] In comparing their adjusted flow funding measure to the regular unadjusted flow funding measure along with the rest of their analysis, they found evidence that actuarial assumptions, particularly the salary growth rate and discount rate, were manipulated for plans in states experiencing high political pressure and fiscal stress.

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[20] Yang and Mitchell (2005) use the same PENDAT files as Doyle (2005), but add two more years of survey results from 1990 and 1991.

[21] Eaton and Nofsinger (2004) assume an equivalent salary growth rate (5.99%) and discount rate (7.86%) to standardize required contribution levels. From an ex-post perspective, their rationale is valid since their pooled cross-sectional sample covered fiscal years 1990 to 1996, a period prior to the implementation of GASB 25 and 27 that standardized public pension accounting and reporting (Steffen, 2001). Since the data I use are from subsequent periods wherein CAFRs are prepared according to these GASB standards, I assume the ARC values in my flow funding ratios are sufficient and valid for comparing across plans.

My flow-funding ratio is also specified as an explanatory variable in Models 3 and 4, but instead of using the ratio measure as is, I specify a dummy variable indicating if the plan employer paid at least 100 percent of its ARC for that given year. The model predicts higher stock funding ratios and less unfunded liabilities for plans that make the full ARC payment compared to plans that fail to pay their full ARC. The hypothesis draws from my analytical framework in Chapter 3 where I directly relate a plan's overall funded status to the degree by which the public plan sponsor is making its ARC payments. For this particular dummy variable indicator of flow-funding dummy, its determinants were examined by Munnell et al. (2008d, 2011c) for two separate fiscal years (FY 2006 and 2008) using cross-sectional data on 126 SLG plans from the NASRA and NCTR Public Funds Survey (PFS) and Public Plans Database at the Center for Retirement Research at Boston College (CRC).[22] Both studies, using similarly specified probit regression models, found that a higher state debt to GSP ratio, and the use of projected-unit-cost (PUC) actuarial valuation method, made it less likely for a plan sponsor to make 100 percent of its ARC payment. Having a large public pension plan, a larger proportion of active to retired employees on the pension board, and Social Security coverage for plan members, were the other factors associated with a lower likelihood of a full ARC payment being made.

Stock Funding Ratio and UAAL as a % of ACP

By definition, since UAAL=AVA-AAL, the plan's stock funding ratio (Model 3 dependent variable), computed as the ratio of a plan's actuarial value of assets (AVA) to its accrued actuarial liabilities (AAL), is used to derive the dependent variable for Model 4, the size of a plan's unfunded liabilities, expressed as a percentage of its annual

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[22] For FY 2006 as analyzed in Munell et al. (2008d), data came from the Public Funds Survey is sponsored by the National Association of State Retirement Administrators and the National Council on Teacher Retirement. The database is maintained by Keith Brainard, NASRA Research Director, and accessed from http://www.publicfundsurvey.org. It is more or less an offshoot of the PPCC PENDAT files that covered public pension funding from 1990 to 2002. For FY 2008 as analyzed in Munnell et al. (2011c), data came from the Public Plans Database, which is produced and maintained by the Center for Retirement Research at Boston College, and whose director is Alicia H. Munnell. The database, available at http://crr.bc.edu/data/public-plans-database/, is co-sponsored by the Center for State and Local Government Excellence (CSLGE).

covered payroll (uaal_acp). Data for all variables comes from the state or plan CAFR *Required Schedule of Funding Progress* section.

A review of the pension funding literature shows that apart from the pension fund performance and governance, the stock funding ratio is the most commonly evaluated pension funding measure (Schneider, 2005). Just as it was with studies that examined flow funding ratios, the majority of studies that examined stock funding ratios were based on estimating cross-sectional data with single equation models (Yang & Mitchell, 2005). Recent examples in the literature include Munnell et al. (2011c, 2008d) who analyze stock funding ratio data from 126 plans for fiscal years 2006 and 2008 separately.[23] Both studies showed that lower stock funding was associated with plans using the PUC actuarial valuation method and when teachers were included in the plan. Conversely, larger plans and plans having a separate investment council positively influenced stock funding ratios. The former result is interesting because it complements my hypothesis on the relationship between stock and flow funding. As Munnell (2011c, 2008a) reported, larger plans having more assets were associated with lower flow funding ratios. When considered altogether, the results suggest that that plans having more assets, holding all else constant, translates into a higher stock funding ratio, and in turn, results in a lower required employer contribution rate. However, the plan sponsor ends up contributing even less because it assumes continuing favorable investment returns in the future.

Results from several longitudinal pension funding studies have provided insight on the temporal aspects of various stock funding determinants. In relating those results to the explanatory variables specified in my own empirical model of stock funding, the literature provides evidence of the significant influence of the following determinants: plan member composition (Giertz & Papke, 2007, Eaton & Nofsinger, 2008); investment rate of return (Yang & Mitchell, 2005); discount rate (Doyle, 2005), and various fiscal

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[23] The two studies utilized the same set of pension funding data used in analyzing flow funding ratios analyzed in Munnell et al (2011c and 2008a).

indicators such as the per capita tax revenue (Giertz & Papke, 2007), the ratio of interest paid to revenue (Eaton & Nofsinger, 2008), and debt to GDP income ratio (Doyle 2005).

Following Mitchell and Smith's (1994) behavioral persistence hypothesis of pension funding that relates a plan's cumulative financial health with current funding efforts, I use the stock funding ratio as an explanatory variable in Models 1 and 2 in determining both the actual employer contribution rate and flow funding ratio. Based on this hypothesis, we would expect stock funding to positively influence both indicators of public pension plan employer contribution behavior. [24]

My fourth and last dependent variable is the unfunded actuarial accrued liability, expressed as a percentage of the plan's annual covered payroll (*uaal_acp*). When we consider that this indicator has been available in state and plan CAFRs since 1997 as part of GASB 25, it is surprising to find that an empirical assessment of this unfunded liability measure is lacking in the literature. To date, the only econometric study that focuses solely on the determinants of unfunded pension liability is that by Coggburn and Kearney (2010) who examined the per capita unfunded pension liability at the state level of both regular pension and other post-employment benefits (OPEBs). Using cross-sectional data from the Pew Center on the unfunded pension liability of all 50 states for FY 2007, the authors found a positive relationship between a state's per capita unfunded pension liability with the employer contribution rate, public employee density per 10,000 population, state per capita personal income, and the ratio of state interest payments to total revenue. A novel contribution of the study was to examine the managerial influence of state administrators on state pension unfunded liability. Using indicators from the Governance Performance Project, Coggburn and Kearney's (2010) analysis suggested that states with better financial management capacity and human resource management were associated with lower unfunded pension liabilities.[25]

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[24] See Mitchell and Hsin (1997), Mitchell and Smith (1994), and Yang and Mitchell (2005)
[25] Barrett, K. and Greene, R. 2005. "Grading the States '05: The Year of Living Dangerously." *Governing*, 18(5): 24–95, as cited in Coggburn and Kearney (2010).

Explanatory Variables

The explanatory variables in my panel regression models are drawn directly from the asset-liability framework in Chapter 3. Each of the variables is hypothesized to directly affect the DB public pension funding outcomes, they are specified as follows: the plan's *employee contribution rate* reported as a percentage of the plan's annual payroll; the *logarithm of average plan benefit payments*; and the *one-year rate of return on investments*. I also include as additional predictors, the plan's *stock* funding ratio and *annual required contribution* rate for my pension funding model of employer contribution rates (Model 1) and flow funding (Model 2).

Employee Contribution Rate

In theory, if we were to hold the number of active plan members constant, increases in the employee contribution rate (*memcon_acp*) increases the amount of revenue inflows and would thus be expected to have a positive effect on a plan's overall funded status. Alternatively, if we take the perspective that the plan sponsor increases the member contributions to reduce the ARC, then the effect of increasing the employee contribution rates is to shift the more of the pension cost burden from the employer to plan members (GAO 2012a).

State DB plan employee members normally contribute a statutorily set percentage of their annual wage. Most state plans administer multi-tiered employee contribution rates, where new plan members are required to contribute at a higher rate than older members do. Because it requires access to relevant member and rate information, an ideal but less feasible approach would be to compute the plan's average employee contribution rate. For the purpose of this study, I use the aggregate plan employee contributions as reported in the CAFR *Statement of Changes in Plan Net Assets* and express it as a percentage of the plan's annual covered payroll.

LOG average annual plan benefit payment

Under GASB 25, total annual plan benefit payments is recorded as part of the 'Deductions' in the *Statement of Changes in Plan Net Assets* in either the state CAFR section for pension trust funds or the CAFR of the pension plan itself (Peng, 2009). I use this data and divide it by the number of retired plan members and then derive the

logarithm of the average annual plan benefit payment, labeled *lnaveben*, to obtain this variable. Holding the number of retirees and beneficiaries constant, reducing retirement benefits reduces the amount of pension liabilities thus resulting in a lower lnaveben. Lowering the value of *lnaveben* in turn is expected to produce favorable funding outcomes as indicated by higher plan funding ratios and fewer unfunded pension liabilities.

One-year rate of return on investment and Annual Required Contribution Rate

As investment income comprises the largest proportion of annual public pension plan revenues, the one-year rate of return on investments variable, *historicalret*, is expected to have a significant impact on both employer contribution behavior and the overall funded status. However, the degree to which a higher investment rate of return increases a plan's stock funding ratio, and reduces its unfunded liability, may be attenuated by the actuarial smoothing assumptions applied in valuing plan asset investments. On the surface, higher investment income means that the plan's asset holdings increased relative to its liabilities, and as a consequence, the plan sponsor's required contribution rate (ARC) is expected to be lower as well *ceteris paribus*. With a lower ARC, holding all other things constant, the plan sponsor should be in a better position to fully meet its current employer contributions, resulting in a higher flow funding ratio. But what happens in practice as widely cited anecdotally in the literature, is that the plan sponsor tends to shirk on its annual funding obligations as it develops optimistic expectations of an upward or favorable trend in investment returns moving forward. Thus, it would not be unexpected to find an inverse relationship between *historicalret* and *ac_acp*, and also between *historicalret* and *flow*.

For econometric modeling purposes, an explanatory variable category for plan level actuarial assumptions is invariably specified in the empirical pension funding literature. The specified variables from this category range from the actuarial costing method to the length of the amortization period. All these assumptions are used in valuing plan assets and liabilities, and ultimately determine the plan's ARC. As earlier defined, the ARC is the actuarially determined amount that the plan sponsor needs to pay in order to

cover current year benefits accrued (normal cost) and an amortization of any UAAL. Therefore, instead of including all these different actuarial assumptions in my panel regression models, I assume that the ARC is a better explanatory variable because it incorporates already, all the relevant actuarial assumptions. Holding everything else constant, my model predicts a positive relationship between ARC and AC, and an inverse relationship between ARC and the flow funding ratio. The size of the estimated coefficient for the ARC variable will be of major interest because the difference from ideal unitary relationship between ARC and AC determines the degree by which the plan sponsor is underfunding its employer contributions.

Other Plan-Level Control Variables

Plan level controls in all models include a control for plan size in terms of membership and current level of total assets at market price. I use the *ratio of active members to plan retirees* and their beneficiaries for the former and the *logarithm of total plan assets* in the latter.

In studying the impact of gender differences on public pension funding levels, Eaton and Nofsinger (2008) found that plans with a higher ratio of retirees to active members were more underfunded. Although Eaton and Nofsinger (2008) do not explain this finding, it could be that the result is due to a larger outflow of benefit payments (plan liabilities) when the proportion of retirees increase. Vice versa, I expect a mirror result with positive funding outcomes associated with plans having a greater proportion of active members to retirees due to higher revenue inflows from member contributions relative to retirement benefit payments.

In controlling for plan size according to asset holdings, larger plans are expected to have better funding outcomes; with more assets, plans have a greater capacity to better handle annual revenue changes if investment returns become volatile. Using the same longitudinal dataset on public pension funding compiled from seven years of PENDAT surveys, Yang and Mitchell (2005) and Listokin (2006) found contrasting results on the relationship between stock funding and asset size (as expressed in logarithm terms). While the former finds no statistically significant association, the latter shows that plan

assets lagged one period earlier has a positive effect on current stock funding. Neither study discusses their result for this variable, but the results might suggest that for this sample of surveyed SLG pension plans from the 1990s, current year actuarial valuations more fully incorporated past market values, rather than the current market value, of total plan assets.

A variation on using plan asset size as a control variable in analyzing pension funding levels was used by Munnell et al. (2008c, 2008d, 2011c). In their separate cross-section regression analyses of 2006 and 2008 fiscal year funding data of public pension plans, an indicator variable was used to denote plans as being a "large plan" if they belonged in the top third of their sample in terms of assets. Munnell and colleagues found that "large plans" were positively related to the stock funding ratio but less likely to pay the full ARC.

To capture the actuarial nature of the dependent variables in all four empirical models, I include another key parameter used in calculating asset values - the assumption made by actuaries about expected plan investment returns. The *assumed rate of return* variable is the rate used for discounting the current and future streams of revenues and benefits earned to determine the present value of all assets and liabilities. In a time value of money context, a higher discount rate lowers the present value of liabilities and unfunded liabilities and results in a lower annual required contribution needed to amortize those same liabilities.[26] As highlighted in the studies of Novy-Marx and Rauh (2009, 2011a, 2011b), the debate over the appropriate discount rate in valuing pension liabilities is related to the various actuarial assumptions that public retirement systems incorporate in their respective plan valuations. In one of the first studies to evaluate the discount rates used by state retirement systems, Chaney et al.

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[26] In practice, plan actuaries calculate the discount rate based on the expected price inflation and the real rate of return. In a recent example provided by a March 14, 2012 CalPERS Press Release (see http://www.calpers.ca.gov/index.jsp?bc=/about/press/pr-2012/mar/discount-rate.xml), the CalPERS Actuarial Office recommended that the CalPERS discount rate of 7.75% be adjusted to 7.25%. They derived this value by adding the current real return of 4.75% to a lower price inflation assumption (from 3 to 2.75%). The press release also highlighted how the lower discount rate affects plan employer contributions and the value of member benefits.

(2002) analyzed state level pension funding data for 44 states from FY 1994 and FY 1995 and found that fiscally stressed states with balanced budget requirements strategically selected higher discount rates. In a subsequent study, Eaton and Nofsinger (2004) uncover a similar result at the individual pension plan level. Using five years of PENDAT surveys, they hypothesized that a combination of fiscal and political factors spur public plan sponsors to manipulate actuarial assumptions in order to appear better funded. More specifically, Eaton and Nofsinger (2004) showed states assumed a higher rate of return on plan assets when experiencing more fiscal stress (as indicated by increases in the ratio of interest payments to revenue and public debt to revenue). Also using five years of PENDAT surveys, a pooled OLS analysis by Doyle (2005) found the discount rate was negatively associated with stock funding ratio. Doyle's hypothesis on the inverse relationship between the discount rate and stock funding was that a higher discount rate presumes the plan actuaries are expecting greater returns from the financial markets, thus lowering the contribution levels required of the plan sponsor. Following the literature then, I expect to find the assumed rate of return is inversely related to employer contribution efforts but positively related to overall plan funded levels.

Several studies have shown a significant relationship between state fiscal condition and public pension funding levels. I follow Chaney et al. (2002) who uses the annual year-ended unreserved General Fund balance (*gfbal_urpc1k*) as scaled by the state's population. In their study, Chaney et al. (2002) explain that *gfbal_urpc1k*, being a cumulative measure, is an appropriate indicator of long-run state fiscal condition. They also point out the importance of the general fund as being, "…the fund in which most state tax revenue is recognized and from which most current spending is financed" (p. 296). While some have questioned using general fund data to measure state financial condition (e.g., Wang et al., 2007), the clear link between the general fund and public pension funding is established by Peng (2004, 2008):

"For state and local governments, most of the pension contributions going into the pension trust fund originally come out of the general fund, which is the government's main operating fund…When viewed in this broader context, public pension funding is no

longer an isolated pension financing issue, but rather part of the overall resource allocation decision in the public sector" (Peng 2008, p. 142).

The above statement about the relationship between public budgeting and public pension financial management draws from the fiscal stress theory of public pension plan underfunding. Past studies examining the impact of various state fiscal indicators on public pension funding found that states experiencing some form of fiscal stress or unfavorable economic condition tend to have underfunded pension plans.[27] This theory of public pension funding behavior maintains that during periods of fiscal or economic stress or in the presence of statutory budget constraints (e.g., balanced budget requirements), governments will tend to underfund their pension plans by reducing employer contributions to free up funds for other budgetary items of greater priority or urgent financial need (Peng, 2004). Assuming this supposition holds, I expect better funding outcomes for DB plans in states having larger unreserved general fund balances.

Estimation Strategy

The standard approach to econometric modeling of panel data usually applies two principal approaches, namely, fixed effects (FE) and random effects (RE) estimators. If the unobserved time-invariant DB plan effects are uncorrelated with all the observed explanatory variables, then using the RE estimator is the appropriate method (Wooldridge, 2008). However, plan level characteristics vary greatly across DB state retirement systems in all aspects of plan funding that range from membership coverage, board composition, to the actuarial valuation methods used. Consequently, omitted variable bias is a concern when we fail to include any of these characteristics in our

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[27] Some of the fiscal stress indicators examined include the following: the *unemployment rate* (Schneider & Damanpour, 2002); *state debt/income ratio* (Munnell et al., 2008c); *state debt ratings* (Listokin, 2006); ratio of state's annual interest payments to total state revenue (Eaton & Nofsinger, 2004; Coggburn & Kearney, 2010); and the presence of *balanced budget requirements* (Chaney et al., 2002). While I included these alternative measures in my preliminary model specifications, I selected the general fund balance as my primary state fiscal indicator since it would most directly relate to the employer contribution behavior and relevant DB plan funding outcomes in my study as described in my asset-liability framework.

regression models that are correlated with our included explanatory funding variables. To control for the possibility that unobserved time-invariant plan specific characteristics systematically affect plan funding outcomes, I estimate my model using a fixed effects approach to estimating my regression models. I also include year dummies to control any unmeasured national factors or universal time shocks that affected all the plans in my sample.

Description of the Dataset

My analysis utilizes a sample of 100 state administered DB pension plans from 50 states over a nine-year period covering fiscal years 2002 to 2010. This unique panel data set pulls together information obtained from government reports consisting of comprehensive annual financial reports (CAFRs) from both the state government and whenever available, from the state retirement system itself. The information on state pension trust funds found in the CAFRs is prepared according to GASB 25, 27, and 34 reporting guidelines, thus ensuring a level of standardization that allows us to compare pension funding indicators across state retirement systems.

Other sources of data include the US Census Bureau *State and Local Government Employee Retirement Systems Survey* (SLGERS) and the U.S. Bureau of Economic Analysis. Due to data collection costs and constraints, my sample is limited to plans covering general state employees and teachers, which typically represent the largest retirement plans administered at the state level. Asset holdings in FY 2010 for the plans in my sample was an estimated $2.1 trillion, which represents over 90 percent of total assets held by all state administered plans for that fiscal year.

Table 4-1 presents the descriptive statistics for the variables included in the study's empirical models for my entire panel consisting of 100 individual state pension plans covering nine fiscal years from 2002 to 2010. A cursory glance of the panel mean for flow and stock funding ratios and comparing actual and required employer contribution rates suggests underfunding in general - with the plans in my sample making 91 percent of annual required employer contributions (flow funding), and setting aside assets that

cover 82 percent of their total actuarial liabilities (stock funding). Underfunding at the plan sponsor level is also immediately apparent as the panel mean for the actual employer contribution rate (AC), 10.16 percent, is less than that of the annual required contribution rate (ARC) of 12.03 percent. As shown in Table 4.1, scaling by the annual covered payroll allows us to show the limited share and variability of employee contributions relative to employer contributions and total unfunded actuarial liabilities. Also notable from Table 4-1 is the 5.27 average rate of return on investments recorded by the plans in my sample over the panel's nine-year period, which is less than the panel mean for the assumed rate of return of 8 percent. It is this gap between the assumed and actual investment rate of return that represents the source of debate between economists and public retirement system administrators over the appropriate discount rate in valuing public pension plan assets.

I use line graphs in Figures 4-1, 4-2 and 4-3 to show how the primary pension funding outcomes and selected plan level variables relate to each other over time. By definition, the inverse relationship between the stock funding ratio and unfunded liability is shown in Figure 4-1. The considerable rise in unfunded pension obligations is evident in the graph were the size of unfunded pension liabilities in FY 2010 was an estimated 197 percent larger than it was in FY 2002.

The line graphs in Figure 4.1 show flow funding ratios and stock funding ratios following a similar trend over the course of the sample period with both indicators exhibiting declining ratios from FY 2002 to FY 2005, followed up an uptick in both ratios onwards until FY 2007. The dramatic deterioration in both funding measures starting around FY 2008 because of the financial crisis is noticeable.

Because flow funding is a function of how well the plan employer is fulfilling its annual required contributions, the line graph in Figure 4-2 illustrates the persistent gap between the annual required contribution rate (ARC) and the plan employer's actual contribution rate (AC).

Table 4-1. Variable Descriptions, Sources, and Descriptive Statistics (100 State DB Plans, FY 2002-FY 2010)

VARIABLE	LABEL	DEFINITION	Mean	Std. Dev.
Dependent Variables				
ac_acp	employer contribution rate	Employer contributions as a percentage of the plan's annual covered payroll	10.16	9.23
flow	Flow Funding Ratio	Employer's actual contribution (AC) / Employer's annual required contribution (ARC)	90.50	31.32
stock	Stock Funding Ratio	Actuarial value of plan assets (AVA) / actuarial accrued liabilities (AAL); in percent	82.40	16.58
uaal_acp	Unfunded liability	Unfunded actuarial accrued liability as a % of annual covered payroll	86.20	266.90
Plan Level Variables				
ln_netasset	ln plan net assets	natural log of DB plan net assets	16.23	1.13
historicalret	1 year ROR	Historical 1 year DB plan annual investment return (%)	5.27	12.36
assumedret	discount rate	Assumed rate of return on plan investments (%)	7.99	0.37
memcon_acp	member contributions	Member contributions as a % of annual covered payroll	5.69	3.12
arc_acp	ARC	Employer's annual required contribution rate expressed as a % of annual covered payroll	12.03	10.43
made_arc	made ARC dummy	Dummy variable indicating whether plan sponsor paid 100% of their ARC	0.54	n.a.
lnaveben	ln average benefit payments	Natural log of DB plan's annual average benefit payments	9.80	0.45
actret	ratio active to retired	Ratio of active plan members to plan beneficiaries	2.61	4.10
State Fiscal Characteristic				
gfbal_urpc1k	pcap GFbal_unreserved(1k)	per capita unreserved General Fund balance ($1000s)	0.21	1.51

Note: All variables from state or plan CAFR except for made_arc and gfbal_urpc1k are author's calculations
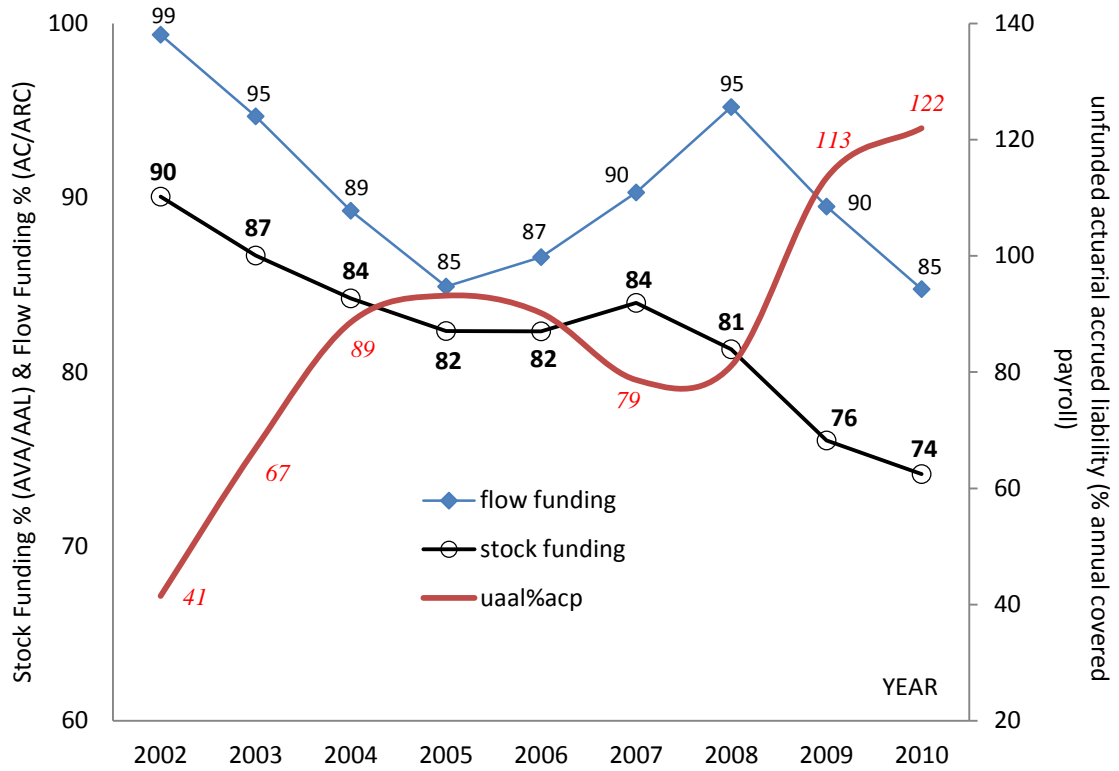
Figure 4-1. Stock & Flow Funding, Unfunded Actuarial Accrued Liabilities, FY 2002-2010
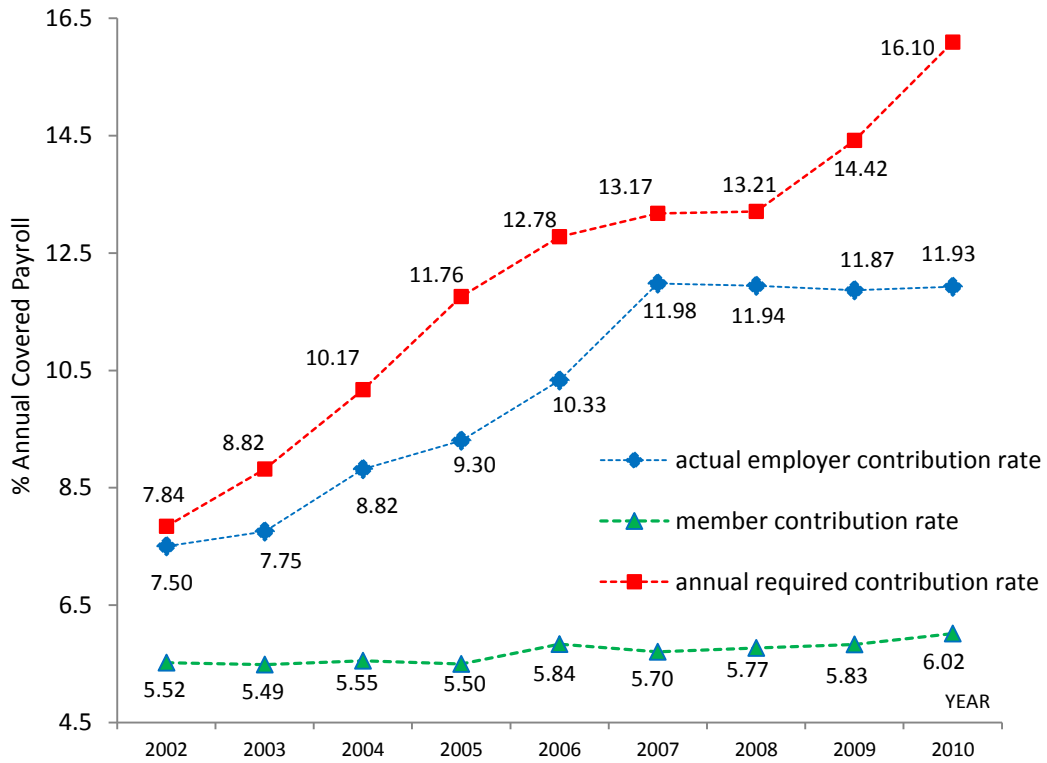
Figure 4-2. Employer & Employee Contribution Rates, FY 2002-2010
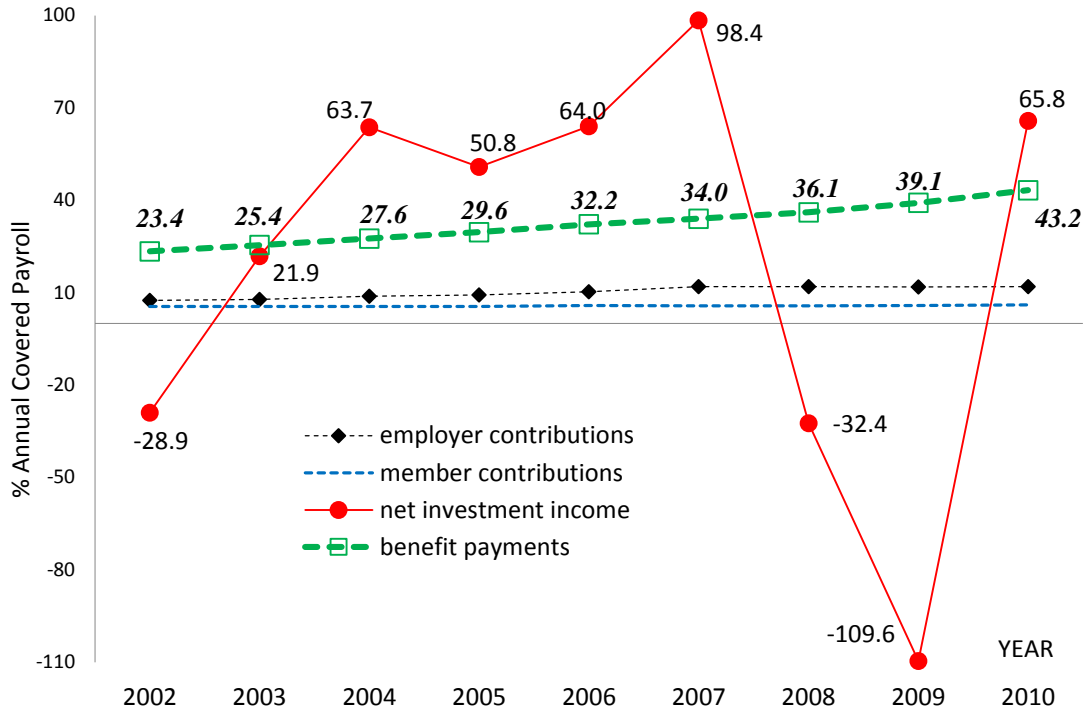
Figure 4-3. Employer, Member Contributions, & Net Investment Income, FY 2002-2010
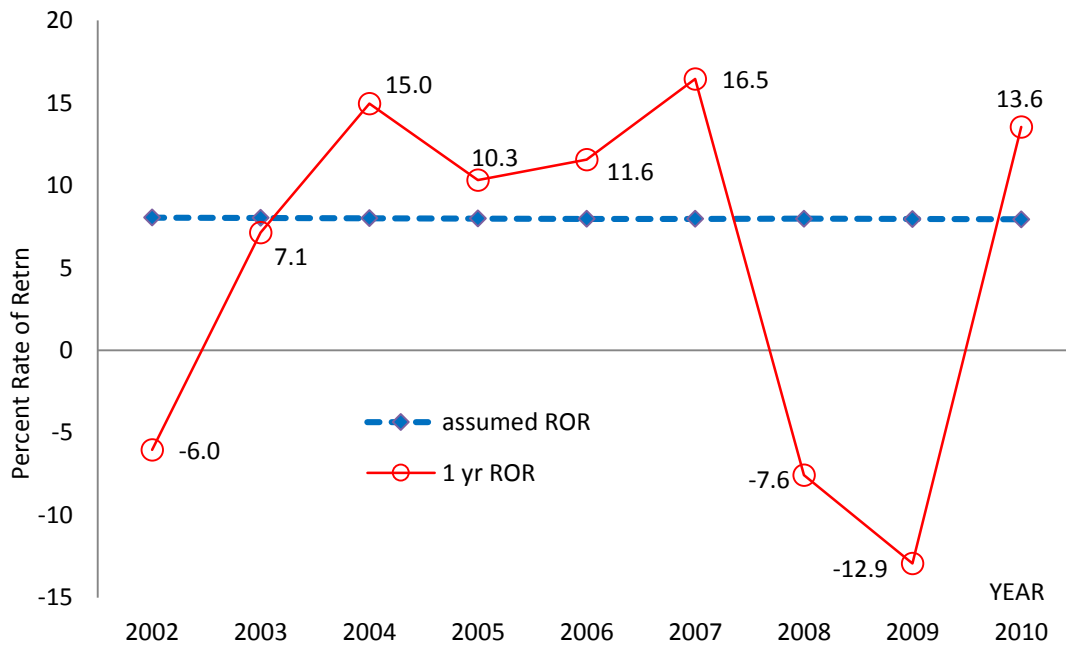
Figure 4-4. Actual & Assumed Rate of Returns, FY 2002-2010

With the fiscal year along the x-axis aligned vertically across both graphs, we see how the changes in the gap distance between ARC and AC in Figure 4-2 visually relate to flow funding levels in Figure 4-1. Having the annual covered payroll as a common scale, we can compare the relative size of the two primary sources of pension contributions. Figure 4-2 shows that plan member employees not only contribute less than plan employers but also follow much more stable contribution rates as well.

By aligning vertically along the years on the x-axis, we can also observe the general trend or shape of the line graph over time for flow funding in Figure 4-1 and its relationship to that of the line graphs for ARC and employer contributions in Figure 4-2. As the rate for ARC increases, so does employer contributions but at a lower rate, creating gaps reflected in the shape of the line graph for flow funding over the sample period as shown in Figure 4-2. The plan sponsors in my panel on average failed to increase their contributions at the same rate as ARC, and this manifested in widening the gap between required and actual employer contributions. When scaled by the annual covered payroll, Figure 4-3 provides a dynamic view on the considerable impact that investment returns have on annual pension plan revenues. This is made clear by the relative size of investment returns compared to both employer and employee contributions.

Apart from the sizeable share and impact on pension revenues, the volatility of investment returns relative to the assumed rate of return for state pension plans in my sample is displayed in Figure 4-4. One can also see the effect of the economic and market downturns of 2001-2002 and 2007-2008 in the line graph of the historical one-year rate of return variable. In practice, actuaries for state pension plans employ a smoothing period by which to calculate the value of current assets based on an average value of a selected number of past years. By averaging out the effects of increases or decreases in market values each year over several years (generally four or five), the effect of this approach is to smooth out or dampen the immediate impact of these severe market drops or spikes in growth and spread it out over time. Because states vary widely in their actuarial practice of smoothing gains and losses on invested assets,

the impact of market changes over time also has varying perceived effects on state funding levels (The Pew Center, 2007).[28]

Concluding Remarks

This chapter presented the research methodology and panel dataset used for evaluating state DB pension funding. Empirical models were specified to analyze four key funding outcomes at the plan level – the employer contribution rate, flow funding ratio, stock funding ratio, and the relative size of unfunded liabilities. The fixed effects panel regression approach was identified as the appropriate econometric strategy to estimate the specified models. I specified and discussed the explanatory and control variables along with a review of their use in past empirical studies. Descriptive statistics of key DB funding variables for my sample of 100 state DB plans in Table 1 and the graphs of their trends over the last decade in Figures 4-1 to 4-4 provided an empirical overview on the hypothesized funding relationships that determine DB public pension plan funding. First, it showed how the trend for stock and flow funding ratios were opposite that of the unfunded liability indicator. Second, it showed that over the same period, actual employer contribution rates failed to keep up with annual required employer contribution rates, and that member/employee contribution rates were relatively fixed and comprised a small share of annual plan revenues. The graphs also illustrated the substantial role of investment income on plan revenues in terms of total revenue share and volatility. Lastly, I noted the trend in total retirement benefit payments increasing every year and its implications for future DB funding outcomes.

In the next chapter, I report and discuss the results of my panel regression models used to test the various hypothesized DB state pension plan funding relationships.

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[28] The Pew Center (2007) provides example of states that use longer smoothing periods like Colorado (4 years) and California (15 years) to show how they retain good and bad years over time. This is contrasted to states like Idaho, Illinois, Oregon and West Virginia, that are expected to show dramatic year-to-year shifts because they use a fair market value approach over a short smoothing period for valuing their major pension plans.

CHAPTER 5

RESULTS AND DISCUSSION

In the previous chapter, I outlined the empirical methods used in this study to evaluate DB state pension plan funding. Four panel regression models were specified to examine the determinants of employer contribution rates (*ac_acp*), flow and stock funding ratios (*flow* and *stock*), and the relative size of plan unfunded liabilities (*uaal_acp*). I presented the panel dataset comprised of 100 state DB pension plans covering fiscal years 2002 to 2010, along with the dependent and explanatory variables in my panel regression models. Based on the initial review of the descriptive statistics and graphs of annual aggregate trend, the explanatory variables reflect a positive funding relationship with the first three dependent variables of interest (*ac_acp*, *flow*, and *stock*) and an inverse relationship with the unfunded liability indicator (*uaal_acp*). This implies that in general, the sign of the estimated coefficients from the *ac_acp*, *flow* and *stock* panel regression models is expected to be opposite those of obtained from the *uaal_acp* model.

In this chapter, I discuss the results of my panel regression analysis. Table 5-1 presents the estimated coefficients from the OLS and Fixed-Effects (FE) regression models of employer contribution rates (Model 1) and flow funding (Model 2). Table 5-2 reports the panel regression results for my stock funding (Model 3) and unfunded liabilities model (Model 4). In each table, the first and third columns report the estimated pooled OLS coefficients while the fixed effects coefficient estimates are listed in the second and fourth columns. I use the unbiased and consistent FE estimates for inference while the OLS coefficients serve as a point of reference to compare my results to the existing empirical public pension literature - the majority of which relied on pooled OLS models to evaluate pension funding. Year dummies are included in all model specifications and coefficient results are reported with clustered standard errors at the state level and robust to cross-sectional heteroskedasticity and serial (within-panel) correlation.

Table 5-1. Estimated Coefficients of Fixed Effects: Employer Contribution Rates and Flow Funding (100 State DB Plans, FY 2002-2010)

	Model 1: Employer Contribution Rate (%ACP)				Model 2: Flow Funding % (AC/ARC)			
	OLS		Fixed Effects		OLS		Fixed Effects	
ln Plan Net Assets	-0.672	**	6.880	**	-3.518	**	31.135	**
	(0.322)		(3.035)		(1.532)		(15.363)	
Member contribution rate (%ACP)	-0.245	**	-0.092		-0.470		-0.535	
	(0.108)		(0.101)		(0.478)		(0.637)	
ln Average retirement benefit payment	1.720	**	-0.854		8.181	**	9.151	
	(0.831)		(0.609)		(4.025)		(7.050)	
Actives/Beneficiaries ratio	-0.033		0.037		-1.057	***	-0.529	**
	(0.023)		(0.035)		(0.146)		(0.230)	
1-yr investment rate of return (%)	-0.020		-0.035	*	-0.253	**	-0.302	**
	(0.019)		(0.018)		(0.104)		(0.125)	
Discount rate (%)	-3.109	**	-1.511		-14.294	**	0.889	
	(1.539)		(1.027)		(5.813)		(6.268)	
Stock funding ratio (%)	-0.158	***	0.039		-0.032		0.367	
	(0.053)		(0.051)		(0.124)		(0.236)	
Annual required contribut'n rate (%ACP)	0.395	**	0.530	***	-0.758	***	0.077	
	(0.154)		(0.123)		(0.189)		(0.334)	
percap unres GenFund balance ($1000s)	0.163	***	0.281	***	0.646		1.028	***
	(0.059)		(0.030)		(0.406)		(0.224)	
$R2$	0.419				0.118			
rho			0.742				0.750	
$R2$ within group			0.247				0.078	
$R2$ between group			0.017				0.003	
$R2$ overall group			0.044				0.000	
F-test of joint significance	58.606		335.942		33.625		60.063	

Notes: * $p<0.10$ ** $p<0.05$ *** $p<0.01$

• ACP: annual covered payroll; Flow funding is the flow funding ratio (%), defined as the ratio of actual employer contributions (AC) to annual required contributions (ARC); Stock funding ratio (%), defined as the ratio of actuarial value of assets (AVA) to actuarial accrued liabilities (AAL); percap unres GenFund balance is state per capita unreserved general fund balance. AC, ARC, & ACP are all expressed in thousand dollars ($1000s).

• Robust standard errors clustered at the state level are reported in the brackets below the coefficient results; "rho" is the share of the estimated variance of the overall error accounted for by the individual plan effect. All panel regression models include year dummies whose estimated coefficients are not reported in this table due to space considerations but can be found in Appendix A.

Table 5-2. Estimated Regression Model Coefficients: Stock Funding and Unfunded Actuarial Accrued Liabilities (100 State DB Plans, FY 2002-2010)

	Model 3: Stock Funding (AVA/AAL) %				Model 4: Unfunded Actuarial Accrued Liabilities (%ACP)			
	OLS		Fixed Effects		OLS		Fixed Effects	
ln Plan Net Assets	2.764	**	25.906	***	5.726		-30.782	
	(1.288)		(7.344)		(7.536)		(33.408)	
Member contribution	-1.045	***	-0.681		2.252		-3.320	
rate (%ACP)	(0.366)		(0.494)		(2.027)		(4.073)	
ln Average retirement	-1.702		4.012		-17.440		21.195	
benefit payment	(3.200)		(3.161)		(26.191)		(17.646)	
1-yr investment rate of	0.055		-0.083	**	-1.183	**	-0.917	*
return (%)	(0.040)		(0.033)		(0.519)		(0.477)	
Discount rate (%)	-4.195		6.941		9.538		-10.338	
	(3.673)		(4.220)		(6.823)		(14.852)	
Actives/Beneficiaries	0.608	***	-0.321	***	-0.173		-1.406	***
ratio	(0.129)		(0.099)		(0.239)		(0.467)	
Employer contribution	-0.714	***	0.041	*	0.020		-1.203	***
rate (%ACP)	(0.159)		(0.023)		(0.849)		(0.125)	
Made ARC dummy	7.132	***	1.466	*	-9.980		0.110	
	(1.860)		(0.751)		(8.093)		(3.786)	
percap unres GenFund	-0.086		-0.021		2.188	***	2.700	***
balance ($1000s)	(0.233)		(0.060)		(0.745)		(0.509)	
R2	0.445				0.063			
rho			0.973				0.381	
R2 within group			0.571				0.071	
R2 between group			0.041				0.039	
R2 overall group			0.057				0.001	
F-test of joint significance	44.076		184.867		52.407		82.590	

Notes: * p<0.10 ** p<0.05 *** p<0.01
• stock: stock funding ratio (%),defined as the ratio of actuarial value of assets (AVA) to actuarial accrued liabilities (AAL); uaal_acp: unfunded actuarial accrued liability expressed as a percentage of annual covered payroll (ACP), where UAAL=AAL-AVA; Employer contribution rate (%ACP); made_arc: dummy variable = 1 if plan made 100% annual required contribution (ARC); percap unres GenFund balance is state per capita unreserved general fund balance ($1000s).
• Model 4 dependent variable is first-differenced to eliminate the unit-root. Robust standard errors clustered at the state level are reported in the brackets below the coefficient results; "rho" is the share of the estimated variance of the overall error accounted for by the individual plan effect. All panel regression models include year dummies whose estimated coefficients are not reported in this table due to space considerations but can be found in Appendix B.

To confirm the appropriateness of using the FE estimator, I calculated the t-statistic from the correlation between the individual plan effect and the fitted values and its standard error for each fixed effects regression model.[29] For all four models, the results indicate that the random effects were highly correlated with the independent variables (i.e., the errors are correlated with the regressors) which would have yielded inconsistent OLS and RE estimates.

Due to the time-series nature of my study's dependent variables, non-stationarity in panel data is also a concern as it results in invalid hypothesis testing of OLS and FE coefficient estimates. I test for unit roots in the panel data for all four dependent variables and find that the stationarity assumption does not hold for the *uaal_acp* variable. I address this issue by taking the first-difference of *uaal_acp* and using its transformed version as my dependent variable for Model 4.[30]

Defined Benefit State Pension Employer Contributions

To test the hypothesis that the state pension plan sponsors in my sample were consistently underfunding their annual employer contributions, I examine the relationship between ARC and the actual employer contribution rate (Model 1) and flow funding ratio (Model 2). An increase in the annual required contribution rate is expected to be directly related to the employer contribution rate but inversely related to the flow funding ratio.

The FE coefficient estimate for ARC was highly significant in Model 1 but was not statistically significant in Model 2. The results indicate that on average holding everything else constant, a percentage point increase in the annual required contribution rate results in a 0.53 percentage point increase in the actual employer

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[29] The t-stat calculated for each model is as follows: Model 1 (- 0.699/0.033)=-20.96; Model 2 (-0.882/0.033)=-26.42; Model 3 (-0.863/0.033)=-25.86; and Model 4 (-0.617 /0.033)=-18.48.
[30] The following is the inverse chi-squared (d.f. = 200) statistic result from the augmented Dickey-Fuller unit root test using a lag structure of one for each dependent variable: ac_acp (Model 1)=305.6; flow (Model 2)=618.52; stock (Model 3)=272.60 ; and uaal_acp (Model 4)=233.99. A Phillips-Perron unit root test also confirmed non-stationarity in the uaal_acp variable.

contribution rate. This finding is important because the *arc_acp* variable encapsulates the actuarial valuation process into one indicator as to what is required of the plan sponsor in the immediate/short-term funding period to maintain overall plan solvency. As noted in Chapter 2, *Keeping up with funding requirements* was the first of five identified categories of public pension policy reform efforts. The ideal policy response would be a 1:1 increase between the ARC and the employer contribution rate. The actual employer contribution response as implied by the results, somewhat follows Yang and Mitchell (2005) who assert that public pension plan sponsors fundamentally exhibit a "behavioral persistence" in underfunding contributions where, "…on average, public plans do make an effort to fill in an underfunding gap over time, though not fully from one year to the next" (p. 16).

The following variables were significant predictors of employer contribution rates and flow funding ratios: the logarithm of plan net assets (*ln_netasset*); the one-year rate of return on investments (*historicalret*), and per capita unreserved General Fund balance (*gfbal_urpc1k*). The ratio of active members to beneficiaries (actret) was statistically significant for flow funding ratio alone.

I find a positive significant relationship between the size of a plan's net assets and the employer contribution rate and flow funding ratio. This finding implies that sponsors of plans with more net assets are able to contribute more and are better able to fund their required contributions. Interestingly, the sign of the FE coefficients in Models 1 and 2 flip from positive to negative when estimated with OLS. The significant but counterintuitive OLS results follows a similar negative relationship reported by Munnell et al. (2008d) between total plan assets and the likelihood of a plan making 100 percent of its ARC payment. The dramatic sign flip between the OLS and FE estimates with respect to the effect of total plan net assets on employer contribution efforts illustrates the bias that may arise from ignoring unobservable plan specific heterogeneity.

In contrast, the intuition underlying the signs of the FE coefficient estimate for the effect of *historicalret* on *ac_acp* and *flow* remains fairly consistent even when estimated under OLS. The results imply that an increase in the one-year rate of return is associated

with a lower employer contribution rate and flow funding ratio. The result could be interpreted in two ways. Because the bulk of annual pension revenues come from investment returns, an improved investment performance should translate into a favorable funding situation where the plan sponsor may not be required to contribute as much as it would have otherwise. Alternatively, the favorable investment performance inclines the plan sponsor to assume similar future trends. Hence, the plan sponsor finds it acceptable to reduce its actual employer contribution because it assumes future investment returns will make up for any contribution shortfall. In a review of the pension funding literature, the only study to specify the investment rate of return as a determinant of flow funding was Yang and Mitchell (2005), and they found no statistically significant relationship between the two variables.

For the active to retiree ratio variable (*actret*), the results from my panel regression analysis indicates that variable had no significant effect on the employer contribution rate. In the *flow* funding model though, coefficient estimates for actret variable were relatively robust, as both OLS and FE estimates show an increase in the proportion of active employees relative to beneficiaries is associated with lower funding ratios *ceteris paribus*. It may be that plan sponsors view the relationship between the employee composition ratio and the exigency of their contribution obligations in temporal terms. In other words, benefits earned by active employees are perceived as future obligations, whereas having a greater proportion of retirees equates to more immediate funding obligations since these are current liabilities that require paying off sooner rather than later.

The coefficient for the per capita unreserved general fund balance variable (*gfbal_urpc1k*) suggests higher employer contribution rates and flow funding ratios are associated with state pension plans administered by states that record larger unreserved general fund balances. The results are robust to both OLS and FE specifications of the employer contribution rate model (Model 1) and provide empirical support for the positive effect that state fiscal condition has on public pension contributions. The result in Model 2 is consistent with the fiscal stress theme in the

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pension funding literature that show a positive association between favorable fiscal

conditions and the ability of state employers to contribute more into their funds. The

most recent example is from Munnell et al. (2008d, 2011c) who find that a higher debt

to GSP ratio makes it less likely that a plan sponsor pays the full ARC.

The coefficient result from the assumed rate of return (*assumedret*) was only

significant in the OLS specifications of employer contribution and flow funding. The OLS

result is consistent with Chaney et al. (2002) and Eaton and Nofsinger (2004) who

suggest public pension plan sponsors have an incentive to assume a higher discount rate

in order to lower contribution requirements. My results on the other hand show that

once we control for plan fixed effects, there is no evidence that the discount rate affects

the actual employer contribution rate, or that it further influences the public plan

sponsor's tendency to underfund its required contribution.

Overall Funded Status of State Defined Benefit Pension Plans

In the second part of my empirical analysis, I examine the effect of the following

explanatory variables on plan stock-funding ratio (Model 3: *stock*) and unfunded

liabilities (Model 4: *uaal_acp*) respectively:

- logarithm of average benefit payments (*lnaveben*)
- employer contribution rate (*ac_acp*)
- indicator variable whether full ARC payment was made (*made_arc*)
- one-year rate of return on investments (*historicalret*)
- plan member contribution rate (*memcon_acp*)

Based on the asset-liability framework in Chapter 3, holding plan membership and

assets constant, an increase in the average cost of retirement benefit payments is

expected to be associated with lower stock funding ratios and higher unfunded pension

liabilities. I fail to find any empirical support for this hypothesis with non-significant FE

and OLS coefficient results for *lnaveben* in both Model 3 and 4 (see Table 5-1). This

result complements Giertz and Papke (2007) who use a three year panel dataset of 85

state pension plans to examine various retirement benefit variables plans and found no

statistically significant effect on stock funding ratio as well. To date, the pension funding

literature has not provided the empirical support for the widespread anecdotal argument that benefit generosity and unfunded benefit enhancements contributed to the pension funding crisis.

The FE coefficients for employer contribution rate (*ac_acp*) are statistically significant and yield the expected sign in both the *stock* funding model (Model 3) and *uaal_acp* (Model 4). The results indicate that raising the employer contribution rate increases the plan's stock funding ratio and reduces its *uaal_acp*. The significant and positive relationship between the coefficient of the full ARC payment dummy variable (*made_arc*) and *stock* funding ratio underscores the importance of fulfilling required employer contributions. Simply put, the coefficient estimates for both variables (*ac_acp* and *made_arc*), suggest that when the plan sponsor contributes more, one can expect some improvement in a plan's overall funded status.

I compare my results with the relevant empirical literature: Doyle (2005) who examined the relationship between *ac_acp* and *stock*; and Coggburn and Kearney (2010) who examined the relationship between *ac_acp* and state per capita unfunded pension liabilities using aggregated state-level data for FY 2007. The Pooled OLS analysis by Doyle (2005) indicated *ac_acp* was negatively associated with *stock*, which is the same inference I get from my OLS coefficient result in Model 3. Doyle does not explain why his finding contradicts his own hypothesis that *ac_acp* should be positively affect *stock*. From an econometric standpoint, the OLS results in this case exemplifies the concern over making erroneous inferences on the various pension funding relationships if we fail to account for unobserved heterogeneity between the different public pension plans. As for the relationship between *ac_acp* and state per capita UAAL, Coggburn and Kearney (2010) found a percentage point increase in *ac_acp* was associated with a 123.84 dollar increase in the per capita UAAL variable. The issue with their result though, is that they frame the direction of causality from UAAL to *ac_acp* in their hypothesis, but in their empirical model, they assume the opposite causal direction, *ac_acp* as a determinant of UAAL. In short, Coggburn and Kearney inadvertently and implicitly convey the

endogenous funding relationship between *ac_acp* and UAAL but fail to acknowledge or address it econometrically.

Investment returns make up the largest proportion of pension revenues, therefore, a higher rate of return is expected to raise a pension plan's stock funding ratio and reduce its unfunded liabilities. The estimated coefficient for the actual one year of return on investments (*historicalret*) was statistically significant for both *stock* funding (Model 3) and *uaal_acp* (Model 4) but did not display the expected sign in Model 3. My FE coefficient results on the impact of investment returns on stock funding differs from the OLS results of Yang and Mitchell (2005) who found a positive and statistically significant relationship between the two variables.

I am uncertain as to why investment returns do not have the expected effect on stock funding, but as postulated earlier, the common actuarial practice of public pension of smoothing out investment returns may be contributing to this result. Some of that effect may be reflected in the trends we observe for the stock funding line graph (Figure 4-1) and the line graph of the annual rate of return (Figure 4-4). It could be that the effects of the market downturn in 2001-2001 at the beginning of my sample period were still being incorporated into the stock funding values up to FY 2007, after which both *historicalret* and *stock* trended downwards in the same direction. Another possible explanation for the inverse relationship of historicalret and stock comes from the results in Table 5-1 that suggest an inverse relationship between *historicalret* and employer contribution behavior. Thus, any gains from investment returns, whose impact is already smoothed out over several periods, were further offset by lower employer contribution levels.

The non-significant coefficients for employee contribution rate (*memcon_acp*) in both FE regression model specifications raise the question over the extent that raising plan member employee contributions is an effective strategy for improving a plan's overall funded status. A review of the descriptive statistics of my panel dataset confirms the relatively fixed nature of the employee contribution rate variable (*memcon_acp*) as indicated by the small within group variation (variation over time for each individual

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plan) of the variable, much of which stems from employee contribution rates being defined by statute or determined under collective bargaining (GAO, 2008; Peng, 2008). Apart from the legal constraints to raising member contribution rates, vested public pension plan members tend to resist any proposed increases in their contributions just as robustly as they would any reductions to their benefits as was nationally played out in Wisconsin (Cogan, 2011; Ferrara, 2012; Walsh, 2011). It is unremarkable then that the majority of pension reforms enacted to raise employee contribution rates have largely been limited to newer employee cohorts (Pew Center, 2012).

Although not the primary focus of my empirical evaluation, the estimated coefficients of the control variables specified for Models 3 and 4 provide additional insights into state DB retirement system funding. Starting with the discount rate variable (*assumedret*), it was noted in previous chapters how the actuarial values of plan assets and liabilities are sensitive to the choice of the discount rate. Nonetheless, the estimated coefficient for *assumedret* was not statistically significant in any of the model specifications. I partly ascribe this to the plans in my sample rarely changing their discount rate assumptions during the sample period, and this was also reflected in the small within-group variation for the variable.

More unclear is the sign of the estimated coefficient for the ratio of active members to retirees variable (*actret*). I expected a positive correlation between *actret* and *stock* as both followed a similar downward trend over the sample period with the cross-sectional sample mean for *actret* steadily decreasing every year from a ratio of 3.52 in FY 2002 to 1.98 in FY 2010. Past studies have shown a direct relationship between the *actret* variable and stock funding (Eaton & Nofsinger, 2008; Giertz & Papke, 2007). It was hypothesized that having more active employee members relative to retired beneficiaries leads to a more favorable funding outcome due to greater revenue inflows from more member contributions relative to cash benefit payment outflows. My estimated FE coefficients for *actret* seem to infer contradictory results when Model 3 and Model 4 are considered together. Though Model 4 shows the expected inverse relationship between *actret* and *uaal_acp*, the estimated coefficient in Model 3

indicates an inverse relationship between *actret* and *stock* that contradicts both my own hypothesis and the extant literature.

It could be that a greater share of the actuarial value of plan liabilities is coming from the benefits accruing to active employees. It follows from the accrual accounting of liabilities, the denominator in the stock funding measure includes the benefits accrued by active employees and not just the retirement benefits paid out to current retirees. Another possible reason for the negative effect of *actret* on stock builds on the statistically significant inverse relationship between *actret* and *flow* obtained from estimating Model 2 (see Table 5-1). Assuming a direct relationship exists between *stock* and *flow* (albeit the unclear direction of causality), then the effect of *actret* on *flow* serves as the indirect link to explain the significant effect of actret on stock.

The estimated coefficient for *gfbal_urpc1k* also produced mixed results in Models 3 and 4. If we take the results from Models 1 and 2, the estimated coefficient for *gfbal_urpc1k* indicated a positive and statistically significant relationship with employer contribution behavior both in terms of the nominal rate and flow funding ratio. Thus, we expect *gfbal_urpc1k* to be positively related to stock and inversely related to *uaal_acp*. Instead, I find that the coefficient for *gfbal_urpc1k* was significant only in the model for unfunded liability, and did not yield the expected sign. The results were robust to both OLS and FE specifications and implied *gfbal_urpc1k* is positively related to *uaal_acp*. In reviewing the general trend for both variables in my panel data set, I find that state general fund balance increased six out of the nine years in my sample period while *uaal_acp* was steadily increasing over the same period. So while the association between the two variables is apparent, the causal link is unclear. At this point, further investigation is needed to determine why the unfunded pension liability would increase for states that record a favorable fiscal condition such as an increase in the general fund balance.

As for the non-significant effect of *gfbal_urpc1k* on *stock*, the result undermines the use of my analytical framework in explaining the relationship between *actret* and *stock* by using the effect of *actret* on *flow* as the indirect causal link. In this case though,

whereas *actret* is a variable that factors in both short-term (*flow*) and long-term (*stock*) actuarial calculations, *gfbal_urpck1k* is an exogenous non-actuarial factor. In other words, the plan sponsor only considers current state budgetary conditions as reflected in the unreserved general fund balance at the time it determines its level of employer contributions. Again, just as with *actret*, further research is needed to determine why differing and unexpected results are obtained for the effect of *gfbal_urpc1k* on *stock* and *uaal_acp*.[31]

Discussion

In this chapter, I reported and discussed the estimated coefficient results from my panel regression models of four DB state pension plan funding outcomes, namely: the employer contribution rate, flow funding ratio, stock funding ratio, and the relative size of plan unfunded liabilities. The results were discussed in relation to my hypotheses on funding relationships and outcomes for those pension reform categories concerned with increasing employee and employer contributions and reducing retirement benefit payments. First, the results of my analysis indicate a statistically significant relationship between employer contribution behavior and DB pension plan funding outcomes along with evidence of the degree to which state government DB plan sponsors were underfunding their annual required contribution requirements. Second, the results call into question the potential effectiveness of reforms related to increasing employee contributions and reducing retirement benefit payment reductions. I found that changes in the employee contribution rate and the size of the average retirement benefit payment had no statistically effect on overall plan funded status. Taken together, the evidence underlines the fiduciary burden that states carry as sponsors of their respective DB retirement systems. Since employee contribution rates and retirement benefit payments are relatively fixed due to the legal protections afforded them,

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[31] Regression models using lagged values of selected explanatory and control variables were also examined and yielded similar results. The only notable exception was the significant positive effect of lagged *gfbal_urpc1k* on flow funding. Overall, the alternative model specifications did not provide any substantial differences in the overall conclusions of the empirical analysis.

employer contributions become the primary recourse for states in covering funding shortfalls that occur from dismal investment returns (Young, 2010). Even though an increasing number of states are moving to increase employee contribution rates and reduce the generosity of retirement benefits, the actuarial impact is expected to be negligible as long as efforts are limited to new and future employee cohorts (GAO, 2012a).

Apart from the contribution and benefit payment variables, I also found empirical support from the results in Model 4 that plans with higher investment returns and a higher plan membership ratio of active employees to retirees are associated with lower unfunded liabilities. As noted earlier, among the host of issues debated over public pension funding, the size of the unfunded liabilities has received the most attention. The results carry important implications in two policy areas for states trying to reduce if not control the growth in unfunded pension liabilities. First, the overarching share of plan assets sourced from investment income drives the efforts to continuously seek ways to improve investment performance by linking it to governance reforms. Second, state governments are dealing with the myriad consequences of a rapidly aging and retiring workforce (Lewis & Cho, 2011; Toosi, 2012). This trend is manifesting itself in the membership composition of state retirement systems where the ratio of retired to active plan members is growing (Becker-Medina, 2011). We could expect a diminishing percentage share of annual revenues from employee contributions. Moreover, states face an increasing fiscal burden not just from having to close the funding gap for future liabilities, but having to pay out retirement benefits in the current year.

Endogeneity of Public Pension Funding

Though not the focus of my hypotheses testing, I was unable to provide a clear explanation for the unexpected sign of the statistically significant coefficient results for *historicalret* and *actret* in the stock funding model. Instead, I proposed a partial explanation for the inverse relationship of both variables with stock funding by referring to the inverse relationship that both variables had with employer contribution behavior in both cases. By using employer contribution behavior as the link to explain the non-

intuitive results in the stock funding model for *historicalret* and *actret*, my results

suggest endogeneity in employer contribution behavior. The endogeneity stems from

the dynamic adjustments that the plan sponsor is making in terms of its employer

contribution in response to the changes in other plan level characteristics and funding

components. Based on this supposition, the appropriateness of evaluating stock funding

in a static framework then becomes a concern. This is because traditional fixed effects

approach my control for the endogeneity from the unobserved plan-specific

heterogeneity, but it does not account for the endogeneity arising from the dynamic

adjustments occurring in the pension funding process. Therefore, an empirical

evaluation within a dynamic framework could therefore yield clearer insights into the

public pension funding process.

Using an abstract example to illustrate this point, consider my two-period model of

an underfunded DB plan illustrated in Figure 3-1 where the state government fails to

make the full ARC payment in the first period. In reality, the actual DB funding process

is more complicated as it involves a multi-period, year-round, ongoing, simultaneous

flow of employer and employee contributions into the fund and retirement benefits

paid out of the fund to plan beneficiaries. Broadly summarized, a state DB plan is a

dynamic and multi-faceted system where investments are managed year-round and

different sets of employee cohorts with multiple salary grade levels enter, leave, or get

promoted. From the plan actuary's perspective, an actuarial valuation of plan assets and

liabilities from where the stock funding ratio and unfunded liability measure is

calculated, involves regularly updating actuarial projections, and accounting for multiple

investment horizons (a function of the investment portfolio) and different amortization

periods (e.g., whether closed or open).

A review of state and pension plan CAFRs show that in practice a time lag exists in

the valuation and financial reporting of stock and flow-funding components. Using my

two-period model example in Figure 3-1, I illustrate how this time lag becomes a source

of endogeneity for both stock and flow funding measures. First, let us assume

investment returns and employee contributions in current year *t* are exogenous revenue

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sources for current year assets. This leaves the third source of revenues, current year actual employer contributions (AC) observed in year t. As the results reported in Table 5-1 indicates, AC is a function of the actuarially determined annual required contribution (ARC) levels. We know by definition, ARC in turn is derived from the value of assets and liabilities accrued (stock) from all periods prior to current year t, and that both AC and ARC are components of the flow funding ratio (i.e., how the plan sponsors responds to ARC in terms of its AC). Thus, by construction, flow funding is endogenously determined. It follows then, that stock funding is endogenously determined since we showed how past stock funding levels can affect current stock funding levels through current employer contribution behavior.

Apart from employer contributions, if we consider that investment returns largely determine stock funding, and if the assumption from the public pension literature holds that governance practices influence investment performance (e.g., board directed investment and asset-allocation policies), then it becomes even more clear how the stock funding ratio, as an indicator of the overall funded status of a plan, is effectively endogenously determined as well.

The paper by Yang and Mitchell (2005) is the only previous study to raise the issue in general of endogeneity in public pension funding, where the positive correlation between current and past stock funding ratios is traced to the endogeneity of investment performance and persistence in overall pension funding levels. Their paper postulated that endogeneity arises from flow funding being determined by stock funding, and in turn, stock funding being determined by investment performance, with investment performance endogenously determined by the governance practices implemented. To model the possibility that current plan past plan funding outcomes influence current funding, Yang and Mitchell include a lagged dependent variable in their pooled OLS regression model of public pension plan stock funding ratios. Their results suggested that a 1-percentage point increase in the stock funding ratio in a given year was associated with a 0.76 percentage point increase the following year in the stock funding ratio. The authors explain that Mitchell and Smith's (1994) behavioral

persistence hypothesis of public pension plan underfunding is partly explained by the lack of regulations requiring public plan sponsors to fulfill their funding obligations. The modeling approach by Yang and Mitchell (2005) essentially extends the static pension funding model expressed in eq.4-1 to take the following general form:

$$funding_{i,t} = \alpha + \delta_1 funding_{i,t-1} + \beta \kappa_{i,t} + \gamma C_{i,t} + \eta_i + \varepsilon_{it}$$ (eq. 5-1)

For parsimony in notation, we denote $funding_{i,t}$ as $y_{i,t}$ and combine $\kappa_{i,t}$ and $C_{i,t}$ into $X_{i,t}$, and where $\mu_{i,t} = \eta_i + \varepsilon_{i,t}$, to write a more general form of the dynamic model in eq. 5-1 and express it as:

$$y_{i,t} = \alpha + \delta_1 y_{i,t-1} + X_{i,t}\beta + u_{i,t}$$ (eq. 5-2)

Where $y_{i,t}$ is the plan's funding ratio for plan i in year t; $X_{i,t}$ is the matrix of time-variant explanatory variables that affect plan funding as specified in eq. 4-4, and $\mu_{i,t}$ is the composite error consisting of the plan fixed effect η_i, and the random error term $\varepsilon_{i,t}$ where $\varepsilon_{i,t} \sim iid(0, \sigma_\varepsilon^2)$. While Yang and Mitchell claim the endogeneity issue is addressed through the use of panel data and inclusion of a lagged dependent variable in their regression model, their use of a pooled OLS estimator failed to address the endogeneity due to *unobserved heterogeneity* and *simultaneity*.

Econometrically, unobservable heterogeneity exists in Eq. 5-2 if $E(\eta_i|X_{i,t}) \neq 0$. As applied to public pension funding, unobserved heterogeneity becomes a source of endogeneity if there are plan specific characteristics or factors that affect both stock funding and explanatory variables (i.e., unobserved determinants are correlated with the observables). Some examples of time-invariant state DB plan related variables that may affect the various stock funding components include actuarial valuation methods and employer sponsorship arrangements that exist for each plan. In our panel setting, no matter how many plan-specific factors we may include in our regressor list, that is, the right hand side of our regression equation, there may be some time-invariant characteristics unique to each plan that affects the plan's funding outcome that we fail to account for. Omission of these variables will result in biased estimates.

As for simultaneity, econometrically this occurs in eq. 5-2 if $E(\varepsilon_{i,t}|X_{i,t}) \neq 0$. Applied to public pension funding, simultaneity exists when there is some feedback relationship

between one or more independent variables and the stock funding variable (i.e., the explanatory variables is jointly determined with the dependent variable). It could be the case of bidirectional causality, or reverse causality, or that both variables are simultaneously observed. For example, if we take the behavioral persistence hypothesis of Mitchell and Smith (1994) that places the direction of causality from stock funding to flow funding, then by construction, *ceteris paribus*, having more assets relative to liabilities results in a lower ARC; making it more likely that the plan sponsor becomes better able to contribute the full ARC payment. Equally conceivable though, is if the plan sponsor is delinquent in meeting its full employer contribution, this would lower the flow-funding ratio, and therefore negatively affect the stock-funding ratio.

Going back to eq. 5-2, if we follow Yang and Mitchell (2005) and apply simple OLS to estimate the dynamic model with a lagged dependent variable, this will lead to inconsistent and biased results in the presence of unobserved heterogeneity (Baltagi, 2008). This is because by construction, $y_{i,t}$ is a function of the fixed effect η_i, it follows that the lagged dependent variable $y_{i,t-1}$, is also a function of the fixed effect η_i and thus, correlated with the error term $\mu_{i,t}$. The correlation does not go away even if we increase the number of individuals n in the sample or sample time periods T (Bond, 2002). One can also show that the correlation between $y_{i,t-1}$ and the fixed effect in η_i inflates or biases upwards δ_1 the coefficient of $y_{i,t-1}$ (Lachenmaier & Rottmann 2011).

To eliminate the plan-specific effects η_i in our panel data, the standard approach is to apply the fixed effects estimator as I did with my static models to obtain a demeaned estimation equation. The consistency and unbiasedness of the FE estimator though relies on a strict exogeneity assumption that current values of both the dependent and explanatory variables are independent of their past realizations. The inclusion of $Y_{i,t-1}$ violates this assumption. Hsiao (2003; section 4.2) and Wintoki et al. (2012) show how applying fixed-effects estimation in the presence of a dynamic relationship results in biased and inconsistent estimates. Even after removing the panel level means, the transformed variables on the right hand side of eq. 5-2 will still be correlated with the demeaned error term $\left(\varepsilon_{i,t} - \bar{\varepsilon}_i\right)$. Lachenmaier and Rottmann (2011) show how this

leads to a downward bias in the estimates of the lagged dependent variable. Even if more regressors are included and the errors are not serially correlated, purging the individual plan effects will not eliminate the dynamic panel bias; it essentially makes every observation of the transformed y endogenous to the error (Nickel, 1981). Only when $T \rightarrow \infty$, the fixed-effects estimator is consistent in a dynamic panel model, which is typically not the case in most panel data sets where T is fixed or relatively small (Bond 2002). A review of the empirical public pension funding literature shows Giertz and Papke (2007), Doyle (2005), and Listokin (2007) were the only previous researchers to apply the FE estimator in their respective panel regression models of stock funding. However, all the empirical analyses were carried out within a static framework; none of the researchers specified a lagged dependent variable in their respective regression equations.

Fortunately, the development of several panel regression models provides us with solutions to with the econometric issues that may arise from estimating a dynamic panel model such as that specified in eq. 5-2. In the next chapter, I describe and implement an empirical strategy that uses the Generalized Method of Moments (GMM) framework for evaluating the dynamic adjustments in DB public pension funding.

CHAPTER 6

A DYNAMIC EMPIRICAL MODEL OF PENSION PLAN FUNDING

In Chapter 5, I presented and discussed the results of my state DB pension funding panel regression models. The Fixed Effects (FE) estimator was identified as the appropriate empirical strategy to control for time-invariant differences between the individual plans in my panel dataset. OLS estimates were also presented to provide comparable results from past studies that may have failed to properly account for the endogeneity arising from unobserved heterogeneity. While the FE estimator ameliorates the omitted variable bias, it does so at the expense of a strong exogeneity assumption that current year values of my model's explanatory variables are completely independent of the past values of the dependent stock funding variable. This is an assumption I argued is unrealistic if we consider the dynamic adjustments that occur in the pension funding process.

This chapter builds on the discussion from the end of the last chapter by examining the relationship between employer funding behavior and its effect on the overall funding levels of state DB pension plans within a dynamic framework. The purpose of this chapter is to outline an empirical strategy that demonstrates the use of a Generalized Method of Moments (GMM) estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998) in estimating a dynamic panel model of state DB plan stock funding ratios. To provide an empirical perspective on the need to consider the dynamic nature of public pension funding, I discuss the results in relation to those obtained from my FE panel regression model of stock funding in Chapter 5.

State DB Pension Funding as a Dynamic Process

Endogeneity, as it relates to dynamic adjustments in public pension funding, is scarcely addressed in the literature. To show conceptually how stock funding and flow funding are endogenously determined, I use the behavioral persistence hypothesis of public pension funding by Mitchell and Smith (1994) as a starting framework. As earlier

cited, this hypothesis predicts a positive unitary relationship between stock and flow funding, where the level of stock funding determines the level of flow funding. But as we also showed, current year flow funding, which essentially represents the plan sponsor's employer contribution behavior, is endogenously determined because it occurs in response to ARC. ARC in turn, is a function of the previous year's stock funding level. Given how the abovementioned funding outcomes are constructed, one can see how current year stock funding is affected by past values of stock funding through current year employer contributions. Consequently, our empirical strategy will have to deal not just with the endogeneity in public pension funding from unobserved heterogeneity and simultaneity, but also the endogeneity that arises from the dynamic nature of the DB public pension funding process.

Because applying OLS or Fixed Effects to estimate the dynamic model in eq. 5-2 leads to biased and inconsistent results, a GMM panel estimator is used instead to examine the relationship between employer contributions and stock funding ratios. This estimator exploits the dynamic relationship between the dependent and independent pension funding variables in my model. The basic estimation procedure essentially consists of two parts (Wintoki et al., 2002). The first part relates to using first-differencing to eliminate the fixed effects in the dynamic model in eq. 6-1 as first proposed by Anderson and Hsiao (1981), whereas the second part relates to the GMM estimator introduced in a series of papers that include Holtz-Eakin et al. (1988), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

Following the parsimonious approach to notation in eq. 5-2, we denote $stock_{i,t}$ in eq.6-1 as $y_{i,t}$ and all the RHS independent variables are indicated by $X_{i,t}$, and write a more general form of the dynamic model in eq.6-1 as:

$$y_{i,t} = \alpha + \delta(y_{i,t-1}) + \beta(X_{i,t}) + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 6-1)}$$

Where α is the constant term and δ is the estimated coefficient of our lagged dependent variable. The first part of the estimation procedure is first-differencing both sides of eq.6-2 such that:

$$\Delta y_{i,t} = \alpha + \delta \Delta y_{i,t-1} + \beta \, \Delta X_{i,t} + \Delta \varepsilon_{i,t} \qquad \text{(eq. 6-2)}$$

The fixed effect η_i has been eliminated, but $y_{i,t-1}$ in $\Delta y_{i,t-1}$ correlates with $\varepsilon_{i,t-1}$ which is in $\Delta \varepsilon_{i,t}$; so, $y_{i,t-1}$ is correlated with $\Delta \varepsilon_{i,t}$ by construction. Taking an IV estimation approach, Anderson and Hsiao (1981) demonstrated that as long as $\varepsilon_{i,t}$ are not serially correlated, one can use two-stage least squares (2SLS) from further lags to construct valid instruments for the lagged dependent variable - either as level (e.g., $y_{i,t-2}$) or difference (e.g., $\Delta y_{i,t-2}$) for $\Delta y_{i,t-1}$. Arellano and Bond (1991) show that while the estimator described by Anderson and Hsiao is unbiased and consistent, it is not the most efficient, because it uses only a limited subset of all possible values of the instrumental variables, and fails to take into account all the potential orthogonality conditions. The 2SLS as applied in Anderson-Hsiao's "first-difference IV" estimator also creates a trade-off between the depth (i.e., number of time periods) of the estimation sample and the lag distance (i.e., number of lags) used to generate internal instruments (Roodman, 2009a).

Holtz-Eakin et al. (1988) and Arellano and Bond (1991) improve upon the IV estimation approach of Anderson and Hsiao (1981) by proposing a Generalized Method of Moments (GMM) framework to estimate eq. 6-2. The Arellano-Bond estimator utilizes all available past values of the dependent variable when creating instruments for the lagged dependent variable without lag and sample depth tradeoff. Arellano and Bond (1991) constructed their estimator, otherwise referred to as Difference GMM, from moment conditions formed using lagged levels of $y_{i,t}$, first-differenced errors, and the first differences of strictly exogenous variables. Later work by Arellano and Bover (1995) showed weak instruments though affected the asymptotic and small-sample performance of the first-difference GMM estimator. When $y_{i,t}$ is close to a random walk (i.e., past levels provide little information about future changes), it renders the untransformed lags as weak instruments for transformed first-differenced variables.

Blundell and Bond (1998), building on the work of Arellano and Bover (1995), augments the Arellano-Bond estimator by forming moment conditions using a system containing both first-differenced and levels equations. When applied to my stock

funding ratio model, this estimation strategy utilizes the lagged differences of the endogenous stock and flow funding variables as instruments in the level equation (eq. 6-2) and the lagged levels of the endogenous variables in the first-differenced equation (eq. 6-3), resulting in a "stacked" system of equations that includes equations in both levels and differences:

$$\begin{bmatrix} y_{i,t} \\ \Delta y_{i,t} \end{bmatrix} = \alpha + \delta \begin{bmatrix} y_{i,t-p} \\ \Delta y_{i,t-p} \end{bmatrix} + \beta \begin{bmatrix} X_{i,t} \\ \Delta X_{i,t} \end{bmatrix} + \varepsilon_{i,t}, \quad p>0 \qquad\qquad \text{(eq. 6-3)}$$

The estimated coefficients are then obtained by solving the appropriate weighted set of the moment conditions from eq. 6-1 and eq. 6-2.[32]

Using Monte-Carlo simulations, Blundell and Bond (1998) showed that the system GMM (sGMM) estimator performed better than difference GMM in finite samples. Blundell and Bond (2000) further showed that exploiting the additional moment conditions in the levels equation improves the precision of sGMM estimates over difference GMM when the dependent variable is persistent.

Both difference and system GMM can be applied in either one- or two-step variants with robust standard errors (Baum 2006). In difference GMM regressions on simulated panels, Windmeijer (2005) finds the two-step efficient GMM performs better than one-step in estimating coefficients, with lower bias and standard errors. However, Monte Carlo studies such as those by Arellano and Bond (1991) have shown that the two-step estimates of both difference and system GMM standard errors are severely biased

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[32] In system GMM, additional moment conditions can be added for endogenous variables whose first-differences can be used as instruments (Cameron & Trivedi 2010). The moment conditions created by assuming particular lagged levels of the dependent and other endogenous variables are orthogonal to the differenced errors are sometimes referred to as "GMM" type moment conditions, whereas those formed using strictly exogenous variables are sometimes referred to as standard "IV-style" moment conditions (Roodman, 2009a). One can instrument the endogenous variable using the same principle for instrumenting the lagged dependent variable. For example, if an explanatory variable $x_{i,t}$ is endogenous, then valid instruments for $\Delta x_{i,t}$ in the first-differenced equation is $x_{i,t-2}$ and earlier realizations of x_i. Valid instruments for $x_{i,t}$ in the level equation is $x_{i,t-1}$ and earlier realizations of $\Delta x_{i,t}$.

downwards in small samples.[33] To address the downward bias in sGMM errors, Windmeijer (2005) developed a small-sample correction to the covariance-matrix for two-step standard errors and reported that his correction resulted in more accurate standard errors; such that two-step estimation with the corrected errors appears modestly superior to robust one-step GMM (Roodman, 2009a). Given the factors that apply in my stock funding ratio model - short panel, a dynamic dependent variable, a lack of good external instruments, along with the ability to instrument potentially endogenous variables (e.g., *ac_acp*, *made_arc*) - the system GMM estimator offers a dynamic panel solution to the problems of endogeneity stemming from simultaneity bias, reverse causality, and omitted variables.

A Dynamic Model of Stock Funding

Following Yang and Mitchell (2005), I extend the static model expressed in Model 3 (eq. 4-4) by including a lagged dependent variable to account for the possibility that a plan's current overall funded status as indicated by the stock funding ratio is influenced by past stock funding outcomes:

$$stock_{i,t} = \beta_0 + \beta_1\,(stock_{i,t-1}) + \beta_2\,(memcon\_acp_{i,t}) + \beta_3\,(lnaveben_{i,t})$$
$$+ \beta_4\,(ac\_acp_{i,t}) + \beta_5\,(made\_arc_{i,t}) + \gamma C_{i,t} + \lambda T_t + \eta_i + \varepsilon_{i,t} \qquad \text{(eq. 6-4)}$$

Where the dependent variable $stock_{i,t}$ is the plan's stock funding ratio for plan i in year t; $stock_{i,t-1}$ is the lagged dependent variable; $memcon\_acp_{i,t}$ is the employee contribution rate expressed as a percentage of the annual covered payroll; $lnaveben_{i,t}$ is the logarithm of a plan's average benefit payment. In this equation, both flow funding related variables, $arc\_acp_{i,t}$ is the annual required contribution rate expressed as a percentage of annual covered payroll, and $made\_arc_{i,t}$, a dummy variable to indicate whether the plan made its full annual required contribution.

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[33] One-step GMM estimators use weight matrices that are independent of estimated parameters, whereas the efficient two-step GMM estimator weighs the moment conditions by a consistent estimate of their covariance matrix (Windmeijer, 2005). The term "two-step" also refers to the optimal weighting matrix constructed in the first-step estimation using an initial consistent estimate of the parameters in the model (Windmeijer, 2005).

The model shares the same set of control variables $C_{i,t}$ as those specified in Model 3 from Chapter 5. These include $actret_{i,t}$ a control for plan member composition between active and retired plan members; $assumedret_{i,t}$ the selected discount rate used in the actuarial asset valuation; and $historicalret_{i,t}$ the one year actual rate of return on investments. T_t is a vector of year dummies to control for any shocks common to all state DB plans. Lastly, η_i is the unobserved plan fixed effect and $\varepsilon_{i,t}$ is the random error term.

The model was fitted using the system GMM (sGMM) estimator by Arellano-Bover (1995) and Blundell-Bond (1998) and implemented in STATA 12.1 using the *xtabond2* user written command by Roodman (2009a). The two-step sGMM coefficient results are reported in Table 6-1 using Windmeijer's (2005) "finite-sample correction" to the robust standard errors, along with the FE estimates obtained from my stock funding model as reported in Table 5-2.

The *xtabond2* user command allows us to specify our endogenous variables as 'GMM' style instruments and incorporate assumptions on which variables are strictly exogenous (i.e., standard `iv' instruments). In this model, the stock funding ratio and both flow funding related variables $arc\_acp_{i,t}$ and $made\_arc_{i,t}$ are assumed to be endogenous. So, for our GMM style instrument set, each of the three identified endogenous variables are instrumented using lagged values (i.e., lagged levels and lagged differences) up to year t-4, and the year dummies are identified as standard IV style instruments (i.e., treated as exogenous). To ensure the statistical validity of the instruments used, the results of the AR(2) and Hansen *J* test are also reported in Table 6-1.

Assessing the Specification of the GMM model

The consistency of the GMM estimator will depend on the absence of serial correlation in the error term and the validity of the instruments. I use the Arellano-Bond test for autocorrelation to test the hypothesis that the idiosyncratic error $\varepsilon_{i,t}$ is not serially correlated.

Table 6-1. Fixed Effects and System GMM Model of Stock Funding Ratios (100 State DB Plans, FY 2002-2010)

	Stock Funding (AVA/AAL) %			
	Fixed Effects		System GMM	
stock$_{t-1}$			0.732	***
			(0.069)	
ln Plan Net Assets	25.906	***	2.335	*
	(7.344)		(1.202)	
Member contribution rate (%ACP)	-0.681		-0.561	
	(0.494)		(0.452)	
ln Average retirement benefit payment	4.012		-3.870	
	(3.161)		(3.944)	
1 yr investment rate of return (%)	-0.083	**	0.509	***
	(0.033)		(0.151)	
Discount rate (%)	6.941		1.340	
	(4.220)		(3.106)	
Actives/Beneficiaries ratio	-0.321	***	1.645	**
	(0.099)		(0.673)	
Employer contribution rate (%ACP)	0.041	*	0.075	**
	(0.023)		(0.035)	
Made ARC dummy	1.466	*	1.745	
	(0.751)		(1.086)	
percap unres GenFund balance ($1000s)	-0.021		-0.172	
	(0.060)		(0.346)	
R^2	0.571			
AR (1) test p-value			0.001	
AR (2) test p-value			0.607	
Hansen *J-test* p-value			0.543	
No. of instruments			111	

Notes: * p<0.10 ** p<0.05 *** p<0.01
• stock: stock funding ratio (%),defined as the ratio of actuarial value of assets (AVA) to actuarial accrued liabilities (AAL); made_arc: dummy variable = 1 if plan made 100% annual required contribution (ARC); percap unres GenFund balance ($1000s): state per capita unreserved general fund balance
• AR(1) and AR(2) are tests for first-order and second-order serial correlation in the first-differenced residuals, where Ho: no serial correlation; Hansen test of over-identification where Ho: all instruments are valid. Robust standard errors clustered at the state level are reported in the brackets below the fixed effects coefficient results while the two-step standard errors for the System GMM estimated values are robust to the Windmeijer (2005) correction for finite-sample heteroskedasticity. All panel regression models include year dummies whose estimated coefficients are not reported in this table but can be found in Appendix C.

By construction, we expect first-order serial correlation in differences since $\Delta\varepsilon_{i,t}$ is mathematically related to $\Delta\varepsilon_{i,t-1}$ via the shared term $\varepsilon_{i,t-1}$. Hence, we are interested in the result of the second-order correlation in differences between $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t}$ and $\varepsilon_{i,t-2}$ in $\Delta\varepsilon_{i,t-2}$. To test for this, Arellano and Bond (1991) recommend using the AR(2) autocorrelation test of the null hypothesis that there is no second-order autocorrelation in the residuals of the equation in differences. The AR(2) test yields a *p*-value of 0.607 which means we cannot reject the null hypothesis of no second-order serial correlation.

Next, I use the robust Hansen (1982) *J* statistic test for overidentification to test the joint validity of the overidentifying restrictions on the GMM estimator. It is the most common diagnostic in GMM estimation used to assess the appropriateness of the model specification (Baum 2006).[34] Rejecting the null hypothesis under this test implies the instruments do not meet the required orthogonality conditions – because either the instruments are not truly exogenous or they are being excluded incorrectly from the regression (Baum 2006). The results in Table 6-1 indicate a *J*-statistic with a *p*-value of 0.543 and as such, we cannot reject the hypothesis that our instruments are valid.

Apart from testing the validity of the full instrument set (i.e. entire set of overidentifying restrictions), I also test the validity of a subsets of instruments (i.e., GMM style and standard IV style instruments) using the *difference-in- Hansen* test. The test, also referred to by Hayashi (2000) as the *C*-statistic, is distributed $\mathcal{X}^2$ with degrees of freedom equal to the loss of overidentifying restrictions under the null hypothesis that the specified variables are proper instruments (Baum et al., 2003). The results for these specification tests are reported in Appendix C and they confirm the statistical validity of my GMM and standard IV instruments. Appendix E provides a more detailed discussion of the system GMM model diagnostic and specification tests used in my analysis.

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[34] The Hansen *J*-Test is used instead of the Sargan Test since the distribution of the Sargan test is only known when the errors are independently and identically distributed. Arellano and Bond (1991) show that the one-step Sargan test over-rejects in the presence of heteroscedasticity and autocorrelation, and a tendency to under-reject when applied after the two-step estimator under the same conditions.

Results and Discussion

A cursory review and comparison of the FE and sGMM coefficients reported in Table 6-1 reveal some notable results. First, the highly significant sGMM coefficient of the stock funding lagged dependent variable confirms the importance of including it in the specification. Conversely, it also suggests omitted dynamics in any static empirical model specification.

The sGMM estimates in Table 6-1 suggest that on average, holding everything else constant, that a 1-percentage point increase in the previous year's stock funding ratio is associated with a 0.732 percentage point increase in the current year's stock funding ratio. This result suggests past funding outcomes have a major influence in determining current and future plan funding outcomes.

Conversely, when we consider the past research, the result implies a concern for omitted dynamics in any static model specification of stock funding ratios. Even apart from sGMM results, we get some indication of the importance of accounting for dynamics in pension funding by just looking at the changes in the R^2 when we add the stock funding ratio lagged dependent variable to our FE and OLS models. The R^2 rises from 0.445 in the static OLS model to 0.929 in the dynamic OLS model, and from 0.057 in the static FE model to 0.417 in the dynamic FE model (see Table 6-1 and Appendix C). Additionally, in comparing the three dynamic model specifications in Appendix C, one would note that the estimated sGMM coefficient of the lagged dependent variable lies between the FE and OLS estimates, where FE_$stock_{t-1}$< sGMM_$stock_{t-1}$<OLS_$stock_{t-1}$ (0.591<0.732<0.939). This illustrates Bond's (2002) discussion of how applying the FE estimator to a dynamic model would bias downwards estimated the coefficient of the lagged dependent variable, and upward biased when simple OLS is applied to a dynamic model.

When the relationship between employer contribution behavior and overall plan funding is evaluated under the FE model, the results indicated that both flow funding related variables - the employer contribution rate *ac_acp*, and making the full ARC payment - were positively related to stock funding ratio. In particular, the estimates for

ac_acp were particularly robust to both model specifications. The positive relationship between *ac_acp* and *stock* is even more pronounced under the sGMM model when we account for pension funding dynamics. The estimated coefficient for ac_acp goes from 0.041 (*p<0.10*) under the FE model to 0.075 (*p<0.05*) under the sGMM model. The other flow related variable, *made_arc*, was only significant under the FE model (*p<0.10*) and not under the sGMM.

After controlling for the endogeneity of both stock and flow funding treat instrumenting for the endogeneity of our flow funding related variables, the results suggest that how much the plan sponsor actually contributes into the plan affects overall funding levels matters more than whether the plan sponsor merely makes the full ARC payment. This finding diverges from my hypothesis that ascribes the growing funding gap in DB state PERS to the recurring failure of states to contribute the full ARC, that is, where the flow funding ratio is less than 100%. So what might account for the non-significance of the *made_arc* variable? One possible reason is related to employer contribution policy and the nature of the variable itself. The funding policy norm for the majority of public pension plans is full payment of the actuarially determined ARC but at the same time, most states are not legally required to pay the full ARC every year (Peng 2008).

We know that from Munnell et al. (2008d, 2011c) that actuarial valuation method and state fiscal condition affect the likelihood that states make the full ARC payment. Both studies further add that anywhere from half to two-thirds of plans who failed to pay the full ARC, cite legal constraints (whether binding or non-binding) as the primary barrier to making the full contributions. Plan actuaries likely incorporate these factors into their annual valuations whenever they determine the future stream of ARC flows. If we take into context an objective of maintaining a certain level of funding, the assumption is that the plan sponsor consistently pays the full ARC each year moving forward. Holding all other plan funding variables constant, it follows then that whenever the plan sponsor fails to pay the full ARC for any given year, plan actuaries will re-adjust

or re-calculate their plan valuations based on the actual employer contribution rate (AC).

As for the other two reform-linked funding components of interest in this study, *memcon_acp* and *lnaveben*, neither variable showed a significant relationship with stock funding ratio. The sGMM results would suggest that even after accounting for the dynamic adjustments in pension plan funding, increasing the employee contribution rate and reducing the size of average plan benefits on average *ceteris paribus*, might not have the intended policy reform impact of increasing a plan's stock funding ratio. The results are fairly robust if we consider the same result is confirmed in the dynamic specifications of the OLS and FE model (see Appendix C).

Taking an actuarial perspective, the practice of smoothing out investment returns to lessen the volatility of ARC rates ensures that the impact of annual investment returns and actual employer contribution rates gets spread over several periods. By contrast, employee contributions and benefit payouts represent single period shocks to plan funding levels. With employee contributions, the rates are relatively fixed and they generate a smaller share of annual pension revenues, and consequently implies an even smaller share of the present value of total accumulated assets. A similar principle applies to the liability side from changes in the level of retirement benefits. This is because current liabilities at market value are comprised mostly of retirement benefit payouts to current retirees in current year *t*. From an actuarial perspective, when the full stream of accrued benefits from both active employees and future retirees are considered for *t-n* and *t+n* periods, the value contributed by a single year of benefit payouts to the total value of actuarial liabilities is substantially less.

Although not the focus of my study, the sGMM coefficient results for the plan level variables still have important funding implications for state DB retirement systems. For example, consider the 1-year investment rate of return variable *historicalret*, and the ratio of active to retired members variable *actret*. Unlike the FE coefficient results, the sGMM estimates for both variables show the expected positive relationship with stock funding ratio. The result for *historicalret* unremarkably confirms the importance of

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investment returns in determining state DB plan funding levels, but the size of the estimated coefficient does raise some interest. The sGMM coefficient results indicate that a 1-percentage point increase in the 1-year rate of return on investments is associated with a 0.509 percentage point increase in a plan's stock funding ratio. The magnitude of estimated relationship is notable since for most public pension plans, a percentage point increase in *historicalret* represents a substantial amount of additional revenues. At the same time, the coefficient result may just reflect the moderating effect from the prevalent actuarial valuation method of smoothing out investment returns

Just as consequential is the statistically significant positive relationship between *actret* and *stock*. I noted earlier how the ratio of active to retired members for my panel of state DB plans decreased continuously every year between FY 2002 and FY 2010 from 3.52 down to 1.98. This trend reflects the increasing number of retiring state and local government employees and an aging workforce in general. When re-stated, the trend points towards an increasing proportion of retired to active plan member employees, one that will pose major funding concerns for state governments. States face increasing retirement system funding pressure in two areas every year moving forward: dwindling percentage share of revenues coming from active plan member contributions, and annual increases in total pension annuities that state governments by law are required to pay no matter what.

Despite carrying the expected sign, the *assumedret* variable falls short of statistical significance under both the FE and sGMM models. The non-significant results fail to provide empirical support to the suggestion drawn from past studies like Eaton and Nofsinger (2004) that states manipulate actuarial assumptions to record favorable funding outcomes. Even if the assertion is tied in with political and fiscal factors, a review of the CAFRs and actuarial reports of the plans in my sample showed very few instances when plans instituted a discount rate change during the 9 year period covered by my panel. I noted earlier how this is reflected in the very small panel within-group variation of the *assumedret* variable. Nonetheless, because the assumed rate of return

is the key assumption that drives the actuarial valuation of plan assets, this issue will remain a major focal point in the debate over public pension plan funding.

In controlling for plan size in terms of plan net assets (*ln_netasset*), the estimated coefficients were significant in both the FE and sGMM model but the difference in the coefficient size is immediately apparent. The dramatically smaller sGMM estimate suggest that the actual effect on current stock funding from changes in current net asset holdings may be inflated in the FE model due to omitted dynamics. Interestingly, the same changes in coefficient size is noted between the static and dynamic FE and OLS models, where the *ln_netasset* coefficient is much smaller in the dynamic specification (see Appendix C). Setting aside the bias and inconsistency of the dynamic OLS and FE specifications, the similar changes observed for *ln_netasset* when it is specified under the dynamic version of all three estimators lend evidence to the importance incorporating past funding outcomes in any pension funding empirical model.

Finally, the coefficient for my unreserved general fund balance variable *gfbal_urpc1k* was not significant in either the FE or sGMM model. When considered across all model specifications, the results are consistent with my analytical framework that showed annual state fiscal indicators would be more directly associated with employer contribution behavior than with overall plan funding. Virtually all empirical public pension studies have incorporated some type or variation of a fiscal indicator in their analysis. Overall though, the results are mixed, with no general consensus over which fiscal indicator best determines flow funding.

Concluding Remarks

In this chapter, I extended my static framework of analyzing public pension funding by specifying a dynamic panel regression model of DB state plan stock funding ratios. I was interested in determining the effect on the overall funded status of state DB plans from changes in my reform-linked funding components as they relate to employer and employee contributions and average retirement benefits. I demonstrated the use a GMM estimator to control for potential endogeneity issues ignored in past empirical

studies, particularly unobserved plan heterogeneity, simultaneity, and endogeneity with respect to dynamic adjustments in the pension funding process. My system GMM model considered the endogeneity of stock and flow funding and utilized lagged values to instrument these variables. I discussed the results from my dynamic model and compared them to those obtained from my fixed effects stock funding ratio model.

The highly significant coefficient of the stock funding lagged dependent variable point to the importance of past funding outcomes in determining current overall funding levels. The significant positive relationship between employer contribution rate and stock funding ratio is robust to both static and dynamic model specifications. The result confirms the fiduciary role of state governments, as demonstrated in their employer contributions, in ensuring the solvency of their respective DB retirement systems. Otherwise stated, what matters most in the end is how much the state government actually contributes into its respective DB plans.

The member contribution rate and average benefit variable were not significant in both the FE and sGMM model, essentially reflecting the nature of this two variables and the way they are incorporated into the actuarial valuation process. From a policy standpoint, the results imply the limited effectiveness of increasing employee contribution rates and reducing the annual cost of pension annuities to improve overall plan funding levels.

The sGMM model also indicated the positive effect of investment performance and active to retired plan membership ratio on stock funding ratio. The results shed insight into incorporating dynamics in modeling public pension funding in view of the actuarial practice of smoothing out investment returns and an aging public employee workforce.

Finally, it should be noted that the system GMM estimator is not a panacea for all dynamic endogeneity related panel data issues. Indeed, Roodman's (2009b) warns about the automated sophistication in the way researchers might utilize the system GMM estimator. While the system GMM estimator offered an appealing solution to the problems I faced in estimating a dynamic model of public pension funding, including, "the combination of a short panel, a dynamic dependent variable, fixed effects, and a

lack of good external instruments" (Roodman, 2009b, p. 256), it also comes with serious limitations. To help reduce the likelihood of invalid results being generated, Roodman (2009a, 2009b) stressed that researchers need to consider carefully the way they specify the instruments used for their regressions and for transparency, report all results from the relevant model diagnostic tests.

CHAPTER 7

SUMMARY, CONCLUSIONS, AND RESEARCH PROSPECTS

Dissertation Summary

The purpose of this dissertation is to provide an empirical evaluation of Defined Benefit (DB) state retirement system funding. As indicated in Chapter 1, DB state pension plans play a major role in the country's labor and financial markets. The motivation for this study conveys the widespread concern over these critically underfunded retirement systems, and state efforts to reform various funding aspects of their respective DB pension plans. A review of annual state pension related legislation reveals a growing impetus for reform in recent years, among an increasing number of states, to address the pension underfunding issue. Reforms fall under five broad categories identified by the Pew Center on the States (2010b), and they are: (1) keeping up with funding requirements; (2) increasing employee contributions; (3) reducing benefits; (4) improving governance and investment oversight; and (5) sharing the risk with employees. The saliency of the reforms is reflected in the fiduciary role of states in ensuring adequate funding for their respective DB plans. By design, the state government fulfills this role by covering any pension funding shortfalls through employer contributions. This raises the question of what determines the actual employer contribution rates, particularly as it relates to meeting annual required contributions. Is there empirical support for the hypothesis that state DB pension plan sponsors underfunded their contributions? The other research question in this study deals with determining an analytical link between each reform category and a specific DB plan funding component. Is there empirical support for the hypothesis that improved funding outcomes from reforms can be linked to increasing employer and employee contributions and reducing benefits?

In Chapter 2, I discuss the rationale behind the various reforms and provide recent examples from each pension reform category. The importance of investment income in determining overall plan funding levels is a likely reason why much of the related

research has focused on examining investment performance and overall funding as a function of governance practices and state fiscal condition. I noted the major constraints of directly examining the impact of specific individual reform on a plan's funded status. As an alternative, a framework was proposed to evaluate the funding impact from each reform category by linking it analytically to a specific DB plan funding component.

This framework is presented in Chapter 3 using a balance-sheet approach to describe the DB plan funding structure and process. The asset-liability framework incorporates the various DB pension plan funding concepts and key measures in relating each pension reform category to a specific DB plan funding component. I paid particular attention to the funding outcomes affected by reform categories related to reducing the cost of retirement benefits, increasing employee contributions, and meeting annual employer funding requirements. There were four plan funding outcomes of interest in this study, namely, the employer contribution rate (*ac_acp*); flow funding ratio (*flow*); stock funding ratio (*stock*); and the unfunded actuarial accrued liability as a percentage of a plan's annual covered payroll (*uaal_acp*). I illustrated an example where my framework could be used to model the impact of employer contributions on the overall funded status of a DB plan.

In Chapter 4, I outlined and described the empirical modeling of DB state pension funding, and the estimation strategy for examining employer contribution behavior and the relationship between improved funding outcomes from changes in the reform-linked DB plan funding components. Using a panel of 100 state administered DB pension plans from 50 states over a nine-year period FY 2002-2010, I empirically tested the following hypotheses using fixed effects (FE) panel regression models:

(1) The hypothesis that states are underfunding their respective DB state plans as indicated by their response (AC) to the annual funding requirement (ARC).

(2) The hypothesis that increasing employer and employee contributions and lowering benefit payments are associated with higher plan funding ratios and lower plan unfunded liabilities.

I presented and discussed my results in Chapter 5 in two parts. In the first part, I analyzed the determinants of employer contribution rates (Model 1) and flow funding ratios (Model 2). I found strong evidence that state DB pension plan sponsors underfund their annual required employer contributions. Specifically, the results from my empirical analysis indicate that a percentage point increase in the annual required contribution rate is associated with only 0.530 percentage point increase in the actual employer contribution rate. The results in both my employer contribution rate model (Model 1) and flow funding ratio model (Model 2) also suggest a significant positive relationship between state fiscal condition and the ability of states to make its employer contributions.

The results from my stock funding ratio model (Model 3) and unfunded liability model (Model 4) formed the second part of my empirical analysis. When considering pension reforms related to changes in employer and employee contributions, my results provide empirical support for the critical relationship between employer contributions and favorable plan funding outcomes. Specifically, increasing the employer contribution rate and making full ARC payments significantly increase plan stock funding ratio and lower the relative size of the unfunded liabilities. On the other hand, I find no significant influence from the employee contribution rate (*memcon_acp*) on any of the plan funding outcomes. I also found no evidence that changes in the average benefit variable (*lnaveben*) had any significant effect on either the stock funding ratio (*stock*) variable or the unfunded liability variable (*uaal_acp*). The non-significant results for *memcon_acp* and *lnaveben* are attributed to the statutory environment and legal constraints that largely limit member contribution rate increases and benefit reductions to new employees. Subsequently, the overall impact on improving public plan funding outcomes from such policy reform efforts is expected to be minimal.

At the end of Chapter 5, I discussed the limitations of using a static analytical framework for evaluating public pension funding given the inherently dynamic nature of the DB funding process. Specifically, I highlighted the endogenous funding relationship between employer contribution behavior and the overall actuarial funded status as

measured by the stock funding ratio. Traditional fixed effects may ameliorate our control of endogeneity arising from unobserved plan heterogeneity, but it is not an appropriate estimator in the presence of dynamic endogeneity. To this point, Yang and Mitchell (2005) were the only researchers to consider the dynamic and endogenous components of public pension funding. However, their attempt to estimate a dynamic model of stock funding ratio using simple pooled OLS raises potential econometric concerns that are noted as well in Chapter 5.

The need for an appropriate estimation strategy in evaluating a dynamic model of public pension funding becomes apparent when we consider the endogenous funding relationship between stock and flow funding. Such an estimation strategy is proposed in Chapter 6, where I presented a dynamic model for analyzing state DB plan stock funding ratios. Specifically, the GMM estimator, as proposed by Blundell and Bond (1998), offered a dynamic panel solution to the problems of endogeneity stemming from simultaneity bias, reverse causality, and omitted variables. This system GMM estimation strategy utilizes the lagged differences of the endogenous variables (i.e. *stock* and *flow*) as instruments in the level equation, and the lagged levels of the endogenous variables in the first-differenced equation, resulting in a stacked system of equations that includes equations in both levels and differences. For inference purposes, I used the estimated coefficients from the two-step system GMM (sGMM) with Windmeijer's (2005) finite-sample correction to the robust standard errors. Specification tests were run to ensure that statistical validity of the instruments used for the endogenous stock and flow funding related variables. The sGMM results were also discussed in relation to the FE results of my stock funding ratio model from Chapter 5 (Model 3).

There were four notable results to mention from the analysis in Chapter 6. The first relates to the highly significant relationship between past and current funding outcomes. This would suggest a concern for omitted dynamics in any static model specification of stock funding ratios. Second, the significant positive relationship between employer contribution rate and stock funding ratio was robust to both static and dynamic model specifications. The result confirms the fiduciary role of state

governments, as demonstrated in their employer contributions, in ensuring the solvency of their respective DB retirement systems. Third, the sGMM results continue to call into question the effectiveness in improving funding outcomes by implementing reforms related to increasing employee contribution rates and/or reducing the total cost of annual retirement benefit payouts. Lastly, the sGMM estimates indicated the positive effect of investment performance and active to retired plan membership ratio on stock funding ratio. The results point to the value of incorporating dynamics in modeling public pension funding. This is especially important as we find evidence that overall plan funding levels are affected by the aging public employee workforce and the actuarial practice of smoothing out investment returns as a means of reducing employer contribution rate volatility.

Conclusion and Implications for Policy and Future Research

In summary, the results of my empirical analysis suggest that increasing a state DB plan's stock funding ratio or reducing its unfunded liabilities centers around the plan sponsor's ability to increase employer contributions and making full ARC payments. These findings have budgetary implications for state governments attempting to reform their seriously underfunded DB retirement systems. This is because the guaranteed nature of these retirement benefits means that state governments are ultimately responsible for covering any funding shortfall (Forman 2009; Young 2006).

Questions are being raised though over the ability of states to cover shortfalls and sustain the solvency of their retirement systems through increased employer contributions in view of current and long-term fiscal challenges. The U.S. Government Accountability Office projects that state and local governments will incur operating deficits of up to $163 billion from 2010 to 2011 (GAO 2010). Therefore, any state effort to raise their DB plan employer contribution rates will greatly be constrained by the ongoing economic downturn in which declining state and local revenues are accompanied by increasing demand for public services. As Peng (2004) concisely puts it, "Because pension contributions come out of the general fund, they directly compete with other government programs for the limited resources in the general fund. Pension

contributions, however, do not have the same immediacy and urgency as other government programs" (p. 62).

The problem is that although the state government can defer from fulfilling its pension funding requirements, it cannot do the same with its annual benefit payments to its current retirees. Widely publicized examples of how annual retiree benefit payments are adding to the fiscal pressures faced by governments in states like California, Illinois, and New York would imply that currently due retirement obligations seemingly trump "other government programs" in the General Fund (e.g., Crane, 2010; Walsh & Schoenfeld, 2010; Lowry, 2010). Just as daunting if not questionably feasible, is the option of pursuing reductions in the current level of retirement benefits accruing to active employee members, thereby lowering the average benefit payments due in future periods. This is why the majority of policy reforms undertaken to reduce retirement benefits are limited to new and future employees and essentially serve to lessen the rate of increase in unfunded liabilities.

Unless the economy and financial condition of states improve and effective pension reforms can be instituted, severely underfunded retirement systems will only increase the costs of paying out these retirement benefits with every year that passes. That cost eventually coming in the form of resources reallocated away from important programs such as education, health, and public safety.

Study Limitations and Future Research

The empirical analysis in this study was limited to examining the effect on our funding outcomes from contributions and benefit payments. Nonetheless, the estimated coefficients for some of the control variables in my econometric models raise some interesting results that warrant further investigation.

The first relates to the effect that state fiscal conditions may have on pension plan funding. The extant empirical literature strongly supports a positive relationship between higher stock and flow funding levels and favorable state fiscal condition. In my analysis, I used as my fiscal indicator, the per capita unreserved General Fund balance,

expressed in $1000s (*gfbal_urpc1k*), to represent the link described by Peng (2008) between the state's general fund and its pension contribution activities.

My results indicate a significant association between *gfbal_urpc1k* and *ac_acp* and *flow* but not with *stock*. If we consider Peng's (2008) Fiscal Stress Hypothesis of public pension funding (i.e., in times of fiscal stress, states contribute less), there is a stronger theoretical argument to be made in linking state fiscal condition with flow funding related outcomes than with the stock values that account for long-term plan solvency. This is why I find the significant positive relationship between *gfbal_urpc1k* and *uaal_acp*, to be unexpected given the inverse relationship of *uaal_acp* with *ac_acp* and flow on *uaal_acp* (i.e., higher employer contributions should reduce the unfunded liability *ceteris paribus*). Additional research using a whole range of fiscal and economic variables should help provide a more definitive picture of state fiscal influence on plan funding levels.

The empirical approach utilized in this study can also be expanded to include the dynamic modeling of DB public plan investment performance. Unlike the FE model, the estimated coefficients for my *historicalret* variable (along with the *actret* variable) yielded the expected coefficient signs under the system GMM model. Not surprisingly, the result essentially confirms the established link between investment returns and pension plan funding. Public pension plans are major players in the capital markets, and accordingly their asset allocation decisions and investment portfolio performance are constantly and extensively monitored and analyzed. In comparison, very few studies have used longitudinal data to examine how governance determines investment performance. Three of those studies, Albrecht and Lynch (2007), Doyle (2005), and Yang and Mitchell (2005) used pooled cross section data from the 1990s to show how a whole range of governance variables – from board composition, management practices, reporting practices, to investment practices - were significantly related to the investment performance of public pension plans.[35] However, empirical analyses that

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[35] As mentioned throughout Chapter 4, all three studies used the same set of PENDAT survey files described in page 44.

properly account for the endogeneity of these governance variables are still lacking in the literature. Future research in this area can yield new insights into the relationship between governance and public pension funding.

As it relates to the fourth and fifth Pew Center identified pension reform categories that address investment performance and investment risk, a follow-up analysis using a GMM framework similar to the one I used for plan stock funding ratios may shed additional insights into the dynamic and endogenous relationship between governance and investment performance. With a more recent panel dataset, we can explore how governance has affected investment performance in the past decade, as well as evaluate the potential impact of efforts to professionalize the investment oversight and management of public pension funds.

Other Post-Employment Benefits (OPEBs)

Lastly, one important area where empirical research on public pension funding is still lacking is the evaluation of state efforts to reform Other Post-Employment Benefits (OPEBs). On top of having to guarantee their sizeable regular pension obligations, states are facing added fiscal pressure in trying to find ways to fund OPEBs. These benefits were historically financed on a Pay-as-You-Go (PAYGO) basis but after GASB 43/45 were issued in 2004, states are now required to account for their OPEB costs and funding on an accrual basis using similar actuarial methods and reporting standards used in valuing their regular DB pension plans (Kearney et al., 2009). By complying with GASB 43/45, states are disclosing a more complete picture of the true cost of financing their respective OPEBs. The picture is a grim one if we consider recent Pew Center (2012) estimates of the total unfunded OPEB liability at around $627 billion, apart from the estimated $757 billion in unfunded regular pension benefits, within the context of a poor economic climate, workforce demographic trends, and escalating healthcare costs (GAO, 2012a,2012b).

Depending on the magnitude of their OPEB liability, the implication of the annual required contribution under GASB 45 is that state governments will now have to contribute significantly more per year to finance other post-employment benefits

compared to what they would have paid on an annual PAYGO basis. GASB 45 does not require states to set up the kind of irrevocable trust funds used for their defined benefit pension plans, it does contain incentives for states to pre-fund their OPEB liabilities. This includes the use of a higher discount rate to value their OPEB obligations, consequently reducing the size of their annual required contributions. We see some evidence of states responding to this incentive as OPEB trust funds were set-up in 13 states in 2007 alone (see Table 3). Applying the same framework of finite operating budget resources to state OPEB funding, this raises questions about the potential budget trade-offs between state contributions into DB pension plans vs. OPEB trust funds and current payments of regular pension benefits and OPEBs to current retirees.

There is growing anecdotal evidence that a combined trend of fiscal pressures caused by employer contributions to pre-fund OPEB and regular pension trust funds along with substantial annual OPEB and regular pension payments to current retirees will have an adverse impact on the financial condition of state budgets. This raises potential endogeneity issues that future research can address.

APPENDICES

Appendix A. Complete Results for OLS and Fixed Effects Specification of Employer Contribution Rate and Flow Funding Ratio

	Model 1: Employer Contribution Rate (%ACP)				Model 2: Flow Funding % (AC/ARC)			
	OLS		Fixed Effects		OLS		Fixed Effects	
ln Plan Net Assets	-0.672	**	6.880	**	-3.518	**	31.135	**
	(0.322)		(3.035)		(1.532)		(15.363)	
Member contributions	-0.245	**	-0.092		-0.470		-0.535	
	(0.108)		(0.101)		(0.478)		(0.637)	
ln average benefit	1.720	**	-0.854		8.181	**	9.151	
	(0.831)		(0.609)		(4.025)		(7.050)	
Actives/Beneficiaries	-0.033		0.037		-1.057	***	-0.529	**
	(0.023)		(0.035)		(0.146)		(0.230)	
1 yr ROR (%)	-0.020		-0.035	*	-0.253	**	-0.302	**
	(0.019)		(0.018)		(0.104)		(0.125)	
Discount rate	-3.109	**	-1.511		-14.294	**	0.889	
	(1.539)		(1.027)		(5.813)		(6.268)	
Stock Funding (%)	-0.158	***	0.039		-0.032		0.367	
	(0.053)		(0.051)		(0.124)		(0.236)	
ARC (% ACP)	0.395	**	0.530	***	-0.758	***	0.077	
	(0.154)		(0.123)		(0.189)		(0.334)	
percap unres GenFund	0.163	***	0.281	***	0.646		1.028	***
balance ($1000s)	(0.059)		(0.030)		(0.406)		(0.224)	
Set of year dummy variables								
yr 2002	1.415		0.258		11.606	**	14.835	**
	(1.158)		(1.070)		(4.797)		(6.746)	
yr 2003	0.722		0.408		9.970	*	13.992	*
	(0.986)		(1.040)		(5.309)		(7.686)	
yr 2004	0.987		0.297		7.014		7.449	
	(0.961)		(0.872)		(4.297)		(4.952)	
yr 2005	0.335		-0.695		1.958		-0.707	
	(0.766)		(0.472)		(3.969)		(3.161)	
yr 2006	0.967		-0.724		4.349		-1.846	
	(1.064)		(0.613)		(4.452)		(3.175)	
yr 2007	2.789		-0.091		9.555		-1.915	
	(1.966)		(1.071)		(5.718)		(4.120)	
yr 2008	1.691	**	-0.316		7.497	*	-1.304	
	(0.735)		(0.812)		(4.351)		(5.043)	
yr 2009	.		0.430		.		-0.737	
	.		(0.416)		.		(3.164)	
yr 2010	-0.364		.		2.940		.	
	(0.373)		.		(3.042)		.	
Constant	37.96	*	-90.03	*	193.92	**	-540.13	**

	(18.99)	(49.04)	(75.55)	(266.9)
Observations (n)	898	898	898	898
R2	0.419		0.118	
rho		0.742		0.750
R2 within group		0.247		0.078
R2 between group		0.017		0.003
R2 overall group		0.044		0.000
F- test of joint significance	58.606	335.942	33.625	60.063

Note: AC-Actual employer Contribution ($1000s); ARC-annual required contribution ($1000s); ACP-Annual Covered Payroll ($1000s); Note: AC-Actual employer Contribution ($1000s); ARC-annual required contribution ($1000s); ACP-Annual Covered Payroll ($1000s); percap unres GenFund balance ($1000s) - is the unreserved general fund balance scaled by the state's population & expressed in thousand dollars. Robust standard errors clustered at the state level are reported in the brackets below the coefficient results; "rho" is the share of the estimated variance of the overall error accounted for by the individual plan effect. All panel regression models include year dummies whose estimated coefficients are not reported in this table but can be found in Appendix A.

Appendix B. Complete Results for OLS and Fixed Effects Specification of Stock Funding and UAAL

	Model 3: Stock Funding (AVA/AAL) %		Model 4: Unfunded Actuarial Accrued Liabilities (%ACP)	
	OLS	Fixed Effects	OLS	Fixed Effects
ln Plan Net Assets	2.764 **	25.906 ***	5.726	-30.782
	(1.288)	(7.344)	(7.536)	(33.408)
Member contributions	-1.045 ***	-0.681	2.252	-3.320
	(0.366)	(0.494)	(2.027)	(4.073)
ln average benefit	-1.702	4.012	-17.440	21.195
	(3.200)	(3.161)	(26.191)	(17.646)
1-yr ROR (%)	0.055	-0.083 **	-1.183 **	-0.917 *
	(0.040)	(0.033)	(0.519)	(0.477)
Discount rate	-4.195	6.941	9.538	-10.338
	(3.673)	(4.220)	(6.823)	(14.852)
Actives/Beneficiaries	0.608 ***	-0.321 ***	-0.173	-1.406 ***
	(0.129)	(0.099)	(0.239)	(0.467)
Employer contributions	-0.714 ***	0.041 *	0.020	-1.203 ***
	(0.159)	(0.023)	(0.849)	(0.125)
Made ARC dummy	7.132 ***	1.466 *	-9.980	0.110
	(1.860)	(0.751)	(8.093)	(3.786)
percap unres GenFund balance ($1000s)	-0.086	-0.021	2.188 ***	2.700 ***
	(0.233)	(0.060)	(0.745)	(0.509)
Set of year dummy variables				
yr 2002	8.825 ***	17.07 ***	.	.
	(2.158)	(2.865)	.	.
yr 2003	5.396 **	13.126 ***	16.148	16.411

	Model 1		Model 2		Model 3		Model 4	
	(2.033)		(2.988)		(12.919)		(19.853)	
yr 2004	3.789	*	8.187	***	19.873		22.899	
	(2.075)		(2.350)		(20.466)		(22.417)	
yr 2005	2.251		3.745	**	-2.234		2.813	
	(1.796)		(1.630)		(9.169)		(4.840)	
yr 2006	3.378	*	1.684	*	-9.139		-0.372	
	(1.742)		(0.921)		(9.378)		(4.689)	
yr 2007	5.472	***	.		-11.873		.	
	(1.867)		.		(10.927)		.	
yr 2008	3.733	***	-2.713	***	-24.768	**	-12.319	
	(0.940)		(0.639)		(11.444)		(14.414)	
yr 2009	.		-3.121	**	.		5.936	
	.		(1.441)		.		(10.550)	
yr 2010	-2.626	**	-5.057	***	6.665		9.261	
	(1.172)		(1.503)		(10.100)		(7.943)	
Constant	91.82	***	-432.50	***	12.803		419.85	
	(32.13)		(132.3)		(82.87)		(565.3)	
R2	0.445				0.063			
rho			0.973				0.381	
R2 within group			0.571				0.071	
R2 between group			0.041				0.039	
R2 overall group			0.057				0.001	
F- test of joint significance	44.076		184.867		52.407		82.590	

Note: AC-Actual employer Contribution ($1000s); ARC-annual required contribution ($1000s); ACP-Annual Covered Payroll ($1000s); percap unres GenFund balance ($1000s) - is the unreserved general fund balance scaled by the state's population & expressed in thousand dollars. Model 4 dependent variable is first-differenced to eliminate the unit-root. Robust standard errors clustered at the state level are reported in the brackets below the coefficient results; "rho" is the share of the estimated variance of the overall error accounted for by the individual plan effect. All panel regression models include year dummies whose estimated coefficients are not reported in this table but can be found in Appendix B.

Appendix C. Complete Results for System GMM specification of Stock Funding

Depvar: Stock Funding	ols (n=896)		fe (n=896)		sgmm (n=896)	
Stock Funding$_{t-1}$	0.939	***	0.591	***	0.732	***
	(0.021)		(0.055)		(0.069)	
ln Plan Net Assets	0.397		13.323	***	2.335	*
	(0.249)		(4.117)		(1.202)	
Member Contributions (% ACP)	-0.112		-0.190		-0.561	
	(0.069)		(0.208)		(0.452)	
ln average plan benefit payments	-0.611		1.187		-3.870	
	(0.558)		(1.444)		(3.944)	
1 yr ROR on investments (%)	0.117	**	0.022		0.509	***
	(0.051)		(0.037)		(0.151)	
Assumed rate of return (%)	-1.246	***	1.788		1.340	

	(0.423)		(1.568)		(3.106)	
Actives/Beneficiaries Ratio	0.169	***	-0.067		1.645	**
	(0.022)		(0.040)		(0.673)	
Employer Contributions (% ACP)	0.084	***	0.116	***	0.075	**
	(0.017)		(0.025)		(0.035)	
made ARC dummy	0.199		0.044		1.745	
	(0.332)		(0.466)		(1.086)	
percap unres GenFund balance ($1000s)	-0.079	**	-0.031		-0.172	
	(0.036)		(0.032)		(0.346)	
Set of year dummy variables						
yr 2002	-3.776	***	8.986	***	7.365	**
	(1.133)		(1.827)		(3.341)	
yr 2003	-3.911	***	7.494	***	2.132	
	(0.848)		(1.648)		(1.987)	
yr 2004	-3.401	***	5.594	***	-1.013	
	(0.711)		(1.236)		(1.257)	
yr 2005	-2.52	***	4.107	***	1.587	
	(0.541)		(0.798)		(1.194)	
yr 2006	-0.916	*	3.953	***	2.731	***
	(0.508)		(0.784)		(0.878)	
yr 2007	.		3.486	***	1.703	*
	.		(0.930)		(0.887)	
yr 2008	-1.233		1.560		10.489	***
	(1.220)		(1.065)		(2.962)	
yr 2009	-3.284	*	0.641		10.995	**
	(1.721)		(1.196)		(4.450)	
yr 2010	-3.364	***	.			
	(0.714)		.			
Constant	13.311	**	-213.908	***	0.133	
	(5.910)		(67.319)		(25.484)	

R^2	0.929		
rho		0.940	
r2_w		0.755	
r2_b		0.380	
r2_o		0.417	
F- test of joint significance	F(18,49)=3185.93	F(18,49)=791.94	F(18,99)=67.98
	Pr>F=0.001	Pr>F=0.001	Pr>F=0.001

System GMM Model Diagnostics (Stock Funding)	
Arellano-Bond test for AR(1) in first differences	z = -3.31
Ho: No first-order serial correlation in residuals	Pr > z = 0.001
Arellano-Bond test for AR(2) in first differences	z = 0.51
Ho: No second-order serial correlation in residuals	Pr > z = 0.543
Hansen J-test of overidentifying restrictions	chi2 (92) = 89.90
Ho: Specified model and all overidentified instruments are valid (i.e. exogenous)	Pr > chi2 = 0.543
Difference-in-Hansen tests of exogeneity of instrument subsets:	
Hansen test excluding system-GMM instruments for levels	chi2 (68) = 81.12
Ho: GMM differenced- instruments are exogenous	Pr > chi2 = 0.132
Exogeneity of GMM instruments for levels	chi2 (24) = 8.77
Ho: system-GMM instruments are exogenous and increases Hansen J-test	Pr > chi2 = 0.998

Hansen test excluding standard "IV" instruments		chi2 (84) = 89.60
Ho: GMM instruments without "IV" instruments are exogenous		Pr > chi2 = **0.318**
Exogeneity of standard "IV" instruments		chi2 (8) = 0.30
Ho: Standard "IV" instruments are exogenous and increases Hansen J-test		Pr > chi2 = 0.999

Details on Instruments used in System GMM Model of Stock Funding

EQUATION / Instrument Type	IV	GMM
First Differences Equation	Diff. (`year dummies`)	Lag (1-4). `stock ac_acp made_arc`
Levels Equation	`year dummies`	Diff. (`stock ac_acp made_arc`)
		Number of instruments 111

Appendix E. Technical Overview: Implementing System GMM in Stata and Comments on Model Diagnostic Tests

In this section, I discuss in more detail how I implemented dynamic GMM estimation in Stata (Version 12.1) using Roodman's (2009) user written command xtabond2. I also comment on the statistical diagnostic tests used to assess the appropriateness and validity of my system GMM pension funding stock funding ratio model.

Implementing System GMM in Stata

Using the user written command xtabond2, I obtained the system GMM results, as reported in Table 6-1, using the following code in Stata:

```
xtabond2 stock lagstock ln_netasset memcon_acp lnaveben
historicalret actret ac_acp made_arc gfbal_urpc1k y02 y03
y04 y05 y06 y07 y08 y09 y10, gmm(stock ac_acp made_arc,
lag(1 4)) iv(y02 y03 y04 y05 y06 y07 y08 y09 y10) twostep
robust small
```

As specified in eq.6-4, the lagged dependent variable `lagstock` is included as an explanatory variable. The `gmm` option invokes our lagged instrument set. In this case, the command incorporates the assumption that the stock funding ratio, employer contribution rate, and "made 100% ARC payment" dummy variable are endogenous (i.e. `gmm style` instruments) , and "(lag(1 4)" invokes instruments from lag periods t-1 up to t-4 respectively. All the year dummies are assumed to be strictly exogenous, hence the `iv style` command option.

Comments on Model Diagnostics

The xtabond2 command also reports the results of several diagnostic tests used to check the validity of the GMM model and instruments used. My discussion draws from the approach outlined by Efendic et al. (2010). When considered altogether, the results provide empirical verification on the appropriateness of my system GMM model specifications and the validity of the instruments used.

F-test of Joint Significance

The first statistical test is the **F**-test of joint significance of independent variables which tests the null hypothesis that the independent variables are jointly equal to zero. The F-test result indicates we reject the null hypothesis that independent variables are jointly equal to zero at any conventional level of significance. Assuming the statistical validity of the model, the independent variables in the dynamic panel regression collectively explain variations of the dependent variable.

First-Order and Second-Order Serial Correlations

These serial correlation tests of the null hypothesis of no first or second order serial correlation are sometimes referred simply as "AR(1)" and "AR(2)" respectively. Assuming the validity of our specification, by construction, the residuals of GMM estimates in first differences should be correlated, but there should be no serial autocorrelation in second differences. The AR(2) test result for my sGMM model of stock funding confirms no second-order serial correlation.

Hansen J-test of over-identifying restrictions

The exogeneity of the instruments is a crucial assumption for the validity of GMM estimates. The dynamic panel GMM estimator uses multiple lags as instruments. This means that our system is over-identified and allows us to implement a Hansen test of over-identification. The Hansen *J*-statistic is the value of the GMM objective function evaluated at the efficient GMM estimator $\hat{\beta}_{EGMM}$ (Baum, 2006). Under the null that that moment conditions are valid:

$$J(\hat{\beta}_{EGMM}) = N\bar{g}(\hat{\beta}_{EGMM})'\hat{S}^{-1}\bar{g}(\hat{\beta}_{EGMM}) \sim \mathcal{X}^2_{l-k}$$

where the matrix $\widehat{S}$ is estimated using the two-step method. The J statistic is asymptotically distributed as χ^2 with degrees of freedom equal to the number of overidentifying restrictions L-k rather than the total number of moment conditions (L). Essentially, k degrees of freedom are spent in estimating the coefficients β (Baum, 2006; p. 201). For my system GMM model, the Hansen test of overidentifying restrictions fails to reject the null at any conventional level of significance. This lends evidence that the instruments used in my specification are valid.

The difference-in-Hansen test for GMM instruments and standard IV instruments

While the Hansen test for overidentification evaluates the entire set of overidentifying restrictions, the "*difference-in-Hansen*" or "*C statistic*" tests the validity of a subset of instruments. The statistic is computed as the difference between two Hansen statistics (Baum et al., 2003): that for the (restricted, fully efficient) regression using the entire set of overidentifying restrictions, versus that for the (unrestricted, inefficient but consistent) regression using a smaller set of restrictions, in which a specified set of instruments are removed from the set.

For excluded instruments, this is equivalent to dropping them from the instrument list, and for included instruments, treating them as endogenous regressors by placing them in the list of included endogenous regressors. The C test, distributed χ^2 with degrees of freedom equal to the loss of overidentifying restrictions (i.e. number of instruments in the subset being tested), has the null hypothesis that the examined instruments are exogenous, and thus, proper instruments (Baum et al. 2003).

Results from all the difference-in-Hansen tests fail to reject the null hypothesis of exogeneity of any GMM instruments and the validity of standard IV instruments.

Cross section dependence

The validity of GMM estimators also rest on the assumption that disturbances are cross-sectionally independent. While cross-sectional dependence is often encountered in macroeconomic and financial panels with long time series where failure to account for cross-unit dependency may lead to misleading inference, it has also been shown to impact short dynamic panel estimators (Baltagi, 2005; Sarafidis & Robertson, 2009). As

common unobserved shocks is one source of potential heterogeneous error cross section dependence across pairs of cross section units (Sarafidis et al. 2009), I include year dummies in my system GMM model specifications as a way to remove universal time-related shocks from the error term.

Sarafidis et al. (2009) proposed a two-part method for detecting cross section dependence in GMM panel data models with a large number of cross-sectional units (N) and relatively small number of time series observations (T). The test combines assessing results from the second order serial correlation test and a difference-in-Hansen test. They show how rejecting the null in the AR(2) test may be an indication of potential heterogeneous error cross section dependence. Sarafidis et al. recommend in one applied example, that after a significant AR(2) test result, to check if the diagnostics from difference-in-Hansen test are worse for the dynamic panel specification after time dummies are excluded. According to them, this would lend evidence of cross section dependence.

Following the above discussion, AR(2) tests for all my model specifications reveal no evidence of error serial correlation and following the diagnostic procedure put forth in Sarafidis et al. (2009), implies possibly no heterogeneous error cross section dependence as well.

Bond's OLS-GMM-FE estimators check

A cursory check of estimator validity in a dynamic panel model was proposed by Bond (2002) who noted that the GMM estimated coefficient of the lagged dependent variable should lie between that of the Fixed Effects estimates (which is biased downwards) and the OLS estimates (which is biased upwards). The FE<SGMM<OLS lagged stock funding ratio dependent variable coefficient results (0.440<0.725<0.908) shows that the system GMM coefficient estimate lies between the lower bound of the fixed effects model and upper bound of the OLS model. Following Bond's (2002) suggestion to compare FE-GMM-OLS coefficient estimates of the lagged dependent variable lend further support to the appropriateness of my system GMM model specifications.

The test for "steady state" assumption

The improved efficiency as a result of the exploitation of additional moments in system GMM relies also on a mild mean stationarity assumption on the initial conditions (Blundell & Bond, 1998). According to Roodman (2009a), this means that changes in the instrumenting variables or deviations from long-term values are not systematically related to the fixed-effects. This is the assumption that enables us to include the levels equations in our GMM estimates and use lagged differences as instruments for these levels. In effect, Roodman points out the sampled individuals are in a "kind of steady-state" throughout the study period. Results from an augmented Dickey-Fuller unit root test indicate that the stock funding variable is stationary. In an applied setting, for the system GMM model specification to be valid, the absolute value of the estimated coefficient of the lagged dependent variable signifies convergence by having an absolute value less than unity (Blundell & Bond, 1998; Roodman, 2009b). The system GMM estimates of the lagged funding ratio dependent variable exhibit this property (0.701 < 1).

Identifying the choice and number of instruments

Problems associated with dynamic short panel econometrics such as weak instrumentation and instrument proliferation can lead to invalid results that appear valid. To address this concern, Roodman (2009b) strongly recommends reporting the number of instruments generated for each regression and results from all specification tests. While there are no clear or standardized rules on what determines "too many" instruments in GMM estimation, Roodman (2009a), mentioned some "rules of thumb" or "telltale" signs as it relates to instrument count and validity, they include: (1) when the number of instruments outnumber individuals in the panel; and (2) a perfect Hansen J-test statistic p value of 1.00. My empirical estimation adheres to both criteria. The number of instruments is less than the number of individual plans in the sample (95 < 100 plans), and the Hansen J-test p values indicate failure to reject the null at any conventional level of significance (p=0.229) and they are far from a perfect p value of 1.

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VITA

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EDUCATION

- Ph.D. in Public Policy and Administration (in progress), Martin School of Public Policy and Administration, University of Kentucky. Dissertation Committee: Dr. Dwight Denison (Chair), Dr. J.S. Butler, Dr. Merl Hackbart, and Dr. Edward Jennings, Jr.
- Dissertation Title: Funding State Defined Benefit Pension Plans: An Empirical Evaluation
- Master of Science in Agricultural and Applied Economics, Virginia Tech, 2001
- Bachelor of Science in Agricultural Economics, University of the Philippines, 1996.

RESEARCH AND TEACHING INTERESTS

Research Interests include: public budgeting and financial management; quantitative research methods, program evaluation, disability policy, agricultural science and biotechnology policy

Teaching Interests include: public and nonprofit budgeting and financial management; quantitative research methods, program evaluation

PUBLICATIONS AND REPORTS

- "Accounting for Natural Disasters: The Impact of Earthquake Risk on California Municipal Bond Pricing." (with Jacob Fowles and Gao Liu). 2009. *Public Budgeting and Finance*, 29(1): 68-83.

- "Economic Evaluation of Transgenic Pest-resistant Rice in the Philippines and Vietnam" (with George W. Norton). 2006. *Quarterly Journal of International Agriculture,* 45(2): 127-144.

- "Costs and Benefits of Multiple Virus Resistant Tomato in the Philippines" in George W. Norton and Desiree M. Hautea (eds.), Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia. International Service for the Acquisition of Agri-biotech Applications and the SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture. 2009. ISBN 978-971-93983-2-5.

- "Support Providing Employees' Association of Kentucky (SPEAK): An Ex-Post Evaluation of Project Impact on Direct Support Professional Agency and Worker-Level Outcomes" (with Edward T. Jennings, Jr.). August 2011. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "An Evaluation of Program Processes and Outcomes for the Kentucky Council on Developmental Disabilities" (with Edward T. Jennings, Jr.). September 10, 2010. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Healthy People 2010 Indicators for Persons with Disabilities: Comparing Kentucky's Healthy People 2010 Indicators with National Healthy People 2010 Objectives" (with Edward T. Jennings, Jr.). January 2010. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Comparing Kentucky (KRS 387) & New Mexico (HB 161) Adult Guardianship Laws as They Relate to Persons with Disabilities" (with Edward T. Jennings, Jr.). February 2010. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Considerations for Implementing a Medicaid Based (Non-Brokered) Wheelchair Van Cooperative Pilot Project" (with Edward T. Jennings, Jr.). September 12, 2008. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Exploring the Use of Cooperatives to Meet the Transportation Needs of Individuals with Disabilities in Kentucky" (with Edward T. Jennings, Jr.). August 7, 2008. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Aging Family Caretakers of Individuals with Disabilities: Background and Issues for Kentucky" (with Edward T. Jennings, Jr.). August 4, 2008. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky

- "Exploring the Use of Volunteers in Handicap Parking Enforcement in Kentucky with Selected Examples from Other States" (with Edward T. Jennings, Jr. and Jeremy L. Hall). February 2008. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "A Brief Overview of Vote Centers: Improving Access and Participation for Voters with Disabilities" (with Edward T. Jennings, Jr.). February 26, 2008. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- State Anti-Bullying Laws and Policies for Schools" (with Edward T. Jennings, Jr. and Jodie Butler). January 2007. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky

- "State Initiatives to Address Autism Spectrum Disorders" (with Edward T. Jennings, Jr., Kristen Hoffman, and Perry Papka). August 2006. Report prepared for the Kentucky Council on Developmental Disabilities. 100 Fair Oaks Lane, 4E-F, Frankfort, Kentucky.

- "Philippine Rice Seed Industry: Status and Prospects." Discussion Paper. Socio-economic Division, Philippine Rice Research Institute. Maligaya, Muñoz, Nueva Ecija, Philippines. May 1998.

CONFERENCE PAPERS AND PRESENTATIONS

- "Support Providing Employees' Association of Kentucky (SPEAK): An Ex-Post Evaluation of Project Impact on Direct Support Professional Agency and Worker-Level Outcomes" with Edward Jennings, Jr. Presented at the 2011 Research Conference of the Southeastern Conference for Public Administration. New Orleans, LA: September 21-24, 2011

- "Selected Policy Reforms in Funding State Retirement Systems and its Fiscal Implications for State Budgets." Presented at 32nd Annual Research Conference of the Association for Public Policy Analysis and Management. Boston, MA: November 4-6, 2010.

- "The Impact of GASB 45 on State Pension Plan Funding." Presented at the annual meeting of the Association for Budgeting and Financial Management. Omaha, NE: October 7-9, 2010.

- "Employer Contributions in Defined Benefit Public Pension Plans: Assessing Contribution Rates in State Retirement Systems." Presented at the annual meeting of the Association for Budgeting and Financial Management. Washington, DC: September 24-26, 2009.

- "Kentucky's Unfunded Public Pension Liabilities: A Framework for Understanding the Relevant Funding Issues for Kentucky's Public Retirement Systems" with Merl M. Hackbart and Lowell Reese. Presented at the *Lexington Business Round Table Meeting*. Lexmark, Lexington, KY: August 26, 2008.

- "Natural Disaster Risk and Municipal Bond Pricing in California" with Jacob Fowles (presenting) and Gao Liu. Presented at the annual meeting of the Association for Budgeting and Financial Management. Washington, DC: October 2007.

- "Economic Development Strategies in the U.S.: Evolution of State Level Entrepreneurial Support and Promotion" with Juita-Elena Yusuf. Presented at the 46th Annual Meeting of the Southern Regional Science Association. Charleston, SC: March 29-31, 2007.

- "Potential Impacts of Rice Biotechnologies in Asia" with G. Hareau (presenting), B. Mills, E. Peterson, and G. Norton. Presented at the NC 1003 Conference on Research Impacts and Decision Strategies for Biotechnologies, Donald Danforth Plant Science Center, St. Louis, MO: March 6, 2004.

- "Economics of Brown Rice Production and Marketing." Presented at the *Asia Rice Foundation Conference on Business Opportunities of Brown Rice*. International Rice Research Institute, Los Baños, Laguna, Philippines: November 21, 2003.

- "Economic Considerations in Producing Coconut Methyl Ester (CME) as a Diesel Fuel Quality Enhancer." Presented at the *Seminar-Forum on Coconut Methyl Ester (CME) in Petroleum Diesel Fuel: A Cleaner Alternative Fuel for the Land-Based Transport Sector*. USAID-Philippine Department of Energy, Energy Environment Training Program, Technological University of the Philippines, Ermita, Manila, Philippines: May 23, 2003.

TEACHING EXPERIENCE

- Assistant Professor, Department of Agricultural Economics, Philippines University of the Philippines-Los Baños (2002-2005).

PROFESSIONAL EXPERIENCE

- Graduate Research Assistant to Dr. Edward T. Jennings, Jr. The Martin School of Public Policy and Administration, University of Kentucky (June 2006

- PhD Research Fellow, Institute for Federalism and Intergovernmental Relations The Martin School of Public Policy and Administration, University of Kentucky.

- Deputy Director Regional Training Program on Food and Nutrition Planning, University of the Philippines-Los Baños in cooperation with The Netherlands Ministry of Development Cooperation and Food and Agricultural Organization of the United Nations (January 2005-July 2005).

- Graduate Research Assistant to Dr. George W. Norton, Virginia Polytechnic & State University, Department of Agricultural and Applied Economics, Blacksburg, Virginia (January 1999-May 2001).

- Research Fellow, Philippine Rice Research Institute, Nueva Ecija, Philippines (July 1996-November 1998).

AWARDS AND RECOGNITION

- Award for *Best Undergraduate Thesis in Agricultural Economics* from the College of Economics and Management, University of the Philippines Los Baños, 1996.
- Award for Scholastic Achievement and Recipient of Chancellor's Pin for graduating *cum laude* from the University of the Philippines Los Baños, 1996.
- Award for Scholastic Achievement from the International Honor Society of Phi Kappa Phi, 1996
- Award for Scholastic Achievement from the Pi Gamma Mu International Honor Society for Social Sciences, 1996.
- Award for Undergraduate Scholastic Achievement from the Gamma Sigma Delta Honor Society for Agriculture, 1996.

PROFESSIONAL AFFILIATIONS

- Association for Public Policy Analysis and Management
- Association for Budgeting and Financial Management