TEACHER PENSION INCENTIVES AND TEACHER LABOR MARKET BEHAVIOR

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ABSTRACT

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My dissertation studies the effect of recent pension reforms on teacher labor market behavior. I begin with "How Large is the Cut? Comparing Net Pension Wealth of State Defined Benefit Pension Plans for Teachers Across States and Over Time." In this essay, I describe the across state and over time variation in the generosity of 41 defined benefit pension plans. To do so, I simulate the present value of the total pension compensation, net of contribution costs, for a representative teacher in each of the 41 defined benefit pension plans. I find large cross-state differences in the present value of net pension wealth as well as net pension wealth cuts. When examining the effect of pension-reducing legislation on hypothetical teachers' net pension wealth, I find that states with more generous benefits pre-reform undertook larger cuts. However, a few states including Illinois, New Jersey, and New Hampshire, which were among the least generous pre-reform also experienced large benefit cuts, decreasing their net pension wealth by more than 50 percentage points. Last, I find that states that do not enroll teachers in Social Security faced worse pension funding crises and harsher cuts compared to those with Social Security coverage.

In my next essay, "The Effect of Recent Teacher Pension Reforms on New Teacher Quality," I estimate the effect of pension generosity on new teacher quality. Between 2007 and 2011, 19 states and four cities enacted salient pension reforms affecting all newly hired teachers. Using pooled cross-sectional teacher-level data from the 2003-2004, 2007-2008 and 2011-2012 Schools and Staffing Survey, I examine how new teacher quality changed differentially between the pre-benefit cuts and post-benefit cuts periods among states and cities that enacted pension

reforms relative to those that did not have pension reforms. The hypothesis is that lower pension benefits, all else equal, decrease the attractiveness of teaching and discourage prospective teachers, particularly those with better alternatives, from entering the profession. Controlling for a complete set of time-varying factors that might affect teacher entry, I find that teachers entering the profession under pension reforms are from undergraduate institutions with 25.63 points lower 25^{th} percentile SAT scores. I also find that a one percent increase in the present value of net pension wealth results in schools hiring new teachers from undergraduate institutions with 32.15 points higher 25^{th} percentile SAT scores.

In my last essay, "Who Chooses to Stay? The Effect of Teacher Pension Incentives on New Teacher Turnover," I use recent pension reforms to identify the effect of pension incentives on the job change decisions of early career teachers. I test the hypotheses that lower expected compensation levels and higher vesting requirements decrease the cost of changing jobs and increase teacher turnover, all else equal. Using pooled cross-sectional teacher level data from the 2003-2005, 2007-2009 and 2011-2013 school years, I examine how new teacher turnover changed differentially between the pre-wealth cut and post-wealth cut periods among states that enacted pension reforms, relative to those that did not. Controlling for teacher and school characteristics, I find no significant effect of benefit-reducing legislation or more stringent vesting requirements on teacher turnover among newly hired teachers. These estimates may suggest that new teachers only value short-term pension wealth accruals or that teachers lack full knowledge of pension structure. Alternatively, the composition of the new teacher pool may have changed during recent pension reforms, with less mobile teachers entering the profession.

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CHAPTER 1

HOW LARGE IS THE CUT? COMPARING NET PENSION WEALTH OF STATE DEFINED BENEFIT PENSION PLANS FOR TEACHERS ACROSS STATES AND OVER TIME

1.1 Introduction

Teacher compensation comes with a total package that includes salary, extra pay, in-kind benefits, and pensions (U.S. Department of Education 2018). Pension benefits are different from other forms of compensation because there is a delay between the time teachers earn and receive their pensions. Moreover, most states require teachers to contribute a portion of their salary to fund their teacher pension plans, so employee contributions need to be netted out from pension wealth because that is not part of the labor compensation (Costrell and Podgursky 2009). Today, most states still offer their public school teachers defined benefit pension plans.[1] Unlike defined contribution plans that tie retirement benefits to total contributions and are subject to market fluctuation, defined benefit plans guarantee retirees a specific level of annual benefits calculated as the product of a multiplier factor, within-system experience, and final average salary.

While teachers can easily learn about their salary, extra pay, and in-kind benefits when they are hired, it can be difficult for teachers to understand how pension parameters could affect their deferred (and discounted) compensation.[2] For example, compared to Alabama, Massachusetts requires teachers to contribute a larger share of their salary and to start collecting their full retirement benefit at an older age. However, Massachusetts also provides a more generous

[1] Among all workers who had access to pensions in 2017, about 20 percent were participating in a defined benefit plan. Source: Bureau of Labor Statistics, National Compensation Survey.
https://www.bls.gov/ncs/ebs/benefits/2017/ownership/civilian/table02a.pdf

[2] Because teachers' pension benefits and costs are incurred at different time periods, adjustments for discount rates help in calculating the present value of net pension wealth.

multiplier factor to calculate teachers' annual benefit.[3] Without calculating net pension wealth, it is hard to tell which state is more generous. Later in this paper, I show that Massachusetts is more generous for teachers who work in the same school from age 25 until they reach their normal retirement age.[4]

The 2008 financial crisis left many pension systems underfunded and struggling.[5] Wilshire Consulting (2017) reports that the median funded level for state retirement systems was 87 percent in 2007 and fell to 67 percent by 2016.[6][7] To reduce pension debt, many states enacted pension reforms that provide less generous pension benefits. Pension plans reformed in numerous ways – including decreasing multipliers, lengthening the years used to compute final average salary, raising retirement eligibility age or service, capping the annual benefit, increasing vesting rules, increasing teacher contribution rates, and lowering cost of living adjustments. Beyond this, many states required school districts to contribute increasingly higher shares of teacher salary into pension systems, which may discourage school districts from raising salaries to attract and retain teachers (Doherty et al. 2012). In fact, the average starting salaries in many states have fallen since the 2007 when adjusted for inflation. While teacher compensation became less attractive following the financial crisis, the Great Recession during the late 2000s and early 2010s reduced outside

[3] A Massachusetts teacher is eligible for reduced early retirement benefit at the age of 60 with at least 10 years of service. For teachers who decide to start collecting benefits at an early retirement age, their multiplier factor used to calculate annual benefit is reduced by 0.125-0.150 percent per year. In contrast, Alabama does not allow teachers to receive retirement benefits before they reach their normal retirement age, which is the age of 62 with at least 10 years of service.

[4] Massachusetts is more generous compared to Alabama in all my simulations in Section 6, except when teachers expect to die at the age of 75, relative to age 80 and 85. This is because under the assumption where teachers die at the age of 75, the Massachusetts teacher would only receive seven years of retirement benefits.

[5] In the past, some states required zero or very low teacher contribution rates; some states overpromised benefits that they now needed to pay; and some states and local governments paid less than their required contributions to fund promised benefits (Doherty et al. 2012).

[6] Wilshire Consulting's 2017 Report on State Retirement Systems reports funding levels and asset allocation of public pension plans that serve teachers only and also plans that cover other state and local government employees along with teachers: https://wilshire.com/Portals/0/consulting/funding/Wilshire_2017_State_Funding_Report.pdf

[7] Doherty et al. (2015) report that teacher pension systems across the states were half a trillion dollars short on their obligation payments in 2014. The authors considered this debt amount as an underestimation because of unrealistic assumed rates of return.

options and may make teaching more attractive. [8]

To characterize how recent pension reforms may affect new teachers, I simulate the present value of net pension wealth for a representative teacher in 41 defined benefit pension plans (40 states and the District of Columbia). These 41 defined benefit pension plans offered teachers a traditional defined benefit plan throughout the years 2007 to 2016. I also present my simulations as the percentage of final average salary. I then rank each plan for its generosity before (2007) and after (2016) the pension reforms.

In the following section, I review the related literature. Section 1.3 describes institutional details and Section 1.4 describes pension data. Section 1.5 describes how I simulate teachers' pension wealth, lifetime contributions, and net pension wealth. Section 1.6 tests the sensitivity of my findings, and Section 1.7 discusses teacher pension interacting with Social Security. Section 1.8 concludes.

1.2 Related Literature

A recent set of papers explores the variation in pension wealth caused by the variation in pension parameters across plans or over time. Earlier pension literature introduced various measures of pension incentives (Coile and Gruber 2007; Stock and Wise 1990). Stock and Wise (1990) emphasize the importance of continuing to work for one more year and develop the option value measure, which captures the difference between current pension wealth and pension wealth after one additional year of work (one-year accrual). Coile and Gruber (2007) develop the peak

[8] The Great Recession during the late 2000s and early 2010s reduced nearly 8.7 million jobs (Bureau of Labor Statistics, 2014). https://www.bls.gov/opub/mlr/2014/article/consumer-spending-and-us-employment-from-the-recession-through-2022.htm

value measure, which captures the difference between current pension wealth and the maximum possible pension wealth.

Table 1.1 summarizes pension literature on pension wealth. Two papers that focus on single-year variation in teachers' pension wealth across states (Costrell and Podgursky 2009; Toutkoushian et al. 2011). Costrell and Podgursky (2009) simulate teachers' net pension wealth in six states using the option value measure. They find that a teacher's net pension value accumulates slowly in the early years of her career, then accelerates in her mid- to late- fifties, and then drops off sharply over the next few years. This backloading of pension wealth accumulation creates a strong "pull" incentive for teachers to stay until they reach the time when pension value spikes. Once they pass the pension value spike, teachers face a strong "push" incentive to leave. Toutkoushian et al. (2011) analyze the parameter differences among 49 state-run defined benefit pension plans for public school teachers.[9] For states that adopted hybrid plans, which combine defined benefit and defined contribution, the authors analyze the defined benefit part of the plans. They collect pension parameters in effect in 2008 from the Public Fund Survey and Schmidt (2010). The authors simulate the peak value net pension wealth a representative teacher would expect to receive when first hired in each of the 49 states. They assume that teachers spent their entire career in the teaching profession from the age of 22 to 65 and had a starting salary of $30,000 that grew 3 percent per year. They also present net pension wealth as a percentage of the representative teacher's lifetime salary. They find that teachers' net pension wealth, on average, represents 44% of their lifetime salary. Overall, their simulations suggest that the number of years used to compute the final average salary does not affect net pension wealth by much. However, the caps imposed on teachers' first-year benefit in some states can greatly reduce the first-year pension benefit a

[9] Alaska adopted a defined contribution pension plan in 2006 and was therefore excluded from the pension wealth simulations in Toutkoushian et al. (2011).

representative teacher would receive. Last, the authors ranked each state's pension generosity and suggested that teachers should consider more than the multiplier factors when comparing pension generosity across states.

On the other hand, Koedel, Ni and Podgursky (2014) focus on single-state over-time variation. They examine the effect of Missouri's pension-enhancement legislation enacted between 1995 and 2002 on teachers' net peak value pension wealth. The authors find that the enhancements resulted in large gains in net pension wealth for teachers who were close to retirement. However, they find lower net pension wealth for younger teachers because of the associated contribution-rate increase.

Much of the teacher pension literature focuses on teacher retirement and separation. Some researchers use the variation in pension parameters across plans to estimate the effect of pension incentives on teacher labor market. For example, Papke and Litwok (2013) estimated large cross-state differences in pension wealth upon vesting using the peak value measure in California, Florida, Michigan, and Wisconsin and found that pension characteristics such as vesting rules, availability of the Defined Contribution (DC) option, and Social Security coverage affect young teachers' decisions to exit from teaching. Friedberg and Turner (2011) are the first to use nationally representative data on teachers. They use the peak value measure to simulate teachers' pension wealth in the 17 largest states. The authors use the variation in pension accrual profiles across states to identify the effect of pension incentives on teacher retirement. They show that teachers' pension wealth reaches its maximum when teachers reach their normal retirement age.[10] Their results suggest that teachers delay retirement while pension wealth is still accumulating and then retire abruptly when it reaches its maximum.

[10] If a teacher retires at her normal retirement age, she is eligible for full pension benefit. Some states allow teachers to retire before reaching their normal retirement age with reduced benefits. This paper only focuses on normal retirement age, because that is when a teacher's pension wealth reaches its peak.

Some researchers study the effect of pension incentives on teacher retirement in specific states using administrative data that capture teacher exit behavior and earnings history (Furgeson, Strauss, and Vogt 2006; Costrell and McGee 2010; Koedel, Ni and Podgursky 2014; Koedel and Xiang 2017). For example, Furgeson, Strauss, and Vogt (2006) simulate teachers' current pension wealth and their maximum possible pension wealth. They find that current pension wealth increases the probability of teacher retirement, while the expected future maximum pension wealth reduces the probability of retiring today. They also find a large increase in teacher retirement following the enactment in Pennsylvania of a policy that temporarily increased early retirement benefits between the 1997-1998 and 1998-1999 school years. Costrell and McGee (2010) simulate teachers' pension wealth using the peak value and option value measures for Arkansas teachers. They find that both peak value and one-year accrual have negative effects on Arkansas teachers' retirement. Koedel and Xiang (2017) simulate teachers' current pension wealth and the maximum possible pension wealth when St. Louis enacted a policy change that increased teacher pension wealth for those who retired after the 1998-1999 school year. The authors show that newly hired teachers, who largely discounted future pension wealth, had a smaller increase in their pension wealth under the new policy, compared to those who were eligible for retirement. The authors use the heterogeneous effects on teachers' pension wealth to identify the effect of pension enhancement on teacher retention. The authors find a temporary delay in retirement among teachers who were eligible for retirement in the 1997-1998 school year. However, they find no significant retention effect among teachers who were not eligible for retirement. They suggest that teachers may lack of full knowledge of their pensions.

My paper is most closely related to Toutkoushian et al. (2011), who also provide simulations of net peak value pension wealth for a representative teacher across states and rank each state's

pension in terms of its generosity. I expand their work by highlighting the cross-states differences in the magnitude of recent benefit cuts. To do so, I present the pension parameter changes between 2007 and 2016 and provide simulations of the hypothetical pension wealth under old rules (before policy change) and new rules (after policy change) for a representative teacher in 41 defined benefit plans.

Previous pension researchers either study variation among states in teacher pension wealth at a certain point of time (Costrell and Podgursky 2009; Friedberg and Turner 2011; Papke and Litwok 2013; Toutkoushian et al. 2011) or study the effect of policy changes on pension wealth in specific states (Costrell and McGee 2010; Furgeson, Strauss, and Vogt 2006; Koedel, Ni and Podgursky 2014; Koedel and Xiang 2017). While the studies that focus on single-state policy changes have the advantage of controlling for state-specific omitted variables, their results only apply to a single state. The results of my study demonstrate that the effects of recent pension-reducing legislation on pension wealth vary significantly across states. This variation of pension incentives could be used to explore the labor market effect.

1.3 Institutional Details

In the U.S., all full-time public school teachers automatically participate in public pension plans. Although each state runs a pension system that covers teachers (state-run pension plans), some large cities like New York and Chicago operate their own municipality-specific pension plans.[11] I exclude these municipality-specific pension plans from my analysis for simplicity. Table 1.2 shows the types of pension plans that states and cities offer teachers during the years I study.

[11] While some teachers participate in plans that serve teachers only, 23 state-run retirement systems cover other state and local government employees along with teachers (Doherty et al. 2012, figure 4).

Historically, all states except Indiana[12] have offered traditional defined benefit pension plans. In more recent years, some states adopted plan structures that shift investment performance risk to teachers (for example, defined contribution plan, hybrid plan, and cash balance plan), and some states allowed teachers to choose one plan or another, but most states still offer teachers traditional defined benefit plans that pay a specific amount upon retirement. Today, 37 states and the District of Columbia offer their public school teachers only a mandatory defined benefit pension plan, and four states offer teachers a choice of defined benefits or other optional plans.

In defined benefit plans, teachers contribute a portion of their salary toward the plan while employed. Teachers who retire after becoming vested collect annual payments until their death.[13] The lifetime pension wealth of a teacher depends on the size of the initial annual payment, adjustments made for cost of living, and the length of time in retirement.

All defined benefit plans use a similar formula to calculate annual payment:

(1) *First-year Annual payment (A) = FAS * Multiplier * Years of Service*

where *FAS* is the teacher's final average salary, calculated as the average salary in the years of employment where the retiree's salary was highest. Because earnings tend to be highest in the final years of employment, FAS increases if pension plans consider fewer years of service when calculating the average. FAS also increases if states offer higher salary. The multiplier in the formula determines the percentage of a teacher's final average salary that she receives for each year of service. The years of service (YOS) in the last part of the formula is the length of teacher's employment. In general, more years of service lead to higher annual payments. But some states cap the first-year annual payment to not exceed a specific percentage of the teacher's final average salary. The formula for a teacher's capped first-year annual payment is:

[12] Indiana automatically enrolls its teachers in a hybrid pension plan.
[13] On average, it takes 5.7 years for teachers in the U.S. to become vested in 2008 (Doherty et al. 2012).

(2) $Capped\ Annual\ payment\ (\mathcal{A})$

$$= \begin{cases} A & with\ no\ limits. \\ Min\ (A, x\ \% * FAS) & if\ states\ limit\ annual\ payments\ to\ x\%\ of\ FAS. \end{cases}$$

To counteract the impact of inflation on retirement income, public pension plans provide retirees with post-retirement cost-of-living adjustments (COLAs). Plans with higher cost-of-living adjustments are more beneficial to teachers.

These pension parameters relate to the size of annual benefits. Other pension parameters such as retirement age and teacher contribution amounts can also affect the pension wealth, without directly changing the annual benefits.[14] Because teachers collect annual benefits from retirement until death, an earlier retirement age implies that teachers receive more from annual payments and enjoy higher lifetime pension wealth. Recall that most states require teachers to contribute a portion of their salary to fund their teacher pension plans. Because a teacher's annual benefit is not tied to teacher contributions (see equation 1), an increasing contribution rate decreases net pension wealth.

1.4 Pension Data

Table 1.3 presents a list of references used to determine each plan's pension parameters. Data primarily come from individual plans' homepages, member handbooks, financial reports, and summaries of legislation. I obtain additional pension plan-level data from the National Education Association (2004, 2008, 2010, 2016) to confirm the years that pension parameters were in effect.

I restrict my analysis to the 40 states and the District of Columbia that offered teachers a traditional defined benefit plan in 2007 and 2016. I exclude states that offered teachers other types

[14] Raising retirement eligibility age or service could indirectly increase annual benefit through more years of service and higher final average salary if teachers decide to work longer.

of pension plans, because their retirees' pension benefits are subject to market fluctuation and are difficult to predict. I choose 2007 as the initial year because 2007 pension parameters capture each state's pension generosity before recent pension-reducing legislation. The most recent available plan-level parameters were documented in 2016 by the National Education Association.

In response to the 2008 financial crisis that lowered investment returns and exacerbated the pension funding crisis, many states enacted reforms after 2007 that reduced teacher benefits or increased required teacher contribution rates. In this section, I present how pension parameters changed between 2007 and 2016.

Table 1.4 provides an overview of the number of years used to calculate FAS. In 2007, 29 pension plans used average salary for three or fewer of the highest years of salary. 12 pension plans used a similar definition with more than three years. Between 2007 and 2016, 17 pension plans increased the number of years used to calculate FAS. By 2016, only 15 pension plans were using three or fewer years of salary to calculate FAS, and 26 pension plans were using more than the three highest years of salary to calculate FAS by 2016.

Table 1.5 provides an overview of the multiplier used in each pension plan. In 2007, 31 pension plans used a constant multiplier that ranged from 1.6 percent (Wisconsin) to 2.67 percent (Nevada). 10 pension plans used multipliers that varied by retirement age or years of service. Between 2007 and 2016, 14 pension plans lowered their multipliers, and Vermont changed from a constant multiplier to multipliers that increase with years of service.

Table 1.6 shows that in 2007, 19 pension plans limited the annual payment to a specific percentage of the teacher's final average salary. The limitation ranged from 53.34 percent to 100 percent. By 2016, Pennsylvania had changed from no limitation on annual payment to 100 percent of the teacher's FAS; Alabama had changed from no limitation on annual payment to 80 percent

of the teacher's FAS; Arizona became more generous by eliminating the 80 percent cap and Vermont became more generous by changing the cap from 53.34 percent to 60 percent.

The pension plans also vary by their cost-of-living adjustments (COLAs). Table 1.7 provides an overview of COLAs in each pension plan. In 2007, 28 states automatically adjusted the cost of living based on a specific percentage or the consumer price index (CPI). On the other hand, 11 pension plans relied on state legislation to decide COLAs for each year, and two states tied their COLAs to their funding level. By 2016, 14 pension plans changed COLAs in ways that were less generous compared to 2007. The changes include lowering the COLA rate, delaying the receipt of COLAs, or switching from automatic adjustments to adjustments that tied COLAs to funding levels or other indexes.

Table 1.8 provides an overview of retirement eligibility in each state. Compared to 2007, by 2016, 28 pension plans had raised the retirement eligibility age or years of service, which shortens the length of years for receiving annual benefits for many teachers.

Table 1.9 provides an overview of the employee contribution rate required by each state. In 2007, Florida and Wyoming did not require their teachers to make any contribution to their pension plans. Other pension plans required their teachers to make contributions ranging from three percent (Delaware) to 12 percent (Missouri) of their salary. Thirty-five pension plans required teachers to contribute at least five percent of their salary. By 2016, every pension plan required teachers to make contributions that ranged from 2.3 percent (Wyoming) to 14.5 percent (Missouri and Nevada) of their salary. Twenty-eight pension plans increased their employee contribution requirements by 2016.

Table 1.10 summarizes the parameter changes in each of the 40 states and the District of Columbia. We can see that among the 37 states that enacted pension reforms between 2007 and

2016, the most frequent parametric pension reforms increased the eligibility age and employee contributions. Twenty-eight states increased retirement age, 28 states increased employee contribution rates, 17 states increased the number of years used as a base for computing final average compensation, 14 states lowered COLAs, 14 states decreased the multipliers, and two states imposed caps on retirees' first year annual payment. The last column in Table 1.10 sums up the parametric pension reforms enacted in each state. Thirty states changed multiple parameters and seven states focused on a single parameter (e.g., increasing retirement age or increasing employee contribution rates). Among states that changed multiple parameters, Alabama, Florida, Hawaii, and New Jersey had the most changes. They all decreased the multipliers, increased the number of years used as a base for computing final average compensation, increased retirement age, and increased employee contribution rates.

Note that while all 37 states enacted changes that reduced teachers' net pension wealth, two states made parameter changes that were more generous for teachers. Arizona, for example, increased the retirement age, increased employee contribution rates, increased the number of years used to calculate final average salary, but also removed its cap on retirees' first-year annual payment. Additionally, Vermont increased the retirement age and employee contribution rate, but also increased multipliers for people with more than 20 years of service and imposed fewer restrictions on retirees' first-year annual payments. In the next section, I discuss how those parameter changes affect teachers' net pension wealth.

1.5 Simulations of Pension Wealth, Lifetime Contributions, and Net Pension Wealth

To more precisely evaluate pension plan generosity, I simulate and compare pension wealth, lifetime contributions, and net pension wealth that a hypothetical teacher would expect to receive

from each of the 41 defined benefit pension plans if she started teaching in 2007 and in 2016.[15] Pension wealth is the actuarial present value of the stream of annual payments teachers expect to receive upon retirement.[16] It not only measures the size of annual payments, but also how long teachers receive these payments.

Suppose a teacher started teaching in year $t=1$, retires in year $t=T$, and collects pension benefits for d years, from $t=T+1$ *to* $t=T+d$. Then her expected present discounted net pension wealth (PDNW) would be calculated using the following formula:

$$(3)\ PDNW_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)}\, \pi_t}{(1+r)^{t-1}} - \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$$

where $\mathcal{A}_t$ is the capped annual payment in year $t > T$, f_t is the cost-of-living adjustment in year t, π_t is the probability of surviving at year t, r is the discount rate, and C_t is the teacher contribution in year $t \leq T$.

In calculating net pension wealth, I address three possible uncertainties outlined by Friedberg (2011).[17] First, the length of retirement varies among teachers because we do not know the date of death. Second, we do not know the true discount rate a teacher faces because future interest rates and the teachers' time preferences are unknown. Third, the future cost-of-living adjustments may change for current teachers. Unlike other pension parameter changes presented in Table 1.10, COLAs are not viewed by courts as core benefits protected under state laws, so COLAs can fluctuate over time (Munnell et al. 2016).

[15] While legal constraints prevent most states from cutting benefits for current employees, all states can change the benefit rules affecting employees not yet hired. Therefore, all the pension parameter changes discussed here affect teachers hired after the changes were made.
[16] Actuarial present value is the product of discounted capped annual payment and probability of surviving that year.
[17] Friedberg (2011) also mentioned that teachers might be uncertain about receiving future pension payments if they think that states might cut their benefits because of underfunding. Because most states have legal protection that constrains their ability to cut benefits for current employees, this paper does not address the last type of uncertainty.

I base the simulations in this paper on the following set of assumptions: First, like Koedel, Ni and Podgursky (2014), I assume the hypothetical teacher starts teaching at age 25. Second, I assume that the hypothetical teacher works in the same school until she reached her maximum pension wealth and then starts collecting retirement benefits right away. Much of the previous pension literature simulates pension wealth using the peak value measure. Recall that teachers' pension wealth reaches its maximum when they reach their normal retirement age (Friedberg and Turner 2011), I therefore identify the closest normal retirement option for the hypothetical teacher in each state year. For example, a hypothetical Alabama teacher who started teaching in 2007 could retire with full retirement benefits at age 60 with at least 10 years of service or at any age with at least 25 years of service. The closest normal retirement option for her would be to retire at age 50. I then determine the teacher's years of service (YOS) by how far the teacher would be from retirement using her age. For example, the hypothetical Alabama teacher who started teaching in 2007 would have 25 (= 50-25) years of service.

Third, I assume the hypothetical teacher started at an annual salary that equals the state's average starting teacher salary reported by the National Education Association.[18] I then calculate the annual salary growth rate in each state using the bachelor's degree salary schedule reported by the National Center for Education Statistics Schools and staffing Survey (SASS) in 2007.[19] I normalize all salary amount in this paper to 2016 dollars using the Consumer Price Index (CPI) for all items less food and energy reported by the Bureau of Labor Statistics.[20] Fourth, I assume

[18] 2016-2017 Average Starting Teacher Salaries by State: http://www.nea.org/home/2016-2017-average-starting-teacher-salary.html. The National Education Association did not report the Average Starting Teacher Salaries in 2007. Therefore, I calculate the state average salary percentage change between 2007 and 2016 reported by the National Education Association: http://www.nea.org/assets/docs/2017_Rankings_and_Estimates_Report-FINAL-SECURED.pdf and http://www.nea.org/assets/docs/HE/09rankings.pdf. I then use the state average salary percentage change and the 2016 average staring teacher salaries by state to impute the 2007 average starting salaries in each state.

[19] Average Yearly Teacher Base Salary, by various levels of degrees and experience and state: 2007–08: https://nces.ed.gov/surveys/sass/tables/sass0708_2009320_d1s_02.asp. The SASS did not report teachers' salary schedule in 2016.

[20] Bureau of Labor Statistics. 2007-2016. "Chained CPI-All Urban Consumers". Website:

that the cost-of-living adjustment for teachers is 3 percent per year throughout her retirement, which is also used in Costrell and Podgursky (2009) and Toutkoushian et al. (2011), assuming the individual would live until age 80 (a female American can expect to live on average 80 years).[21]

Last, like Koedel, Ni and Podgursky (2014), I assume a 4 percent discount rate that allows a positive real interest rate and a time preference in earning. In the next section, I examine the sensitivity of my findings to changes in the stated assumptions including expected longevity, assumed discount rate, and COLAs. With the stated assumptions, I calculate FAS using the following formula:

$$(6)\quad FAS = \left(\frac{1}{n}\right) * \sum_{z=1}^{z=n}(S_t) * (1+g)^{YOS-z}$$

where n is the number of years used to calculate FAS, S_t is the starting salary in year *t*, g is the salary annual growth rate, and *YOS* is the years of service.

1.5.1 Comparison of Starting Salary, Years of Service, and Final Average Salary

The first and fourth columns of Table 1.11 present the starting salaries for the hypothetical teacher hired in 2007 and in 2016, all in 2016 dollars. The starting salaries ranged from $29,027 (Montana) to $52,034 (New Jersey) for those hired in 2007 and from $30,036 (Montana) to $51,359 (Delaware) for those hired in 2016. Compared to 2007, 27 states had lower starting teacher salaries in 2016 and 14 states had higher real starting salaries in 2016. Overall, both the mean and median starting salaries in 40 states and the District of Columbia decreased by more than $1000 between 2007 and 2016.

https://data.bls.gov/pdq/SurveyOutputServlet. I use CPI for all items less food and energy because food and energy are very volatile prices.

[21] Life expectancy at birth: https://www.cdc.gov/nchs/data/hus/2010/022.pdf. Man has shorter life expectancy.

The second and fifth columns of Table 1.11 contain the years of service it takes for a hypothetical teacher to reach her closest normal retirement option in each state. The years of service ranged from 20 years (Massachusetts) to 41 years (Minnesota) in 2007 and from 27 years (Kentucky) to 42 years (Massachusetts) in 2016. On average, teachers hired in 2016 would have to wait four more years, relative to those hired in 2007, to start collecting their full pension benefits.

The results show that the variation in years of service caused by the different retirement options available across states and over time were economically large. For example, Massachusetts allows teachers hired in 2007 to retire with full pension benefits at age 65 with at least 10 years of service or at any age with at least 20 years of service, but teachers hired in 2016 can only retire with full benefits at the age of 67 with at least 10 years of service.[22] These changes in retirement options increased the hypothetical Massachusetts teacher's years of service from 20 years to 42 years.

The third and sixth columns of Table 1.11 contain the final average salaries a hypothetical teacher hired in 2007 and in 2016 would expect to earn, which I calculate using equation 6. On average, teachers hired in 2016 would expect to earn $4,186 higher final average salary than those hired in 2007. Because teachers' salaries increase with their years of service, the variation in final average salary across states and over time depends on the starting salary, annual salary growth rate, the number of years used for calculation, and the years of service. For example, Alabama decreased teachers' starting salary and increased the years used to compute FAS for teachers hired in 2016 relative to those hired in 2007. These two changes decreased the final average salary. However, under my assumptions that teachers teach until they reach their normal retirement age, a

[22] In my simulations where hypothetical teachers entered teaching at age 25, the increasing retirement eligibility age and service enacted between 2007 and 2016 in Delaware, Nevada, Pennsylvania, Wisconsin, and Wyoming did not affect their teachers' years of service.

hypothetical Alabama teacher hired in 2016 would expect to work 12 more years compared to those hired in 2007. This change increased the final average salary. Overall, a hypothetical Alabama teacher hired in 2016 would expect to earn about $7,000 more in final average salary than one hired in 2007. If the hypothetical Alabama teachers chose not to work longer when the state raised the normal retirement eligibility, her expected final average salary would decrease.

1.5.2 Simulation of First-year Pension Benefits Across States

Recall that all defined benefit plans use the same formulas, equations 1 and 2, to calculate a teacher's first-year capped annual payments. Table 1.12 presents the simulated first-year capped annual payments that a hypothetical teacher hired in 2007 and in 2016 would expect to receive across the pension plans in 40 states and the District of Columbia. First-year annual benefits (first and fourth columns) are the product of the multiplier, years of service, and final average salary. The second and fifth columns are the capped first-year annual benefits after accounting for the caps that were imposed on first-year benefits. The third and sixth columns present the capped first-year annual benefits as the share of final average salary. The results show that the variation in the capped first-year annual benefits across states and over time were economically large. The capped first-year annual benefits ranged from $23,876 (Montana) to $96,096 (Connecticut), with a median of $45,140 for those hired in 2007. On the other hand, for those hired in 2016, the capped first-year annual benefits ranged from $25,816 (South Dakota) to $154,589 (Massachusetts), with a median of $45,694. On average, teachers hired in 2007 would expect to receive $48,834 (62 percent of FAS) in the first year of retirement, while those hired in 2016 would expect to receive

$54,086 (66 percent of FAS). Although more years of expected service increases annual benefits (see equation 1), the shorter length of retirement decreases lifetime pension wealth.

When comparing the values in the first and second columns of Table 1.12, I find that the cap is only binding for teachers hired in 2007 in Illinois, who would receive $1,953 less first-year annual benefits with a cap (compared to not having a cap), and teachers hired in 2007 in Nevada, who would receive $4,100 less with a cap. Other states either do not have a cap or their teachers would not earn more than the capped amount. Recall from Table 1.6 that between 2007 and 2016, Pennsylvania and Alabama started to cap teachers' annual payment, while Arizona and Vermont relaxed their caps. Because the hypothetical teacher in these four states never earned more than the capped amount, recent changes in annual pension payment caps would have no influence on the hypothetical teacher's pension wealth. Although the caps in other states did not change between 2007 and 2016, the pension reforms in other pension parameters could affect how much caps reduce a teacher's first-year annual benefits. I find that caps imposed on annual benefits could largely affect teachers in states that greatly increased retirement eligibility age without decreasing multipliers. For example, Illinois and Massachusetts raised the retirement eligibility age for teachers hired in 2016, which increased teachers' first-year annual benefits, because more years of service directly contribute to higher annual benefits using equation 1 and indirectly increase annual benefits by increasing final average salary. The hypothetical Illinois teacher hired in 2016 would receive $16,954 less in first-year annual benefits with a cap, and the hypothetical Massachusetts teacher hired in 2016 would receive $48,309 less with a cap, relative to no cap.

1.5.3 Comparison of Simulated Pension Wealth and Lifetime Contributions

The first and third columns of Table 1.13 contain the sum of lifetime pension payments that a hypothetical teacher hired in 2007 and in 2016 would expect to receive in each state. Payments ranged from $178,696 (Oklahoma) to $519,830 (Massachusetts), with the median equal to $296,308 for those hired in 2007. For those hired in 2016, the payments ranged from $152,560 (Oklahoma) to $432,229 (Connecticut), with the median equal to $242,970. On average, teachers hired in 2016 would expect to receive $43,685 less in pension wealth compared to those hired in 2016.

The second and fourth columns of Table 1.13 present pension wealth as a percentage of final average salary. Payments ranged from 197 percent of FAS (Minnesota) to 655 percent of FAS (Massachusetts) for those hired in 2007 and from 170 percent of FAS (New Hampshire) to 555 percent of FAS (Kentucky) for those hired in 2016. On average, teachers hired in 2016 would expect to receive 331 percent of their FAS in pension wealth, and those hired in 2007 would expect to receive 397 percent of their FAS in pension wealth.

Recall from Table 1.9 that it costs teachers a proportion of their salary to participate in their pension plans, and the cost varies across states and over time. The first and third columns of Table 1.14 contain the simulated value of the sum of contributions a hypothetical teacher hired in 2007 and in 2016 would expect to pay in each state. The sum of contributions ranged from zero dollars (Florida, New York, and Wyoming) to $114,022 (Illinois), with a median of $58,895 for those hired in 2007. On the other hand, teachers hired in 2016 would expect to contribute from a low of $22,613 (Wyoming) to a high of $199,459 (Massachusetts), with a median of $76,499. On average, a teacher hired in 2016 would expect to contribute $18,198 more than one hired in 2007.

The second and fourth columns of Table 1.14 present lifetime contributions as a percentage of the final average salary. We can see that lifetime contributions ranged from 0 percent of FAS (Florida, New York, and Wyoming) to 169 percent of FAS (Missouri), with a median of 86 percent of FAS for those hired in 2007. For teachers hired in 2016, the sum of contributions ranged from 33 percent of FAS (Wyoming) to 204 percent of FAS (Missouri), with a median of 96 percent of FAS. On average, teachers hired in 2016 would expect to pay 19 percentage points more of their FAS compared to those hired in 2007.

1.5.4 Comparison of Net Pension Wealth Across States and Over Time

In Table 1.15, the first and fourth columns contain the simulated values of net pension wealth (pension wealth minus lifetime contributions) that a hypothetical teacher would receive in each state. The simulated value of net pension wealth ranged from $124,191 (Oklahoma) to $432,364 (Massachusetts) for those hired in 2007 and from $50,968 (Illinois) to $345,233 (Connecticut) for those hired in 2016.

I find large differences among states in the present value of net pension wealth. Prior to the pension reforms, the net pension wealth that a hypothetical Massachusetts teacher would expect to receive upon retirement was more than triple the amount a hypothetical Oklahoma teacher would expect to receive, $432,364 compared to $124,191. Recent pension parameters and salary changes enlarge the differences among states. For those hired in 2016, the net pension wealth that a hypothetical Connecticut teacher would expect to receive upon retirement is six times more than the amount a hypothetical Illinois teacher would expect to receive, $345,233 compared to $50,968.

The second and fifth columns of Table 1.15 present net pension wealth as a percentage of final average salary. Net pension wealth ranged from 132 percent of FAS (Minnesota) to 545

percent of FAS (Massachusetts), with a median of 303 percent of FAS for those hired in 2007. For teachers hired in 2016, net pension wealth ranged from 52 percent of FAS (Illinois) to 389 percent of FAS (Kentucky), with a median of 232 percent of FAS.

To illustrate the size of pension income relative to salary income, the third and sixth columns of Table 1.15 present each hypothetical teacher's net pension wealth as the percentage of lifetime salary. The results suggest that the size of net pension wealth relative to lifetime salary income ranged from 11 percent (Minnesota) to 54 percent (Massachusetts), with a median of 25 percent for those hired in 2007. For teachers hired in 2016, the size of net pension wealth relative to lifetime salary income ranged from four percent (Illinois) to 30 percent (Kentucky), with a median of 17 percent. Compared to teachers hired in 2007, net pension wealth represents a much smaller share of lifetime salary for those hired in 2016.

Table 1.16 compares how net pension wealth changed between 2007 and 2016. The first three columns contain the differences of net pension wealth measured as 2016 dollars, the percentage of FAS, and the percentage of lifetime salary before and after recent pension reforms. On average, a hypothetical teacher hired in 2016 would expect to receive $62,179 less net pension wealth, 85 percent less of her FAS, and seven percent less lifetime salary compared to those hired in 2007.

To describe the percentage change in the net pension wealth before and after recent pension reforms, I calculate the rates of change in each state using the following formula:

$$(7)\quad NPW\,Rate\ of\ Change_s = \frac{NPW_{s\,2016} - NPW_{s\,2007}}{NPW_{s\,2007}}$$

where NPW is one of the measures of net pension wealth described above in state *s*. Column 4 in Table 1.16 shows that the net pension wealth rates of change ranged from positive nine percent (District of Columbia) to negative 76 percent (Illinois). When net pension wealth is measured by

the percentage of FAS and lifetime salary, the largest rate of change is negative 85 percent, in Massachusetts (see column 5 and 6). All three measures of net pension wealth show that hypothetical teachers hired in 2016 would expect to receive about 25 percent less net pension wealth compared to those hired in 2007.

Table 1.17 summarizes the changes in pension parameters and starting salary in each of the 40 states and the District of Columbia. Between 2007 and 2016, 37 states enacted less generous parametric pension changes. Twenty-seven states lowered the starting salaries for their new teachers, and 14 states increased the starting salaries instead. Among the four states that did not enact pension changes between 2007 and 2016, Arkansas and North Carolina decreased teacher starting salary while the District of Columbia and Connecticut increased it.

Because changes in pension parameters and teacher salary both result in changes in pension wealth, to distinguish the effect of pension parameter changes on pension wealth, the blue bars in Figure 1.1 reflect the changes in pension wealth measured as 2016 dollars assuming each state's teacher salary holds constant overtime. The green and the blue bars combine to reflect the effect of changes in pension parameters and teacher salary on pension wealth. Figure 1.1 shows that the increases in pension wealth were all driven by salary increases. Furthermore, it shows that teachers in states that undertook larger pension cuts, such as Massachusetts and Illinois, experienced salary declines.[23] Overall, I find that in most states, most of the pension wealth changes were driven by pension parameter changes.

The second and fourth columns of Table 1.18 compare the rankings of net pension wealth, measured by the percentage of FAS, where 1 is the most generous and 41 is the least. Columns 5

[23] Although most states cannot change pension parameters to be less generous for current employees, allowing real salary to fall can have the same effect on pension wealth. Teachers in 34 states experienced lower state average real salary between 2007 and 2016 reported by the National Education Association: http://www.nea.org/assets/docs/2017_Rankings_and_Estimates_Report-FINAL-SECURED.pdf and http://www.nea.org/assets/docs/HE/09rankings.pdf.

and 7 compare how expected net pension wealth was affected for teachers hired before and after the pension changes in terms of the magnitude difference and percentage declined, respectively. Columns 6 and 8 compare the rankings of columns 5 and 7, where 1 is the largest cut and 41 is the smallest. Results show that states that ranked among the most generous pre-reform experienced larger net benefit cuts as measured by magnitude difference and percentage decline. However, a few states including Illinois, New Jersey, and New Hampshire that were among the least generous pre-reform also experienced large benefit cuts that decreased net pension wealth by more than 50 percentage points. The four states that did not enact pension changes between 2007 and 2016 became relatively more generous as measured by percentages of FAS when other states reduced their teachers' pension benefits. For example, Connecticut's ranking increased from the 33rd in 2007 to the 18th in 2016.

1.6 Sensitivity to Assumptions

All of these simulations are for a hypothetical teacher with the set of assumptions described. While this paper provides a basic comparison of pension generosity across states and over time, the actual benefits and costs of participating in pension plans vary depending on each teacher's career path and expected longevity. To consider the sensitivity of my findings to changes in these assumptions, I recalculate net pension wealth from Table 1.15 using different assumptions.

Table 1.19 presents the simulated pension wealth for teachers hired in 2007 by expected years to live. Unsurprisingly, longer expected longevity increases expected net pension wealth. I find that net pension wealth, measured as the share of lifetime salary, increased by six percentage points for every five additional years in retirement. Therefore, teachers who live longer would experience larger cuts in their expected pension wealth compared to those with shorter lifespans. However, if

increasing retirement eligibility greatly increases teachers' years of service and annual benefits, longer lifespan would allow teachers to receive more years of high annual benefits and could decrease the magnitude of the cuts.

Table 1.20 contains simulations of the effect of changing the assumed discount rate on net pension wealth for teachers hired in 2007. I find that a one percentage point increase in the discount rate would reduce net pension wealth as measured by the share of lifetime salary by about 10 percentage points. Therefore, teachers who face higher discount rates would experience smaller cuts in their expected net pension wealth.

Table 1.21 contains simulations of the effect of changing assumed COLAs on net pension wealth for teachers hired in 2007. Results suggest that a one percentage increase in COLA rate would increase net pension wealth as measured by the share of lifetime salary by about 4 percentage points. Therefore, teachers who expected higher COLA rates would experience larger cuts in their expected net pension wealth.

Recall from Table 1.12 that increasing retirement eligibility age or years of service increases the hypothetical teacher's annual benefits but also shortens the number of years she receives annual benefits. Under conditions where teachers do not work longer but still wait longer to start collecting retirement benefits, their annual benefits would be lower and they would experience larger cuts in their expected net pension wealth.

1.7 Social Security and Teacher Pensions

In addition to participating pension systems, many teachers mandatorily participate in another defined benefit plan—Social Security. Perhaps more surprisingly, about 40 percent of all U.S. public school teachers are not covered by Social Security (Kan and Aldeman 2014). When

Social Security was first created in 1935, all state and local government employees, including public school teachers, were excluded from the coverage. The exclusion was based on constitutional concern of whether the federal government should be allowed to impose a tax on state government. In the 1950s, Congress enacted Section 218 along with an amendment of the Social Security Act, allowing states to voluntarily extend Social Security coverage to state and local government employees.[24] Starting in 1991, the Omnibus Budget Reconciliation Act of 1990 extended mandatory Social Security coverage to all state and local government employees who were not enrolled in Social Security or a Social Security equivalent pension system (The United States Social Security Administration 2018). In my sample of 40 states and the District of Columbia, 27 states automatically enroll their teachers in Social Security (last column of Table 1.13). In the remaining 13 states and the District of Columbia, teachers are exempt (or partially exempt) from Social Security.[25]

In states that enroll their teachers in Social Security, teachers and their employers each pay a 6.2% Federal Insurance Contributions Act (FICA) tax on the teacher's earning, for a total tax burden of 12.4% to fund the Social Security system.[26] To be eligible to collect full Social Security payments, a person must have worked and paid the payroll tax for at least 10 years and must be age 67 or older for those born in 1960 or later. Teachers collect Social Security upon retirement until death. Social Security payments are based on the individual's Average Indexed Monthly Earnings (AIME), calculated as the average monthly salary in the 35 years of employment where the retiree's salary was highest. Primary Insurance Amount (PIA), the monthly benefit under normal retirement age, is then calculated as 90% of AIME up to the first bend point, 32% of AIME

[24] States that extended Social Security coverage to public employees through Section 218 agreements cannot terminate the coverage after April 20, 1983 (the 1983 Amendments).
[25] In Georgia, Kentucky, and Rhode Island, Social Security coverage varies across school districts within the states.
[26] The Medicare Tax is 1.45% on the teacher's earning.

exceeds the first bend point but less than the second bend point, plus 15% of AIME exceeds the second bend point (The United States Social Security Administration 2018).[27]

Pension plans usually offer higher formula multipliers for teachers who do not participate in Social Security. For example, in 2007 four out of the five most generous pension plans as measured by pension wealth as a percent of FAS (Massachusetts, Kentucky, Louisiana, and Colorado; see Table 1.13) do not allow their teachers to participate in Social Security. In addition, these states use relatively high multipliers (2.35 to 2.50; see Table 1.5) when calculating teachers' annual pension benefits. In contrast, during 2007, four of five least generous states (Minnesota, New Hampshire, New Jersey, and Wisconsin) enroll their teachers in Social Security. These states use below-average multipliers (1.6 to 2.0; see Table 1.5) when calculating annual pension benefits, and four of five of them.

Recall that many states enacted pension reforms because the 2008 financial crisis lowered investment returns and exacerbated the pension funding crisis. Some scholars argued that many states with no Social Security coverage failed to meet the fundamental requirement of not enrolling in Social Security (the Omnibus Budget Reconciliation Act of 1990) (Doherty et al. 2012). To study whether this argument holds, I first examine how pension funding level in states with no Social Security coverage has changed over this period, compared to states that enroll teachers in Social Security. I obtain state's yearly pension funding ratio (actuarial assets divided by the actuarial liability) data from the Public Plans Database.[28] Figure 1.2 plots average pension funding ratio by year from 2007 through 2016 for states that enroll their teachers in Social Security versus

[27] The bend points in 2018 are $895 and $5,397. For example, if a teacher's AIME is $6,000, her PIA would be: PIA=0.9*($895)+0.32*($5,397-$895)+0.15*($6,000-$5,397)=$2,336.59. Previous bend points can be found on Social Security homepage: https://www.ssa.gov/oact/cola/bendpoints.html.

[28] Public Plans Database provides state's pension funding ratio under the accounting rules set by the Governmental Accounting Standards Board. The funding ratio is the ratio of actuarial assets to actuarial liability. A funding ratio greater than one means the pension system has enough money to cover all obligated payments.

states that do not. The figure shows that states that do not enroll their teachers in Social Security experienced a steeper drop in the funding ratio between 2008 and 2009. This suggests that the 2008 financial crisis hit the states that do not enroll their teachers in Social Security harder.

Second, I examine whether states that suffered from increasing underfunded pension liabilities enacted larger pension benefit cuts. In Figure 1.3, I show the relationship between net pension wealth cuts and pension funding ratio, again by whether states enroll teachers in Social Security. The negative relationship between pension funding ratio and the magnitude of pension wealth cuts suggests that states enacting the harshest cuts sustained more serious financial trouble. In addition, the slopes' steepness suggests that teachers who do not participate in Social Security experience harsher cuts given the same level of underfunding. In fact, I find that the two states that experienced the largest percentage change in net pension wealth under recent pension reforms do not enroll their teachers in Social Security (Massachusetts and Illinois; see Table 1.18).

1.8 Conclusion

This paper demonstrates large differences across states in the present value of net pension wealth and net benefit cuts. Prior to recent pension changes, the simulated values of net pension wealth in some states were more than triple those of the least generous state, and recent pension changes enlarged these differences by making net pension wealth in some states more than six times as large as the least generous state.

I find that states that ranked among the most generous pre-reform experienced larger net benefit cuts. However, a few states including Illinois, New Jersey, and New Hampshire that were among

the least generous pre-reform also experienced large benefit cuts that decreased net pension wealth by more than 50 percent.

I also find that states that *do not* enroll their teachers in Social Security experienced worse pension funding crises and harsher cuts than other states. If teachers respond to these changes, this could have implication for both state budgets and teacher labor market.

To conclude, this study provides several policy implications. First, my paper provides information for state policy makers who want to learn about how their state pension plan and salary scale compare to those of neighboring states, especially for those struggling to staff their classrooms. Second, teachers without strong geographic preferences might choose to teach in a state that is more generous. Last, some scholars suggest that all teachers should join Social Security, a more secure defined benefit pension plan (Doherty et al. 2012). Given the dramatic declines in teacher pensions among states that do not enroll their teachers in SS, future research should consider more carefully whether states are meeting the fundamental requirement in order to exclude their teachers in SS.

CHAPTER 2

THE EFFECT OF RECENT TEACHER PENSION REFORMS ON NEW TEACHER QUALITY

2.1 Introduction

Teacher pensions represent a large share of lifetime compensation for public school teachers– those who qualify for full pensions receive total pension payments worth about 46 percent of their lifetime salary (Toutkoushian et al. 2011).[29] The cost to maintain teacher pensions is high – states and school districts in the United States pay more than $50 billion toward teacher pensions every year (Aldeman and Robson 2017). The increasing burden of pension on school districts forces policy makers to consider whether current teacher pension systems succeed in attracting and retaining better teachers. Empirical evidence consistently shows that senior teachers respond to pension retirement-timing incentives (Furgeson, Strauss, and Vogt 2006; Costrell and McGee 2010; Costrell and Podgursky 2009; Koedel and Xiang 2017). A few papers also find that young teachers respond to cross-state differences in pension generosity and pension characteristics such as vesting requirements. (Munnell and Fraenkel 2013; Papke and Litwok 2013). Nevertheless, we know very little about the influence of teacher pension incentives on teacher recruitment.

Today, many teacher pension systems report large underfunded liabilities. In the past, some states required zero or very low teacher contribution rates; some states promised pension benefits that they could not afford; and some states and local governments paid less than their legally required contributions (Doherty et al. 2012). The 2008 financial crisis lowered investment returns and exacerbated the pension funding crisis. To reduce pension debt, a few states changed their

[29] Toutkoushian et al. (2011) calculate a simulation of pension wealth for one identical teacher in 49 states that offered public school teachers state-run defined benefit pension plans. The percentage presented here is for a teacher who works from age 22 to 65 and receives 20 years of pension payments.

pension structure from traditional defined benefit (DB) pension plan to plans that shift investment performance risk from the state to teachers.[30] Most states, moreover, either reduced benefits, increased teacher contributions, or both. Because most states have laws that prevent benefit cuts for current employees, significant changes to pension plans often only apply to new teachers. These changes provide an identification strategy for estimating pensions' effect on new teacher quality and discovering the pension factors to which teachers respond. The hypothesis is that lower pension benefits, all else equal, would discourage prospective teachers, particularly teachers with better alternatives, from entering the profession. However, if new teachers are not forward looking or know little about their pension plans, the effect of pension changes on teacher recruitment may be small (Goldhaber et al. 2017). As many states continue to struggle with pension issues, understanding whether and how much new teachers respond to pension benefits gives policy makers a more complete picture of benefits and costs associated with potential pension reforms.

I use selectivity of a teacher's undergraduate institution as the primary proxy measure of teacher quality. Angrist and Guryan (2004) suggest that measures of a teacher's undergraduate institutional selectivity could be a good predictor of her aptitude. In particular, I use the 25th percentile SAT scores at a teacher's undergraduate institution as my proxy measure.[31] I also use an indicator for whether the teacher has a postgraduate degree and an indicator for whether the teacher majored in the subject she teaches as other teacher quality measures. Using pooled cross-sectional teacher-level data from the 2003-2004, 2007-2008 and 2011-2012 Schools and Staffing Survey, I estimate the differential change in new teacher quality before and after the cuts between states and cities that enacted pension reforms between 2007 and 2011 and those that did not. My

[30] A few states replaced their defined benefit pension plans to defined contribution plan, hybrid plan, and cash balance plan.
[31] The SAT score of teachers' undergraduate institution is used as a measure of teacher quality in this literature (for example, Munnel and Fraenkel 2013; Angrist and Guryan 2008; Hoxby and Leight 2004; Figlio 2002). I use the 2004 25th percentile SAT score because there is a major testing design change in 2005. If scores for a school are not available in 2004, they are imputed across years 2001-2004.

analysis focuses on 2,640 first-year teachers who participated in a mandatory, traditional defined benefit plan between 2003 and 2011.

Moreover, I consider year-to-year variation in other time-related factors that might affect teacher entry. Over the past three decades, every state has reported teacher shortages to the U.S. Department of Education (U.S. Department of Education Office of Postsecondary Education 2017).[32] Struggling to staff their classrooms, some states lowered testing requirements for entry into the teaching profession (Partelow 2015). Some school districts, on the other hand, used financial incentives like signing bonuses and free training to recruit teachers, especially in fields where the shortages are greatest. Entry barrier changes and more attractive district recruitment policy can affect teacher quality (Hanushek and Pace 1995; Figlio 2002). Existing literature also consistently finds that relative teacher pay affects teachers' labor decisions (Nagler, Piopiunik and West 2015; Munnell and Fraenkel 2013; Bacolod 2007; Figlio 2002). Over the last century, the market for educated women expanded substantially while teachers' salaries grew slowly relative to other professional fields. The relatively low salary could make teaching – a traditionally female-dominated occupation—less attractive. On the other hand, the Great Recession during the late 2000s and early 2010s reduced the outside job options for teachers and could make teaching more attractive. To better understand the effect of pension reforms on new teacher quality, my analysis accounts for a complete set of time-varying covariates for these contemporaneous changes in state and district policies and economic conditions.

My estimates show that potential new teachers respond to pension incentives offered by school districts. In states and cities that enacted pension reforms, schools hire teachers from undergraduate

[32] According to 34 CFR 682.210(q)(8)(vii), "teacher shortage area" means "an area of specific grade, subject matter or discipline classification, or a geographic area in which the Secretary determines that there is an inadequate supply of elementary or secondary school teachers."

institutions 25.63 points lower (more than one fifth a standard deviation) 25th percentile SAT scores. I also find that a one percent increase in the present value of net pension wealth results in schools hiring new teachers from undergraduate institutions with 32.15 points higher (more than one forth a standard deviation) 25th percentile SAT scores.

In the next section, I review the relevant literature. Section 2.3 describes the pension data and institutional details. Section 2.4 provides a description of the teacher data from the Schools and Staffing Survey and how I match these to district level pension data. Section 2.5 presents the empirical specifications and results, and Section 2.6 concludes.

2.2 Related Literature

2.2.1 Teacher Pensions and Teacher Turnover

Much of the literature on teacher pensions focuses on teacher retirement. Costrell and McGee (2010) find that both peak value (the difference between current pension wealth and the maximum possible pension wealth) and one year accrual (the difference between current pension wealth and the pension wealth after one additional year of work) have negative effects on Arkansas teachers' retirement.

Some researchers study the effect of pension incentives on teacher retirement in specific states using administrative data that capture teacher exit behavior and earnings history (Furgeson, Strauss, and Vogt 2006; Costrell and McGee 2010; Brown and Laschever 2012; Brown 2013; Koedel and Xiang 2017). They find that senior teachers respond to pension retirement-timing incentives. Two other papers explore policy changes affecting pension wealth and employ difference-in-difference models to estimate the effect of pension incentives on the timing of teacher exit decisions. Furgeson, Strauss, and Vogt (2006) find a large increase in teacher retirement when Pennsylvania

enacted a pension policy which temporarily increased early retirement benefits between 1997-1998 and 1998-1999. Koedel and Xiang (2017) investigate a policy change in St. Louis that increased teacher retirement benefits for those who retired after the 1998-1999 school year. Using administrative panel data from the Missouri Department of Elementary and Secondary Education, they find a temporary delay in retirement among teachers who were eligible for retirement in the previous school year. However, they find no significant retention effect among teachers who were not eligible for retirement. They offer a possible explanation that teachers may lack of full knowledge of their pensions.

Some papers ask how DB pension parameters affect teacher turnover by comparing differences across pension plans. Costrell and Podgursky (2009) analyze the time pattern of pension incentives by simulating pension wealth accrual over a teacher's career in six states. They find that teachers' pension values accumulate slowly in the early years of their careers, then accelerate in teachers' mid- to late fifties, and drop off sharply over the next few years. This backloading of pension wealth accumulation creates a strong "pull" incentive for teachers to stay until they reach the time when pension value spikes. Once they pass the pension value spike, teachers face a strong "push" incentive to leave. Friedberg and Turner (2011) use a peak value model to estimate the effect of variation in pension parameters on teacher retirement across 17 pension plans. Using teacher-level data from the School and Staffing Survey (SASS), they find that teachers tend to delay retiring while pension wealth accumulates, then retire abruptly after reaching peak pension wealth.

Two other papers explore policy changes affecting pension wealth and employ difference-in-difference models to estimate the effect of pension incentives on the timing of teacher exit decisions. Furgeson, Strauss, and Vogt (2006) find a large increase in teacher retirement when

Pennsylvania enacted a pension policy which temporarily increased early retirement benefits between 1997-1998 and 1998-1999. Koedel and Xiang (2017) investigate a policy change in St. Louis that increased teacher retirement benefits for those who retired after the 1998-1999 school year. Using administrative panel data from the Missouri Department of Elementary and Secondary Education, they find a temporary delay in retirement among teachers who were eligible for retirement in the previous school year. However, they find no significant retention effect among teachers who were not eligible for retirement. They offer a possible explanation that teachers may lack of full knowledge of their pensions.

Unlike defined contribution (DC) plans that tie retirement benefits to total contributions and are subject to market fluctuation, defined benefit plans guarantee retirees a specific level of annual benefits calculated as the product of a multiplier factor, within-system experience, and final average salary. Other papers compare DB plans and other pension plans. For example, Gustman and Steinmeier (1993) use the Survey of Income and Program Participation (SIPP) to compare worker turnover between DB plans and DC plans. While DC plans accrue benefits overtime, DB plans backload pension benefits – the formula used to calculate guaranteed annual benefits relies on within-system years of service (YOS) and final average salary (FAS). DC plans are not backloaded: they do not guarantee retirees minimum or maximum pension benefits and allow vested workers to take their full retirement saving with them when moving from one job to another. Gustman and Steinmeier (1993) find that pension coverage was associated with lower one-year turnover rate regardless of pension types (DB or DC). Friedberg and Owyang (2005) study the link between DB coverage and job tenure. Using data from 1983-2001 Survey of Consumer Finance (SCF) and 1993 Current Population Survey (CPS) and controlling for job characteristics, they find that workers with DB pensions work in the same job longer than workers with no pensions or with

DC pensions.[33] They also find that workers with more generous DB pensions stay longer, controlling for levels of earning. Goldhaber et al. (2017) investigate whether moving away from a backloaded defined benefit plan increases levels of employee turnover. Using data from Washington Teacher Retirement system, the authors compare the turnover rate of teachers who enrolled in either a traditional defined benefit (DB) plan or a hybrid plan (combines DB and DC) during the same period of time. They find that turnover was lower among teachers who transferred out of the DB plan into the hybrid plan. Papke and Litwok (2013) ask whether cross-state pension differences in four states affected young teachers' first exit from teaching. They find that the presence of defined contribution alternatives is positively and significantly related to the hazard rate of first exit. They also find that more stringent vesting requirements are positively and significantly related to the hazard rate of first exit.

2.2.2 Teacher Pensions and Teacher Quality

A small but growing literature focuses on how pension incentives affect teacher workforce quality. A few papers use administrative data to study the type of teachers who respond to pension turnover incentives in specific states and use student achievement as the teacher quality measure (Koedel et al. 2013; Fitzpatrick and Lovenheim 2014; Chingos and West 2015). Koedel et al. (2013) use teachers' value-added as a measure of teacher quality to examine the pull and push incentives in Missouri pension system on teacher workforce quality. If teachers who stay because of the pull incentives are more effective, or teachers who leave because of the push incentives are less effective, then pension incentives improve teacher workforce quality. They find no evidence that pension incentives improve teacher quality and suggest that increasing the retirement age could

[33] Job characteristics include industry, occupation and firm size controls.

yield large cost saving without harming teacher workforce quality. Fitzpatrick and Lovenheim (2014) find a large increase in retirement among highly experienced teachers when Illinois temporarily increased the early retirement benefits (the ERI program) between 1992-1993 and 1993-1994 school years.[34] By examining how student test scores changed differently between the pre-ERI and post-ERI periods among schools with more highly experienced teachers relative to schools with fewer in pre-ERI period, they find that teachers who are close to retirement are less productive and ERI did little to reduce student test scores. Chingos and West (2015) examine teacher preferences over pension types and their effectiveness in raising student achievement when Florida allowed their newly hired public school teachers to choose between a DB plan and a DC plan with DB plan as the default option in 2002. While the DC plan and its rapid vesting, portability, and smooth pension wealth accrual could make teaching more attractive to younger workers, possible career-switchers, as well as workers who are geographically mobile, the fact that employees, rather than taxpayers bear the consequences of investment performance may make teaching less attractive. The authors find no strong relationship between pension plan choice and teacher effectiveness, with teachers in the bottom value-added quartile being two percentage points less likely to choose the DC option than teachers in any other quartiles. They suggest that states can modify pension structure without reducing the effectiveness of teachers attracted into teaching.

One previous paper suggests that teacher pensions matter for new teacher quality. Munnell and Fraenkel (2013) use data from the SASS to examine how pension differences across pension plans affect the quality of newly hired teachers who are under the age of 30 and have been teaching for three years or less. Using employers' pension contributions as a proxy for cross-sectional

[34] Illinois had a two year ERI program offered to all Illinois public school teachers in 1992-1993 and 1993-1994 school year that allows teachers to purchase an extra five years of age and experience as creditable service to calculate retirement benefit if they retire immediately.

variation in pension generosity, they find that schools offering more generous pension plans hire new teachers from colleges with higher SAT scores.

2.2.3 Other Factors that Attract Teachers

A large literature exists on other factors that influence the decision to enter teaching and the quality of new teachers. The key explanatory variable of most of these studies is the role of salary and relative pay in teaching (Nagler, Piopiunik and West 2015; Munnell and Fraenkel 2013; Bacolod 2007; Figlio 2002). For example, Figlio (2002) uses district-level data from the SASS and uses two measures of teacher quality including the average SAT score at a teacher's undergraduate institution and an indicator of whether a teacher majored in the subject she teaches. He finds that a district's probability of hiring well-qualified teachers increases with higher teacher salaries, which implies that district recruitment policies (for example, signing bonuses) matter when attracting teachers. Nagler et al. (2015) use Florida's administrative data and exploit business cycle conditions as a source of exogenous variation in teachers' outside options. They find that teachers who entered the profession during recessions are significantly more effective in raising student test scores.

Other research shows that teacher licensing requirements affect new teachers' entry decision and teacher quality (Berger and Toma 1994; Hanushek and Pace 1995). For example, Berger and Toma (1994) find a negative relationship between master's degree requirement for teacher certification and student performance when measured by students' SAT score. Hanushek and Pace (1995) use a panel data from the High School and Beyond to trace a group of students who aspire to be a teacher when they are in high school. They find that the state requirements of courses and

tests for teacher certification lower the probability that students complete their teacher preparation program, which results to a smaller pool of trained teachers.[35]

My research contributes to the existing literature in several ways. First, this paper expands earlier teacher pension studies by focusing on teacher recruitment. My paper is most closely related to Munnell and Fraenkel (2013), who also evaluate the response of new teachers to pension benefits. To highlight the effect of pension incentives on teacher recruitment, I focus exclusively on the new entrants. Second, I use policy changes as an identification strategy to estimate the causal relationship between pension incentives and new teacher quality. Third, because pension reforms occurred during a time of the Great Recession where other factors such as teachers' outside options were changing over time, I account for a complete set of time-varying covariates that previous researchers have shown to affect teacher quality.

2.3 Institutional Details and Pension Data

In the U.S., all full-time public school teachers automatically participate in public pension plans. While each state runs a pension system that covers teachers (state-run pension plans), some large cities like New York and Chicago operate their own municipality-specific pension plans.[36] Table 2.1 shows the types of pension plans that states and cities offer teachers during the years I consider. In this paper, I restrict my analysis to the 36 state-run pension plans and 11 municipality-specific pension plans that automatically enroll teachers into a mandatory, traditional defined benefit plan throughout the years 2003 to 2011.[37]

In defined benefit plans, teachers contribute a portion of salary towards the plan while

[35] For example, complete a bachelor degree in education or teaching.
[36] While some teachers participate in plans that serve teachers only, 23 state-run retirement systems cover other state and local governments' employees along with teachers (Doherty et al., 2012, figure 4).
[37] I exclude states that offered teachers other types of pension plans, because their retirees' pension benefits are subject to market fluctuation and are therefore difficult to predict. Alaska, Florida, Indiana, Michigan, Ohio, Oregon, South Carolina, Utah,

employed. Teachers who retire after becoming vested collect annual payments until their death.[38] The lifetime pension wealth of a teacher depends on the size of initial annual payments, adjustments made for cost of living, and the length of time in retirement.

All defined benefit plans use a similar formula to calculate annual payments:

(3) *First-year Annual payments (A) = FAS * Multiplier * Years of Service*

where *FAS* is the teacher's final average salary, calculated as the average salary in the years of employment where the retiree's salary was highest. The multiplier in the formula determines the percentage of a teacher's final average salary that she receives for each year of service. The years of service (YOS) in the last part of the formula is the length of teacher's employment. In general, more years of service lead to higher annual payments. But some states cap the first-year annual payment to not exceed a specific percentage of the teacher's final average salary. The formula for teachers' capped first-year annual payments is:

(4) $Capped\ Annual\ payments\ (\mathcal{A})$

$$= \begin{cases} A & with\ no\ limits. \\ Min\ (A, x\ \% * FAS) & if\ states\ limit\ annual\ payments\ to\ x\%\ of\ FAS. \end{cases}$$

In order to counteract the impact of inflation on retirement income, public pension plans provide retirees with post-retirement cost of living adjustments (COLAs). Plans with higher cost of living adjustments are more beneficial to teachers.

The pension parameters discussed above relate to the size of annual benefits. Other pension parameters such as retirement age and teacher contribution amount may also affect pension wealth,

Washington, and West Virginia did not automatically enroll their teachers into defined-benefit plans during 2003-2011. They either automatically enrolled teachers into defined contribution plans or hybrid plans, or allowed teachers to choose between plans. I therefore exclude these states from the sample. District of Columbia, Hawaii, Maryland and Rhode Island have low response rate in 2011 SASS survey and are therefore excluded from the analysis. Vermont enacted a pension reform that increased annual payments but delayed retirement for all teachers aged under 57 and hired on or after June 30, 2010. It is unclear whether this reform cut pension wealth or not so I exclude Vermont from the sample.

[38] On average, it takes 5.7 years for teachers in the U.S. to become vested in 2008 (Doherty et al. 2012).

without directly changing annual benefits.[39] Because teachers collect annual benefits from retirement until death, an earlier retirement age causes teachers to receive more annual payments and enjoy higher lifetime pension wealth. Recall that most states require teachers to contribute a portion of salary to fund their pension plans. Because a teacher's annual benefit is not tied to teacher contributions (see equation (1)), increasing contribution rate decreases net pension wealth.

To more precisely evaluate pension plan generosity, I calculate net pension wealth as the actuarial present value of the payment stream that teachers expect to receive upon retirement, net of employee contributions.[40] Suppose a teacher started teaching in year *t=1*, retires in year *t=T*, and collect pension benefits for d years, from *t=T+1 to* $t=T+d$. Then, her expected present discounted net pension wealth (PDNW) is calculated using the following formula:

$$(3)\ PDNW_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)}\, \pi_t}{(1+r)^{t-1}} - \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$$

where $\mathcal{A}_t$ is the capped annual payment in year $t > T$, f_t is the cost of living adjustment in year t, π_t is the probability of surviving at year t, r is the discount rate, and C_t is the teacher contribution in year $t \leq T$.

Table 2.2 presents the list of references that I used to determine each plan's pension parameters. I gathered data primarily from individual plans' homepages, member handbooks, financial reports, and summaries of legislation. I obtained additional pension plan-level data on pension funding ratio and employer contribution rate from the Public Plans Database (PPD).[41]

It is possible that some new teachers enter teaching with the intent to teach for a short period of time, are uncertain how long they will remain in the profession, or are likely to be geographically

[39] Raising retirement eligibility age or service could indirectly increase annual benefit through more years of service and higher final average salary if teachers decide to work longer.
[40] Actuarial present value is the sum of discounted capped annual payments each discounted by the probability of surviving that year.
[41] Pension funding ratio is the ratio of actuarial assets to actuarial liability. A funding ratio greater than one means the pension system has enough money to cover all obligated payments.

mobile. These teachers would care more about pension vesting rules, the amount they can withdraw if they leave before vested, and whether they have Social Security coverage. Vesting rules determine how long a teacher must work under the same pension plan to eligible for pension benefits. Teachers who leave before being vested not only lose future rights for pension benefits but also lose accrued funding saved –teachers who leave before being vested can only withdraw their own contributions, sometimes with interest, and rarely with employer contributions. Therefore, the longer the vesting rule is (or the less teachers can withdraw before being vested), the less attractive it is to teachers who do not plan to stay long. In addition to participating in pension systems, teachers in 31 pension plans mandatorily participate in another defined benefit plan—Social Security (Table 2.3). Teachers who do not participate in Social Security have more dependency on their pension plans. In general, pension plans that allow teachers to participate in Social Security require lower teacher contribution rate and offer a lower formula multiplier. While some potential teachers might treat Social Security as a substitute for a teacher pension plan and value Social Security coverage for its portability across state lines and jobs for low risk of retirement benefits, some might find Social Security coverage less attractive because they need to contribute an extra 6.20 percent of their salary to fund Social Security.

In response to the financial crisis among pension plans, many pension plans enacted reforms between 2007 and 2011 that reduced teacher benefits or increased required teacher contribution rates. Although legal constraints prevent most states from cutting benefits for current employees, all states can change the benefit rules affecting employees not yet hired. Therefore, all the pension parameters changes discussed below affect teachers hired in the 2011-2012 school year.

Table 2.3 provides an overview of the numbers of years used to calculate FAS. In 2007, 32 pension plans used average salary for the three or fewer of the highest years of salary. 15 pension

plans used a similar definition with more than three years. Compared to 2007, 8 pension plans increased the number of years used to calculate FAS by 2011. While 25 pension plans used three or fewer years of salary, 22 pension plans used more than three highest years of salary to calculate FAS by 2011.

Table 2.4 provides an overview of the multiplier used in each pension plans. In 2007, 37 pension plans use a constant multiplier that ranged from 1.55 percent (South Dakota) to 2.67 percent (Nevada). 10 pension plans used multipliers that varied by retirement age or years of service. Compared to 2007, eight pension plans changed their multipliers in ways that reduced benefits by 2011.

Table 2.5 shows that 23 pension plans limited the annual payment to a specific percentage of the teacher's final average salary in 2007. The limitation ranged from 60 percent to 100 percent. By 2011, Pennsylvania changed from no limitation of annual payments to 100 percent of the teacher's FAS and Arizona became more generous by eliminating the 80 percent cap.

The pension plans also vary by their cost of living adjustments. Table 2.6 provides an overview of COLAs in each pension plans. In 2007, 34 states automatically adjusted cost of living based on a specific percentage or the Consumer Price Index (CPI). On the other hand, 12 pension plans relied on state legislation to decide COLAs for each year, and two states tied their COLAs to their funding level. By 2011, ten pension plans changed COLAs in ways that are less generous. The changes include lowering the COLA rate, delaying the receipt of COLA, or switching from automatic adjustments to adjustments that tied COLAs to funding levels or other indexes.

Table 2.7 provides an overview of retirement eligibility in each state. Compared to 2007, 18 pension plans raised retirement eligibility age or years of service by 2011, which would shorten the length of years receiving annual benefits for many teachers.

Table 2.8 provides an overview of the employee contribution rate in 2007 and 2011. In 2007, Wyoming did not require their teachers to make any contribution to their pension plans. Other pension plans required their teachers to make contributions ranging from three to 12 percent of their salary. 40 pension plans required teachers to contribute at least a five percent of their salary. By 2011, every pension plan required their teacher to make contributions that ranged from 1.43 to 14 percent of their salary. 17 pension plans increased their employee contribution requirements between 2007 and 2011.

Table 2.9 provides an overview of vesting rules. Seven pension plans increased the time to vesting between 2007 and 2011. Once exception to the increase in time is Kansas, which moved from a 10-year vesting rule to a 5-years vesting rule, but lengthened years used to compute FAS and increased time to retirement eligibility, so vesting is not worth what it was previously.

Table 2.10 provides an overview of how much pension plans permit teachers to withdraw from their pension plan if they leave before being fully vested. I use the indicators presented in Table 2.10 to measure pension portability. The majority of pension plans (81 percent) allow teachers to withdraw their own contribution plus interest if they leave before being vested. While three pension plans allow teachers to withdraw more than their contribution plus interest, five pension plans only allow teachers to withdraw their contributions and no interest if they leave before being vested. In Colorado, a teacher hired before 2011 may withdraw her contributions, interest, and partial employer contributions. However, a teacher hired in 2011 or later who leaves before being vested can only withdraw the employee contribution plus interest.

2.4 Teacher Data

The teacher data I use come from the Schools and Staffing Survey (SASS), the largest and most extensive survey of elementary and secondary teachers, administrators, schools, and school districts in the U.S. today. The National Center for Education Statistics (NCES) initially conducted the survey in school year 1987-1988 and conducted the survey seven times since then. I use the 2003-2004, 2007-2008 and 2011-2012 waves, because the most recent available data are from the 2011-2012 wave, and the earliest available data that contain consistent questions on district-level hiring practices over time are from the 2003-2004 wave. To be consistent with the pension parameters teachers faced when they started teaching, I will index school years by the calendar year in which a school year starts hereafter. For example, I will refer to the 2011-2012 school year as 2011.

The SASS data have a number of strengths for this study. First, the information on each teacher's year of entry into teaching allows me to target my sample to a group of new entrants. Second, SASS includes information on each teacher's education background that I use as proxy measures of teacher quality. Third, the restricted-use state and zip-code identifiers allow me to match individual teachers to their pension parameters and state variables. Fourth, the information on each teacher's current salary allows me to compare teachers' outside options and impute an earning history so that I can simulate individuals' pension wealth.[42] Lastly, the variation of interest in this paper is at the state by year level, and with the proper weighting, each wave of SASS is designed to be representative at the state level.

[42] Because teacher's salary generally follows a salary scale that increases to years of service (Friedberg 2011), I run a regression of teachers' current earning on polynomials of their total experience. Based on the estimates of how salary changes with experience, I impute an earning history for each individual teacher and calculate her final average salary.

One of the weaknesses of using SASS is that I only observe workers who entered teaching but not those who considered teaching and later decided not to. Therefore, I do not directly measure how pension incentives affect potential teachers. Instead, this paper focuses on the effect of pension incentives on the composition of newly hired teachers. Another weakness of using SASS is that I only observe teachers in limited years (2003, 2007, and 2011), which only leaves potential teachers a few years to respond to the changes in pension incentives. It will take more years of post-treatment data to observe a larger change in new teacher composition if recent pension reforms also affect students' decisions to enter (or transfer out) from education programs.

Because pension reforms should affect newly hired teachers the most, I restrict my sample to newly hired teachers who work full time.[43] I define newly hired teachers as those who have no teaching experience before the survey year.[44] Overall, there are 3,410 teacher-year observations in 2003, 2007, and 2011 in the 36 states of interest.

The institution's SAT score data come from the National Center for Education Statistics Integrated Postsecondary Education Data System (NCES IPEDS). NCES provides the 25th percentile entering SAT/ACT scores for schools that require test scores for admission and have at least 60 percent of enrolled students submitting a test score. For teachers who attended an undergraduate institution that provides only ACT scores, I convert ACT scores to SAT scores using the College Board's official concordance formula and tables (Dorans 1999). I exclude teachers who attended undergraduate institutions that did not collect or report SAT/ACT scores, which eliminates 440 teacher-year observations. I also exclude teachers at charter schools, which eliminates 210 teacher-year observations, because pension mandates do not always apply to charter

[43] That is, teachers who classify themselves as a part-time teacher, student teachers, teacher's aids or substitute teachers are not included in the analysis.
[44] The teacher questionnaire asks teachers to report the year they began teaching. For example, in the 2003-2004 survey, newly hired teachers are those who report they began teaching in 2003.

schools. Finally, I exclude teachers who are above age 50 from the sample, which eliminates 70 teacher-year observations, as older entrants are too close to retirement to accumulate much pension wealth. The final teacher-level dataset I use for the analysis contains 2,640 teacher-year observations.

The other measures of teacher quality come directly from SASS teacher education background information, including an indicator *(Advanced Degree*) for whether the teacher has a postgraduate degree, and an indicator (*Subject Major*) for whether the teacher has specific training in the subject she teaches.[45] Teachers with specific training in the subject they teach, all else equal, are expected to be better qualified compared to other teachers who teach that subject (Figlio 2002). Because school district administrators often claim to want math and science teachers who majored in their subject (Angrist and Guryan 2008), I code *Subject Major* as a dummy that equals one if the teacher meets one of the following criteria: 1) the teacher's main field assigned is math, and she completed either a B.A, M.A., Ph.D., Certificate of Advanced Graduate Studies, or Education Specialist degree with a major in either Mathematics, Engineering or Economics; 2) the teacher's main field assigned is Natural Science, and she completed either a B.A, M.A., Ph.D., Certificate of Advanced Graduate Studies, or Education Specialist degree with a major in either Biology, Chemistry, Earth Science, Physics, or another Natural Science.

Using restricted SASS data, I identify the state in which schools are located and match individual teachers to their state variables. NCES provides data on state testing requirements for initial certification of elementary and secondary teachers.[46]

[45] Master's degree, Education specialist, Certificate of Advanced Graduate Studies, or Doctorate or Professional degree.
[46] National Center for Education Statistics. "States requiring testing for initial certification of elementary and secondary teachers, by skills or knowledge assessment and state: 2010 and 2011" Table 179.
https://nces.ed.gov/programs/digest/d11/tables/dt11_179.asp

I use the following procedure to match individual teachers to their pension plan and benefit group. First, I assume that schools are covered under a municipal-specific pension if their U.S. Postal Service zip codes match the zip code of the big cities that operate their own pension plans. I then assume the state-run pension plans that enroll teachers automatically cover all remaining schools. Table 2.11 explains how individual pension plans decide a teacher's benefit group.[47] With the school residence and information of the year the teacher answered the survey, I then match individual teachers to their pension plan and benefit group.

To control for outside options when teachers decide whether to stay, I calculate *Alternative Teacher Pay* as the ratio of each teacher's alternative salary the year following the SASS administration to her starting salary. I predict each teacher's alternative salary, based on an earning function that depends on the teacher's age, education, state, and gender using individuals' data from the March Current Population Survey (CPS). I normalize all salaries in this paper to 2011 dollars using the CPI for all items less food and energy, reported by the Bureau of Labor Statistics. I also include state unemployment rates from the Bureau of Labor Statistics as a measure of the outside labor market options.

Table 2.12 and Table 2.13 report weighted descriptive statistics for subgroups of teachers in the treatment group (states and cities that reduced benefits) and the control group (states and cities that did not reduce benefits). The top panel of Table 2.12 shows the summary statistics of the quality measures. Between the pre-treatment (2003 and 2007) and post-treatment (2011) periods, the average 25th percentile SAT score in the treatment group decreased from 975 to 962 (on a scale of 1,600), while the average 25th percentile SAT score in the control group increased from 940 to

[47] A teacher's pension benefit eligibility and pension formula vary depends on the benefit group she belongs to. Most states determine a teacher's benefit group solely from the date she was hired. A few states, however, determine a teacher's tiers from the date she was hired and her vested status as of a certain date.

961. The means of *Advanced Degree* and *Subject Major* show that both groups experienced a higher share of teachers who majored in the subject they taught and a higher share of teachers who entered teaching with an advanced degree over this period, especially in the control group.

The next panel characterizes state and city level pension variables. The mean of *Vesting Rules shows that* it takes on average two years longer for treatment group teachers hired post-treatment to vest, compared to those hired pre-treatment. On the other hand, post-treatment control group teachers became vested 0.66 year earlier than pre-treatment control group teachers. The mean of *pension funding ratio* shows that pension fund problems worsened over this period, especially in the treatment group (a drop from 86 percent funded to 72 percent).[48]

Higher *Teacher Contribution Rate* may discourage high quality individuals from entering the profession, because it decreases teachers' take home pay. Compared to pre-treatment periods, treatment group teachers contributed 0.98 percentage point more of teacher salary to fund pension post-treatment, and control group teachers contributed 0.26 percentage point more of teacher salary.

Higher *Employer Contribution Rates* could also affect the quality of teachers attracted into the profession if higher employer contributions reallocate school resources away from current school expenditures that attract teachers. On the other hand, new teacher quality may increase if school districts demand fewer new teachers because of the higher pension cost. Compared to pre-treatment periods, school districts in both groups contributed a higher potion of teacher salary to fund pension plans – from 7.84 percent to 11.87 percent in the treatment group and from 10.98 percent to 14.62 percent in the control group.

[48] Doherty et al. (2012) suggest that pension plans overestimate their funded level due to unrealistic actuarial assumptions and projections about investment returns.

As discussed in Section 3, pension plans reformed in numerous ways – including decreasing multipliers, lengthening the years used to compute final average salary, raising retirement eligibility age or service, capping the annual benefit, increasing vesting rules, increasing teacher contribution rates, and lowering cost of living adjustments. These pension reforms changed teacher's pension wealth differently across states, cities, as well as individuals (depending on teachers' entry age).[49] To more precisely measure the change in pension incentives facing newly hired teachers, I calculate each teacher's peak net pension wealth using individual teacher's year of entry into teaching, age, gender, and starting salary using equations (3) - (5). See appendix A for calculation details.

The mean of *Net pension wealth* shows that among teachers hired pre-treatment, treatment group teachers receive on average 47 thousand dollars more net pension wealth compared to those in the control group. However, among teachers hired post-treatment, treatment group teachers receive on average 58 thousand dollars less net pension wealth compared to control group teachers.

The bottom panel of Table 2.12 reports means of matched outside options variables. Compared to pre-treatment periods, the treatment and control groups both experienced higher unemployment rates. Over this period, the alternative teacher pay in the treatment group increased from 136 percent to 140 percent, compared to a decrease from 140 percent to 137 percent in the control group.

[49] For example, Mr. Ara started teaching at the age of 35 and Mr. Brown started teaching at the age of 30. Both of them teach in Louisiana, which changed its retirement eligibility from (60/5; 55/25; A/30) to 60/5. Before the policy change, both Mr. Ara and Mr. Brown will work 25 years until they are eligible to start collecting benefits. However, after the policy change, Mr. Ara would still work 25 years while Mr. Brown would have to work 30 years to start collecting benefits.

The top panel of Table 2.13 compares state requirements for becoming a teacher. [50] State required testing for teacher certification creates entry barriers to teaching professional that may increase or decrease teacher quality. While testing requirements set a higher knowledge bar for individuals to enter teaching, the entry barriers also increase labor cost which could discourage individuals with higher outside options to become teachers (Angrist and Guryan 2008). Between the pre-treatment and post-treatment periods, the share of treatment group teachers teaching in states that required a basic skill test increased from 34 percent to 37 percent, while the share of control group teachers decreased from 78 percent to 70 percent. On the other hand, the share of treatment group teachers teaching in states that required a knowledge of teaching test or a teaching performance test decreased over this period, while the share of control group teachers remained the same. Both groups experienced a smaller share of teachers teaching in states that required a subject matter test.

The next panel reports whether the school district uses incentives to recruit teachers in the survey year. Between the pre-treatment and post-treatment periods, school districts in both groups used fewer financial incentives to recruit new teachers, especially in the control group.

The bottom panel of Table 2.13 reports individual teacher characteristics. Compared to the pre-treatment period, the average age of newly hired treatment group teachers decreased from 29 to 27, where control group teachers' average age remained at around 28. Compared to treatment group teachers, the share of female control group teachers increased between the pre- and post-treatment periods.

[50] Subject matter test measures teacher's knowledge of the subject to be taught. Basic Skills test measures basic literacy and mathematics. Knowledge of teaching includes knowledge such as delivery techniques and classroom management. Teaching Performance test is a performance based assessment that measures the planning, analytical and instructional skills.

2.5 Methodology and Estimates

2.5.1 Pension Reforms and Teacher Quality

In this section, I examine whether new teacher quality changed differently between the pre-benefit cuts and post-benefit cuts periods among states and cities that enacted pension reforms relative to those that did not. Table 2.14 summarizes the parameter changes between 2007 and 2011 that reduce the newly hires' pension benefits in 23 pension plans discussed in Section 3. These pension reforms generate a decrease in incentives to become public school teachers among potential teachers. Teachers who taught in states and cities listed in Table 2.14 belong to the treatment group in the following analysis. Using teacher-level data from SASS, I compare measures of new teacher quality in the pre-treatment periods (2003 and 2007) and the post-treatment period (2011). I separately control for the pension parameters that do not directly affect the calculation of pension benefits.

I begin by estimating the following difference-in-differences model:

$$(6)\quad Quality\ Measure_{ikst} = \gamma_0 + \gamma_1(Benefit\ Cuts_s * Post_t) + \gamma_2(Benefit\ Cuts_s) + S_{st}\beta_1 + R_{kst}\beta_2 + D_s + d_t + \varepsilon_{ikst},$$

where $Quality\ Measure_{ijkst}$ is one of the measures of quality described above, i indexes the teacher, *k, and s* indexes the school district and state in which the teacher worked respectively, and *t* indexes the year teacher started teaching (2003, 2007, or 2011). $Benefit\ Cut_s$ is an indicator that equals one if teacher *i* taught in a state or city that enacted benefit-reducing reforms from 2007 to 2011 (listed in Table 2.14). $Post_t$ is an indicator for year 2011. The coefficient on $Benefit\ Cut * Post$ captures the effect of benefit-reducing reforms on teacher quality.

The vector S_{st} includes the state's alternative teacher pay, unemployment rate, and separate indicators for whether the state had required testing (basic skills exam, knowledge of teaching

exam, teaching performance exam, and subject matter exam) for certification of elementary and secondary teachers.

The vector R_{kst} includes teacher contribution rate, employer contribution rate, pension funding ratio, and separate indicators for whether the school district uses some incentives (signing bonus, forgiveness of student loans funded by the district, relocation assistance, finder's fee to existing staff for new teacher referrals, free training for fields with teacher shortages, and pay incentives to teachers who teach in fields with shortages) to recruit teachers. All specifications include a full set of state dummies and year dummies (D_s and d_t, respectively).

To account for the stratified sampling frame used by SASS, I weigh each teacher by the teacher's final sample weight which is included in teacher-level SASS data. This weight contains the inverse of the teacher's probability of selection during the survey year, as well as adjustments for nonresponse rate and other sampling considerations that arise after the sample has been drawn.

Table 2.15 reports estimates of γ_1 from specification (6) separately for the effects of pension reforms on the 25th percentile SAT score at a newly hired teacher's undergraduate institution and two alternative measures of teacher quality – whether the teacher has an advanced degree and whether the teacher majored in the subject she taught. In the first column, the estimate of γ_1 suggests that under pension reforms, schools are hiring new teachers from undergraduate institutions with 25.63 points lower (more than one fifth a standard deviation) 25th percentile SAT scores, with a standard error of 14.77. This finding, consistent with the hypothesis, suggests that a reduction in pension benefits reduces the quality of teachers attracted to the public schools. In other regressions, the estimates of γ_1 suggest that pension reforms lower the probability of schools hiring a new teacher with an advanced degree by 4.90 percentage points with a standard error of 0.05 (column 2) and lower the probability of schools hiring a new teacher who majored in her

subject by 6.35 percentage points with a standard error of 0.04 (column 3). Although I cannot reject the null hypothesis that the estimated coefficients in column 2 and column 3 are equal to zero, the negative relationships between pension reforms and these two quality measures are intuitive.

To identify the estimates, I assume that trends in new teacher quality in states with no benefit-reducing legislation provide an accurate counterfactual for the trend in states with pension wealth cuts. To support the identification assumption, I compare the difference in new teacher quality among the treatment and control groups in the pre-treatment periods. Table 2.16 shows the difference-in-difference coefficients from equation (6) using 2007 and 2011 as post-treatment periods and 2003 as pre-treatment period. I cannot reject the null hypothesis that γ_1 and γ_2 are equal to zero. I find no evidence that new teacher quality in the treatment group was different from the control group before the pension reforms.

Table 2.15 also suggests that outside options matter to new teacher quality. The estimates of *Alternative Salary Rate* in the first two columns suggest that a higher alternative teacher pay attracts a pool of lower quality new teachers, although I find no statistically significant evidence in the third column. In addition, the estimate of *Unemployment Rate* in the second column suggests that fewer job opportunities outside of teaching attracts a larger pool of teachers with advanced degrees, although I find no statistically significant evidence in the other two columns. These findings, consistent with existing literature, suggest that lower alternative teacher pay and higher unemployment rates attract higher quality teachers into the profession (Munnell and Fraenkel 2013; Nagler et al. 2015).

The estimates of β_2 in the second column suggests that a one percentage point increase in contribution rate lowers the probability of schools hiring new teachers with an advanced degree

by 2.42 percentage points (standard error of 0.01). This finding, consistent with the hypothesis, suggests that a higher contribution rate is less attractive to teachers. I find no statistically significant relationship between teacher quality measure and other pension parameters in the first and third columns.

District recruitment policies appear to attract teachers from better undergraduate institutions. Column 1 suggests that schools in districts that offer a loan forgiveness attract teachers from undergraduate institutions with 36.99 points higher (more than one fourth a standard deviation) 25^{th} percentile SAT scores, with a standard error of 19.44, although I find no statistically significant evidence of this policy on new teacher quality when measure in two other ways. Column 2 suggests that schools in districts that offer a signing bonus are 7.72 percentage points more likely to hired teachers who entered teaching with an advanced degree (standard error of 0.04). Although, I find no statistically significant evidence of the relationship between signing bonus policy and new teacher quality when in the first the third columns, the positive signs are intuitive. Interestingly, the second and third columns shows that schools in districts that offer a finder's fee are less likely to attract more qualified teachers. Perhaps there is no extra financial incentive to attract more qualified teachers into the districts, because the finder's fee is paid to the existing staff who referred the new teachers. Moreover, schools might be willing to hire a less qualified teacher referred by an existing staff.

Table 2.15 also reports estimates of state required testing for teaching certification. I find no evidence that state required testing affect new teacher quality when measured by a teacher's college SAT scores. The estimates in the second column suggest that a subject matter test increases the probability of a newly hired teacher entering the profession with an advanced degree by 13.4 percentage points, with a standard error of 0.05; the knowledge of teaching test decreases the

probability that a newly hired teacher has an advanced degree by 12.7 percentage points, with a standard error of 0.05). The estimates in the third column suggest that a basic skills test decreases the probability that a newly hired teacher majored in the subject she taught by 7.49 percentage points, with a standard error of 0.03. Perhaps the basic skills test and the knowledge of teaching test discourage individuals with higher outside options to become teachers, while the subject major test set a higher knowledge bar for individuals to enter teaching.

Overall, estimates in Table 2.15 suggest that teachers value their pension benefits even when they are far from their retirement eligibility. Less generous pension plans discouraged high quality individuals from entering the profession and result to a pool of lower quality new teachers.

2.5.2 Pension Wealth and Teacher Quality

Recall that pension reforms changed teacher's pension wealth differently across states, cities, as well as individuals. These heterogeneous effects of the pension reforms on teachers' pension wealth allow me to examine the relationship between the natural logarithm of an individual teacher's net pension wealth and teacher quality using the following model:

(7) $Quality\ Measure_{ikst} = \gamma_0 + \gamma_1\ Log(Net\ Pension\ Wealth)_{ikst} + S_{st}\beta_1 + R_{kst}\beta_2 + D_s + d_t + \varepsilon_{ikst}$,

where $Net\ Pension\ Wealth$ is the estimate of individual teacher's pension wealth. Similar to equation (6), all specifications include a full set of state dummies and year dummies (D_s and d_t, respectively), and control for time-varying state-level variables S_{st} as well as school district characteristics R_{kst}.

The coefficient of interest in equation (7) is γ_1, which is the estimate of a one percent increase in net pension wealth on new teacher quality. Table 17 reports estimates of γ_1 from specification

(7) separately for the effects of pension reforms on measures of teacher quality. The first column suggests that a one percent increase in net pension wealth results in schools hiring new teachers from undergraduate institutions with 32.15 points higher (more than one fourth a standard deviation) 25th percentile SAT scores, with a standard error of 14.47. This finding, consistent with the hypothesis, suggests that school with more generous pension systems attract a pool of higher quality new teachers.

In column 2 and 3, the estimates of γ_1 suggest that a one percent increase in net pension wealth increases the probability of schools hiring a new teacher with an advanced degree by 2.52 percentage points with a standard error of 0.05 and increases the probability of schools hiring a new teacher who majored in her subject by 2.94 percentage points with a standard error of 0. Although I cannot reject the null hypothesis that the estimated coefficients in column 2 and column 3 are equal to zero, the positive relationships between pension reforms and these two quality measures are intuitive.

2.6 Conclusion

Much of the existing pension literature focuses on how senior teachers respond to pension incentives. Along with Munnell and Fraenkel (2013) and Papke and Litwok (2013), I am among the first to study how younger teachers respond to pension incentives. To highlight the effect of pension incentives on teacher recruitment, this paper studies whether, and to what degree, pension incentives affect new teacher quality.

Based on my findings, pension incentives affect the composition of new entrants into teaching. Controlling for outside options and other factors that could affect teacher quality, I find that states and cities that cut pension benefits hire new teachers from undergraduate institutions with 25.63

points lower 25th percentile SAT scores. I also find that a one percent increase in the present value of net pension wealth results in schools hiring new teachers from undergraduate institutions with 32.15 points higher 25th percentile SAT scores. Note that my results are based on one year of post-treatment data (2011), so my findings only capture immediate changes in new teacher composition after states enacted their pension reforms. Thus, the effect of recent pension reforms on new teacher quality may be larger if recent pension reforms also affect students' decisions to enter (or transfer out) from education programs. Overall, my findings suggest that using benefit cuts to reduce pension debt might impair school districts attempts to attract qualified teachers.

Recall that pension reforms occurred during the Great Recession where there were fewer teachers' outside options and lower alternative teacher pay. Because stable teaching jobs might be particularly attractive during the Great Recession, I control for time-varying outside options when examining the effect of pension generosity on new teacher quality. Consistent with existing literature, I find that lower alternative teacher pay and higher unemployment rates attract higher quality teachers into the profession.

In addition, my results suggest that district recruitment policies affect new teacher quality. I find that school districts that offer a signing bonus policy or a loan forgiveness attract more qualified teachers into the profession, while school districts that offer a finder's fee has a pool of lower quality teacher. Perhaps school districts are willing to hire a less qualified teacher when she is refereed by an existing employee.

According to the National Council on Teacher Quality, 22 states made changes to their teacher pension systems in 2012 alone and more states are joining the teacher pension reform (Doherty et al. 2012). Policy makers should consider the unintended cost of benefit cuts on teacher recruitments associated with potential pension reforms.

CHAPTER 3

WHO CHOOSES TO STAY? THE EFFECT OF TEACHER PENSION INCENTIVES ON NEW TEACHER TURNOVER

3.1 Introduction

Though defined-contribution (DC) pension plans predominate among private-sector professions, the majority of states still offer their public-sector employees defined-benefit (DB) pension plans.[51] While DC plans accrue benefits overtime, DB plans backload pension benefits – the formula used to calculate guaranteed annual benefits relies on within-system years of service (YOS) and final average salary (FAS).[52] Therefore, teachers accrue pension wealth more rapidly towards the end of their careers. Because DB pensions are rarely portable, it is costly for teachers to leave their pension systems – those who leave will not preserve their years of service for pension purposes.[53] Moreover, FAS is frozen at the time the worker exits the pension system. Because earnings tend to be highest in the final years of employment, teacher who exit the system earlier will earn pensions based on lower FAS value. This backloading structure creates an incentive for teachers to stay. Theoretically, a higher degree of backloading increases the opportunity cost of leaving the pension system and could decrease teacher turnover.

Improving retention is particularly important for schools. High turnover can significantly impair students' performance (Ronfeldt et al. 2013; Boyd et al. 2005; Guin 2004; Hanushek et al. 1999). In recent decades, however, researchers have estimated mixed effects of backloaded

[51] Among all workers that have access to pensions in 2017, about 20 percent were participating in a defined benefit plan. Source: Bureau of Labor Statistics.
Beyond the Numbers: https://www.bls.gov/opub/btn/volume-5/pdf/defined-contribution-retirement-plans-who-has-them-and-what-do-they-cost.pdf
National Compensation Survey: https://www.bls.gov/ncs/ebs/benefits/2017/ownership/civilian/table02a.pdf
[52] DC plans tie retirement benefits to total contributions and are subject to market fluctuation.
[53] If a teacher leaves her pension system, her DB benefit calculation starts from zero again in the new system, also she may still be eligible for benefits from the old system if she had reached vesting.

pension incentives on teacher turnover. Goldhaber, Grout, and Holden (2017) find a positive effect, while some find no significant effect (Gustman and Steinmeier 1993; Koedel and Xiang 2017), and some find a negative effect (Papke and Litwok 2013; Friedberg and Owyang 2005).

Vesting rules – the time it takes teachers to qualify for guaranteed pensions upon retirement – may also provide a financial incentive for new teachers to stay. Figure 3.1 shows an example of net pension wealth accrual over the early career cycle for a representative Arkansas teacher who started teaching at age 25. In the figure, each point represents the simulated present value of maximum net pension wealth if the Arkansas teacher separates from her pension system immediately at 25. The y-axis presents net pension wealth in 2011 dollars. The teacher accrues nothing towards her pension wealth until vested. Once she reaches 5 years of service, her pension wealth jumps to 133 percent of her starting salary. The jump creates a financial incentive for teachers to stay until vested. The financial incentive strengthens as teachers approach vesting. Thus, a longer vesting period reduces financial incentives for teachers to stay. Papke and Litwok (2013) find that remaining years to vesting positively correlates with turnover rate.

The 2008 financial crisis lowered investment returns and sharply reduced funded levels among state pension plans.[54] Between 2007 and 2011, many states enacted pension reforms to reduce pension debt. Some states either reduced benefits, increased teacher contributions, or both. In addition, some states increased the years required to vest. Because most states have laws that prevent benefit cuts for current employees, significant changes to pension plans usually apply to new teachers only. In Section 3, I illustrate the effect of recent benefit-reducing legislation on teachers' net pension wealth accrual over the career cycle. I find that recent benefit-reducing legislation decreases the degree of backloading.

[54] Wilshire Consulting (2017) reports that the median funded level for state retirement systems was 87 percent in 2007 and fell to 67 percent by 2016. https://wilshire.com/Portals/0/consulting/funding/Wilshire_2017_State_Funding_Report.pdf

Using pooled cross-sectional teacher-level data from the Schools and Staffing Survey (SASS) and the Teacher Follow-up Survey (TFS), I estimate the differential change in new teacher turnover after 2007-2011 benefit-reducing legislation between states and cities that enacted pension reforms and those that did not. My analysis focuses on 1,380 first-year teachers who participated in a mandatory, traditional defined benefit plan between 2003 and 2011. Controlling for teacher and school characteristics, I find no significant effect of benefit-reducing legislation on teacher turnover among newly hired teachers.

I also examine how new teacher turnover changed between the pre- and post- reform periods among states and cities that increased their vesting rules relative to those that did not. Economic theory indicates a forward-looking, unvested teacher would consider the present value of pension wealth associated with becoming vested and weigh the opportunity cost of quitting. However, if teachers only consider short-term pension wealth accruals, changing vesting rules will have little influence on teacher exit decisions. I find no evidence that more stringent vesting requirements affect the probability of a new teacher exiting after one year of employment.

In the next section, I review the related literature. Section 3.3 describes pension data and institutional details. Section 3.4 provides a description of the teacher data from the Schools and Staffing Survey and the Teacher Follow-up Survey. Section 3.5 presents the empirical specifications and results, and Section 3.6 concludes.

3.2 Related Literature

3.2.1 Teacher Pensions and Teacher Turnover

Teacher turnover includes moving to another school and exiting the teaching profession. Much of the teacher pension literature focuses on senior teacher exit behavior. Costrell and McGee (2010)

find that both peak value (the difference between current pension wealth and the maximum possible pension wealth) and one year accrual (the difference between current pension wealth and pension wealth after one additional year of work) were negatively related to Arkansas teachers' retirement rate.

Some papers ask how DB pension parameters affect teacher turnover by comparing differences across pension plans. Costrell and Podgursky (2009) analyze the time pattern of pension incentives by simulating pension wealth accrual over a teacher's career in six states. They find that a teacher's net pension value accumulates slowly in the early years of her career, then accelerate in her mid- to late- fifties, and drops off sharply over the next few years. This backloading of pension wealth accumulation creates a strong "pull" incentive for teachers to stay until they reach the time when pension value spikes. Once they pass the pension value spike, teachers face a strong "push" incentive to leave. Friedberg and Turner (2011) use a peak value model to estimate the effect of variation in pension parameters on teacher retirement across 17 pension plans. Using teacher-level data from the School and Staffing Survey (SASS), they find that teachers tend to delay retiring while pension wealth accumulates, then retire abruptly after reaching peak pension wealth.

Two other papers explore policy changes affecting pension wealth and employ difference-in-difference models to estimate the effect of pension incentives on the timing of teacher exit decisions. Furgeson, Strauss, and Vogt (2006) find a large increase in teacher retirement when Pennsylvania enacted a pension policy which temporarily increased early retirement benefits between 1997-1998 and 1998-1999. Koedel and Xiang (2017) investigate a policy change in St. Louis that increased teacher retirement benefits for those who retired after the 1998-1999 school year. Using administrative panel data from the Missouri Department of Elementary and Secondary

Education, they examine retention effects throughout the workforce using younger teachers as their control group. The authors find a temporary delay in retirement among teachers who were eligible for retirement in the previous school year. However, they find no significant retention effect among teachers who were not eligible for retirement. They offer a possible explanation that teachers may lack of full knowledge of their pensions.

Other papers compare DB plans and alternative plans with no (or less) backloading. For example, Gustman and Steinmeier (1993) use the Survey of Income and Program Participation (SIPP) to compare worker turnover (not restricted to teachers) between DB plans and DC plans. DC plans are not backloaded: they do not guarantee retirees minimum or maximum pension benefits and allow vested workers to take their full retirement saving with them when moving from one job to another. Gustman and Steinmeier (1993) find that pension coverage was associated with lower one-year turnover rate regardless of pension types (DB or DC). Friedberg and Owyang (2005) study the link between DB coverage and job tenure. Using data from 1983-2001 Survey of Consumer Finance (SCF) and 1993 Current Population Survey (CPS) and controlling for job characteristics, they find that workers (not restricted to teachers) with DB pensions work in the same job longer than workers with no pensions or with DC pensions.[55] They also find that workers with more generous DB pensions stay longer, controlling for levels of earning. Goldhaber et al. (2017) investigate whether moving away from a backloaded defined benefit plan increases levels of employee turnover. Using data from Washington Teacher Retirement system, the authors compare the turnover rate of teachers who enrolled in either a traditional defined benefit (DB) plan or a hybrid plan (combines DB and DC) during the same period of time. They find that turnover was lower among teachers who transferred out of the DB plan into the hybrid plan.

[55] Job characteristics include industry, occupation and firm size controls.

Papke and Litwok (2013) are the first to study the effect of pension incentives on younger teachers' exit behavior. The authors ask whether cross-state pension differences in four states affected young teachers' first exit from teaching. They find that the presence of defined contribution alternatives is positively and significantly related to the hazard rate of first exit. They also find that more stringent vesting requirements are positively and significantly related to the hazard rate of first exit.

3.2.2 Teacher Outside Options and Teacher Turnover

A large literature studies how teacher pay and outside options influence the decision to leave. For example, Rees (1991) finds a negative relationship between teacher salary and teacher turnover. He also uses education level as a measure of outside options and finds that teachers with higher educational degrees are more likely to leave.[56] Gritz and Theobald (1996) find that higher salary increases the probability of a teacher staying in the teaching profession. However, these salary effects diminish with teaching experience. Stockard and Lehman (2004) find that higher salary increases the probability of a teacher staying in the same school next year.

My research advances the existing literature in several ways. Along with Koedel and Xiang (2017), I am among the first to study how benefit-reducing teacher pension reforms affect retention. My paper focuses on several states and therefore provides more general results than previous research identifying the effect of a single state policy change. Moreover, because pension reforms occurred during a time of the Great Recession where other factors such as teachers' outside options changed over time, I also account for time-varying outside options covariates that previous researchers show to affect teacher turnover.

[56] Theobald (1990), Brewer (1996), and Hanushek et al. (1999) have similar findings.

3.3 Institutional Details and Pension Data

In the U.S., all full-time public school teachers automatically participate in public pension plans. While each state runs a pension system that covers teachers (state-run pension plans), some large cities like New York and Chicago operate their own municipality-specific pension plans.[57] Table 3.1 shows the types of pension plans that states and cities offer teachers during the years I consider. In this paper, I restrict my analysis to the 36 state-run pension plans and 11 municipality-specific pension plans that automatically enroll teachers into a mandatory, traditional defined benefit plan throughout the years 2003 to 2011.[58]

In defined benefit plans, teachers contribute a portion of salary towards the plan while employed. Teachers who retire after becoming vested collect annual payments until their death.[59] The lifetime pension wealth of a teacher depends on the size of initial annual payments, adjustments made for cost of living, and the length of time in retirement.

All defined benefit plans use a similar formula to calculate annual payments:

(5) *First-year Annual payments (A) = FAS * Multiplier * Years of Service*

where *FAS* is the teacher's final average salary, calculated as the average salary in the years of employment where the retiree's salary was highest. The multiplier in the formula determines the percentage of a teacher's final average salary that she receives for each year of service. The years of service (YOS) in the last part of the formula is the length of teacher's employment. In general,

[57] While some teachers participate in plans that serve teachers only, 23 state-run retirement systems cover other state and local governments' employees along with teachers (Doherty et al., 2012, figure 4).
[58] I exclude states that offered teachers other types of pension plans, because their retirees' pension benefits are subject to market fluctuation and are therefore difficult to predict. Alaska, Florida, Indiana, Michigan, Ohio, Oregon, South Carolina, Utah, Washington, and West Virginia did not automatically enroll their teachers into defined-benefit plans during 2003-2011. They either automatically enrolled teachers into defined contribution plans or hybrid plans, or allowed teachers to choose between plans. I therefore exclude these states from the sample. District of Columbia, Hawaii, Maryland and Rhode Island have low response rate in 2011 SASS survey and are therefore excluded from the analysis. Vermont enacted a pension reform that increased annual payments but delayed retirement for all teachers aged under 57 and hired on or after June 30, 2010. It is unclear whether this reform cut pension wealth or not so I exclude Vermont from the sample.
[59] On average, it takes 5.7 years for teachers in the U.S. to become vested in 2008 (Doherty et al. 2012).

more years of service lead to higher annual payments. But some states cap the first-year annual payment to not exceed a specific percentage of the teacher's final average salary. The formula for teachers' capped first-year annual payments is:

(6) $Capped\ Annual\ payments\ (\mathcal{A})$

$$= \begin{cases} A & with\ no\ limits. \\ Min\ (A, x\ \% * FAS) & if\ states\ limit\ annual\ payments\ to\ x\%\ of\ FAS. \end{cases}$$

In order to counteract the impact of inflation on retirement income, public pension plans provide retirees with post-retirement cost of living adjustments (COLAs). Plans with higher cost of living adjustments are more beneficial to teachers.

The pension parameters discussed above relate to the size of annual benefits. Other pension parameters such as retirement age and teacher contribution amount may also affect pension wealth, without directly changing annual benefits.[60] Because teachers collect annual benefits from retirement until death, an earlier retirement age causes teachers to receive more annual payments and enjoy higher lifetime pension wealth. Recall that most states require teachers to contribute a portion of salary to fund their pension plans. Because a teacher's annual benefit is not tied to teacher contributions (see equation (1)), increasing contribution rate decreases net pension wealth.

To more precisely evaluate pension plan generosity, I calculate net pension wealth as the actuarial present value of the payment stream that teachers expect to receive upon retirement, net of employee contributions.[61] Suppose a teacher started teaching in year *t=1*, retires in year *t=T*, and collect pension benefits for d years, from *t=T+1 to* $t=T+d$. Then, her expected present discounted

[60] Raising retirement eligibility age or service could indirectly increase annual benefit through more years of service and higher final average salary if teachers decide to work longer.
[61] Actuarial present value is the sum of discounted capped annual payments each discounted by the probability of surviving that year.

net pension wealth (PDNW) is calculated using the following formula:

$$(3)\ PDNW_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)} \pi_t}{(1+r)^{t-1}} - \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$$

where $\mathcal{A}_t$ is the capped annual payment in year $t > T$, f_t is the cost of living adjustment in year t, π_t is the probability of surviving at year t, r is the discount rate, and C_t is the teacher contribution in year $t \leq T$.

Table 3.2 presents the list of references that I used to determine each plan's pension parameters. I gathered data primarily from individual plans' homepages, member handbooks, financial reports, and summaries of legislation. I obtained additional pension plan-level data on pension funding ratio and employer contribution rate from the Public Plans Database (PPD).[62]

Table 3.3 summarizes changes in pension parameters in each of 36 state-run pension plans and 11 municipality-specific pension plans between 2007 and 2011.[63] While legal constraints prevent most states from cutting benefits for current employees, all states can change the benefit rules affecting employees not yet hired. Therefore, all the pension parameters changes discussed below affect teachers hired in the 2011-2012 school year.[64]

Between 2007 and 2011, 23 pension plans enacted legislation that reduced benefits. Figure 3.2 illustrates net pension wealth accrual over the career cycle for a representative teacher, who started teaching at age 25, in each state under new rules (post-reform) and old rules (pre-reform).[65][66]

[62] Pension funding ratio is the ratio of actuarial assets to actuarial liability. A funding ratio greater than one means the pension system has enough money to cover all obligated payments.
[63] See Chou (2018) for a detailed description of the pension parameter changes between 2007 and 2011.
[64] Data on teachers come from two pre-reform periods: 2003-2004 and 2007-2008, and a post-reform period 2011-2012.
[65] See calculation details in appendix A.
[66] Note that most state review and adjust contribution rates annually and COLAs are not viewed by courts as core benefits protected under state laws (Munnell et al. 2016). Thus, COLAs and contribution rates can fluctuate over time. For simplicity, I calculate teacher's pension wealth using the employee contribution rate and COLAs released in the year she was hired.

Under the old rules and new rules, all but one states' net pension wealth profiles are single peaked. The exception is Illinois, which has a cap that binds the peak pension wealth for teachers hired in 2016. The peak matches the closest normal retirement option for each state's representative teacher.[67] Compared to teachers hired pre-reforms, those hired post-reforms have flatter pension wealth accruals and lower pension wealth at peak. Lower expected pension wealth may increase teacher turnover because it lowers the opportunity cost of separating from the pension system.

The right column of Table 3.3 shows that seven pension plans increased the time to vesting between 2007 and 2011. The exception is Kansas, which moved from a 10-year vesting rule to a 5-years vesting rule. Figure 3.3 illustrates how changing vesting rules affect a representative teacher's net pension wealth accrual over the early career cycle. The delayed jump in net pension wealth lowers pension wealth accruals and decreases the incentive to stay. However, if teachers only consider short-term pension wealth accruals, changing vesting rules will have little influence on teacher exit decisions. For example, Illinois moved from a 5-year vesting rule to a 10-year vesting rule. In both periods, the first four years' pension wealth accruals remain zero. If Illinois teachers only consider 4-year or less pension wealth accruals, increasing vesting rule will not affect the incentive to stay.

3.4 Teacher Data

Data on teachers come from the Schools and Staffing Survey (SASS), the largest and most extensive survey of elementary and secondary teachers in the U.S. The Census Bureau conducted

[67] For example, a hypothetical Alabama teacher who started teaching pre-reform can retire with full retirement benefits at age 60 with at least 10 years of service or at any age with at least 25 years of service. The closest normal retirement option for her is to retire at age 50.

the survey seven times between 1987-1988 and 2011-2012.[68] SASS covers a wide range of topics including teacher characteristics, teacher compensation, and general conditions in schools. To determine whether teachers still taught at the same school, had moved to a different school, or had left the teaching profession since the SASS administration, NCES conducted the Teacher Follow-up Survey (TFS) for a sample of teachers who had completed SASS during the previous school year. [69] The most recent available TFS data are from the 2012-2013 wave, and the earliest available SASS data that contain consistent questions are from the 2003-2004 wave.[70] For these reasons, I use the 2003-2004, 2007-2008 and 2011-2012 waves of the SASS, and the 2004-2005, 2008-2009 and 2012-2013 waves of the TFS. To remain consistent with the pension parameters teachers faced when they started teaching, I index school years by the calendar year when a school year starts. For example, I refer to the 2011-2012 school year as 2011.

The SASS and TFS data have a number of strengths for this study. First, they contain teacher's year of entry into teaching. This lets me target a sample of new entrants affected by recent pension reductions. Second, TFS includes information on each teacher's status the following year. This gives me a measure of one-year mobility to study teacher turnover. Third, the restricted-use state and zip-code identifiers allow me to match individual teachers to their pension parameters and other state variables. Fourth, the information on each teacher's current salary allows me to compare her alternative opportunity within-state relative to teaching salary, and to impute an earnings history. With this information, I can simulate individuals' pension wealth. Lastly, the variation of interest in this paper is at the state by year level. With the proper weighting, each wave of SASS is designed to be representative at the state level. One of the weaknesses of using SASS is that I

[68] The Census Bureau requested schools or school districts to provide a complete list of teachers employed at each school. SASS then surveyed a sample of teachers who were on the list.
[69] National Center of Education Statistics (NCES) sponsored the U.S. Census Bureau to conduct SASS and TFS.
[70] NCES redesigned SASS and renamed it the National Teacher and Principle Survey (NTPS). NCES released the restricted data of 2015-2016 NTPS in November 2017, but the corresponding TFS is not available yet.

only observe one year of follow up for each teacher. Therefore, if a teacher left then returned, I still considered this as an exit.

I restrict my sample to newly hired teachers who work full time.[71] I define newly hired teachers as those who have no teaching experience before the survey year.[72] Because pension mandates do not always apply to charter schools, I exclude teachers employed at charter schools, eliminating 130 teacher-year observations. To separate exit decisions from involuntarily exit behavior, I exclude teachers whose contracts were not renewed or were laid off, eliminating 130 teacher-year observations.[73] The final teacher-level dataset I use for the analysis contains 1,380 teacher-year observations in 2003, 2007, and 2011 in the 36 states of interest, representing 257,070 teachers in the population.

I measure teacher turnover using an indicator for whether the teacher leaves her pension system after the first year of employment (*Leave*). I code *Leave* as a dummy that equals one if the teacher met any of the following criteria in the next school year: 1) the teacher left the teaching profession; 2) the teacher was teaching in a different state. I use one-year turnover measure because school districts may want to learn what affect new teachers' turnover, given that teacher turnover is highest in the first year. In addition, financial incentives may have larger retention effects on new teachers (Gritz and Theobald 1996).

I use the following procedure to match each individual teacher to her pension plan and benefit group. First, I assume that a municipality-specific pension covers the school if its U.S. Postal Service zip code matches the zip code of a big city that operates its own pension plan. I then assume state-run pension plans cover all remaining schools. Table 3.4 explains how each state and city

[71] Teachers who classify themselves as a part-time teacher, student teachers, teacher's aids or substitute teachers are not included in the analysis.
[72] The SASS teacher questionnaire asks teachers to report the year they began teaching. For example, in the 2003-2004 survey, newly hired teachers are those who report they began teaching in 2003.
[73] As required by NCES, I round all unweighted sample size numbers to the nearest ten.

decides a teacher's pension plan.[74] I then match each individual teacher to her pension plan based on where she teaches and when she started teaching.

To control for outside options when teachers decide whether to stay, I calculate *Alternative teacher pay* as the ratio of each teacher's alternative salary the year following the SASS administration to her starting salary. I predict each teacher's alternative salary, based on an earning function that depends on the teacher's age, education, state, and gender using individuals' data from the March Current Population Survey (CPS). I normalize all salaries in this paper to 2011 dollars using the CPI for all items less food and energy, reported by the Bureau of Labor Statistics. I also include state unemployment rates from the Bureau of Labor Statistics as a measure of the outside labor market options.

Table 3.5 reports weighted descriptive statistics for subgroups of teachers in the treatment group (states and cities that reduced benefits) and the control group (states and cities that did not reduce benefits). The top panel describes teacher mobility. Between the pre-treatment (2003 and 2007) and post-treatment (2011) periods, both groups experienced a higher share of teachers who left in the following year.

The next panel characterizes state and city level pension variables. The mean of *Net pension wealth* shows that among teachers hired pre-treatment, treatment group teachers have more generous pension plans — treatment group teachers receive on average 35 thousand dollars more net pension wealth compared to those in the control group. However, after the benefit cuts, treatment group teachers receive on average 64 thousand dollars less net pension wealth compared to control group teachers.

[74] A teacher's pension benefit eligibility and pension formula vary depending on the pension plan she belongs to. Most states determine a teacher's pension plan solely from the date she was hired. A few states, however, determine a teacher's tiers from the date she was hired and her vested status as of a certain date.

For teachers hired after the reforms, it takes on average 1.79 more years for treatment group teachers to vest, while it takes on average 0.60 fewer year for control group teachers. Compared to pre-treatment periods, treatment group teachers contributed 1.27 percentage points more of teacher salary to fund pension post-treatment, and control group teachers contributed 0.36 percentage point less of teacher salary. Higher *Teacher Contribution Rate* may increase teacher turnover because it decreases teachers' take home pay. *Employer Contribution Rates* could also indirectly affect teacher turnover if higher employer contributions reallocate school resources away from current school expenditures that attract teachers. Compared to pre-treatment periods, school districts in both groups contributed a higher potion of teacher salary to fund pension plans, especially in the treatment group (from 7.55 percent to 12.67 percent).

The middle panel reports means of matched outside options variables. Compared to pre-treatment periods, the treatment and control groups both experienced higher unemployment rates. The alternative teacher pay in the treatment group increased from 136 percent to 141 percent, compared to a decrease from 138 percent to 132 percent in the control group. Given that a higher alternative teacher pay may make teaching less attractive while fewer outside options make stable teaching jobs more attractive, I control for both of the time-varying variables to more precisely estimate the effect of recent pension reforms on teacher turnover.

3.5 Methodology and Estimates

3.5.1 Pension Reforms and Teacher Turnover

I compare the difference in one-year teacher turnover from the pre-treatment to post-treatment periods among states and cities that reduced benefits relative to the difference in states with no benefit-reducing legislation. I also estimate the effect of vesting rule changes on turnover and

separately control for the pension parameters that do not directly affect the calculation of pension benefits.

I estimate the following difference-in-differences model:

(4) $Leave_{ist}=\gamma_0 + \gamma_1(Benefit\ Cut_s) + \gamma_2(Benefit\ Cut_s * Post_t) + \gamma_3(Increasing\ Vesting\ Rule_s) + \gamma_4(Increasing\ Vesting\ Rule_s * Post_t) + S_{s,t+1}\beta_1 + K_{jst}\beta_2 + D_s + d_t + \varepsilon_{ijst}$,

where $Leave_{ijst}$ is a dummy that equals one if the teacher left the teaching profession or was teaching in a different state after the first year of employment, *i* indexes the teacher, *j* and *s* index the school districts and state where the teacher worked, and *t* indexes the year the teacher started teaching (2003, 2007, or 2011). $Benefit\ Cut_s$ is an indicator that equals one if teacher *i* taught in a state or city that enacted benefit-reducing reforms from 2007 to 2011. $Post_t$ is an indicator for year 2011. The coefficient on $Benefit\ Cut * Post$ captures the effect of benefit-reducing reforms on teacher turnover. $Increasing\ Vesting\ Rule_s$ is an indicator that equals one if teacher *i* taught in a state or city that increased vesting rules from 2007 to 2011. The coefficient on $Increasing\ Vesting\ Rule * Post$ captures the effect of more stringent vesting requirements on teacher turnover.

The vector $S_{s,t+1}$ includes the state's alternative teacher pay and unemployment rate. The vector K_{jst} includes teacher contribution rate, employer contribution rate, and pension funding ratio. All specifications include a full set of state dummies and state dummies (D_s and d_t, respectively).

To account for the stratified sampling frame used by SASS, I weigh each teacher by the teacher's final sample weight, included in the teacher-level TFS data. This weight contains the

inverse of the teacher's probability of selection during the TFS survey year, as well as adjustments for nonresponse rate and other sampling considerations that arise after the sample has been drawn.

Table 3.6 reports the difference-in-difference coefficients controlling for potential turnover determinants that changed simultaneously with the benefit-reducing reforms. The estimate of γ_1 suggests that among teachers hired pre-treatment, treatment group teachers are 34.6 percentage points less likely to leave her pension system after one year of employment, with a standard error of 0.14. Recall from Table 3.5 that states that later enacted pension reforms between 2007 and 2011 originally offered teachers more generous pension benefits compared to states that did not cut pension benefits. Thus, this finding suggests that higher expected compensation levels are negatively correlated with teacher turnover.

The estimate of γ_2 suggests that under pension reforms, new teachers are 2.6 percentage points less likely to leave in the following year, with a standard error of 0.10. The point estimate is statistically insignificant. Thus, I have no sufficient evidence that pension benefits cuts affect the probability of a new teacher exiting. This finding is inconsistent with the hypothesis that lower expected compensation levels decrease the cost of moving jobs and could increase teacher turnover.

On the other hand, the estimate of γ_3 suggests that among teachers hired pre-treatment, those hired in states that later increased vesting requirements are 42.8 percentage points more likely to leave her pension system after one year of employment, with a standard error of 0.18. Because states that later increased vesting requirements originally allowed teachers to vest sooner, the estimate of γ_4 suggests that shorter vesting requirements are positively correlated with teacher turnover.

The estimate of γ_4 suggests that increasing the years until a teacher is fully vested is associated with a 18.8 percentage points increase in the probability of a teacher leaving her pension system

in the following year, with a standard error of 0.18. Although the point estimate is large (about one half a standard deviation), it is statistically insignificant. Again, I cannot reject the null hypothesis that $\gamma_4 \, is$ equal to zero. Thus, I have no sufficient evidence that more stringent vesting requirements change the probability of a new teacher exiting.

The estimate of the coefficient on *teacher contribution rate* is also statistically insignificant, suggesting increasing the teacher contribution rate does not change the probability of a new teacher exiting. This finding is inconsistent with the hypothesis that lower take home pay decreases the incentive to stay.

The estimates in Table 3.6 also suggests that a one percentage point increase in the employer contribution rate is associated with a 0.005 percentage point increase in the probability of a teacher leaving in the following year, with a standard error of 0.003. This finding may suggest that higher employer contribution rates relocate school resources from expenditures that help retain teachers. It may also suggest that higher pension costs discourage school districts from retaining teachers.

A one percentage point increase in the pension funding ratio is associated with a 0.002 percentage point increase in the probability of a teacher leaving in the following year, with a standard error of 0.002. The point estimate is small and statistically insignificant.

When examining the effect of outside options on teacher turnover, I find that alternative salary matters to teacher exit decisions. The point estimate 0.0007 (0.0004) is statistically significant, suggesting that a one standard deviation increase in alternative salary is associated with a 0.02 percentage point increase in the probability of a teacher leaving in the following year. The estimate of the coefficient *unemployment rate* is negative, suggesting that fewer job opportunities outside of teaching decreases teacher turnover, although the point estimate -0.03 (standard error=0.03) is statistically insignificant.

To identify the estimates, I assume that trends in new teacher turnover in states with no benefit-reducing legislation provide an accurate counterfactual for the trend in states with pension wealth cuts. To support the identification assumption, I compare the difference in one-year teacher turnover among the treatment and control groups in the pre-treatment periods. Table 3.7 shows the difference-in-difference coefficients equation (4) using 2007 and 2011 as post-treatment periods and 2003 as pre-treatment period. I cannot reject the null hypothesis that γ_2 and γ_4 are equal to zero. I find no evidence that new teacher turnover in the treatment group was different from the control group before the pension reforms.

3.5.2 Pension Wealth and Teacher Turnover

As discussed in Section 3, pension plans reformed in numerous ways. To more precisely measure the change in pension incentives facing newly hired teachers, I calculate each teacher's peak net pension wealth using individual teacher's year of entry into teaching, age, gender, and starting salary. See appendix A for calculation details. These heterogeneous effects of the pension reforms on teachers' net pension wealth allow me to examine the relationship between the natural logarithm of an individual teacher's net pension wealth and teacher turnover behavior using the following model:

(4) $Leave_{ist} = \gamma_0 + \gamma_1 \, Log(Net\ Pension\ Wealth)_{ijst} + \gamma_2 \, Vesting\ Rule_{jst} + S_{s,t+1}\beta_1 + K_{jst}\beta_2 + X_{ijst}\beta_3 + D_s + d_t + \varepsilon_{ijst}$,

where $Net\ Pension\ Wealth$ is the estimate of each teacher's own net pension wealth. Similar to equation (4), all specifications include a full set of state dummies and year dummies (D_s and d_t, respectively), and control for time-varying state-level variables $S_{s,t+1}$, school and pension characteristics K_{jst}, and individual characteristics X_{ijst}.

The coefficients of interest in equation (5) are γ_1 and γ_2, which are the estimates of a one percent increase in net pension wealth and a one additional year in vesting requirements on the probability of a teacher leaving after the first year of employment. Table 3.8 reports the estimates from equation (5). The estimate of γ_1 suggests that a one percent increase in net pension wealth is associated with a 0.03 percentage point increase in the probability of a teacher leaving in the following year, with a standard error of 0.03. Because the estimate is statistically insignificant, I cannot reject the null hypothesis that γ_1 is equal to zero. Thus, I have no sufficient evidence that a one percent increase in net pension wealth affect teacher turnover. The estimate of γ_2 is positive, suggesting that more stringent vesting requirement increases teacher turnover, although the point estimate 0.0007 (002) is small and statistically insignificant.

3.6 Conclusion

High teacher turnover presents an ongoing concern for many states and school districts. Turnover forces schools to spend more on recruitment, hiring, and training. Turnover is highest among new teachers and those close to retirement. Because retirement is not avoidable, schools may want to focus more on retaining new teachers (Raue and Gray 2015). The purpose of this paper is to study whether, and to what degree, pension incentives affect new teacher exit decisions.

I use recent pension policy changes to identify the effect of pension incentives on teacher exit decisions. Based on my results, I find no sufficient evidence that more stringent vesting requirements affect the probability of a new teacher exiting. Recall from Table 3.5 that it takes pre-treatment treatment group teachers on average five years to be vested. Perhaps teachers only consider four-year or less pension wealth accruals. Thus, increasing vesting requirements from five years to more than five years does not affect a teacher's incentive to stay. When examining

whether the back-loading structure of DB pension plan helps retain new teachers, I find no evidence that pension benefits cuts affect the probability of a new teacher exiting. Perhaps new teachers do not value their pension benefits or lack full knowledge of their pensions. Alternatively, the composition of the new teacher pool may have changed during recent pension reforms, with less mobile teachers entering the profession. For example, Chou (2018) finds that teachers entering the profession under pension reforms were from undergraduate institutions with lower average SAT scores. Given that teachers with lower test scores are less likely to leave (Podgursky et al. 2004), recent pension reforms may have a positive effect on teacher recruitment but was offset by the effect on teacher recruitment.

I find no evidence that increasing the teacher contribution rate changes the probability of a new teacher exiting. Given the small variation in teacher contribution rates between 2007 and 2011, it is possible that teachers are not aware of the changes.

My estimates suggest that the employer contribution rate affect teacher turnover. I find that a one percentage point increase in the employer contribution rate is associate with a 1.38 percentage points increase in the probability of a teacher leaving in the following year. While a change in the employer contribution rate does not affect a teacher's pension wealth, it may reallocate school resources away from current school expenditures that attract teachers. Overall, my findings suggest that using increasing employer contributions to reduce pension debt might impair school districts attempts to retain new teachers.

As a final note on my findings, the issue of using a one-year turnover measure is that some first-year teachers may exit teaching after finding teaching a bad match for them. Teachers may also decide to leave because of non-financial incentives that are difficult to parameterize, such as

lack of support from school principle and student discipline problems. If these omitted variables changed between 2007 and 2011, then my findings will be biased.

APPENDICES

APPENDIX A

PENSION WEALTH CALCULATION

I use the individual teacher's information of 1) age, 2) gender, and 3) school related annual earnings from the SASS to calculate each individual teacher's pension wealth. I assume all teachers work in the same school until they reach their eligibility for normal retirement and start collecting retirement benefits right away.[75] Since my sample only includes first-year teachers, their teaching experience are all fixed. I therefore determine a teacher's years of service by how far teachers are from retirement using their age. SASS only reports current earnings but not earning histories of teachers, so I impute an earning history for each individual teacher and calculate her final average salary.

With FAS calculated above, I impute teacher pension wealth using equations (3) – (5) mentioned in section 2.3. I use the Actuarial Life Table provided by the Social Security Administration (by gender and age) to determine individual teacher's survival probabilities over their life cycle.[76] This paper assumes a 4 percent discount rate that allows a positive real interest rate and a time preference in earning. I assume that Consumer Price index increases 3 percent annually for pension plans that tied COLAs to changes in Consumer Price Index and assume a 3 percent ad hoc for teacher pension that tied COLAs to state legislation.

Note that courts do not view COLAs as core benefits protected under the state laws (Munnell et al. 2016). At the same time, most state review and adjust contribution rates annually. Therefore, teachers may expect that COLAs and contribution rates would fluctuate over time. For simplicity,

[75] A teacher is eligible for normal retirement if she can retire immediately with an unreduced benefit.
[76] Source: https://www.ssa.gov/oact/STATS/table4c6.html

I calculate teacher's pension wealth using the employee contribution rate and COLAs released in the year she was hired.

APPENDIX B

TABLES

Table 1.1: Summary of Selected Pension Literature on Pension Wealth

Measures of Pension Incentives	Assumptions	Pension Plan Data; States (year of data);	Policy Changes	Results
1. Costrell and Podgursky (2009)				
Q. Examine how teachers accumulate pension wealth with each year of employment.				
Option value (the estimate of pension wealth is net of contributions)	Entry age=25; discount rate=5%; Annual COLAs =3%	Individual state comprehensive annual financial reports and pension handbooks; Ohio (2007), Arkansas (2007), Missouri (2008), California (2007), Texas (2007), and Massachusetts (2006)	N/A	Teachers' net pension values accumulate slowly in the early years of their career, then accelerate in their mid- to late fifties, and then drop off sharply over the next few years.
2. Toutkoushian, Bathon, and McCarthy (2011)				
Q. Analyze the parameter differences and net pension benefits among 49 state-run defined benefit pension plans for public school employees.				
Peak value (the estimate of pension wealth is net of contributions)	Starting salary: $30,000; annual salary increase rate=3%; years of service=44 years; discount rate=3%; Annual COLAs =3%	Public Fund Survey and Schmidt (2010); 49 state-run defined benefit pension plans (2008)	N/A	Defined benefit plans vary significantly across states in terms of both the benefits and costs.

Table 1.1 (cont'd)

Measures of Pension Incentives	Assumptions	Pension Plan Data; States (year of data);	Policy Changes	Results
3. Papke and Litwok (2013)				
Q. Whether cross-state pension differences affect young teachers' first exit from teaching.				
Peak value (the estimate of pension wealth is net of contributions)	Teacher's starting salary equal to the state's average salary; annual salary increase rate=3%; discount rate=3%; No COLAs	Public Fund Survey (2001-2011); California, Florida, Michigan, and Wisconsin (2002-2010)	N/A	Find large cross-state differences in the actuarial present value of pension wealth upon vesting. Find a negative relationship between state vesting rules and the experience distribution of a state's teacher population
4. Furgeson, Strauss, and Vogt (2006)				
Q. The effects of defined benefit pension incentives on teacher retirement decisions.				
Current net pension benefits (if retire at the current age) and future net pension benefits (maximum possible pension wealth)	Discount rate=6%	Pennsylvania State Employees' Retirement System; Pennsylvania (1997-8 and 1998-9 school year)	Pennsylvania increased the incentive to retire by 25 percent by enacting a temporary retirement incentive of "thirty and out," which allowed a teacher with thirty or more years of experience to retire with full benefits, regardless of age.	A large increase in teacher retirement when Pennsylvania enacted a pension policy that temporarily increased the early retirement benefits between 1997-1998 and 1998-1999.

Table 1.1 (cont'd)

Measures of Pension Incentives	Assumptions	Pension Plan Data; States (year of data);	Policy Changes	Results
5. Costrell and McGee (2010)				
Q. The effect of pension wealth accrual on teacher retirement decisions.				
Peak value and option value	Discount rate=5%	Arkansas Teacher Retirement System (ATRS) and the Arkansas Department of Education (ADE); Arkansas (2000–1 to 2007–8 school year)	N/A	Both peak value and one year accrual have negative effects on Arkansas teachers' retirement.
6. Koedel, Ni and Podgursky (2014)				
Q. Who benefits from the enhancements?				
Peak Value, current pension wealth, and expected pension wealth (the estimate of pension wealth is net of contributions)	Teachers started teaching at age 25; discount rate=4%	Administrative personnel data in Missouri (1993 to1994; 2006 to 2007)	Missouri increased multipliers, lowered retirement eligibility, and increased COLAs for all teachers between 1995 and 2002.	The enhancements resulted in large windfall gains for teachers who were close to retirement when the legislation was enacted. By contrast, novice teachers, and teachers who had not yet entered the labor force, were made worse off.

Table 1.1 (cont'd)

Measures of Pension Incentives	Assumptions	Pension Plan Data; States (year of data);	Policy Changes	Results
7. Koedel and Xiang (2017)				
Q. The effect on retention of increasing pension back- loading through benefit-formula enhancements.				
Peak Value, current pension wealth, and expected pension wealth	Discount rate=4%	Administrative data panel from the Missouri Department of Elementary and Secondary Education; St. Louis (1994–95 through 1999–2000 school year)	St. Louis enacted a policy change that increased teacher retirement benefits for those who retired after the 1998-1999 school year.	The strength of the incentive increase varied across the workforce depending on how far teachers were from retirement eligibility when it was enacted. A temporary delay in retirement among teachers who were eligible for retirement in the 1997-1998 school year
8. Friedberg and Turner (2011)				
Q. Analyze the parameter differences among 17 state-run defined benefit pension plans for public school teachers and study the effect of pension incentive on teacher retirement.				
Peak Value		National Education Association (2008), the 17 largest U.S. states	N/A	Dissatisfied teachers respond much more to pension incentives than satisfied teachers. Teachers delay retirement while pension wealth is still accumulating and then retire abruptly.

Table 1.2: Types of Pension Plans States offered Teachers

State	2007	2011	2016
Alabama	DB	DB	DB
Alaska	DC	DC	DC
Arizona	DB	DB	DB
Arkansas	DB	DB	DB
California	DB	DB	DB
Colorado	DB	DB	DB
Connecticut	DB	DB	DB
Delaware	DB	DB	DB
DC	DB	DB	DB
Florida	DB/DC	DB/DC	DB/DC
Georgia	DB	DB	DB
Hawaii	DB	DB	DB
Idaho	DB	DB	DB
Illinois	DB	DB	DB
Indiana	Hybrid	Hybrid	Hybrid
Iowa	DB	DB	DB
Kansas	DB	DB	Cash Balance
Kentucky	DB	DB	DB
Louisiana	DB	DB	DB
Maine	DB	DB	DB
Maryland	DB	DB	DB
Massachusetts	DB	DB	DB
Michigan	DB	Hybrid	Hybrid/DC
Minnesota	DB	DB	DB
Mississippi	DB	DB	DB
Missouri	DB	DB	DB
Montana	DB	DB	DB
Nebraska	DB	DB	DB
Nevada	DB	DB	DB
New Hampshire	DB	DB	DB
New Jersey	DB	DB	DB
New Mexico	DB	DB	DB
New York	DB	DB	DB
North Carolina	DB	DB	DB
North Dakota	DB	DB	DB

Note:

*DB = Defined Benefit Plan; DC = Defined Contribution Plan;
DB/DC = Can choose between DB and DC.

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.2 (cont'd)

State	2007	2011	2016
Ohio	DB/DC/Hybrid	DB/DC/Hybrid	DB/DC/Hybrid
Oklahoma	DB	DB	DB
Oregon	Hybrid	Hybrid	Hybrid
Pennsylvania	DB	DB	DB
Rhode Island	DB	DB	Hybrid
South Carolina	DB /DC	DB /DC	DB /DC
South Dakota	DB	DB	DB
Tennessee	DB	DB	Hybrid
Texas	DB	DB	DB
Utah	DB	Hybrid/DC	Hybrid/DC
Vermont	DB	DB	DB
Virginia	DB	DB	Hybrid
Washington	Hybrid	Hybrid /DB	Hybrid /DB
West Virginia	DB	DB	DB
Wisconsin	DB	DB	DB
Wyoming	DB	DB	DB

Note:

*DB = Defined Benefit Plan; DC = Defined Contribution Plan;
DB/DC = Can choose between DB and DC.

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.3: State Teacher Pension Homepage, Handbooks, and Other Resources

Alabama	The Retirement Systems of Alabama, Teachers' Retirement System	
	Homepage	http://www.rsa-al.gov/index.php/members/trs/
	Tier 1 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T1_bookmarked.pdf#Membership
	Tier 2 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T2_bookmarked.pdf#Membership
	Contribution History	http://www.lfo.state.al.us/PDFs/Presentations/Retirement_Systems_Presentation.pdf
Alaska	The PERS/TRS Defined Contribution Retirement Plan, Teachers' Retirement System	
	Homepage	http://doa.alaska.gov/drb/dcrp/index.html#.WG11Q3eZO8U
Arizona	Arizona State Retirement System	
	Homepage	https://www.azasrs.gov
	Annual Financial Report (2016; 2011)	https://www.azasrs.gov/sites/default/files/pdf/ASRS%202016%20CAFR.PDF; https://www.azasrs.gov/sites/default/files/pdf/ASRS_2011_CAFR.pdf
Arkansas	Arkansas Teacher Retirement System	
	Homepage	https://www.artrs.gov
California	California State Teachers' Retirement System	
	Homepage	http://www.calstrs.com
	Handbook	https://www.calstrs.com/sites/main/files/file-attachments/memberhandbook2017.pdf
Colorado	Colorado Public Employees' Retirement Association	
	Homepage	https://www.copera.org
	Handbook	https://www.copera.org/sites/default/files/documents/5-5.pdf
Connecticut	The Connecticut Teachers' Retirement System	
	Homepage	http://www.ct.gov/trb/site/default.asp
DC	District of Columbia Retirement Board	
	Homepage	http://dcrb.dc.gov/publication/teachers-summary-plan-description
	Summary Plan Description	https://dcrb.dc.gov/sites/default/files/dc/sites/dcrb/publication/attachments/DCRBTeachers%27Plan2012web%20update%20june%202014.pdf
Delaware	State of Delaware Office of Pensions	
	Homepage	http://www.delawarepensions.com/default.shtml
	Annual Financial Report (2016)	http://www.delawarepensions.com/FinancialReports/financials/fy16cafr.pdf

Table 1.3 (cont'd)

Florida	Florida Retirement System Pension Plan	
	Homepage	https://www.myfrs.com/FRSPro_Pension.htm
	Handbook	https://www.rol.frs.state.fl.us/forms/member_handbook.pdf
Georgia	Teachers Retirement System of Georgia	
	Homepage	http://www.trsga.com/home
	Handbook	http://www.trsga.com/downloadPublications/Members%20Guide%202015%20with%20Cover_092115_web.pdf
Hawaii	State of Hawaii Employees' Retirement System	
	Homepage	http://ers.ehawaii.gov
	Handbook (Hybrid)	http://ers.ehawaii.gov/wp-content/uploads/2012/02/ContribHybrid201205.pdf
Idaho	Public Employee Retirement System of Idaho	
	Homepage	https://persi.idaho.gov
	Handbook	https://persi.idaho.gov/Documents/Members/PERSI_Member_Handbook.pdf
Illinois	Teachers' Retirement System of the State of Illinois	
	Homepage	https://www.trsil.org
Indiana	Indiana State Teachers' Retirement Fund	
	Homepage	http://www.in.gov/inprs/
Iowa	Iowa Public Employees' Retirement System	
	Homepage	https://www.ipers.org/home
	Handbook	https://www.ipers.org/sites/default/files/media/Member%20Handbook.pdf
Kansas	Kansas Public Employees Retirement System	
	Homepage	https://www.kpers.org
Kentucky	Kentucky Teachers' Retirement System	
	Homepage	https://trs.ky.gov
Louisiana	Teachers' Retirement System of Louisiana	
	Homepage	https://www.trsl.org/main/home
	Handbook	https://www.trsl.org/uploads/File/Brochures/memberHandbook_WEB.pdf
Maine	Maine Public Employees Retirement System	
	Homepage	http://www.mainepers.org
	Handbook	http://www.mainepers.org/PDFs/handbooks/Teacher_Booklet_web.pdf
Maryland	Employees' and Teachers' Pension System	
	Homepage	http://www.sra.state.md.us
	Handbook	http://www.sra.state.md.us/Participants/Members/Downloads/Handbooks/BenefitHandbook-Emp-Pen.pdf

Table 1.3 (cont'd)

Massachusetts	Massachusetts Teachers' Retirement System	
	Homepage	http://www.mass.gov/mtrs/
	Seminar and reference guide	http://www.mass.gov/mtrs/docs/publications/yrbenefitsbklet.pdf
Michigan	Pension Plus, Michigan Public School Employees Retirement System	
	Homepage (MIP)	http://www.michigan.gov/orsschools/
	Homepage (Pension Plus)	http://www.mipensionplus.org
Minnesota	Minnesota Teachers Retirement Association	
	Homepage	https://www.minnesotatra.org
	Handbook	https://www.minnesotatra.org/images/pdf/Member%20Handbook.pdf
Mississippi	Public Employees' Retirement System of Mississippi	
	Homepage	http://www.pers.ms.gov/Pages/Home.aspx
	Handbook	http://www.pers.ms.gov/Content/Handbooks/Member_Handbook.pdf
Missouri	Public School & Education Employee Retirement System of Missouri	
	Homepage	https://www.psrs-peers.org
Montana	Montana Teachers' Retirement System	
	Homepage	https://trs.mt.gov
	Handbook	https://trs.mt.gov/miscellaneous/PdfFiles/Members/2016_TRS_Active_Member_Handbook.pdf
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System	
	Homepage	http://npers.ne.gov/SelfService/public/planInformation/school/schoolPlanInfo.jsp
	Handbook	http://npers.ne.gov/SelfService/public/howto/handbooks/handbookSchool.pdf
Nevada	Nevada Public Employees' Retirement System	
	Homepage	http://www.nvpers.org/public/members/
	Summary Plan Description Tier 1	https://www.nvpers.org/public/publications/regPlan.pdf
	Summary Plan Description Tier 2	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-1-1-2010.pdf
	Summary Plan Description Tier 3	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-7-1-2015.pdf
	Legislation	https://www.leg.state.nv.us/NRS/NRS-286.html#NRS286Sec537

Table 1.3 (cont'd)

New Hampshire	New Hampshire Retirement System	
	Homepage	https://www.nhrs.org/members
	Legislation	http://www.gencourt.state.nh.us/rsa/html/vi/100-a/100-a-mrg.htm
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund	
	Homepage	http://www.nj.gov/treasury/pensions/
	Handbook	http://www.nj.gov/treasury/pensions/pdf/handbook/tpafbook.pdf
	Comprehensive Audited Financial Report	http://www.nj.gov/treasury/pensions/pdf/financial/2016divisioncombined.pdf
New Mexico	New Mexico Educational Retirement Board	
	Handbook (updated 2015)	https://www.nmerb.org/pdfs/memberwebhandbooksep2015.pdf
New York	New York State Teachers' Retirement System	
	Homepage	https://www.nystrs.org
	Handbook	https://www.nystrs.org/NYSTRS/media/PDF/Library/Publications/Active%20Members/handbook.pdf
North Carolina	Teachers' and State Employees' Retirement System	
	Homepage	https://www.nctreasurer.com/retirement-and-savings/managing-my-retirement/pages/default.aspx
	Handbook	https://www.nctreasurer.com/ret/Benefits%20Handbooks/TSERShandbook.pdf
North Dakota	North Dakota Teachers' Fund for Retirement	
	Handbook	http://www.nd.gov/rio/TFFR/Publications/Handbook.pdf
Ohio	State Teachers Retirement System of Ohio	
	Homepage	https://www.strsoh.org/actives/index.html
	Handbook	https://www.strsoh.org/_pdfs/brochureseries/benefitpayoptns/15-126.pdf
	Legislation	https://www.strsoh.org/_pdfs/legislation/20-663.pdf
Oklahoma	Oklahoma Teachers Retirement System	
	Homepage	https://www.ok.gov/TRS/
	Handbook	https://www.ok.gov/TRS/documents/Client%20Handbook%20V10%20(2016).pdf
Oregon	Oregon Public Employees' Retirement System	
	Homepage	http://www.oregon.gov/PERS/pages/index.aspx
Pennsylvania	Public School Employees' Retirement System	
	Homepage	http://www.psers.state.pa.us
	Handbook	http://www.psers.pa.gov/FPP/Publications/Active/Documents/Active%20Handbook.pdf

Table 1.3 (cont'd)

Rhode Island	Employees' Retirement System of Rhode Island	
	Homepage	https://www.ersri.org/#gsc.tab=0
	Benefit Introduction	https://d10k7k7mywg42z.cloudfront.net/assets/568549a8edb2f3791a1f46d7/Teachers_Retirement_Presentation_Dec_2015.pdf
	An Employee's Guide to Understanding the Rhode Island Retirement Security Act	https://d10k7k7mywg42z.cloudfront.net/assets/4f2feb51dabe9d2cb600fa49/final_rirsaguide_january2012.pdf
South Carolina	South Carolina Retirement Systems	
	Homepage	http://www.peba.sc.gov/retirement.html
	Handbook	http://www.peba.sc.gov/assets/scrshandbook.pdf
South Dakota	South Dakota Retirement System	
	Homepage	http://sdrs.sd.gov/about/default.aspx
	Handbook	http://sdrs.sd.gov/docs/ClassAFoundationMemberHandbook.pdf
Tennessee	Tennessee Consolidated Retirement System	
	Homepage	http://treasury.tn.gov/tcrs/
	Handbook (DB)	http://www.treasury.state.tn.us/tcrs/PDFs/Con-Teachers.pdf
	Handbook (Hybrid)	http://treasury.tn.gov/tcrs/PDFs/hybridplan.pdf
Texas	Teacher Retirement System of Texas	
	Homepage	https://www.trs.texas.gov/Pages/Homepage.aspx
	Handbook	https://www.trs.texas.gov/TRS%20Documents/benefits_handbook.pdf
Utah	Utah Retirement Systems	
	Homepage	https://www.urs.org
Vermont	Vermont State Teachers' Retirement System	
	Homepage	http://www.vermonttreasurer.gov/content/retirement/teacher
Virginia	Virginia Retirement System	
	Homepage	http://www.varetire.org
	Handbook (Plan 1)	http://www.varetire.org/pdf/publications/handbook-plan-1.pdf
	Handbook (Plan 2)	http://www.varetire.org/Pdf/Publications/handbook-plan-2.pdf
Washington	Washington Teachers' Retirement System	
	Homepage	http://www.drs.wa.gov
	Handbook (Plan 2)	http://www.drs.wa.gov/member/handbooks/trs/plan-2/t2hbk.pdf

Table 1.3 (cont'd)

West Virginia	West Virginia Teachers' Retirement System	
	Homepage	http://www.wvretirement.com/TRS.html
	Tier 1 Introduction	http://www.wvretirement.com/Forms/TRS-Brochure2017.pdf
	Tier 2 Introduction	https://www.wvretirement.com/Forms/TRS-Brochure2017-TIER2.pdf
Wisconsin	Wisconsin Retirement System	
	Homepage	http://etf.wi.gov
	Handbook	http://etf.wi.gov/publications/et2119.pdf
Wyoming	Wyoming Retirement System	
	Homepage	http://retirement.state.wy.us/pension/index.html

Table 1.4: Comparison of the Number of Years Used to Calculate Final Average Salary

State	2007	2016
Alabama	3	5
Arizona	3	5
Arkansas	3	3
California	1	3
Colorado	3	3
Connecticut	3	3
Delaware	3	3
DC	3	3
Florida	5	8
Georgia	2	2
Hawaii	3	5
Idaho	3.5	3.5
Illinois	4	8
Iowa	3	5
Kentucky	5	5
Louisiana	3	5
Maine	3	3
Maryland	3	5
Massachusetts	3	5
Minnesota	5	5
Mississippi	4	4
Missouri	3	3
Montana	3	5
Nebraska	3	5
Nevada	3	3
New Hampshire	5	5
New Jersey	3	5
New Mexico	5	5
New York	3	5

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.4 (cont'd)

State	2007	2016
North Carolina	4	4
North Dakota	3	5
Ohio	3	3
Oklahoma	5	5
Pennsylvania	3	3
South Carolina	3	5
South Dakota	3	3
Texas	5	5
Vermont	3	3
West Virginia	5	5
Wisconsin	3	3
Wyoming	3	5
Summary Statistics by Year		
Mean	3.40	4.30
Median	3	5
Mode	3	5
Maximum	5	8
Minimum	1	2

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.5: Comparison of the Formula Multiplier

	2007	2016
Alabama	2.01	1.65
Arizona	Multiple	Multiple
Arkansas	2.15	2.15
California	Multiple	2
Colorado	2.5	2.5
Connecticut	2	2
Delaware	1.85	1.85
DC	2	2
Florida	Multiple	Multiple
Georgia	2	2
Hawaii	2	1.75
Idaho	2	2
Illinois	2.2	2.2
Iowa	Multiple	Multiple
Kentucky	Multiple	Multiple
Louisiana	2.5	2.5
Maine	2	2
Maryland	1.8	1.5
Massachusetts	Multiple	Multiple
Minnesota	1.9	1.9
Mississippi	Multiple	Multiple
Missouri	2.5	2.5

Note: The multipliers can be constant or vary by retirement age or years of service. In Arizona, the multipliers were 2.1% for the first 20 years, 2.15% for year 20 -25, 2.2% for year 25 -30, and 2.3% for years over 30. In California, the multipliers were 2% if YOS<=30, 2.2% if YOS=31, 2.4% if YOS>=32. In Florida, the multipliers for teachers hired before July 1, 2011 were 1.6% for age 62 or YOS=30, 1.63% for age 63 or YOS=31, 1.65% for age 64 or YOS=32, 1.68% for age 65 or YOS=33; the multipliers for teachers hired on or after July 1, 2011 were 1.60% for age 65 YOS=33, 1.63% for age 66 or YOS=34, 1.65% for age 67 or YOS=35, 1.68% for age 68 or YOS=36. In Iowa, the multipliers were 2% for years up to 30 and 1% for each year 31 through 35. In Kentucky, the multipliers for teachers hired between July 1, 2002 and June 30, 2008 were 2% if YOS <=10, 2.5% if years between 10-30, 3% for all years over 30. The multipliers for teachers hired after June 30, 2008 were 1.7% if YOS<= 10 at retirement), 2% if YOS were between 10-20 years, 2.3% if YOS were between 20-26 years, 2.5% if YOS were between 26-30, 3% if years 30+. In Massachusetts, the multiplier is 2.5 plus Retirement Plus enhancement, if applicable. In Mississippi, the multipliers for teachers hired on or before June 30, 2011 were 2% for YOS<=25 and 2.5% for all years over 25. The multipliers for teachers hired after June 30, 2011 were 2% for YOS<=30 and 2.5% for all years over 30.
Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.5 (cont'd)

	2007	2016
Montana	1.67	1.67
Nebraska	2	2
Nevada	2.67	2.25
New Hampshire	1.67	1.52
New Jersey	1.82	1.67
New Mexico	2.35	2.35
New York	Multiple	Multiple
North Carolina	1.82	1.82
North Dakota	2	2
Ohio	Multiple	Multiple
Oklahoma	2	2
Pennsylvania	2.5	2
South Carolina	1.82	1.82
South Dakota	1.7	1.55
Texas	2.3	2.3
Vermont	1.67	Multiple
West Virginia	2	2
Wisconsin	1.6	1.6
Wyoming	Multiple	2
Summary Statistics by Year*		
Mean	2.03	1.97
Median	2	2
Mode	2	2
Maximum	2.67	2.5
Minimum	1.6	1.5

Note: The multipliers can be constant or vary by retirement age or years of service. In New York, the multipliers for tier 4 teachers were 2% for years up to 30, 1.50% for all years over 30. The multiplier was 1.67% if retired with less than 20 years of service. The multipliers for tier 5 teachers were 2% for years up to 30, 1.50% for all years over 30. The multiplier was 1.67% if retired with less than 25 years of service. The multipliers for tier 6 teachers were 1.75% for years up to 20, 2% for all years over 20. The multiplier was 1.67% if retired with less than 20 years of service. In Ohio, the multipliers were 2.2% for years up to 30; varying rates after 30. In Rhode Island, the multipliers were 1.6% for years 1-10, 1.8% for years 11-20, 2% for years 21-25, 2.25% for years 26-30, 2.5% for years 31-37, 2.25% for years over 38. In Tennessee, the multipliers were 1.50% plus 0.25% x years x (FAS - 90% FAS Social Security Integration Level). In Vermont, the multipliers were 1.67% for all years plus 2.0% after attaining 20 years. In Wyoming, the multipliers were 2.125% for years up to 15 and 2.25% for years over 15.

*The summary statistics here are only for constant multipliers.

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.6: The Limitation on First Year Annual Benefits as a Percentage of FAS

State	2007	2016
Alabama	None	80
Arizona	80	None
Arkansas	None	None
California	None	None
Colorado	100	100
Connecticut	75	75
Delaware	None	None
DC	None	None
Florida	100	100
Georgia	80	80
Hawaii	None	None
Idaho	100	100
Illinois	75	75
Iowa	65	65
Kentucky	100	100
Louisiana	100	100
Maine	None	None
Maryland	None	None
Massachusetts	80	80
Minnesota	100	100
Mississippi	None	None
Missouri	100	100
Montana	None	None
Nebraska	None	None
Nevada	75	75
New Hampshire	100	100
New Jersey	None	None
New Mexico	None	None
New York	None	None
North Carolina	None	None
North Dakota	None	None
Ohio	100	100
Oklahoma	100	100
Pennsylvania	None	100
South Carolina	None	None
South Dakota	None	None
Texas	None	None
Vermont	53.34	60
West Virginia	None	None
Wisconsin	70	70
Wyoming	None	None

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.7: Comparison of the Cost of Living Adjustments

State	2007	2016
Alabama	Ad Hoc	Ad Hoc
Arizona	Investment surplus capped at 4%	Investment surplus capped at 4%
Arkansas	Annual 3%	Annual 3%
California	Annual 2%	Annual 2%
Colorado	Lesser of 2% or the average of the monthly CPI-W	Lesser of 2% or the average of the monthly CPI-W
Connecticut	Social Security COLAs (capped under different investment performance)	Social Security COLAs (capped under different investment performance)
Delaware	Ad Hoc	Ad Hoc
DC	CPI up to 3%	CPI up to 3%
Florida	Annual 3%	0
Georgia	CPI up to 3%	1.5% if current CPI higher
Hawaii	Annual 2.5%	Annual 1.5%
Idaho	Lesser of CPI or 6% discretionary maximum	Lesser of CPI or 6% discretionary maximum
Illinois	Annual 3% on January 1 after they turn 61	min (3%, 1/2 CPI)
Iowa	0	0
Kentucky	Automatic 1.5% plus ad hoc	Automatic 1.5% plus ad hoc
Louisiana	3%	Ad Hoc
Maine	CPI up to 4%	CPI up to 3% on the first $20000
Maryland	CPI up to 3%	CPI up to 2.5%
Massachusetts	Ad hoc with 3% maximum	The first $13,000 of a retiree's total allowance is subject to an annual COLA of up to 3 percent
Minnesota	CPI up to 2.5% + investment surplus	CPI up to 2.5% + investment surplus
Mississippi	Annual 3%	Annual 3%
Missouri	CPI up to 5%; lifetime COLAs limited to 80% of original benefit	CPI up to 5%; lifetime COLAs limited to 80% of original benefit

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.7 (cont'd)

State	2007	2016
Montana	Annual 1.5% for retirees who have been retired at least 3 years	0.5-1.5% (after 3 years of retirement)
Nebraska	CPI up to 2.5%	CPI up to 1.0%
Nevada	Cost of living increases are provided after three full years of benefits at the rates of 2% in each of the fourth, fifth, and sixth years; 3% in years seven, eight, and nine; 3.5% in years 10 and 11; and 5% in year 14 and each year thereafter.	Cost of living increases are provided after three full years of benefits at the rates of 2% in each of the fourth, fifth, and sixth years; 3% in years seven, eight, and nine; 3.5% in years 10 and 11; and 4% in year 12 and each year thereafter.
New Hampshire	Ad Hoc	Ad Hoc
New Jersey	60% of change in CPI	Suspended to all members in 2011
New Mexico	50% of change in CPI up to 4%; not less than 2% (began at age 65)	CPI if <2%; 50% of change in CPI up to 4%; not less than 2% (began at age 67)
New York	50% of change in CPI up to 3%, but at least 1% minimum	50% of change in CPI up to 3%, but at least 1% minimum
North Carolina	Ad Hoc	Ad Hoc
North Dakota	Ad Hoc	Ad Hoc
Ohio	Annual 3 %	Annual 3 %
Oklahoma	Ad Hoc	Ad Hoc
Pennsylvania	Ad Hoc	Ad Hoc
South Carolina	CPI up to 2%; up to 4% additional discretionary	CPI up to 2%; up to 4% additional discretionary
South Dakota	Annual 3.1%	Annual 3.1 % (COLA based on CPI)
Texas	Ad Hoc	Ad Hoc
Vermont	½ CPI up to 5%	½ CPI up to 5%
West Virginia	Ad Hoc	Ad Hoc
Wisconsin	Depends on investment performance and other indicators	Depends on investment performance and other indicators
Wyoming	CPI up to 3%	CPI up to 3%

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.8: Comparison of Retirement Eligibility

State	2007	2016
Alabama	60/10; A/25	62/10
Arizona	65/A; 62/10; R-80	65/A; 62/10; 60/25;55/30
Arkansas	60/5; A/28	60/5; A/28
California	60/5	62/5
Colorado	65/5; 60/25; 55/30; A/35	65/5; 58/30; A/35
Connecticut	60/20; A/35	60/20; A/35
Delaware	62/5; 60/15; A/30	65/10; 60/20; A/30
DC	62/5;60/20; A/30	62/5;60/20; A/30
Florida	62/6; A/30	65/8; A/33
Georgia	60/10; A/30	60/10; A/30
Hawaii	62/5; 55/30	65/10; 60/30
Idaho	65/5; R-90	65/5; R-90
Illinois	62/5; 60/10; 55/35	67/10
Iowa	65/A; 62/20; R-88	65/A; 62/20; R-88
Kentucky	60/5; A/27	60/5; A/27
Louisiana	60/5; 55/25; A/30	62/5
Maine	62/5	65/5
Maryland	62/5; 63/4; 64/3; 65/2; A/30	65/10; R-90
Massachusetts	65/10; A/20	67/10
Minnesota	66/3	66/3
Mississippi	60/8; A/25	60/8; A/30
Missouri	60/5; A/30; R-80	60/5; A/30; R-80
Montana	60/5; A/25	60/5; 55/30
Nebraska	65/5; R-85/age 55	65/5; R-85/age 55

Note: Read 60/5 as 5 years of service at age 60; read R-80 as a combination of years of service plus year = 80; Read R-80/age 60 the same as R-80 but need to be at least age 60.
*The summary statistics here are based on assumptions that teachers started teaching at age 25 and work in the same school until they reach their normal retirement age.
Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.8 (cont'd)

State	2007	2016
Nevada	65/5; 60/10; A/30	65/5; 62/10; 55/30; A/33.3
New Hampshire	60/A	65/A
New Jersey	60/A	65/A
New Mexico	65/5; A/25; R-75(60/25)	67/5; 55/30; R-80(65/30)
New York	62/5; 55/30	63/10
North Carolina	65/5; 60/25; A/30	65/5; 60/25; A/30
North Dakota	65/3; R-85	65/5; R-90/age 60
Ohio	60/5; A/30	60/5; A/30
Oklahoma	62/5; R-90	65/5; R-90/age 60
Pennsylvania	62/1; 60/30; A/35	65/3; 57/35
South Carolina	65/5; A/28	65/8; R-90
South Dakota	65/3; R-85	65/3; R-85
Texas	65/5; R-80	65/5; R-80/age 62
Vermont	62/5; A/30	65/5 or R-90
West Virginia	60/5; 55/30; A/35	62/10
Wisconsin	65/A; 57/30	65/5; 57/30
Wyoming	60/4; R-85	65/4; R-85
Summary Statistics by Year*		
Mean	30.48	33.56
Median	30	32.5
Mode	30	30
Maximum	41	42
Minimum	20	27

Note: Read 60/5 as 5 years of service at age 60; read R-80 as a combination of years of service plus year = 80; Read R-80/age 60 the same as R-80 but need to be at least age 60.
*The summary statistics here are based on assumptions that teachers started teaching at age 25 and work in the same school until they reach their normal retirement age.
Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.9: Comparison of the Employee Contribution Rates

State	2007	2016
Alabama	5	6
Arizona	9.1	11.35
Arkansas	6	6
California	8	9.205
Colorado	8	8
Connecticut	6	6
Delaware	3	5
DC	8	8
Florida	0	3
Georgia	5	6
Hawaii	6	8
Idaho	6.23	6.79
Illinois	9.4	9.4
Iowa	3.9	5.95
Kentucky	9.855	12.855
Louisiana	8	8
Maine	7.65	7.65
Maryland	7	7
Massachusetts	11	11
Minnesota	5.5	7.5
Mississippi	7.25	9
Missouri	12	14.5
Montana	7.15	8.15
Nebraska	7.28	9.78
Nevada	10.5	14.5
New Hampshire	5	7
New Jersey	5.5	7.06

Note: In Delaware, teachers contribute a portion of their monthly compensation which exceeds $6,000 per year.
Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.9 (cont'd)

State	2007	2016
New Mexico	7.825	Multiple
New York	Multiple	Multiple
North Carolina	6	6
North Dakota	7.75	11.75
Ohio	10	14
Oklahoma	7	7
Pennsylvania	7.5	Multiple
South Carolina	6.5	8.16
South Dakota	6	6
Texas	6.4	7.2
Vermont	3.4	5
West Virginia	6	6
Wisconsin	5	6.6
Wyoming	0	2.3
Summary Statistics by Year*		
Mean	6.67	7.97
Median	6.75	7.35
Mode	6	6
Maximum	12	14.5
Minimum	0	2.3

Note: In New Mexico, teachers are required to contribute 11.15% for salary over $20000 and 7.9% for salary below $20000 in 2011 and 2016. In New York, teachers hired before 2007 contribute 3% of their salary for the first 10 years, no contributions after the 11th year of employments. In New York, teachers hired in 2016 contribute 3% if salary <=$45000; 3.5% if salary between $45,000-$55,000; 4.5% if salary between $55000-$75,000; 5.75% if salary between $75,000 and $100,000, 6% for salary over $179000. In Pennsylvania, contributions are between 7.5% and 9.5% in 2016. In Wyoming, employers pay parts or all the employee contribution. Here I only show the part teachers need to pay.
*The summary statistics here are only for constant contribution rates.
Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.10: Summary of Reforms Between 2007 and 2016 that Reduced Teacher Benefits

State	Reforms Include:						Total Parametric Pension Reforms
	Decreasing Multiplier	Lengthen the Years Used to Compute FAS	Raising Retirement Eligibility Age or Service	Capped on Annual Benefits	Less Generous COLAs	Increasing Employee Contribution Rates	
Alabama	Yes	Yes	Yes	Yes		Yes	5
Arizona		Yes	Yes	(Removed caps)		Yes	4
Arkansas							
California	Yes	Yes	Yes			Yes	4
Colorado			Yes				1
Connecticut							
Delaware			Yes			Yes	2
DC							
Florida	Yes	Yes	Yes		Yes	Yes	5
Georgia					Yes	Yes	2
Hawaii	Yes	Yes	Yes		Yes	Yes	5
Idaho						Yes	1
Illinois		Yes	Yes		Yes		3
Iowa		Yes				Yes	2
Kentucky	Yes					Yes	2
Louisiana		Yes	Yes		Yes		3
Maine			Yes		Yes		2
Maryland	Yes	Yes	Yes		Yes		4
Massachusetts		Yes	Yes		Yes		3
Minnesota						Yes	1
Mississippi	Yes		Yes			Yes	3
Missouri						Yes	1

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.10 (cont'd)

State	Reforms Include:						Total Parametric Pension Reforms
	Decreasing Multiplier	Lengthen the Years Used to Compute FAS	Raising Retirement Eligibility Age or Service	Capped on Annual Benefits	Less Generous COLAs	Increasing Employee Contribution Rates	
Montana		Yes	Yes		Yes	Yes	4
Nebraska		Yes			Yes	Yes	3
Nevada	Yes		Yes		Yes	Yes	4
New Hampshire	Yes		Yes			Yes	3
New Jersey	Yes	Yes	Yes		Yes	Yes	5
New Mexico			Yes		Yes	Yes	3
New York	Yes	Yes	Yes			Yes	4
North Carolina							
North Dakota		Yes	Yes			Yes	3
Ohio						Yes	1
Oklahoma			Yes				1
Pennsylvania	Yes		Yes	Yes		Yes	4
South Carolina		Yes	Yes			Yes	3
South Dakota	Yes				Yes		2
Texas			Yes			Yes	2
Vermont	(Increasing)		Yes	Less restriction		Yes	4
West Virginia			Yes				1
Wisconsin			Yes			Yes	2
Wyoming	Yes	Yes	Yes			Yes	4
Total	14	17	28	2	14	28	

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.11: Comparison of Starting Salary, Years of Service, and Final Average Salary

	2007			2016		
	(1)	(2)	(3)	(4)	(5)	(6)
State	Starting Salary	Years of Service	Final Average Salary	Starting Salary	Years of Service	Final Average Salary
Alabama	$42,515	25	$65,156	$38,477	37	$72,339
Arizona	$37,989	27.5	$67,231	$34,068	30	$62,370
Arkansas	$37,098	28	$54,933	$33,973	28	$50,305
California	$43,000	35	$102,684	$44,782	37	$109,736
Colorado	$38,836	30	$66,451	$32,980	33	$59,773
Connecticut	$44,827	35	$137,280	$45,280	35	$138,668
DC	$47,248	30	$93,277	$51,359	30	$101,393
Delaware	$44,490	30	$95,783	$41,415	30	$89,162
Florida	$41,043	30	$60,315	$37,405	33	$56,174
Georgia	$38,167	30	$74,642	$34,872	30	$68,197
Hawaii	$49,161	30	$62,831	$45,963	35	$60,842
Idaho	$37,113	32.5	$56,989	$33,743	32.5	$51,815
Illinois	$44,024	35	$97,645	$38,820	42	$97,440
Iowa	$35,281	31.5	$75,163	$35,766	31.5	$74,299
Kentucky	$38,013	27	$63,528	$36,494	27	$60,991
Louisiana	$43,580	30	$61,335	$40,128	37	$60,773
Maine	$33,489	37	$93,096	$33,876	40	$102,797
Maryland	$46,452	30	$83,593	$44,675	32.5	$82,990
Massachusetts	$40,415	20	$79,395	$44,726	42	$193,236
Minnesota	$38,486	41	$102,861	$37,644	41	$100,612
Mississippi	$39,689	25	$55,207	$34,780	30	$52,057

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.11 (cont'd)

State	2007			2016		
	(1)	(2)	(3)	(4)	(5)	(6)
	Starting Salary	Years of Service	Final Average Salary	Starting Salary	Years of Service	Final Average Salary
Missouri	$33,000	30	$50,745	$31,842	30	$48,965
Montana	$29,027	25	$57,187	$30,036	30	$66,619
Nebraska	$32,501	30	$58,248	$33,854	30	$59,441
Nevada	$36,599	30	$80,383	$37,973	30	$83,401
New Hampshire	$35,641	35	$99,867	$36,845	40	$121,257
New Jersey	$52,034	35	$103,559	$51,179	40	$110,750
New Mexico	$38,009	25	$69,395	$34,544	30	$72,304
New York	$40,706	30	$84,652	$44,935	38	$112,264
North Carolina	$42,625	30	$84,678	$37,514	30	$74,524
North Dakota	$34,914	30	$58,177	$38,032	32.5	$65,145
Ohio	$38,370	30	$107,337	$35,249	30	$98,606
Oklahoma	$35,318	32.5	$52,379	$31,919	35	$48,944
Pennsylvania	$43,517	35	$104,987	$44,144	35	$106,500
South Carolina	$35,679	28	$65,689	$33,057	32.5	$66,097
South Dakota	$37,563	30	$55,732	$37,419	30	$55,519
Texas	$41,691	27.5	$70,021	$40,725	37	$83,616
Vermont	$35,018	30	$79,250	$38,483	32.5	$93,678
West Virginia	$36,121	35	$66,656	$33,684	37	$64,585
Wisconsin	$38,561	32	$88,555	$36,983	32	$84,930
Wyoming	$47,471	30	$73,481	$45,207	30	$68,903
Summary Statistics by Year						
Mean	$39,641	30	$77,082	$38,411	34	$81,269
Median	$38,486	30	$73,481	$37,419	33	$72,339
Maximum	$52,034	41	$137,280	$51,359	42	$193,236
Minimum	$29,027	20	$50,745	$30,036	27	$48,944

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.12: Simulation of First-year Pension Benefits Across States

State	2007			2016		
	(1)	(2)	(3)	(4)	(5)	(6)
	First Year Annual Benefits	Capped First Year Annual Benefits		First Year Annual Benefits	Capped First Year Annual Benefits	
		Dollars Amount	% of FAS		Dollars Amount	% of FAS
Alabama	$32,782	$32,782	50%	$44,163	$44,163	61%
Arizona	$39,750	$39,750	59%	$40,229	$40,229	65%
Arkansas	$33,070	$33,070	60%	$30,284	$30,284	60%
California	$86,254	$86,254	84%	$81,204	$81,204	74%
Colorado	$49,839	$49,839	75%	$49,313	$49,313	83%
Connecticut	$96,096	$96,096	70%	$97,067	$97,067	70%
DC	$55,966	$55,966	60%	$60,835	$60,835	60%
Delaware	$53,159	$53,159	55%	$49,485	$49,485	55%
Florida	$28,951	$28,951	48%	$29,660	$29,660	53%
Georgia	$44,785	$44,785	60%	$40,918	$40,918	60%
Hawaii	$37,699	$37,699	60%	$37,266	$37,266	61%
Idaho	$37,043	$37,043	65%	$33,679	$33,679	65%
Illinois	$75,187	$73,234	75%	$90,034	$73,080	75%
Iowa	$46,225	$46,225	62%	$45,694	$45,694	62%
Kentucky	$42,882	$42,882	67%	$41,169	$41,169	67%
Louisiana	$46,001	$46,001	75%	$56,215	$56,215	92%
Maine	$68,891	$68,891	74%	$82,238	$82,238	80%
Maryland	$45,140	$45,140	54%	$40,458	$40,458	49%
Massachusetts	$39,697	$39,697	50%	$202,898	$154,589	80%
Minnesota	$80,129	$80,129	78%	$78,377	$78,377	78%

Note: First-year Annual payments (A) = Final Average Salary * Multiplier * Years of Service
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.12 (cont'd)

State	2007			2016		
	(1)	(2)	(3)	(4)	(5)	(6)
	First Year Annual Benefits	Capped First Year Annual Benefits		First Year Annual Benefits	Capped First Year Annual Benefits	
		Dollars Amount	% of FAS		Dollars Amount	% of FAS
Mississippi	$27,603	$27,603	50%	$31,234	$31,234	60%
Missouri	$38,058	$38,058	75%	$36,724	$36,724	75%
Montana	$23,876	$23,876	42%	$33,376	$33,376	50%
Nebraska	$34,949	$34,949	60%	$35,664	$35,664	60%
Nevada	$64,387	$60,287	75%	$56,296	$56,296	68%
New Hampshire	$58,372	$58,372	58%	$73,482	$73,482	61%
New Jersey	$65,901	$65,901	64%	$73,834	$73,834	67%
New Mexico	$40,770	$40,770	59%	$50,974	$50,974	70%
New York	$50,791	$50,791	60%	$79,707	$79,707	71%
North Carolina	$46,234	$46,234	55%	$40,690	$40,690	55%
North Dakota	$34,906	$34,906	60%	$42,344	$42,344	65%
Ohio	$70,843	$70,843	66%	$65,080	$65,080	66%
Oklahoma	$34,046	$34,046	65%	$34,261	$34,261	70%
Pennsylvania	$91,864	$91,864	87%	$74,550	$74,550	70%
South Carolina	$33,475	$33,475	51%	$39,096	$39,096	59%
South Dakota	$28,423	$28,423	51%	$25,816	$25,816	46%
Texas	$44,289	$44,289	63%	$71,157	$71,157	85%
Vermont	$39,704	$39,704	50%	$54,708	$54,708	58%
West Virginia	$46,659	$46,659	70%	$47,793	$47,793	74%
Wisconsin	$45,340	$45,340	51%	$43,484	$43,484	51%
Wyoming	$48,222	$48,222	66%	$41,342	$41,342	60%
Summary Statistics by Year						
Mean	$48,982	$48,834	62%	$55,678	$54,086	66%
Median	$45,140	$45,140	60%	$45,694	$45,694	65%
Maximum	$96,096	$96,096	87%	$202,898	$154,589	92%
Minimum	$23,876	$23,876	42%	$25,816	$25,816	46%

Note: First-year Annual payments (A) = Final Average Salary * Multiplier * Years of Service
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.13: Comparison of Simulated Pension Wealth

State	2007		2016		Difference		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pension Wealth	% of FAS	Pension Wealth	% of FAS	Pension Wealth	% of FAS	Social Security
Alabama	$309,430	475%	$165,174	228%	-$144,256	-247%	Yes
Arizona	$304,381	453%	$266,160	427%	-$38,221	-26%	Yes
Arkansas	$253,224	461%	$231,894	461%	-$21,330	0%	Yes
California	$384,081	374%	$303,713	277%	-$80,368	-97%	No
Colorado	$329,741	496%	$258,825	433%	-$70,916	-63%	No
Connecticut	$427,905	312%	$432,229	312%	$4,324	0%	No
DC	$370,284	397%	$402,499	397%	$32,215	0%	No
Delaware	$351,712	367%	$327,403	367%	-$24,309	0%	Yes
Florida	$191,548	318%	$155,675	277%	-$35,873	-40%	No
Georgia	$296,308	397%	$270,722	397%	-$25,586	0%	Partial
Hawaii	$249,422	397%	$165,939	273%	-$83,483	-124%	Yes
Idaho	$194,426	341%	$176,771	341%	-$17,655	0%	Yes
Illinois	$326,101	334%	$166,117	170%	-$159,984	-163%	No
Iowa	$262,567	349%	$259,550	349%	-$3,017	0%	Yes
Kentucky	$352,510	555%	$338,428	555%	-$14,082	0%	No
Louisiana	$304,352	496%	$210,250	346%	-$94,102	-150%	No
Maine	$257,660	277%	$231,100	225%	-$26,560	-52%	No
Maryland	$298,654	357%	$212,348	256%	-$86,306	-101%	Yes
Massachusetts	$519,830	655%	$351,395	182%	-$168,435	-473%	No
Minnesota	$203,035	197%	$198,596	197%	-$4,439	0%	Yes

Note: $\text{Pension Wealth}_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)} \pi_t}{(1+r)^{t-1}}$

where $\mathcal{A}_t$ is the capped annual payment in year t >T, f_t is the cost of living adjustment in year t, π_t is the probability of surviving at year t, and r is the discount rate.
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.13 (cont'd)

State	2007		2016		Difference		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pension Wealth	% of FAS	Pension Wealth	% of FAS	Pension Wealth	% of FAS	Social Security
Mississippi	$260,550	472%	$206,651	397%	-$53,899	-75%	Yes
Missouri	$251,802	496%	$242,970	496%	-$8,832	0%	No
Montana	$225,364	394%	$220,823	331%	-$4,541	-63%	Yes
Nebraska	$231,227	397%	$235,962	397%	$4,735	0%	Yes
Nevada	$398,872	496%	$372,464	447%	-$26,408	-50%	No
New Hampshire	$259,926	260%	$206,495	170%	-$53,431	-90%	Yes
New Jersey	$293,451	283%	$207,484	187%	-$85,967	-96%	Yes
New Mexico	$384,827	555%	$337,253	466%	-$47,574	-88%	Yes
New York	$336,044	397%	$271,997	242%	-$64,047	-155%	Yes
North Carolina	$305,893	361%	$269,213	361%	-$36,680	0%	Yes
North Dakota	$230,945	397%	$222,248	341%	-$8,697	-56%	Yes
Ohio	$468,707	437%	$430,580	437%	-$38,127	0%	No
Oklahoma	$178,696	341%	$152,560	312%	-$26,136	-29%	Yes
Pennsylvania	$409,059	390%	$331,964	312%	-$77,095	-78%	Yes
South Carolina	$256,328	390%	$205,202	310%	-$51,126	-80%	Yes
South Dakota	$188,054	337%	$170,805	308%	-$17,249	-30%	Yes
Texas	$339,132	484%	$266,136	318%	-$72,996	-166%	Yes
Vermont	$262,692	331%	$287,141	307%	$24,449	-25%	Yes
West Virginia	$207,767	312%	$178,751	277%	-$29,016	-35%	Yes
Wisconsin	$257,540	291%	$246,999	291%	-$10,541	0%	Yes
Wyoming	$319,044	434%	$273,527	397%	-$45,517	-37%	Yes
Summary Statistics by Year							
Mean	$298,856	397%	$255,171	331%	-$43,685	-66%	
Median	$296,308	394%	$242,970	318%	-$35,873	-40%	
Maximum	$519,830	655%	$432,229	555%	$32,215	0%	
Minimum	$178,696	197%	$152,560	170%	-$168,435	-473%	

Note: $\text{Pension Wealth}_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)} \pi_t}{(1+r)^{t-1}}$

where $\mathcal{A}_t$ is the capped annual payment in year t >T, f_t is the cost of living adjustment in year t, π_t is the probability of surviving at year t, and r is the discount rate.
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.14: Comparison of Simulated Lifetime Contributions

State	2007		2016		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
	Lifetime Contributions	% of FAS	Lifetime Contributions	% of FAS	Lifetime Contributions	% of FAS
Alabama	$41,935	64%	$60,331	83%	$18,396	19%
Arizona	$75,633	112%	$91,835	147%	$16,202	35%
Arkansas	$45,859	83%	$41,996	83%	-$3,863	0%
California	$96,423	94%	$120,627	110%	$24,205	16%
Colorado	$70,754	106%	$64,338	108%	-$6,416	1%
Connecticut	$86,126	63%	$86,996	63%	$870	0%
DC	$92,080	99%	$100,091	99%	$8,011	0%
Delaware	$33,900	35%	$52,595	59%	$18,695	24%
Florida	$0	0%	$25,542	45%	$25,542	45%
Georgia	$46,024	62%	$50,460	74%	$4,436	12%
Hawaii	$58,895	94%	$80,361	132%	$21,466	38%
Idaho	$51,526	90%	$51,058	99%	-$468	8%
Illinois	$114,022	117%	$115,149	118%	$1,127	1%
Iowa	$35,046	47%	$54,202	73%	$19,156	26%
Kentucky	$80,985	127%	$101,418	166%	$20,433	39%
Louisiana	$72,640	118%	$76,113	125%	$3,473	7%
Maine	$79,604	86%	$85,839	84%	$6,235	-2%
Maryland	$75,813	91%	$76,499	92%	$687	1%
Massachusetts	$87,465	110%	$199,459	103%	$111,994	-7%
Minnesota	$67,260	65%	$89,713	89%	$22,453	24%

Note: $Lifetime\ Contributions_{t=1} = \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$

where C_t is the teacher contribution in year $t \leq T$ and r is the discount rate. The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.14 (cont'd)

State	2007		2016		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
	Lifetime Contributions	% of FAS	Lifetime Contributions	% of FAS	Lifetime Contributions	% of FAS
Mississippi	$54,419	99%	$67,267	129%	$12,848	31%
Missouri	$85,863	169%	$100,112	204%	$14,249	35%
Montana	$46,270	81%	$63,984	96%	$17,714	15%
Nebraska	$55,059	95%	$77,048	130%	$21,989	35%
Nevada	$98,560	123%	$141,217	169%	$42,657	47%
New Hampshire	$55,463	56%	$90,206	74%	$34,743	19%
New Jersey	$74,567	72%	$103,303	93%	$28,736	21%
New Mexico	$64,705	93%	$97,765	135%	$33,061	42%
New York	$11,522	14%	$64,268	57%	$52,746	44%
North Carolina	$62,858	74%	$55,320	74%	-$7,537	0%
North Dakota	$60,868	105%	$105,239	162%	$44,371	57%
Ohio	$111,042	103%	$142,813	145%	$31,771	41%
Oklahoma	$54,505	104%	$52,114	106%	-$2,391	2%
Pennsylvania	$93,042	89%	$119,552	112%	$26,510	24%
South Carolina	$52,922	81%	$68,337	103%	$15,415	23%
South Dakota	$48,083	86%	$47,899	86%	-$184	0%
Texas	$57,522	82%	$79,828	95%	$22,306	13%
Vermont	$30,987	39%	$52,909	56%	$21,922	17%
West Virginia	$55,027	83%	$53,297	83%	-$1,730	0%
Wisconsin	$51,904	59%	$65,709	77%	$13,805	19%
Wyoming	$0	0%	$22,613	33%	$22,613	33%
Summary Statistics by Year						
Mean	$61,882	82%	$80,376	102%	$18,494	20%
Median	$58,895	86%	$76,499	96%	$18,396	19%
Maximum	$114,022	169%	$199,459	204%	$111,994	57%
Minimum	$0	0%	$22,613	33%	-$7,537	-7%

Note: $Lifetime\ Contributions_{t=1} = \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$

where C_t is the teacher contribution in year $t \leq T$ and r is the discount rate.
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away;
2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.15: Comparison of Net Pension Wealth

State	2007			2016			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Net Pension Wealth	% of FAS	% of Salary	Net Pension Wealth	% of FAS	% of Salary	Social Security
Alabama	$267,495	411%	32%	$104,843	145%	10%	Yes
Arizona	$228,747	340%	28%	$174,324	280%	22%	Yes
Arkansas	$207,365	377%	27%	$189,897	377%	27%	Yes
California	$287,658	280%	24%	$183,086	167%	14%	No
Colorado	$258,987	390%	29%	$194,487	325%	24%	No
Connecticut	$341,780	249%	24%	$345,233	249%	24%	No
DC	$278,205	298%	24%	$302,408	298%	24%	No
Delaware	$317,811	332%	28%	$274,807	308%	26%	Yes
Florida	$191,548	318%	22%	$130,133	232%	15%	No
Georgia	$250,284	335%	27%	$220,262	323%	26%	Partial
Hawaii	$190,527	303%	19%	$85,579	141%	9%	Yes
Idaho	$142,900	251%	17%	$125,713	243%	17%	Yes
Illinois	$212,080	217%	17%	$50,968	52%	4%	No
Iowa	$227,520	303%	25%	$205,348	276%	23%	Yes
Kentucky	$271,525	427%	33%	$237,010	389%	30%	No
Louisiana	$231,712	378%	26%	$134,137	221%	14%	No
Maine	$178,056	191%	17%	$145,261	141%	13%	No
Maryland	$222,842	267%	21%	$135,849	164%	12%	Yes
Massachusetts	$432,364	545%	54%	$151,936	79%	8%	No

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.15 (cont'd)

State	2007			2016			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Net Pension Wealth	% of FAS	% of Salary	Net Pension Wealth	% of FAS	% of Salary	Social Security
Minnesota	$135,775	132%	11%	$108,884	108%	9%	Yes
Mississippi	$206,131	373%	27%	$139,384	268%	19%	Yes
Missouri	$165,939	327%	23%	$142,858	292%	21%	No
Montana	$179,094	313%	28%	$156,839	235%	20%	Yes
Nebraska	$176,168	302%	23%	$158,914	267%	20%	Yes
Nevada	$300,312	374%	32%	$231,247	277%	24%	No
New Hampshire	$204,463	205%	18%	$116,289	96%	9%	Yes
New Jersey	$218,884	211%	16%	$104,181	94%	7%	Yes
New Mexico	$320,123	461%	39%	$239,488	331%	27%	Yes
New York	$324,522	383%	32%	$207,730	185%	15%	Yes
North Carolina	$243,036	287%	23%	$213,893	287%	23%	Yes
North Dakota	$170,077	292%	22%	$117,009	180%	13%	Yes
Ohio	$357,665	333%	32%	$287,767	292%	28%	No
Oklahoma	$124,191	237%	16%	$100,446	205%	13%	Yes
Pennsylvania	$316,017	301%	25%	$212,412	199%	17%	Yes
South Carolina	$203,406	310%	25%	$136,865	207%	16%	Yes
South Dakota	$139,971	251%	17%	$122,906	221%	15%	Yes
Texas	$281,610	402%	31%	$186,309	223%	17%	Yes
Vermont	$231,705	292%	25%	$234,231	250%	22%	Yes
West Virginia	$152,740	229%	17%	$125,454	194%	14%	Yes
Wisconsin	$205,636	232%	20%	$181,291	213%	18%	Yes
Wyoming	$319,044	434%	31%	$250,914	364%	26%	Yes
Summary Statistics by Year							
Mean	$236,973	315%	25%	$174,795	229%	18%	68%
Median	$227,520	303%	25%	$158,914	232%	17%	100%
Maximum	$432,364	545%	54%	$345,233	389%	30%	
Minimum	$124,191	132%	11%	$50,968	52%	4%	

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.16: Comparison of Net Pension Wealth Across States and Overtime

	Difference			Rate of Change			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
State	Net Pension Wealth	% of FAS	% of Salary	Net Pension Wealth	% of FAS	% of Salary	Social Security
Alabama	-$162,653	-266%	-21%	-61%	-65%	-67%	Yes
Arizona	-$54,423	-61%	-6%	-24%	-18%	-22%	Yes
Arkansas	-$17,468	0%	0%	-8%	0%	0%	Yes
California	-$104,572	-113%	-10%	-36%	-40%	-41%	No
Colorado	-$64,500	-64%	-5%	-25%	-17%	-17%	No
Connecticut	$3,454	0%	0%	1%	0%	0%	No
DC	$24,203	0%	0%	9%	0%	0%	No
Delaware	-$43,004	-24%	-2%	-14%	-7%	-7%	Yes
Florida	-$61,415	-86%	-7%	-32%	-27%	-30%	No
Georgia	-$30,022	-12%	-1%	-12%	-4%	-4%	Partial
Hawaii	-$104,949	-163%	-11%	-55%	-54%	-56%	Yes
Idaho	-$17,187	-8%	-1%	-12%	-3%	-3%	Yes
Illinois	-$161,111	-165%	-13%	-76%	-76%	-76%	No
Iowa	-$22,173	-26%	-3%	-10%	-9%	-11%	Yes
Kentucky	-$34,515	-39%	-3%	-13%	-9%	-9%	No
Louisiana	-$97,575	-157%	-11%	-42%	-42%	-45%	No
Maine	-$32,795	-50%	-4%	-18%	-26%	-24%	No
Maryland	-$86,993	-103%	-8%	-39%	-39%	-40%	Yes
Massachusetts	-$280,428	-466%	-46%	-65%	-86%	-85%	No
Minnesota	-$26,891	-24%	-2%	-20%	-18%	-18%	Yes

Note: $\text{NPW Rate of Change}_s = \frac{\text{NPW}_{s\ 2016} - \text{NPW}_{s\ 2007}}{\text{NPW}_{s\ 2007}}$

where NPW is one of the measures of net pension wealth described above in state s.
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.16 (cont'd)

State	Difference			Rate of Change			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Net Pension Wealth	% of FAS	% of Salary	Net Pension Wealth	% of FAS	% of Salary	Social Security
Mississippi	-$66,747	-106%	-9%	-32%	-28%	-32%	Yes
Missouri	-$23,081	-35%	-2%	-14%	-11%	-11%	No
Montana	-$22,255	-78%	-8%	-12%	-25%	-28%	Yes
Nebraska	-$17,254	-35%	-3%	-10%	-12%	-13%	Yes
Nevada	-$69,065	-96%	-8%	-23%	-26%	-26%	No
New Hampshire	-$88,174	-109%	-9%	-43%	-53%	-51%	Yes
New Jersey	-$114,704	-117%	-9%	-52%	-55%	-56%	Yes
New Mexico	-$80,635	-130%	-11%	-25%	-28%	-29%	Yes
New York	-$116,792	-198%	-17%	-36%	-52%	-52%	Yes
North Carolina	-$29,143	0%	0%	-12%	0%	0%	Yes
North Dakota	-$53,067	-113%	-9%	-31%	-39%	-40%	Yes
Ohio	-$69,898	-41%	-4%	-20%	-12%	-12%	No
Oklahoma	-$23,745	-32%	-2%	-19%	-13%	-15%	Yes
Pennsylvania	-$103,605	-102%	-9%	-33%	-34%	-34%	Yes
South Carolina	-$66,541	-103%	-9%	-33%	-33%	-35%	Yes
South Dakota	-$17,065	-30%	-2%	-12%	-12%	-12%	Yes
Texas	-$95,302	-179%	-15%	-34%	-45%	-46%	Yes
Vermont	$2,527	-42%	-3%	1%	-14%	-13%	Yes
West Virginia	-$27,286	-35%	-3%	-18%	-15%	-15%	Yes
Wisconsin	-$24,346	-19%	-2%	-12%	-8%	-8%	Yes
Wyoming	-$68,130	-70%	-5%	-21%	-16%	-17%	Yes
Summary Statistics by Year							
Mean	-$62,179	-85%	-7%	-25%	-26%	-27%	68%
Median	-$54,423	-64%	-5%	-21%	-18%	-22%	100%
Maximum	$24,203	0%	0%	9%	0%	0%	
Minimum	-$280,428	-466%	-46%	-76%	-86%	-85%	

Note: $\text{NPW Rate of Change}_s = \frac{\text{NPW}_{s\ 2016} - \text{NPW}_{s\ 2007}}{\text{NPW}_{s\ 2007}}$

where NPW is one of the measures of net pension wealth described above in state s.
The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.17: Summary of Pension Reforms and Salary Changes Between 2007 and 2016

State	Reforms Include:			
	Less Generous Parametric Pension Reforms	More Generous Parametric Pension Reforms	Increasing Starting Salary	Decreasing Starting Salary
Alabama	Yes			Yes
Arizona	Yes	Removed Caps		Yes
Arkansas				Yes
California	Yes		Yes	
Colorado	Yes			Yes
Connecticut			Yes	
Delaware	Yes			Yes
DC			Yes	
Florida	Yes			Yes
Georgia	Yes			Yes
Hawaii	Yes			Yes
Idaho	Yes			Yes
Illinois	Yes			Yes
Iowa	Yes		Yes	
Kentucky	Yes			Yes
Louisiana	Yes			Yes
Maine	Yes		Yes	
Maryland	Yes			Yes
Massachusetts	Yes		Yes	
Minnesota	Yes			Yes
Mississippi	Yes			Yes
Missouri	Yes			Yes
Montana	Yes		Yes	
Nebraska	Yes		Yes	
Nevada	Yes		Yes	
New Hampshire	Yes		Yes	
New Jersey	Yes			Yes
New Mexico	Yes			Yes
New York	Yes		Yes	
North Carolina				Yes
North Dakota	Yes		Yes	
Ohio	Yes			Yes
Oklahoma	Yes			Yes
Pennsylvania	Yes		Yes	
South Carolina	Yes			Yes
South Dakota	Yes			Yes
Texas	Yes			Yes
Vermont	Yes	Less restriction on caps and increased multipliers	Yes	
West Virginia	Yes			Yes
Wisconsin	Yes			Yes
Wyoming	Yes			Yes
Total	37	2	14	27

Source: Author's tabulation from pension-plan-specific information detailed in Table 1.3.

Table 1.18: Comparison of the Rankings of Net Pension Wealth, Measured by the Percentage of Final Average Salary

	2007		2016		Difference		Rate of Change		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
State	% of FAS	Rank	% of FAS	Rank	% of FAS	Rank	% of FAS	Rank	Social Security
Alabama	411%	6	145%	35	-266%	2	-65%	3	Yes
Arizona	340%	14	280%	13	-61%	22	-18%	22	Yes
Arkansas	377%	11	377%	3	0%	38	0%	38	Yes
California	280%	30	167%	33	-113%	10	-40%	10	No
Colorado	390%	8	325%	6	-64%	21	-17%	23	No
Connecticut	249%	34	249%	19	0%	38	0%	38	No
DC	298%	26	298%	9	0%	38	0%	38	No
Delaware	332%	17	308%	8	-24%	34	-7%	35	Yes
Florida	318%	19	232%	22	-86%	18	-27%	17	No
Georgia	335%	15	323%	7	-12%	36	-4%	36	Partial
Hawaii	303%	22	141%	37	-163%	6	-54%	5	Yes
Idaho	251%	33	243%	20	-8%	37	-3%	37	Yes
Illinois	217%	38	52%	42	-165%	5	-76%	2	No
Iowa	303%	23	276%	15	-26%	32	-9%	33	Yes
Kentucky	427%	5	389%	2	-39%	26	-9%	32	No
Louisiana	378%	10	221%	25	-157%	7	-42%	9	No
Maine	191%	41	141%	36	-50%	23	-26%	18	No
Maryland	267%	31	164%	34	-103%	14	-39%	11	Yes
Massachusetts	545%	2	79%	41	-466%	1	-86%	1	No
Minnesota	132%	42	108%	38	-24%	33	-18%	21	Yes
Mississippi	373%	13	268%	16	-106%	13	-28%	15	Yes

Note: $\text{NPW Rate of Change}_s = \frac{\text{NPW}_{s\ 2016} - \text{NPW}_{s\ 2007}}{\text{NPW}_{s\ 2007}}$

The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.

Source: Author's calculations.

Table 1.18 (cont'd)

State	2007		2016		Difference		Rate of Change		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	% of FAS	Rank	% of FAS	Rank	% of FAS	Rank	% of FAS	Rank	Social Security
Missouri	327%	18	292%	11	-35%	27	-11%	31	No
Montana	313%	20	235%	21	-78%	19	-25%	20	Yes
Nebraska	302%	24	267%	17	-35%	28	-12%	30	Yes
Nevada	374%	12	277%	14	-96%	17	-26%	19	No
New Hampshire	205%	40	96%	39	-109%	12	-53%	6	Yes
New Jersey	211%	39	94%	40	-117%	9	-55%	4	Yes
New Mexico	461%	3	331%	5	-130%	8	-28%	16	Yes
New York	383%	9	185%	31	-198%	3	-52%	7	Yes
North Carolina	287%	29	287%	12	0%	41	0%	41	Yes
North Dakota	292%	28	180%	32	-113%	11	-39%	12	Yes
Ohio	333%	16	292%	10	-41%	25	-12%	28	No
Oklahoma	237%	35	205%	28	-32%	30	-13%	27	Yes
Pennsylvania	301%	25	199%	29	-102%	16	-34%	13	Yes
South Carolina	310%	21	207%	27	-103%	15	-33%	14	Yes
South Dakota	251%	32	221%	24	-30%	31	-12%	29	Yes
Texas	402%	7	223%	23	-179%	4	-45%	8	Yes
Vermont	292%	27	250%	18	-42%	24	-14%	26	Yes
West Virginia	229%	37	194%	30	-35%	29	-15%	25	Yes
Wisconsin	232%	36	213%	26	-19%	35	-8%	34	Yes
Wyoming	434%	4	364%	4	-70%	20	-16%	24	Yes

Note: $\text{NPW Rate of Change}_s = \frac{\text{NPW}_{s\ 2016} - \text{NPW}_{s\ 2007}}{\text{NPW}_{s\ 2007}}$

The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.

Source: Author's calculations.

Table 1.19: Simulation of Net Pension Wealth for Teachers Hired in 2007 by Years to Live and State

State	Pension Wealth if Expect to Live Until					
	Age 75		Age 80		Age 85	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Alabama	$221,946	26%	$267,495	32%	$310,896	37%
Arizona	$178,203	21%	$228,747	28%	$276,909	33%
Arkansas	$165,315	22%	$207,365	27%	$247,432	32%
California	$198,480	16%	$287,658	24%	$372,630	31%
Colorado	$199,252	23%	$258,987	29%	$315,904	36%
Connecticut	$242,426	17%	$341,780	24%	$436,448	30%
DC	$211,125	18%	$278,205	24%	$342,121	30%
Delaware	$254,096	22%	$317,811	28%	$378,521	33%
Florida	$156,848	18%	$191,548	22%	$224,612	26%
Georgia	$196,605	21%	$250,284	27%	$301,431	33%
Hawaii	$145,343	15%	$190,527	19%	$233,581	24%
Idaho	$102,269	12%	$142,900	17%	$181,615	22%
Illinois	$136,363	11%	$212,080	17%	$284,225	23%
Iowa	$175,297	20%	$227,520	25%	$277,281	31%
Kentucky	$215,362	26%	$271,525	33%	$325,038	40%
Louisiana	$176,576	19%	$231,712	26%	$284,247	31%
Maine	$110,919	11%	$178,056	17%	$242,027	23%
Maryland	$168,738	16%	$222,842	21%	$274,393	25%
Massachusetts	$368,421	46%	$432,364	54%	$493,292	62%
Minnesota	$66,394	5%	$135,775	11%	$201,884	17%
Mississippi	$167,777	22%	$206,131	27%	$242,676	32%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.19 (cont'd)

State	Pension Wealth if Expect to Live Until					
	Age 75		Age 80		Age 85	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Missouri	$120,323	17%	$165,939	23%	$209,403	29%
Montana	$145,919	23%	$179,094	28%	$210,703	33%
Nebraska	$134,279	18%	$176,168	23%	$216,081	29%
Nevada	$228,054	24%	$300,312	32%	$369,163	39%
New Hampshire	$144,112	13%	$204,463	18%	$261,968	24%
New Jersey	$150,749	11%	$218,884	16%	$283,806	21%
New Mexico	$263,474	32%	$320,123	39%	$374,099	45%
New York	$275,167	27%	$336,044	33%	$394,050	39%
North Carolina	$187,621	18%	$243,036	23%	$295,837	28%
North Dakota	$128,239	16%	$170,077	22%	$209,941	27%
Ohio	$272,755	25%	$357,665	32%	$438,570	39%
Oklahoma	$86,847	11%	$124,191	16%	$159,774	21%
Pennsylvania	$221,039	18%	$316,017	25%	$406,516	33%
South Carolina	$160,841	20%	$203,406	25%	$243,964	30%
South Dakota	$105,904	13%	$139,971	17%	$172,432	22%
Texas	$225,294	25%	$281,610	31%	$335,270	37%
Vermont	$184,116	20%	$231,705	25%	$277,049	30%
West Virginia	$104,500	11%	$152,740	17%	$198,706	22%
Wisconsin	$154,413	15%	$205,636	20%	$254,444	25%
Wyoming	$261,247	25%	$319,044	31%	$374,116	36%
Summary Statistics by Year						
Mean	$180,796	19%	$237,254	25%	$291,050	31%
Median	$175,297	18%	$227,520	25%	$277,281	30%
Maximum	$368,421	46%	$432,364	54%	$493,292	62%
Minimum	$66,394	5%	$124,191	11%	$159,774	17%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement; 3. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.20: Simulation of Net Pension Wealth for Teachers Hired in 2007 by Discount Rate and State

State	Pension Wealth if Discount Rate Equals					
	3%		4%		5%	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Alabama	$409,306	44%	$267,495	32%	$174,333	23%
Arizona	$370,278	40%	$228,747	28%	$137,727	19%
Arkansas	$327,270	38%	$207,365	27%	$129,812	19%
California	$482,555	34%	$287,658	24%	$166,223	16%
Colorado	$417,863	42%	$258,987	29%	$157,398	20%
Connecticut	$561,676	33%	$341,780	24%	$204,210	17%
DC	$454,491	35%	$278,205	24%	$165,856	16%
Delaware	$492,775	38%	$317,811	28%	$204,884	21%
Florida	$289,505	29%	$191,548	22%	$127,846	16%
Georgia	$395,308	38%	$250,284	27%	$157,116	19%
Hawaii	$310,457	28%	$190,527	19%	$113,921	13%
Idaho	$239,440	25%	$142,900	17%	$82,209	11%
Illinois	$372,285	26%	$212,080	17%	$113,208	11%
Iowa	$360,606	35%	$227,520	25%	$142,598	18%
Kentucky	$433,665	47%	$271,525	33%	$166,663	23%
Louisiana	$377,754	37%	$231,712	26%	$138,470	17%
Maine	$309,107	25%	$178,056	17%	$97,640	11%
Maryland	$365,012	30%	$222,842	21%	$132,252	14%
Massachusetts	$650,905	75%	$432,364	54%	$286,433	39%
Minnesota	$243,492	17%	$135,775	11%	$71,035	7%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.20 (cont'd)

State	Pension Wealth if Discount Rate Equals					
	3%		4%		5%	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Mississippi	$323,478	39%	$206,131	27%	$129,450	19%
Missouri	$283,140	35%	$165,939	23%	$91,792	14%
Montana	$280,300	39%	$179,094	28%	$112,994	19%
Nebraska	$286,754	33%	$176,168	23%	$105,607	16%
Nevada	$489,988	46%	$300,312	32%	$179,450	22%
New Hampshire	$337,588	26%	$204,463	18%	$121,264	13%
New Jersey	$368,045	23%	$218,884	16%	$125,933	11%
New Mexico	$494,739	53%	$320,123	39%	$205,731	28%
New York	$507,896	44%	$336,044	33%	$224,287	25%
North Carolina	$390,508	33%	$243,036	23%	$148,701	16%
North Dakota	$279,839	31%	$170,077	22%	$100,181	14%
Ohio	$580,447	45%	$357,665	32%	$215,670	22%
Oklahoma	$211,942	24%	$124,191	16%	$69,216	10%
Pennsylvania	$525,099	36%	$316,017	25%	$185,466	17%
South Carolina	$323,652	35%	$203,406	25%	$125,828	17%
South Dakota	$229,712	25%	$139,971	17%	$82,765	12%
Texas	$442,713	44%	$281,610	31%	$177,330	22%
Vermont	$361,519	35%	$231,705	25%	$148,069	18%
West Virginia	$258,091	24%	$152,740	17%	$87,144	11%
Wisconsin	$333,213	28%	$205,636	20%	$124,722	14%
Wyoming	$482,203	41%	$319,044	31%	$212,941	23%
Summary Statistics by Year						
Mean	$372,729	35%	$231,606	25%	$141,533	17%
Median	$366,528	35%	$225,181	25%	$134,990	17%
Maximum	$650,905	75%	$432,364	54%	$286,433	39%
Minimum	$0	17%	$0	11%	$0	7%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. the cost of living adjustments for teachers are 3 percent per year throughout her retirement. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.21: Simulation of Net Pension Wealth for Teachers Hired in 2007 by COLAs and State

State	Pension Wealth if COLAs Equal					
	2.5%		3.0%		3.5%	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Alabama	$247,686	30%	$267,495	32%	$289,134	34%
Arizona	$211,109	25%	$228,747	28%	$247,837	30%
Arkansas	$192,691	25%	$207,365	27%	$223,246	29%
California	$271,024	22%	$287,658	24%	$305,272	25%
Colorado	$241,235	27%	$258,987	29%	$278,080	31%
Connecticut	$323,248	23%	$341,780	24%	$361,404	25%
DC	$258,270	22%	$278,205	24%	$299,645	26%
Delaware	$298,877	26%	$317,811	28%	$338,177	30%
Florida	$181,236	21%	$191,548	22%	$202,639	23%
Georgia	$234,332	25%	$250,284	27%	$267,441	29%
Hawaii	$177,100	18%	$190,527	19%	$204,970	21%
Idaho	$133,653	16%	$142,900	17%	$152,753	18%
Illinois	$197,957	16%	$212,080	17%	$227,035	19%
Iowa	$214,480	24%	$227,520	25%	$241,460	27%
Kentucky	$250,379	30%	$271,525	33%	$294,481	36%
Louisiana	$215,327	24%	$231,712	26%	$249,335	27%
Maine	$168,008	16%	$178,056	17%	$188,630	18%
Maryland	$206,763	19%	$222,842	21%	$240,135	22%
Massachusetts	$393,965	50%	$432,364	54%	$474,957	60%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 1.21 (cont'd)

State	Pension Wealth if COLAs Equal					
	2.5%		3.0%		3.5%	
	(1)	(2)	(3)	(4)	(5)	(6)
	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary	Net Pension Wealth	% Salary
Minnesota	$129,642	11%	$135,775	11%	$142,149	12%
Mississippi	$189,451	25%	$206,131	27%	$224,351	30%
Missouri	$152,383	21%	$165,939	23%	$180,519	25%
Montana	$164,666	25%	$179,094	28%	$194,853	30%
Nebraska	$163,720	22%	$176,168	23%	$189,557	25%
Nevada	$278,839	30%	$300,312	32%	$323,408	34%
New Hampshire	$193,206	17%	$204,463	18%	$216,383	20%
New Jersey	$206,176	15%	$218,884	16%	$232,342	17%
New Mexico	$295,486	36%	$320,123	39%	$347,034	42%
New York	$317,953	31%	$336,044	33%	$355,502	35%
North Carolina	$226,568	22%	$243,036	23%	$260,748	25%
North Dakota	$157,644	20%	$170,077	22%	$183,449	23%
Ohio	$332,432	30%	$357,665	32%	$384,805	35%
Oklahoma	$115,692	15%	$124,191	16%	$133,247	17%
Pennsylvania	$298,301	24%	$316,017	25%	$334,776	27%
South Carolina	$188,552	23%	$203,406	25%	$219,482	27%
South Dakota	$129,847	16%	$139,971	17%	$150,860	19%
Texas	$261,958	29%	$281,610	31%	$302,879	34%
Vermont	$217,563	24%	$231,705	25%	$246,915	27%
West Virginia	$143,742	16%	$152,740	17%	$162,268	18%
Wisconsin	$192,845	19%	$205,636	20%	$219,308	21%
Wyoming	$301,869	29%	$319,044	31%	$337,518	33%
Summary Statistics by Year						
Mean	$216,092	23%	$231,606	25%	$248,309	27%
Median	$208,936	23%	$225,181	25%	$240,797	27%
Maximum	$393,965	50%	$432,364	54%	$474,957	60%
Minimum	$0	11%	$0	11%	$0	12%

Note: The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25 until she reaches her eligibility for normal retirement and starts collecting retirement benefits right away; 2. I assume a 4 percent discount rate. All simulations are in 2016 dollars.
Source: Author's calculations.

Table 2.1: Types of Pension Plans States and Cities Offered Teachers

State	2003	2007	2011	2016
Alabama	DB	DB	DB	DB
Alaska	DB	DC	DC	DC
Arizona	DB	DB	DB	DB
Arkansas	DB	DB	DB	DB
California	DB	DB	DB	DB
Colorado	DB	DB	DB	DB
Denver	DB	DB	DB	DB
Connecticut	DB	DB	DB	DB
Delaware	DB	DB	DB	DB
DC	DB	DB	DB	DB
Florida	DB/DC	DB/DC	DB/DC	DB/DC
Georgia	DB	DB	DB	DB
Hawaii	DB	DB	DB	DB
Idaho	DB	DB	DB	DB
Illinois	DB	DB	DB	DB
Chicago	DB	DB	DB	DB
Indiana	Hybrid	Hybrid	Hybrid	Hybrid
Iowa	DB	DB	DB	DB
Kansas	DB	DB	DB	Cash balance
Kentucky	DB	DB	DB	DB
Louisiana	DB	DB	DB	DB
Maine	DB	DB	DB	DB
Maryland	DB	DB	DB	DB
Massachusetts	DB	DB	DB	DB
Boston	DB	DB	DB	DB
Michigan	DB	DB	Hybrid	Hybrid/DC
Minnesota	DB	DB	DB	DB
Duluth	DB	DB	DB	DB
Minneapolis	DB	DB	DB	DB
St. Paul	DB	DB	DB	DB
Mississippi	DB	DB	DB	DB

Note:
*DB = Defined Benefit Plan; DC = Defined Contribution Plan; DB/DC = Can choose between DB and DC.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.1 (cont'd)

State	2003	2007	2011	2016
Missouri	DB	DB	DB	DB
Kansas City	DB	DB	DB	DB
St. Louis	DB	DB	DB	DB
Montana	DB	DB	DB	DB
Nebraska	DB	DB	DB	DB
Omaha	DB	DB	DB	DB
Nevada	DB	DB	DB	DB
New Hampshire	DB	DB	DB	DB
New Jersey	DB	DB	DB	DB
New Mexico	DB	DB	DB	DB
New York	DB	DB	DB	DB
New York City	DB	DB	DB	DB
North Carolina	DB	DB	DB	DB
North Dakota	DB	DB	DB	DB
Ohio	DB/DC/Hybrid	DB/DC/Hybrid	DB/DC/Hybrid	DB/DC/Hybrid
Oklahoma	DB	DB	DB	DB
Oregon	Hybrid	Hybrid	Hybrid	Hybrid
Pennsylvania	DB	DB	DB	DB
Rhode Island	DB	DB	DB	Hybrid
South Carolina	DB /DC	DB /DC	DB /DC	DB /DC
South Dakota	DB	DB	DB	DB
Tennessee	DB	DB	DB	Hybrid
Texas	DB	DB	DB	DB
Utah	DB	DB	Hybrid/DC	Hybrid/DC
*Vermont	DB	DB	DB	DB
Virginia	DB	DB	DB	Hybrid
Fairfax	DB	DB	DB	Hybrid
Washington	Hybrid	Hybrid	Hybrid /DB	Hybrid /DB
West Virginia	DC	DB	DB	DB
Wisconsin	DB	DB	DB	DB
Wyoming	DB	DB	DB	DB

Note:
*DB = Defined Benefit Plan; DC = Defined Contribution Plan; DB/DC = Can choose between DB and DC.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.2: State Teacher Pension Homepage, Handbooks, and Other Resources

Alabama	The Retirement Systems of Alabama, Teachers' Retirement System	
	Homepage	http://www.rsa-al.gov/index.php/members/trs/
	Tier 1 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T1_bookmarked.pdf#Membership
	Tier 2 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T2_bookmarked.pdf#Membership
	Contribution History	http://www.lfo.state.al.us/PDFs/Presentations/Retirement_Systems_Presentation.pdf
Alaska	The PERS/TRS Defined Contribution Retirement Plan, Teachers' Retirement System	
	Homepage	http://doa.alaska.gov/drb/dcrp/index.html#.WG11Q3eZO8U
Arizona	Arizona State Retirement System	
	Homepage	https://www.azasrs.gov
	Annual Financial Report (2016; 2011)	https://www.azasrs.gov/sites/default/files/pdf/ASRS%202016%20CAFR.PDF; https://www.azasrs.gov/sites/default/files/pdf/ASRS_2011_CAFR.pdf
Arkansas	Arkansas Teacher Retirement System	
	Homepage	https://www.artrs.gov
California	California State Teachers' Retirement System	
	Homepage	http://www.calstrs.com
	Handbook	https://www.calstrs.com/sites/main/files/file-attachments/memberhandbook2017.pdf
Colorado	Colorado Public Employees' Retirement Association	
	Homepage	https://www.copera.org
	Handbook	https://www.copera.org/sites/default/files/documents/5-5.pdf
Connecticut	The Connecticut Teachers' Retirement System	
	Homepage	http://www.ct.gov/trb/site/default.asp
DC	District of Columbia Retirement Board	
	Homepage	http://dcrb.dc.gov/publication/teachers-summary-plan-description
	Summary Plan Description	https://dcrb.dc.gov/sites/default/files/dc/sites/dcrb/publication/attachments/DCRBTeachers%27Plan2012web%20update%20june%202014.pdf
Delaware	State of Delaware Office of Pensions	
	Homepage	http://www.delawarepensions.com/default.shtml
	Annual Financial Report (2016)	http://www.delawarepensions.com/FinancialReports/financials/fy16cafr.pdf

Table 2.2 (cont'd)

Florida	Florida Retirement System Pension Plan	
	Homepage	https://www.myfrs.com/FRSPro_Pension.htm
	Handbook	https://www.rol.frs.state.fl.us/forms/member_handbook.pdf
Georgia	Teachers Retirement System of Georgia	
	Homepage	http://www.trsga.com/home
	Handbook	http://www.trsga.com/downloadPublications/Members%20Guide%202015%20with%20Cover_092115_web.pdf
Hawaii	State of Hawaii Employees' Retirement System	
	Homepage	http://ers.ehawaii.gov
	Handbook (Hybrid)	http://ers.ehawaii.gov/wp-content/uploads/2012/02/ContribHybrid201205.pdf
Idaho	Public Employee Retirement System of Idaho	
	Homepage	https://persi.idaho.gov
	Handbook	https://persi.idaho.gov/Documents/Members/PERSI_Member_Handbook.pdf
Illinois	Teachers' Retirement System of the State of Illinois	
	Homepage	https://www.trsil.org
Indiana	Indiana State Teachers' Retirement Fund	
	Homepage	http://www.in.gov/inprs/
Iowa	Iowa Public Employees' Retirement System	
	Homepage	https://www.ipers.org/home
	Handbook	https://www.ipers.org/sites/default/files/media/Member%20Handbook.pdf
Kansas	Kansas Public Employees Retirement System	
	Homepage	https://www.kpers.org
Kentucky	Kentucky Teachers' Retirement System	
	Homepage	https://trs.ky.gov
Louisiana	Teachers' Retirement System of Louisiana	
	Homepage	https://www.trsl.org/main/home
	Handbook	https://www.trsl.org/uploads/File/Brochures/memberHandbook_WEB.pdf
Maine	Maine Public Employees Retirement System	
	Homepage	http://www.mainepers.org
	Handbook	http://www.mainepers.org/PDFs/handbooks/Teacher_Booklet_web.pdf
Maryland	Employees' and Teachers' Pension System	
	Homepage	http://www.sra.state.md.us
	Handbook	http://www.sra.state.md.us/Participants/Members/Downloads/Handbooks/BenefitHandbook-Emp-Pen.pdf

Table 2.2 (cont'd)

Massachusetts	Massachusetts Teachers' Retirement System	
	Homepage	http://www.mass.gov/mtrs/
	Seminar and reference guide	http://www.mass.gov/mtrs/docs/publications/yrbenefitsbklet.pdf
Michigan	Pension Plus, Michigan Public School Employees Retirement System	
	Homepage (MIP)	http://www.michigan.gov/orsschools/
	Homepage (Pension Plus)	http://www.mipensionplus.org
Minnesota	Minnesota Teachers Retirement Association	
	Homepage	https://www.minnesotatra.org
	Handbook	https://www.minnesotatra.org/images/pdf/Member%20Handbook.pdf
Mississippi	Public Employees' Retirement System of Mississippi	
	Homepage	http://www.pers.ms.gov/Pages/Home.aspx
	Handbook	http://www.pers.ms.gov/Content/Handbooks/Member_Handbook.pdf
Missouri	Public School & Education Employee Retirement System of Missouri	
	Homepage	https://www.psrs-peers.org
Montana	Montana Teachers' Retirement System	
	Homepage	https://trs.mt.gov
	Handbook	https://trs.mt.gov/miscellaneous/PdfFiles/Members/2016_TRS_Active_Member_Handbook.pdf
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System	
	Homepage	http://npers.ne.gov/SelfService/public/planInformation/school/schoolPlanInfo.jsp
	Handbook	http://npers.ne.gov/SelfService/public/howto/handbooks/handbookSchool.pdf
Nevada	Nevada Public Employees' Retirement System	
	Homepage	http://www.nvpers.org/public/members/
	Summary Plan Description Tier 1	https://www.nvpers.org/public/publications/regPlan.pdf
	Summary Plan Description Tier 2	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-1-1-2010.pdf
	Summary Plan Description Tier 3	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-7-1-2015.pdf
	Legislation	https://www.leg.state.nv.us/NRS/NRS-286.html#NRS286Sec537

Table 2.2 (cont'd)

New Hampshire	New Hampshire Retirement System	
	Homepage	https://www.nhrs.org/members
	Legislation	http://www.gencourt.state.nh.us/rsa/html/vi/100-a/100-a-mrg.htm
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund	
	Homepage	http://www.nj.gov/treasury/pensions/
	Handbook	http://www.nj.gov/treasury/pensions/pdf/handbook/tpafbook.pdf
	Comprehensive Audited Financial Report	http://www.nj.gov/treasury/pensions/pdf/financial/2016divisioncombined.pdf
New Mexico	New Mexico Educational Retirement Board	
	Handbook (updated 2015)	https://www.nmerb.org/pdfs/memberwebhandbooksep2015.pdf
New York	New York State Teachers' Retirement System	
	Homepage	https://www.nystrs.org
	Handbook	https://www.nystrs.org/NYSTRS/media/PDF/Library/Publications/Active%20Members/handbook.pdf
North Carolina	Teachers' and State Employees' Retirement System	
	Homepage	https://www.nctreasurer.com/retirement-and-savings/managing-my-retirement/pages/default.aspx
	Handbook	https://www.nctreasurer.com/ret/Benefits%20Handbooks/TSERShandbook.pdf
North Dakota	North Dakota Teachers' Fund for Retirement	
	Handbook	http://www.nd.gov/rio/TFFR/Publications/Handbook.pdf
Ohio	State Teachers Retirement System of Ohio	
	Homepage	https://www.strsoh.org/actives/index.html
	Handbook	https://www.strsoh.org/_pdfs/brochureseries/benefitpayoptns/15-126.pdf
	Legislation	https://www.strsoh.org/_pdfs/legislation/20-663.pdf
Oklahoma	Oklahoma Teachers Retirement System	
	Homepage	https://www.ok.gov/TRS/
	Handbook	https://www.ok.gov/TRS/documents/Client%20Handbook%20V10%20(2016).pdf
Oregon	Oregon Public Employees' Retirement System	
	Homepage	http://www.oregon.gov/PERS/pages/index.aspx
Pennsylvania	Public School Employees' Retirement System	
	Homepage	http://www.psers.state.pa.us
	Handbook	http://www.psers.pa.gov/FPP/Publications/Active/Documents/Active%20Handbook.pdf

Table 2.2 (cont'd)

Rhode Island	Employees' Retirement System of Rhode Island	
	Homepage	https://www.ersri.org/#gsc.tab=0
	Benefit Introduction	https://d10k7k7mywg42z.cloudfront.net/assets/568549a8edb2f3791a1f46d7/Teachers_Retirement_Presentation_Dec_2015.pdf
	An Employee's Guide to Understanding the Rhode Island Retirement Security Act	https://d10k7k7mywg42z.cloudfront.net/assets/4f2feb51dabe9d2cb600fa49/final_rirsaguide_january2012.pdf
South Carolina	South Carolina Retirement Systems	
	Homepage	http://www.peba.sc.gov/retirement.html
	Handbook	http://www.peba.sc.gov/assets/scrshandbook.pdf
South Dakota	South Dakota Retirement System	
	Homepage	http://sdrs.sd.gov/about/default.aspx
	Handbook	http://sdrs.sd.gov/docs/ClassAFoundationMemberHandbook.pdf
Tennessee	Tennessee Consolidated Retirement System	
	Homepage	http://treasury.tn.gov/tcrs/
	Handbook (DB)	http://www.treasury.state.tn.us/tcrs/PDFs/Con-Teachers.pdf
	Handbook (Hybrid)	http://treasury.tn.gov/tcrs/PDFs/hybridplan.pdf
Texas	Teacher Retirement System of Texas	
	Homepage	https://www.trs.texas.gov/Pages/Homepage.aspx
	Handbook	https://www.trs.texas.gov/TRS%20Documents/benefits_handbook.pdf
Utah	Utah Retirement Systems	
	Homepage	https://www.urs.org
Vermont	Vermont State Teachers' Retirement System	
	Homepage	http://www.vermonttreasurer.gov/content/retirement/teacher
Virginia	Virginia Retirement System	
	Homepage	http://www.varetire.org
	Handbook (Plan 1)	http://www.varetire.org/pdf/publications/handbook-plan-1.pdf
	Handbook (Plan 2)	http://www.varetire.org/Pdf/Publications/handbook-plan-2.pdf
Washington	Washington Teachers' Retirement System	
	Homepage	http://www.drs.wa.gov
	Handbook (Plan 2)	http://www.drs.wa.gov/member/handbooks/trs/plan-2/t2hbk.pdf

Table 2.2 (cont'd)

West Virginia	West Virginia Teachers' Retirement System	
	Homepage	http://www.wvretirement.com/TRS.html
	Tier 1 Introduction	http://www.wvretirement.com/Forms/TRS-Brochure2017.pdf
	Tier 2 Introduction	https://www.wvretirement.com/Forms/TRS-Brochure2017-TIER2.pdf
Wisconsin	Wisconsin Retirement System	
	Homepage	http://etf.wi.gov
	Handbook	http://etf.wi.gov/publications/et2119.pdf
Wyoming	Wyoming Retirement System	
	Homepage	http://retirement.state.wy.us/pension/index.html

Table 2.3: Comparison of the Number of Years Used to Calculate Final Average Salary

State	2003	2007	2011	Pension Plan Lengthen Years Used to Compute FAS Between 2007 and 2011	Social Security
Alabama	3	3	3		Yes
Arizona	3	3	5	Yes	Yes
Arkansas	3	3	3		Yes
California	1	1	1		No
Colorado	3	3	3		No
CO-Denver	3	3	3		No
Connecticut	3	3	3		No
Delaware	3	3	3		Yes
Georgia	2	2	2		Partial
Idaho	3.5	3.5	3.5		Yes
Illinois	4	4	8	Yes	No
IL-Chicago	4	4	8	Yes	No
Iowa	3	3	3		Yes
Kansas	3	3	5	Yes	Yes
Kentucky	5	5	5		No
Louisiana	3	3	5	Yes	No
Maine	3	3	3		No
Massachusetts	3	3	3		No
MA-Boston	3	3	3		No
Minnesota	5	5	5		Yes
MN-Duluth	5	5	5		Yes
MN-Minneapolis*	5	5	5		Yes
MN-St. Paul	5	5	5		Yes
Mississippi	4	4	4		Yes
Missouri	3	3	3		No
MO-Kansas City	4	4	4		Yes
MO-St. Louis	3	3	3		Yes
Montana	3	3	3		Yes
Nebraska	3	3	3		Yes

Note: *In 2006, the Minneapolis Teachers Retirement Fund Association merged with state run pension.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.3 (cont'd)

State	2003	2007	2011	Pension Plan Lengthen Years Used to Compute FAS Between 2007 and 2011	Social Security
NE-Omaha	3	3	3		Yes
Nevada	3	3	3		No
New Hampshire	5	5	5		Yes
New Jersey	3	3	5	Yes	Yes
New Mexico	5	5	5		Yes
New York	3	3	3		Yes
NY-New York City	3	3	3		Yes
North Carolina	4	4	4		Yes
North Dakota	3	3	5	Yes	Yes
Oklahoma	5	5	5		Yes
Pennsylvania	3	3	3		Yes
South Dakota	3	3	3		Yes
Tennessee	5	5	5		Yes
Texas	3	5	5		No
Virginia	3	3	5	Yes	Yes
VA-Fairfax	3	3	3		Yes
Wisconsin	3	3	3		Yes
Wyoming	3	3	3		Yes

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.4: Comparison of the Formula Multiplier

State	2003	2007	2011	Pension Plan Decreased Multiplier Between 2007 and 2011
Alabama	2.0125	2.0125	2.0125	
Arizona	Multiple	Multiple	Multiple	
Arkansas	2.15	2.15	2.15	
California	Multiple	Multiple	Multiple	
Colorado	2.5	2.5	2.5	
CO-Denver	2.5	2.5	2.5	
Connecticut	2	2	2	
Delaware	1.85	1.85	1.85	
Georgia	2	2	2	
Idaho	2	2	2	
Illinois	2.2	2.2	2.2	
IL-Chicago	2.2	2.2	2.2	
Iowa	Multiple	Multiple	Multiple	
Kansas	1.75	1.75	1.75	
Kentucky	Multiple	Multiple	Multiple	Yes
Louisiana	2.5	2.5	2.5	
Maine	2	2	2	
Massachusetts	Multiple	Multiple	Multiple	
MA-Boston	2.5	2.5	2.5	
Minnesota	Multiple	1.9	1.9	
MN-Duluth	1.7	1.7	1.7	
MN-Minneapolis*	Multiple	1.9	1.9	
MN-St. Paul	1.7	1.7	1.7	
Mississippi	Multiple	Multiple	Multiple	Yes

Note: The multipliers can be constant or vary by retirement age or years of service. In Arizona, the multipliers were 2.1% for the first 20 years, 2.15% for year 20-25, 2.2% for year 25-30, and 2.3% for years over 30. In California, the multipliers were 2% if YOS<=30, 2.2% if YOS=31, 2.4% if YOS>=32. In Iowa, the multipliers were 2% for years up to 30 and 1% for each year 31 through 35. In Kentucky, the multipliers for teachers hired between July 1, 2002 and June 30, 2008 were 2% if YOS <=10, 2.5% if years between 10-30, 3% for all years over 30. The multipliers for teachers hired after June 30, 2008 were 1.7% if year were 10 or less at retirement), 2% if YOS were between 10-20 years, 2.3% if YOS were between 20-26 years, 2.5% if YOS were between 26-30, 3% if years 30+. In Massachusetts, the multipliers were 2.5 plus Retirement Plus enhancement, if applicable. In Minnesota and Minneapolis, the multipliers for teachers who were hired in 2003 were 1.2% for year 10 and under and 1.7% for all years over 10. In Mississippi, the multipliers for teachers hired on and before June 30, 2011 were 2% for years 25 and under and 2.5% for all years over 25. The multipliers for teachers hired after June 30, 2011 were 2% for years 30 and under and 2.5% for all years over 30.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.4 (cont'd)

State	2003	2007	2011	Pension Plan Decreased Multiplier Between 2007 and 2011
Missouri	2.5	2.5	2.5	
MO-Kansas City	2	2	2	
MO-St. Louis	2	2	2	
Montana	1.67	1.67	1.67	
Nebraska	2	2	2	
NE-Omaha	2	2	2	
Nevada	2.67	2.67	2.5	Yes
New Hampshire	1.67	1.67	1.51	Yes
New Jersey	1.82	1.82	1.67	Yes
New Mexico	2.35	2.35	2.35	
New York	Multiple	Multiple	Multiple	Yes
NY-New York City	Multiple	Multiple	Multiple	
North Carolina	1.82	1.82	1.82	
North Dakota	2	2	2	
Oklahoma	2	2	2	
Pennsylvania	2.5	2.5	2	Yes
South Dakota	1.55	1.55	1.55	
Tennessee	Multiple	Multiple	Multiple	
Texas	2.3	2.3	2.3	
Virginia	1.7	1.7	1.65	Yes
VA-Fairfax	0.8	0.8	0.8	
Wisconsin	1.6	1.6	1.6	
Wyoming	Multiple	Multiple	Multiple	

Note: In New York, the multipliers for teachers hired before January 1, 2010 were 2% for years up to 30, 1.50% for all years over 30. The multipliers were 1.67% if retired with less than 20 years of service. The multipliers for teachers hired on or after January 1, 2010, and before April 1, 2012 were 2% for years up to 30, 1.50% for all years over 30. The multipliers were 1.67% if retired with less than 25 years of service. In New York City, the multipliers were 2% for years up to 30, 1.50% for all years over 30. The multipliers were 1.67% if retired with less than 20 years of service. In Tennessee, the multipliers were 1.50% plus 0.25% x years x (FAS - 90% FAS Social Security Integration Level). In Vermont, the multipliers for teachers who were hired on or after July 1, 1990, under age 57, and less than 25 years of service credit on June 30, 2010, were 1.67% for all years plus 2.0% after attaining 20 years. In Wyoming, the multipliers were 2.125% for years up to 15 and 2.25% for years over 15.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.5: The Limitation on First Year Annual Benefits as a Percentage of FAS

State	2003	2007	2011
Alabama	None	None	None
Arizona*	80	80	None
Arkansas	None	None	None
California	None	None	None
Colorado	100	100	100
CO-Denver	None	None	100
Connecticut	75	75	75
Delaware	None	None	None
Georgia	80	80	80
Idaho	100	100	100
Illinois	75	75	75
IL-Chicago	75	75	75
Iowa	65	65	65
Kansas	None	None	None
Kentucky	100	100	100
Louisiana	100	100	100
Maine	None	None	None
Massachusetts	80	80	80
MA-Boston	80	80	80
Minnesota	100	100	100
MN-Duluth	None	None	None
MN-Minneapolis	100	100	100
MN-St. Paul	None	None	None
Mississippi	None	None	None
Missouri	100	100	100
MO-Kansas City	60	60	60
MO-St. Louis	60	60	60
Montana	None	None	None
Nebraska	None	None	None
NE-Omaha	None	None	None
Nevada	75	75	75
New Hampshire	100	100	100
New Jersey	None	None	None
New Mexico	None	None	None

Note: Arizona eliminates the 80% cap on monthly benefits on July 10, 2009.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.5 (cont'd)

State	2003	2007	2011
New York	None	None	None
NY-New York City	None	None	None
North Carolina	None	None	None
North Dakota	None	None	None
Oklahoma	100	100	100
Pennsylvania	None	None	100
South Dakota	None	None	None
Tennessee	94.5	94.5	94.5
Texas	None	None	None
Virginia	None	None	None
VA-Fairfax	100	100	100
Wisconsin	70	70	70
Wyoming	None	None	None

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.6: Comparison of the Cost of Living Adjustments

State	2003	2007	2011
Alabama	Ad hoc	Ad hoc	Ad hoc
Arizona*	Investment surplus capped at 4	Investment surplus capped at 4	Investment surplus capped at 4
Arkansas	Annual 3%	Annual 3%	Annual 3%
California	Annual 2%	Annual 2%	Annual 2%
Colorado	Annual 3.5%	The lesser of 2 percent or the average of the monthly CPI-W	The lesser of 2 percent or the average of the monthly CPI-W
CO-Denver	Annual 3.25%	CPI up to 3%	The lesser of 2 percent or the average of the monthly CPI-W
Connecticut	Annual 3.5%	Annual 3.3%	Social Security benefit COLA granted and TRF investment returns for the prior year, to a maximum of 5 percent.
Delaware	Ad hoc	Ad hoc	Ad hoc
Georgia	CPI up to 3%	CPI up to 3%	1.5% biannually if current CPI higher that retirement date
Idaho	Lesser of CPI or 6% discretionary maximum	Lesser of CPI or 6% discretionary maximum	Lesser of CPI or 6% discretionary maximum
Illinois	Annual 3% on January 1 after they turn 61	Annual 3% on January 1 after they turn 61	Min (3%, 1/2 CPI)
IL-Chicago	Annual 3% after they turn 61	Annual 3% they turn 61	3% or 1/2 the increase in the CPI, after they turn 67
Iowa	0	0	0
Kansas	Ad hoc	Ad hoc	2
Kentucky	Automatic 1.5% plus ad hoc	Automatic 1.5% plus ad hoc	Automatic 1.5% plus ad hoc
Louisiana	3%	3%	The lesser of 2 percent or the CPI
Maine	CPI up to 4%	CPI up to 4%	CPI up to 3% on the first $20000
Massachusetts	Ad hoc with 3% maximum	Ad hoc with 3% maximum	Ad hoc with 3% maximum
MA-Boston	Ad hoc with 3% maximum	Ad hoc with 3% maximum	Ad hoc with 3% maximum
Minnesota	CPI up to 2.5% + investment surplus	CPI up to 2.5% + investment surplus	CPI up to 2.5% + investment surplus

* Arizona had no COLAs in 2011.

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.6 (cont'd)

State	2003	2007	2011
MN-Duluth	Annual 2% + investment surplus	Annual 2% + investment surplus	Annual 2% + investment surplus
MN-Minneapolis*	Annual 2% + investment surplus	CPI up to 2.5% + investment surplus	CPI up to 2.5% + investment surplus
MN-St. Paul	Annual 2% + investment surplus	CPI up to 2.5% + investment surplus	Suspension for one year
Mississippi	Annual 3%	Annual 3%	Annual 3%
Missouri	CPI up to 5%; lifetime COLAs limited to 80% of original benefit	CPI up to 5%; lifetime COLAs limited to 80% of original benefit	CPI up to 5%; lifetime COLAs limited to 80% of original benefit
MO-Kansas City	CPI up to 3%	CPI up to 3%	CPI up to 3%
MO-St. Louis	Ad hoc	Ad hoc	Ad hoc
Montana	Annual 1.5% for retirees who have been retired at least 3 years	Annual 1.5% for retirees who have been retired at least 3 years	Annual 1.5% for retirees who have been retired at least 3 years
Nebraska	CPI up to 2.5%	CPI up to 2.5%	CPI up to 2.5%
NE-Omaha	1.5% plus ad hoc	1.5% plus ad hoc	1.5% plus ad hoc
Nevada	Cost of living increases are provided after three full years of benefits at the rates of 2% in each of the fourth, fifth, and sixth years; 3% in years seven, eight, and nine; 3.5% in years 10 and 11; and 5% in year 14 and each year thereafter.	Cost of living increases are provided after three full years of benefits at the rates of 2% in each of the fourth, fifth, and sixth years; 3% in years seven, eight, and nine; 3.5% in years 10 and 11; and 5% in year 14 and each year thereafter.	Cost of living increases are provided after three full years of benefits at the rates of 2% in each of the fourth, fifth, and sixth years; 3% in years seven, eight, and nine; 3.5% in years 10 and 11; and 4% in year 12 and each year thereafter.
New Hampshire	Ad hoc	Ad hoc	Ad hoc
New Jersey	60% of change in CPI	60% of change in CPI	Suspended to all members in 2011
New Mexico	50% of change in CPI up to 4%; not less than 2% (began at age 65)	50% of change in CPI up to 4%; not less than 2% (began at age 65)	50% of change in CPI up to 4%; not less than 2% (began at age 65)

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.6 (cont'd)

State	2003	2007	2011
New York	50% of change in CPI up to 3%, but at least 1% minimum	50% of change in CPI up to 3%, but at least 1% minimum	50% of change in CPI up to 3%, but at least 1% minimum
NY-New York City	50% of change in CPI up to 3%, but at least 1% minimum	50% of change in CPI up to 3%, but at least 1% minimum	50% of change in CPI up to 3%, but at least 1% minimum
North Carolina	Ad hoc	Ad hoc	Ad hoc
North Dakota	Ad hoc	Ad hoc	Ad hoc
Oklahoma	Ad hoc	Ad hoc	Ad hoc
Pennsylvania	Ad hoc	Ad hoc	Ad hoc
South Dakota	Annual 3.1 %	Annual 3.1 %	Annual 2.1 %
Tennessee	CPI up to 3%	CPI up to 3%	CPI up to 3%
Texas	Ad hoc	Ad hoc	Ad hoc
Virginia	CPI up to 3% + 1⁄2 CPI between 3% and 7% up to total of 5% maximum	CPI up to 3% + 1⁄2 CPI between 3% and 7% up to total of 5% maximum	CPI up to 2% + 1/2 CPI between 2% and 4% up to total of 3% maximum
VA-Fairfax	Annual 3 %	Annual 3 %	Annual 3 %
Wisconsin*	Depends on investment performance and other indicators	Depends on investment performance and other indicators	Depends on investment performance and other indicators
Wyoming	CPI up to 3%	CPI up to 3%	CPI up to 3%

* Wisconsin had no COLAs in 2011.

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.7: Comparison of Retirement Eligibility

State	2003	2007	2011	Pension Plan Changed Retirement Eligibility to Become Less Generous Between 2007 and 2011
Alabama	60/10; A/25	60/10; A/25	60/10; A/25	
Arizona	65/A; 62/10; R-80	65/A; 62/10; R-80	65/A; 62/10; 60/25; 55/30	Yes
Arkansas	60/5; A/28	60/5; A/28	60/5; A/28	
California	60/5	60/5	60/5	
Colorado	65/5; 50/30; R-80/age 55	65/5; R-85/age 55; A/35	65/5; 58/30; A/35	Yes
CO-Denver	65/5; 55/25; 50/30	65/5; 55/25; 50/30	65/5; 58/30; A/35	Yes
Connecticut	60/20; A/35	60/20; A/35	60/20; A/35	
Delaware	62/5; 60/15; A/30	62/5; 60/15; A/30	62/5; 60/15; A/30	
Georgia	60/10; A/30	60/10; A/30	60/10; A/30	
Idaho	65/5; R-90	65/5; R-90	65/5; R-90	
Illinois	62/5; 60/10; 55/35	62/5; 60/10; 55/35	67/10	Yes
IL-Chicago	62/5; 60/20; 55/34	62/5; 60/20; 55/34	67/10	Yes
Iowa	65/A; 62/20; R-88	65/A; 62/20; R-88	65/A; 62/20; R-88	
Kansas	65/A; 62/10; R-85	65/A; 62/10; R-85	65/5; 60/30	Yes
Kentucky	60/5; A/27	60/5; A/27	60/5; A/27	
Louisiana	60/5; 55/25; A/30	60/5; 55/25; A/30	60/5	Yes
Maine	62/5	62/5	62/5	
Massachusetts	65/10; A/20	65/10; A/20	65/10; A/20	
MA-Boston	65/10	65/10	65/10	
Minnesota	66/3	66/3	66/3	
MN-Duluth	66	66	66	
MN-Minneapolis*	65/3; R-90	66/3	66/3	
MN-St. Paul	65/3	65/3	65/3	
Mississippi	60/4; A/25	60/8; A/25	60/8; A/30	Yes
Missouri	60/5; A/30; R-80	60/5; A/30; R-80	60/5; A/30; R-80	
MO-Kansas City	60/5, R-75	60/5, R-75	60/5, R-75	
MO-St. Louis	65/A; R-85	65/A; R-85	65/A; R-85	
Montana	60/5; A/25	60/5; A/25	60/5; A/25	

Table 2.7 (cont'd)

State	2003	2007	2011	Pension Plan Changed Retirement Eligibility to Become Less Generous Between 2007 and 2011
Nebraska	65/5; R-85/age 55	65/5; R-85/age 55	65/5; R-85/age 55	
NE-Omaha	65/5; 62/10; R-85/age55	65/5; 62/10; R-85/age55	65/5; 62/10; R-85/age55	
Nevada	65/5; 60/10; A/30	65/5; 60/10; A/30	65/5; 62/10; A/30	Yes
New Hampshire	60/A	60/A	65/A	Yes
New Jersey	60/A	60/A	65/A	Yes
New Mexico	65/5; A/25; R-75/age 60	65/5; A/25; R-75/age 60	67/5; A/30; R-80/age 65	Yes
New York	62/5; 55/30	62/5; 55/30	62/10; 57/30	Yes
NY-New York City	62/5; 55/30	62/5; 55/30	62/5; 55/30	
North Carolina	65/5; 60/25; A/30	65/5; 60/25; A/30	65/5; 60/25; A/30	
North Dakota	65/3; R-85	65/3; R-85	65/5; R-90/age 60	Yes
Oklahoma	62/5; R-90	62/5; R-90	62/5; R-90	
Pennsylvania	62/1; 60/30; A/35	62/1; 60/30; A/35	65/3; 92/YOS=35	Yes
South Dakota	65/3; R-85	65/3; R-85	65/3; R-85	
Tennessee	60/5; A/30	60/5; A/30	60/5; A/30	
Texas	65/5; R-80	65/5; R-80	65/5; R-80 /Age 60	Yes
Virginia	65/5; 50/30	65/5; 50/30	Normal Social Security retirement age; R-90	Yes
VA-Fairfax	60/5; A/30	60/5; A/30	60/5; A/30	
Wisconsin	65/A; 57/30	65/A; 57/30	65/5; 57/30	Yes
Wyoming	60/4; R-85	60/4; R-85	60/4; R-85	

Note: Read 60/5 as 5 years of service at age 60; read R-80 as a combination of years of service plus year = 80; Read R-80/age 60 the same as R-80 but need to be at least age 60.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.8: Comparison of the Employee Contribution Rates

State	2003	2007	2011	Pension Plan Increased Teacher Contribution Between 2007 and 2011
Alabama	5	5	7.25	Yes
Arizona	5.2	9.1	10.5	Yes
Arkansas	6	6	6	0
California	8	8	8	0
Colorado	8	8	8	0
CO-Denver	8	8	8	
Connecticut	6	6	6	0
Delaware	3	3	3	0
Georgia	5	5	5.53	Yes
Idaho	5.86	6.23	6.23	0
Illinois	9	9.4	9.4	
IL-Chicago	9	9	9	
Iowa	3.7	3.9	5.38	Yes
Kansas	4	4	6	Yes
Kentucky	9.855	9.855	10.355	Yes
Louisiana	8	8	8	0
Maine	7.65	7.65	7.65	0
Massachusetts	11	11	11	0
MA-Boston	11	11	11	
Minnesota	5	5.5	5.5	0
MN-Duluth	5.5	5.5	5.5	
MN-Minneapolis	5.5	5.5	5.5	
MN-St. Paul	5.5	5.55	5.55	
Mississippi	7.25	7.25	9	Yes
Missouri	10.5	12	14	Yes
MO-Kansas City	7.5	7.5	7.5	
MO-St. Louis	5	5	5	
Montana	7.15	7.15	7.15	0
Nebraska	7.28	7.28	8.88	Yes
NE-Omaha	6.3	7.3	8.3	Yes

Note: In Delaware, teachers contribute a portion of their monthly compensation which exceeds $6,000 per year.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.8 (cont'd)

State	2003	2007	2011	Pension Plan Increased Teacher Contribution Between 2007 and 2011
Nevada	9.75	10.5	11.25	Yes
New Hampshire	5	5	7	Yes
New Jersey	5	5.5	6.5	Yes
New Mexico	7.6	7.825	Multiple	Yes
New York	Multiple	Multiple	3.5	Yes
NY-New York City	Multiple	Multiple	Multiple	
North Carolina	6	6	6	
North Dakota	7.75	7.75	7.75	
Oklahoma	7	7	7	
Pennsylvania	7.5	7.5	7.5	
South Dakota	6	6	6	
Tennessee	5	5	5	
Texas	6.4	6.4	6.4	
Virginia	5	5	5	
VA-Fairfax	4	4	3	
Wisconsin	5	5	5.8	Yes
Wyoming	0	0	1.43	Yes

Note: In New Mexico, teachers are required to contribute 11.15 for salary over $20,000 and 7.9% for salary below $20,000 in 2011. In New York, teachers hired before 2007 contribute 3% of their salary for the first 10 years, no contributions after the 11th year of employments. In New York City, teachers contribute 3% of their salary for the first 10 years, no contributions after the 11th year of employments.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.9: Comparison of Vesting Requirements

State	2003	2007	2011	Pension Plan Increased Vesting Requirements Between 2007 and 2011
Alabama	10	10	10	
Arizona	0	0	0	
Arkansas	5	5	5	
California	5	5	5	
Colorado	5	5	5	
CO-Denver	5	5	5	
Connecticut	10	10	10	
Delaware	5	5	5	
Georgia	10	10	10	
Idaho	5	5	5	
Illinois	5	5	10	Yes
IL-Chicago	5	5	10	Yes
Iowa	4	4	4	
Kansas	10	10	5	Decreased
Kentucky	5	5	5	
Louisiana	5	5	5	
Maine	5	5	5	
Massachusetts	10	10	10	
MA-Boston	10	10	10	
Minnesota	3	3	3	
MN-Duluth	3	3	3	
MN-Minneapolis*	3	3	3	
MN-St. Paul	3	3	3	
Mississippi	4	8	8	
Missouri	5	5	5	
MO-Kansas City	5	5	5	
MO-St. Louis	5	5	5	
Montana	5	5	5	
Nebraska/SRS	5	5	5	
NE-Omaha	5	5	5	
Nevada	5	5	5	
New Hampshire	10	10	10	
New Jersey	10	10	10	

Note: *In 2006, the Minneapolis Teachers Retirement Fund Association merged with state run pension.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.9 (cont'd)

State	2003	2007	2011	Pension Plan Increased Vesting Rules Between 2007 and 2011
New Mexico	5	5	5	
New York	5	5	10	Yes
NY-New York City	5	5	10	Yes
North Carolina	5	5	5	
North Dakota	3	3	5	Yes
Oklahoma	10	5	5	
Pennsylvania	5	5	10	Yes
South Dakota	3	3	3	
Tennessee	5	5	5	
Texas	5	5	5	
Virginia	5	5	5	
VA-Fairfax	5	5	5	
Wisconsin	0	0	5	Yes
Wyoming	4	4	4	

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.10: Refund if Teachers Leave Before Vested

State	Employee contribution	Employee contribution + interest	Employee contribution + interest+ partial employer contribution
Alabama		1	
Arizona		1	
Arkansas		1	
California		1	
Colorado*			1
CO-Denver		1	
Connecticut	1		
Delaware		1	
Georgia		1	
Idaho		1	
Illinois	1		
IL-Chicago*			1
Iowa		1	
Kansas		1	
Kentucky		1	
Louisiana	1		
Maine		1	
Massachusetts		1	
MA-Boston	1		
Minnesota		1	
MN-Duluth		1	
MN-Minneapolis		1	
MN-St. Paul		1	
Mississippi		1	
Missouri		1	
MO-Kansas City		1	
MO-St. Louis		1	
Montana		1	

Note: In Colorado, teachers hired after 2011 can only refund employee contribution plus interest. In Chicago, your refund includes employee contribution and employer contribution but no interest.
Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.10 (cont'd)

State	Employee contribution	Employee contribution + interest	Employee contribution + interest+ partial employer contribution
Nebraska		1	
NE-Omaha		1	
Nevada		1	
New Hampshire		1	
New Jersey		1	
New Mexico		1	
New York		1	
NY-New York City	1		
North Carolina		1	
North Dakota		1	
Oklahoma		1	
Pennsylvania		1	
South Dakota			1
Tennessee		1	
Texas		1	
Virginia		1	
VA-Fairfax		1	
Wisconsin		1	
Wyoming		1	

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11: Membership of Public Pension Plans that Enroll Teachers

State	Plan	Membership
Alabama	Teachers' Retirement System -Tier1 (DB)	Hired before January 1, 2013
Alabama	Teachers' Retirement System -Tier 2 (DB)	Hired on or after January 1, 2013
Arizona	Arizona State Retirement System (DB)	Hired before January 1, 1984
Arizona	Arizona State Retirement System (DB)	Hired between January 1, 1984 and June 30, 2011
Arizona	Arizona State Retirement System (DB)	Hired on or after July 1, 2011
Arkansas	Arkansas Teacher Retirement System (DB)	All teachers
California	California State Teachers' Retirement System (DB)	Hired before January 1, 2013
California	California State Teachers' Retirement System (DB)	Hired on or after January 1, 2013
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or before June 30, 2005, and vested on January 1, 2011,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired between July 1, 2005, and December 31, 2006, and vested on January 1, 2011,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or before December 31, 2006, not vested on January 1, 2011; Or hired between January 1, 2007, and December 31, 2010,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired between January 1, 2011, and December 31, 2016
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or after January 1, 2017
CO-Denver	Denver Public Schools Retirement System (DB)	Merged with the Colorado Public Employees Association effective January 1, 2010.
Connecticut	Connecticut Teachers' Retirement System (DB)	All teachers
Delaware	State Employee Pension Plan (DB)	Hired before January 1, 2012
Delaware	State Employee Pension Plan (DB)	Hired on or after January 1, 2012
Georgia	Teachers Retirement System of Georgia (DB)	All teachers
Idaho	Public Employee Retirement System of Idaho (DB)	All teachers

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11 (cont'd)

Illinois	Teachers' Retirement System of the State of Illinois - Tier 1 (DB)	Hired before January 1, 2011
Illinois	Teachers' Retirement System of the State of Illinois - Tier 2 (DB)	Hired on or after January 1, 2011
Iowa	Iowa Public Employees' Retirement System (DB)	Retired before July 1, 2012
Iowa	Iowa Public Employees' Retirement System (DB)	Retired after July 1, 2012
Kansas	Kansas Public Employees Retirement System - Tier 1 (DB)	Hired before July 1, 2009
Kansas	Kansas Public Employees Retirement System - Tier 2 (DB)	Hired between July 1, 2009 and Dec 31, 2014
Kansas	Kansas Public Employees Retirement System - Tier 3 (Cash Balance)	Hired after January 1, 2015
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired before July 1, 2002
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired between July 1, 2002 and June 30, 2008
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired on or after July 1, 2008
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired before July 1, 1999
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired between July 1, 1999 and Dec 31, 2010
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired between January 1, 2011, and June 30, 2015
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired after July 1, 2015
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 1993, had at least 10 years of service credit, or reached age 60 and had at least a year of service credit.
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 2011, had at least 5 years of service credit or, reached age 62 and had at least a year of service credit immediately prior to reaching age 62.
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 2011, you had less than 5 years of service credit and not reached age 62 with at least a year of service credit.

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11 (cont'd)

Massachusetts	Massachusetts Teachers' Retirement System -Tier 1 (DB)	Hired before April 2, 2012
Massachusetts	Massachusetts Teachers' Retirement System -Tier 2 (DB)	Hired on or after April 2, 2012
Minnesota	Minnesota Teachers Retirement Association - Tier 1 (DB)	Hired on or before June 30, 1989
Minnesota	Minnesota Teachers Retirement Association - Tier 2 (DB)	Hired after June 30, 1989
Mississippi	Public Employees' Retirement System of Mississippi - Tier 1 (DB)	Hired before July 1, 1992
Mississippi	Public Employees' Retirement System of Mississippi - Tier 2 (DB)	Hired between July 1, 1992, and June 30, 2007
Mississippi	Public Employees' Retirement System of Mississippi - Tier 3 (DB)	Hired between July 1, 2007, and June 30, 2011
Mississippi	Public Employees' Retirement System of Mississippi - Tier 4 (DB)	Hired on or after July 1, 2011
Missouri	Public School & Education Employee Retirement System of Missouri (DB)	All teachers
Montana	Montana Teachers' Retirement System - Tier 1 (DB)	Hired Before July 1, 2013
Montana	Montana Teachers' Retirement System - Tier 2 (DB)	Hired on or after July 1, 2013
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System (DB)	Hired Before July 1, 2013
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System (DB)	Hired on or after July 1, 2013
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after July 1, 1989, and before January 1, 2010
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after January 1, 2010, and before July 1, 2015
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after July 1, 2015

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11 (cont'd)

New Hampshire	New Hampshire Retirement System (DB)	Hired before July 1, 2011 and vested prior to January 1, 2012
New Hampshire	New Hampshire Retirement System (DB)	Hired before July 1, 2011 and not vested prior to January 1, 2012
New Hampshire	New Hampshire Retirement System (DB)	Hired on or after July 1, 2011
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 1 (DB)	Hired before July 1, 2007
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 2 (DB)	Hired on or after July 1, 2007, and before Nov 2, 2008
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 3 (DB)	Hired on or after Nov. 2, 2008, and before May 22, 2010
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 4 (DB)	Hired on or after May 22, 2010, and before June 28, 2011
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 5 (DB)	Hired on or after June 28, 2011
New Mexico	New Mexico Educational Retirement Board-Tier 1 (DB)	Hired before July 1, 2010
New Mexico	New Mexico Educational Retirement Board-Tier 2 (DB)	Hired on or after July 1, 2010, and before July 1, 2013
New Mexico	New Mexico Educational Retirement Board-Tier 3 (DB)	Hired on or after July 1, 2013
New York	New York State Teachers' Retirement System- Tier 1 (DB)	Hired before July 1, 1973
New York	New York State Teachers' Retirement System- Tier 2 (DB)	Hired on or after July 1, 1973, and before July 27, 1976
New York	New York State Teachers' Retirement System- Tier 3 (DB)	Hired on or after July 27, 1976, and before Sept 1, 1983
New York	New York State Teachers' Retirement System- Tier 4 (DB)	Hired on or after Sept 1, 1983, and before January. 1, 2010
New York	New York State Teachers' Retirement System - Tier 5 (DB)	Hired on or after January. 1, 2010, and before April 1, 2012
New York	New York State Teachers' Retirement System -Tier 6 (DB)	Hired on or after April 1, 2012

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11 (cont'd)

North Carolina	Teachers' and State Employees' Retirement System (DB)	All teachers
North Dakota	North Dakota Teachers' Fund for Retirement - Tier 1 (DB)	Hired before July 1, 2008
North Dakota	North Dakota Teachers' Fund for Retirement -Tier 2 (DB)	Hired on or after July 1, 2008
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired before July 1, 1992
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired after June 30, 1992, and before November 1, 2011
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired on or after November 1, 2011
Pennsylvania	Public School Employees' Retirement System - Class TC (DB)	Hired before July 1, 2001
Pennsylvania	Public School Employees' Retirement System - Class TD (DB)	Hired after June 30, 2001, and before July 1, 2011
Pennsylvania	Public School Employees' Retirement System - Class TE (DB)	Hired on or after July 1, 2011
South Dakota	South Dakota Retirement System (DB)	All teachers (but a 2008 law apply to everyone including retirees)
Tennessee	Tennessee Consolidated Retirement System (DB)	Hired on or after July 1, 1976, and before July 1, 2014
Tennessee	Tennessee Consolidated Retirement System (Hybrid)	Hired on or after July 1, 2014
Texas	Teacher Retirement System of Texas - Tier 1 (DB)	Hire before September 1, 2007 and met the 2005 eligibility requirements to be grandfathered: were at least 50 years of age; or age and years of service credit totaled at least 70; or had at least 25 years of service credit as a member of TRS before Sept. 1, 2005
Texas	Teacher Retirement System of Texas - Tier 2 (DB)	Hire before September 1, 2007 but did not meet the 2005 eligibility requirements to be grandfathered:
Texas	Teacher Retirement System of Texas - Tier 3 (DB)	Hire on and after September 1, 2007 and had at least five years of service credit in TRS as of August 31, 2014
Texas	Teacher Retirement System of Texas - Tier 4 (DB)	Current membership starts on and after September 1, 2007, meet the 2005 eligibility requirements to be grandfathered, and had at least five years of service credit in TRS as of August 31, 2014

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.11 (cont'd)

Texas	Teacher Retirement System of Texas - Tier 5 (DB)	Did not meet the 2005 eligibility requirements to be grandfathered and 1) you did not have at least five years of service credit on August 31, 2014; or 2) your current membership in TRS began on or after Sept. 1, 2014; or 3) you had at least five years of service credit on August 31, 2014, but you terminated your membership in TRS by withdrawing your accumulated contributions and resumed membership in TRS after August 31, 2014
Texas	Teacher Retirement System of Texas - Tier 6 (DB)	Meet the 2005 eligibility requirements to be grandfathered and 1) you did not have at least five years of service credit on August 31, 2014; or 2) your current membership in TRS began on or after Sept. 1, 2014; or 3) you had at least five years of service credit on August 31, 2014, but you terminated your membership in TRS by withdrawing your accumulated contributions and resumed membership in TRS after August 31, 2014
Virginia	Virginia Retirement System - Plan 1 (DB)	Hired before July 1, 2010, and vested on January. 1, 2013
Virginia	Virginia Retirement System - Plan 2 (DB)	Hired between July 1, 2010-Dec 31, 2013, or hired before 2010 but not vested on January 1, 2013
Virginia	Virginia Retirement System - Hybrid Retirement Plan (Hybrid)	on or after January 1, 2014, and to VRS Plan 1 and VRS Plan 2 members who were eligible to opt into the plan during the special election window in 2014.
Washington	Washington Teachers' Retirement System - Plan 2 (DB)	Hired after Sept. 30, 1977, and before July 1, 1996; or on or after July 1, 2007 and chose Plan 2.
Washington	Washington Teachers' Retirement System - Plan 3 (Hybrid)	Hired on or after July 1, 1996, and before July 1, 2007; or on or after July 1, 2007 and chose Plan 2.
Wisconsin	Wisconsin Retirement System (DB)	Hired before July 1, 2011
Wisconsin	Wisconsin Retirement System (DB)	Hired on or after July 1, 2011
Wyoming	Wyoming Retirement System - Tier 1 (DB)	Hired before September 1, 2012
Wyoming	Wyoming Retirement System - Tier 2 (DB)	Hired on or after September 1, 2012

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.2.

Table 2.12: Weighted Means of Variables

	Benefit Reducing Legislation				No Benefit Reducing			
	(1)		(2)		(3)		(4)	
	Pre-reform		Post-reform		Pre-reform		Post-reform	
Variable	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.
Quality Measures								
25th Percentile SAT	**975**	131	**962**	105	**940**	123	**961**	123
Advanced Degree	**0.16**	0.36	**0.21**	0.41	**0.14**	0.35	**0.26**	0.44
Subject Major	**0.06**	0.24	**0.09**	0.29	**0.07**	0.26	**0.18**	0.38
Pension Characteristics								
Vesting Rules	**5.11**	2.35	**7.11**	3.33	**6.38**	2.37	**5.71**	2.00
Teacher Contribution Rate	**6.34**	1.97	**7.33**	1.99	**6.75**	2.16	**7.01**	2.29
Pension Funding Ratio	**85.81**	12.49	**72.43**	13.88	**89.23**	12.70	**78.48**	12.07
Employer Contribution Rate	**7.84**	4.86	**11.87**	5.64	**10.98**	4.93	**14.62**	6.35
Net Pension Wealth ($1000)	**391.48**	124.25	**278.83**	119.33	**344.61**	88.11	**336.60**	87.42
Outside Options								
Unemployment Rate	**5.15**	1.05	**8.33**	1.24	**5.19**	0.91	**8.91**	1.99
Alternative Teacher Pay	**136.22**	37.52	**139.85**	39.81	**139.79**	36.41	**137.48**	36.38
Weights	100,340		27,724		56,619		19,683	

Note: Sample is restricted to first-year full time teachers. Statistics of school and teacher characteristics are summarized from the 2003-2004, 2007-2008, and 2011-2012 waves of School and Staffing Survey.

Table 2.13: Weighted Means of Variables

	Benefit Reducing Legislation				No Benefit Reducing			
	(1)		(2)		(3)		(4)	
	Pre-reform		Post-reform		Pre-reform		Post-reform	
Variable	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.
State Testing Requirements								
Basic Skills	**0.34**	0.48	**0.37**	0.48	**0.78**	0.42	**0.70**	0.46
Knowledge of Teaching	**0.61**	0.49	**0.47**	0.50	**0.29**	0.45	**0.30**	0.46
Teaching Performance	**0.17**	0.38	**0.11**	0.32	**0.44**	0.50	**0.45**	0.50
Subject Matter	**0.65**	0.48	**0.59**	0.49	**0.70**	0.46	**0.53**	0.50
School District Recruitment Incentives								
Signing Bonus	**0.22**	0.41	**0.07**	0.26	**0.23**	0.42	**0.05**	0.22
Loan Forgiveness	**0.12**	0.32	**0.10**	0.30	**0.08**	0.28	**0.03**	0.18
Finder's Fee	**0.04**	0.18	**0.01**	0.11	**0.07**	0.25	**0.00**	0.00
Free Training - Shortage	**0.39**	0.49	**0.30**	0.46	**0.43**	0.49	**0.27**	0.45
Bonus - Shortage	**0.43**	0.49	**0.36**	0.48	**0.29**	0.45	**0.20**	0.40
Teacher Characteristics								
Female	**0.74**	0.44	**0.74**	0.44	**0.75**	0.43	**0.79**	0.41
Age	**28.50**	7.69	**26.75**	6.09	**28.48**	7.34	**27.53**	6.31
Weights	100,340		27,724		56,619		19,683	

Note: Sample is restricted to first-year full time teachers. Statistics of school and teacher characteristics are summarized from the 2003-2004, 2007-2008, and 2011-2012 waves of School and Staffing Survey.

Table 2.14: Reforms that Reduced Teacher Benefits

State	Affect Teachers Hired After	Reforms Include: Decreasing multiplier	Lengthen the Years Ysed to Computed FAS	Raising Retirement Eligibility Age or Service	Capped on Annual Benefits	Less Generous COLAs
Arizona	2011		Yes	Yes	(Removed)	Yes
Colorado	2011			Yes		
CO-Denver	2010			Yes	Yes	Yes
CO-Denver	2011			Yes		
Connecticut	2007					Yes
Illinois	2011		Yes	Yes		Yes
Chicago	2011		Yes	Yes		Yes
Kansas	2009		Yes	Yes		Yes
Kentucky	2008	Yes				
Louisiana	2011		Yes	Yes		Yes
Maine	2011					Yes
St. Paul	2010					Yes
Mississippi	2011	Yes		Yes		
Nevada	2010	Yes		Yes		Yes
New Hampshire	2011	Yes		Yes		
New Jersey	2008	Yes	Yes	Yes		
New Jersey	2011					Yes
New Mexico	2010			Yes		
New York	2010	Yes		Yes		
North Dakota	2008		Yes	Yes		
Pennsylvania	2011	Yes		Yes	Yes	
South Dakota	2010					Yes
Texas	2007			Yes		
Virginia	2010	Yes	Yes	Yes		Yes
Wisconsin	2011			Yes		Yes
Total		8	8	19	2	14

Source: Author's tabulation from pension-plan-specific information detailed in Table 2.

Table 2.15: Estimates of the Effects of Pension Reform on New Teacher Quality

VARIABLES	(1) 25th percentile SAT	(2) Advanced Degree	(3) Subject Major
Benefit Cut*Post	-25.63*	-0.0490	-0.0635
	(14.77)	(0.0550)	(0.0407)
Benefit Cut	42.86	0.0548	-0.00471
	(31.19)	(0.171)	(0.105)
Teacher Contribution Rate	-0.142	-0.0242**	0.00482
	(3.728)	(0.0119)	(0.00860)
Employer Contribution Rate	-0.853	0.00202	0.00488
	(1.460)	(0.00527)	(0.00344)
Pension Funding Ratio	0.479	0.00102	0.000735
	(0.705)	(0.00294)	(0.00173)
Alternative Salary Rate	-0.359***	-0.000701**	1.35e-05
	(0.114)	(0.000273)	(0.000179)
Unemployment Rate	-3.503	0.0331*	0.0189
	(6.015)	(0.0179)	(0.0163)
Basic Skills	0.696	-0.00461	-0.0749***
	(13.64)	(0.0576)	(0.0289)
Knowledge of Teaching	5.337	-0.127***	-0.0148
	(19.77)	(0.0480)	(0.0432)
Teaching Performance	-8.028	-0.0633	-0.0309
	(16.72)	(0.0493)	(0.0282)
Subject Matter	-15.90	0.134***	0.0441
	(18.17)	(0.0470)	(0.0310)
Signing Bonus	16.13	0.0772**	0.0357
	(15.98)	(0.0380)	(0.0313)
Loan Forgiveness	36.99*	-0.0175	0.0383
	(19.44)	(0.0457)	(0.0412)
Finder's Fee	-42.18	-0.0984*	-0.0791**
	(29.57)	(0.0506)	(0.0359)
Free Training - Shortage	1.551	-0.0109	0.00293
	(9.292)	(0.0216)	(0.0175)
Bonus - Shortage	12.05	-0.0403	-0.0311
	(9.667)	(0.0280)	(0.0214)
Weights	204,365	204,365	204,365
Observations	2,640	2,640	2,640
R-squared	0.187	0.100	0.043

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.16: The Difference in New Teacher Quality between the Control and Treatment Groups before Recent Pension Reforms

VARIABLES	(1) 25th percentile SAT	(2) Advanced Degree	(3) Subject Major
Benefit Cut*Post	7.346	0.0391	-0.0126
	(14.63)	(0.0448)	(0.0314)
Benefit Cut	32.75	0.0295	-0.0225
	(31.84)	(0.172)	(0.106)
Teacher Contribution Rate	-0.482	-0.0243**	0.00333
	(3.677)	(0.0120)	(0.00859)
Employer Contribution Rate	-0.896	0.00187	0.00485
	(1.449)	(0.00523)	(0.00345)
Pension Funding Ratio	0.618	0.00142	0.000910
	(0.693)	(0.00297)	(0.00171)
Alternative Salary Rate	-0.363***	-0.000709***	7.05e-06
	(0.114)	(0.000274)	(0.000180)
Unemployment Rate	-1.316	0.0378**	0.0237
	(6.206)	(0.0189)	(0.0175)
Basic Skills	-2.292	-0.00776	-0.0854***
	(13.72)	(0.0570)	(0.0301)
Knowledge of Teaching	7.342	-0.118**	-0.0157
	(19.08)	(0.0485)	(0.0424)
Teaching Performance	-4.964	-0.0546	-0.0268
	(16.64)	(0.0492)	(0.0284)
Subject Matter	-17.73	0.126***	0.0448
	(17.97)	(0.0465)	(0.0313)
Signing Bonus	16.16	0.0773**	0.0357
	(15.98)	(0.0380)	(0.0313)
Loan Forgiveness	36.60*	-0.0175	0.0364
	(19.50)	(0.0456)	(0.0415)
Finder's Fee	-42.22	-0.0971*	-0.0808**
	(29.78)	(0.0509)	(0.0360)
Free Training - Shortage	1.631	-0.00975	0.00196
	(9.262)	(0.0217)	(0.0171)
Bonus - Shortage	11.94	-0.0411	-0.0307
	(9.655)	(0.0280)	(0.0215)
Weights	204,365	204,365	204,365
Observations	2,640	2,640	2,640
R-squared	0.186	0.100	0.041

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.17: The Effect of Net Pension Wealth on Teacher Quality

VARIABLES	(1) 25th percentile SAT	(2) Advanced Degree	(3) Subject Major
Log (Net Pension Wealth)	32.15**	0.0252	0.0294
	(14.47)	(0.0539)	(0.0312)
Vesting Requirements	-3.389	0.00337	-0.00336
	(2.931)	(0.00908)	(0.00561)
Employer Contribution Rate	-0.392	0.00219	0.00514
	(1.479)	(0.00524)	(0.00350)
Pension Funding Ratio	0.442	0.00124	0.000883
	(0.709)	(0.00292)	(0.00173)
Alternative Salary Rate	-0.295***	-0.000673**	7.27e-05
	(0.111)	(0.000274)	(0.000182)
Unemployment Rate	-2.855	0.0346*	0.0232
	(6.156)	(0.0183)	(0.0170)
Basic Skills	0.955	-0.0148	-0.0802***
	(13.87)	(0.0569)	(0.0305)
Knowledge of Teaching	4.884	-0.113**	-0.0156
	(19.56)	(0.0481)	(0.0431)
Teaching Performance	-8.044	-0.0490	-0.0300
	(16.58)	(0.0496)	(0.0284)
Subject Matter	-17.48	0.124***	0.0429
	(17.94)	(0.0467)	(0.0311)
Signing Bonus	16.85	0.0758**	0.0369
	(15.88)	(0.0379)	(0.0314)
Loan Forgiveness	36.23*	-0.0205	0.0363
	(19.35)	(0.0460)	(0.0414)
Finder's Fee	-43.18	-0.101**	-0.0804**
	(29.54)	(0.0507)	(0.0360)
Free Training - Shortage	1.323	-0.0110	0.00225
	(9.265)	(0.0216)	(0.0176)
Bonus - Shortage	12.84	-0.0403	-0.0304
	(9.718)	(0.0280)	(0.0216)
Weights	204,365	204,365	204,365
Observations	2,640	2,640	2,640
R-squared	0.190	0.098	0.041

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.1: Types of Pension Plans States and Cities Offered Teachers

State	2003	2007	2011
Alabama	DB	DB	DB
Alaska	DB	DC	DC
Arizona	DB	DB	DB
Arkansas	DB	DB	DB
California	DB	DB	DB
Colorado	DB	DB	DB
Denver	DB	DB	DB
Connecticut	DB	DB	DB
Delaware	DB	DB	DB
DC	DB	DB	DB
Florida	DB/DC	DB/DC	DB/DC
Georgia	DB	DB	DB
Hawaii	DB	DB	DB
Idaho	DB	DB	DB
Illinois	DB	DB	DB
Chicago	DB	DB	DB
Indiana	Hybrid	Hybrid	Hybrid
Iowa	DB	DB	DB
Kansas	DB	DB	DB
Kentucky	DB	DB	DB
Louisiana	DB	DB	DB
Maine	DB	DB	DB
Maryland	DB	DB	DB
Massachusetts	DB	DB	DB
Boston	DB	DB	DB
Michigan	DB	DB	Hybrid
Minnesota	DB	DB	DB
Duluth	DB	DB	DB
Minneapolis	DB	DB	DB
St. Paul	DB	DB	DB
Mississippi	DB	DB	DB

Note:
*DB = Defined Benefit Plan; DC = Defined Contribution Plan;
DB/DC = Can choose between DB and DC.
*Alaska, Florida, Indiana, Michigan, Ohio, Oregon, South Carolina, Utah, Washington, and West Virginia did not enroll their teachers into defined-benefit plans during 2003-2011 and are therefore excluded from the sample.
*DC, Hawaii, Maryland and Rhode Island have low response rate in 2011 SASS survey and are therefore excluded from the analysis.
Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.1 (cont'd)

State	2003	2007	2011
Missouri	DB	DB	DB
Kansas City	DB	DB	DB
St. Louis	DB	DB	DB
Montana	DB	DB	DB
Nebraska	DB	DB	DB
Omaha	DB	DB	DB
Nevada	DB	DB	DB
New Hampshire	DB	DB	DB
New Jersey	DB	DB	DB
New Mexico	DB	DB	DB
New York	DB	DB	DB
New York City	DB	DB	DB
North Carolina	DB	DB	DB
North Dakota	DB	DB	DB
Ohio	DB/DC/Hybrid	DB/DC/Hybrid	DB/DC/Hybrid
Oklahoma	DB	DB	DB
Oregon	Hybrid	Hybrid	Hybrid
Pennsylvania	DB	DB	DB
Rhode Island	DB	DB	DB
South Carolina	DB /DC	DB /DC	DB /DC
South Dakota	DB	DB	DB
Tennessee	DB	DB	DB
Texas	DB	DB	DB
Utah	DB	DB	Hybrid/DC
*Vermont	DB	DB	DB
Virginia	DB	DB	DB
Fairfax	DB	DB	DB
Washington	Hybrid	Hybrid	Hybrid /DB
West Virginia	DC	DB	DB
Wisconsin	DB	DB	DB
Wyoming	DB	DB	DB

Note:

*DB = Defined Benefit Plan; DC = Defined Contribution Plan;
DB/DC = Can choose between DB and DC.
*Vermont enacted a pension reform that increase annual payments but delay retirements for all teachers age under 57 and hired on or after June 30, 2010. It is unclear whether this reform cut benefits or not so I exclude Vermont from the sample.
Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.2: State Teacher Pension Homepage, Handbooks, and Other Resources

Alabama	The Retirement Systems of Alabama, Teachers' Retirement System	
	Homepage	http://www.rsa-al.gov/index.php/members/trs/
	Tier 1 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T1_bookmarked.pdf#Membership
	Tier 2 Handbook	http://www.rsa-al.gov/uploads/files/TRS_Member_Handbook_T2_bookmarked.pdf#Membership
	Contribution History	http://www.lfo.state.al.us/PDFs/Presentations/Retirement_Systems_Presentation.pdf
Alaska	The PERS/TRS Defined Contribution Retirement Plan, Teachers' Retirement System	
	Homepage	http://doa.alaska.gov/drb/dcrp/index.html#.WG11Q3eZO8U
Arizona	Arizona State Retirement System	
	Homepage	https://www.azasrs.gov
	Annual Financial Report (2016; 2011)	https://www.azasrs.gov/sites/default/files/pdf/ASRS%202016%20CAFR.PDF; https://www.azasrs.gov/sites/default/files/pdf/ASRS_2011_CAFR.pdf
Arkansas	Arkansas Teacher Retirement System	
	Homepage	https://www.artrs.gov
California	California State Teachers' Retirement System	
	Homepage	http://www.calstrs.com
	Handbook	https://www.calstrs.com/sites/main/files/file-attachments/memberhandbook2017.pdf
Colorado	Colorado Public Employees' Retirement Association	
	Homepage	https://www.copera.org
	Handbook	https://www.copera.org/sites/default/files/documents/5-5.pdf
Connecticut	The Connecticut Teachers' Retirement System	
	Homepage	http://www.ct.gov/trb/site/default.asp
DC	District of Columbia Retirement Board	
	Homepage	http://dcrb.dc.gov/publication/teachers-summary-plan-description
	Summary Plan Description	https://dcrb.dc.gov/sites/default/files/dc/sites/dcrb/publication/attachments/DCRBTeachers%27Plan2012web%20update%20june%202014.pdf
Delaware	State of Delaware Office of Pensions	
	Homepage	http://www.delawarepensions.com/default.shtml
	Annual Financial Report (2016)	http://www.delawarepensions.com/FinancialReports/financials/fy16cafr.pdf

Table 3.2 (cont'd)

Florida	Florida Retirement System Pension Plan	
	Homepage	https://www.myfrs.com/FRSPro_Pension.htm
	Handbook	https://www.rol.frs.state.fl.us/forms/member_handbook.pdf
Georgia	Teachers Retirement System of Georgia	
	Homepage	http://www.trsga.com/home
	Handbook	http://www.trsga.com/downloadPublications/Members%20Guide%202015%20with%20Cover_092115_web.pdf
Hawaii	State of Hawaii Employees' Retirement System	
	Homepage	http://ers.ehawaii.gov
	Handbook (Hybrid)	http://ers.ehawaii.gov/wp-content/uploads/2012/02/ContribHybrid201205.pdf
Idaho	Public Employee Retirement System of Idaho	
	Homepage	https://persi.idaho.gov
	Handbook	https://persi.idaho.gov/Documents/Members/PERSI_Member_Handbook.pdf
Illinois	Teachers' Retirement System of the State of Illinois	
	Homepage	https://www.trsil.org
Indiana	Indiana State Teachers' Retirement Fund	
	Homepage	http://www.in.gov/inprs/
Iowa	Iowa Public Employees' Retirement System	
	Homepage	https://www.ipers.org/home
	Handbook	https://www.ipers.org/sites/default/files/media/Member%20Handbook.pdf
Kansas	Kansas Public Employees Retirement System	
	Homepage	https://www.kpers.org
Kentucky	Kentucky Teachers' Retirement System	
	Homepage	https://trs.ky.gov
Louisiana	Teachers' Retirement System of Louisiana	
	Homepage	https://www.trsl.org/main/home
	Handbook	https://www.trsl.org/uploads/File/Brochures/memberHandbook_WEB.pdf
Maine	Maine Public Employees Retirement System	
	Homepage	http://www.mainepers.org
	Handbook	http://www.mainepers.org/PDFs/handbooks/Teacher_Booklet_web.pdf
Maryland	Employees' and Teachers' Pension System	
	Homepage	http://www.sra.state.md.us
	Handbook	http://www.sra.state.md.us/Participants/Members/Downloads/Handbooks/BenefitHandbook-Emp-Pen.pdf

Table 3.2 (cont'd)

Massachusetts	Massachusetts Teachers' Retirement System	
	Homepage	http://www.mass.gov/mtrs/
	Seminar and reference guide	http://www.mass.gov/mtrs/docs/publications/yrbenefitsbklet.pdf
Michigan	Pension Plus, Michigan Public School Employees Retirement System	
	Homepage (MIP)	http://www.michigan.gov/orsschools/
	Homepage (Pension Plus)	http://www.mipensionplus.org
Minnesota	Minnesota Teachers Retirement Association	
	Homepage	https://www.minnesotatra.org
	Handbook	https://www.minnesotatra.org/images/pdf/Member%20Handbook.pdf
Mississippi	Public Employees' Retirement System of Mississippi	
	Homepage	http://www.pers.ms.gov/Pages/Home.aspx
	Handbook	http://www.pers.ms.gov/Content/Handbooks/Member_Handbook.pdf
Missouri	Public School & Education Employee Retirement System of Missouri	
	Homepage	https://www.psrs-peers.org
Montana	Montana Teachers' Retirement System	
	Homepage	https://trs.mt.gov
	Handbook	https://trs.mt.gov/miscellaneous/PdfFiles/Members/2016_TRS_Active_Member_Handbook.pdf
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System	
	Homepage	http://npers.ne.gov/SelfService/public/planInformation/school/schoolPlanInfo.jsp
	Handbook	http://npers.ne.gov/SelfService/public/howto/handbooks/handbookSchool.pdf
Nevada	Nevada Public Employees' Retirement System	
	Homepage	http://www.nvpers.org/public/members/
	Summary Plan Description Tier 1	https://www.nvpers.org/public/publications/regPlan.pdf
	Summary Plan Description Tier 2	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-1-1-2010.pdf
	Summary Plan Description Tier 3	https://www.nvpers.org/public/publications/regPlan-EnrolAfter-7-1-2015.pdf
	Legislation	https://www.leg.state.nv.us/NRS/NRS-286.html#NRS286Sec537

Table 3.2 (cont'd)

New Hampshire	New Hampshire Retirement System	
	Homepage	https://www.nhrs.org/members
	Legislation	http://www.gencourt.state.nh.us/rsa/html/vi/100-a/100-a-mrg.htm
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund	
	Homepage	http://www.nj.gov/treasury/pensions/
	Handbook	http://www.nj.gov/treasury/pensions/pdf/handbook/tpafbook.pdf
	Comprehensive Audited Financial Report	http://www.nj.gov/treasury/pensions/pdf/financial/2016divisioncombined.pdf
New Mexico	New Mexico Educational Retirement Board	
	Handbook (updated 2015)	https://www.nmerb.org/pdfs/memberwebhandbooksep2015.pdf
New York	New York State Teachers' Retirement System	
	Homepage	https://www.nystrs.org
	Handbook	https://www.nystrs.org/NYSTRS/media/PDF/Library/Publications/Active%20Members/handbook.pdf
North Carolina	Teachers' and State Employees' Retirement System	
	Homepage	https://www.nctreasurer.com/retirement-and-savings/managing-my-retirement/pages/default.aspx
	Handbook	https://www.nctreasurer.com/ret/Benefits%20Handbooks/TSERShandbook.pdf
North Dakota	North Dakota Teachers' Fund for Retirement	
	Handbook	http://www.nd.gov/rio/TFFR/Publications/Handbook.pdf
Ohio	State Teachers Retirement System of Ohio	
	Homepage	https://www.strsoh.org/actives/index.html
	Handbook	https://www.strsoh.org/_pdfs/brochureseries/benefitpayoptns/15-126.pdf
	Legislation	https://www.strsoh.org/_pdfs/legislation/20-663.pdf
Oklahoma	Oklahoma Teachers Retirement System	
	Homepage	https://www.ok.gov/TRS/
	Handbook	https://www.ok.gov/TRS/documents/Client%20Handbook%20V10%20(2016).pdf
Oregon	Oregon Public Employees' Retirement System	
	Homepage	http://www.oregon.gov/PERS/pages/index.aspx
Pennsylvania	Public School Employees' Retirement System	
	Homepage	http://www.psers.state.pa.us
	Handbook	http://www.psers.pa.gov/FPP/Publications/Active/Documents/Active%20Handbook.pdf

Table 3.2 (cont'd)

Rhode Island	Employees' Retirement System of Rhode Island	
	Homepage	https://www.ersri.org/#gsc.tab=0
	Benefit Introduction	https://d10k7k7mywg42z.cloudfront.net/assets/568549a8edb2f3791a1f46d7/Teachers_Retirement_Presentation_Dec_2015.pdf
	An Employee's Guide to Understanding the Rhode Island Retirement Security Act	https://d10k7k7mywg42z.cloudfront.net/assets/4f2feb51dabe9d2cb600fa49/final_rirsaguide_january2012.pdf
South Carolina	South Carolina Retirement Systems	
	Homepage	http://www.peba.sc.gov/retirement.html
	Handbook	http://www.peba.sc.gov/assets/scrshandbook.pdf
South Dakota	South Dakota Retirement System	
	Homepage	http://sdrs.sd.gov/about/default.aspx
	Handbook	http://sdrs.sd.gov/docs/ClassAFoundationMemberHandbook.pdf
Tennessee	Tennessee Consolidated Retirement System	
	Homepage	http://treasury.tn.gov/tcrs/
	Handbook (DB)	http://www.treasury.state.tn.us/tcrs/PDFs/Con-Teachers.pdf
	Handbook (Hybrid)	http://treasury.tn.gov/tcrs/PDFs/hybridplan.pdf
Texas	Teacher Retirement System of Texas	
	Homepage	https://www.trs.texas.gov/Pages/Homepage.aspx
	Handbook	https://www.trs.texas.gov/TRS%20Documents/benefits_handbook.pdf
Utah	Utah Retirement Systems	
	Homepage	https://www.urs.org
Vermont	Vermont State Teachers' Retirement System	
	Homepage	http://www.vermonttreasurer.gov/content/retirement/teacher
Virginia	Virginia Retirement System	
	Homepage	http://www.varetire.org
	Handbook (Plan 1)	http://www.varetire.org/pdf/publications/handbook-plan-1.pdf
	Handbook (Plan 2)	http://www.varetire.org/Pdf/Publications/handbook-plan-2.pdf
Washington	Washington Teachers' Retirement System	
	Homepage	http://www.drs.wa.gov
	Handbook (Plan 2)	http://www.drs.wa.gov/member/handbooks/trs/plan-2/t2hbk.pdf

Table 3.2 (cont'd)

West Virginia	West Virginia Teachers' Retirement System	
	Homepage	http://www.wvretirement.com/TRS.html
	Tier 1 Introduction	http://www.wvretirement.com/Forms/TRS-Brochure2017.pdf
	Tier 2 Introduction	https://www.wvretirement.com/Forms/TRS-Brochure2017-TIER2.pdf
Wisconsin	Wisconsin Retirement System	
	Homepage	http://etf.wi.gov
	Handbook	http://etf.wi.gov/publications/et2119.pdf
Wyoming	Wyoming Retirement System	
	Homepage	http://retirement.state.wy.us/pension/index.html

Table 3.3: Pension Reforms Between 2007 and 2011

State	Reforms Include:	
	Reducing Benefits	Increasing Vesting Rules
Alabama		
Arizona	Yes	
Arkansas		
California		
Colorado	Yes	
CO-Denver	Yes	
Connecticut		
Delaware		
Georgia		
Idaho		
Illinois	Yes	Yes
IL-Chicago	Yes	Yes
Iowa		
Kansas	Yes	(decreasing)
Kentucky	Yes	
Louisiana	Yes	
Maine	Yes	
Massachusetts		
MA-Boston		
Minnesota		
MN-Duluth		
MN-Minneapolis*		
MN-St. Paul	Yes	
Mississippi	Yes	
Missouri		
MO-Kansas City		
MO-St. Louis		
Montana		

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.3 (cont'd)

State	Reforms Include:	
	Reducing Benefits	Increasing Vesting Rules
Nebraska		
NE-Omaha		
Nevada	Yes	
New Hampshire	Yes	
New Jersey	Yes	
New Mexico	Yes	
New York	Yes	Yes
NY-New York City	Yes	Yes
North Carolina		
North Dakota	Yes	Yes
Oklahoma		
Pennsylvania	Yes	Yes
South Dakota	Yes	
Tennessee		
Texas	Yes	
Virginia	Yes	
VA-Fairfax		
Wisconsin	Yes	Yes
Wyoming		
Total	23	7

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.4: Membership of Public Pension Plans that Enroll Teachers

State	Plan	Membership
Alabama	Teachers' Retirement System -Tier1 (DB)	Hired before January 1, 2013
Alabama	Teachers' Retirement System -Tier 2 (DB)	Hired on or after January 1, 2013
Arizona	Arizona State Retirement System (DB)	Hired before January 1, 1984
Arizona	Arizona State Retirement System (DB)	Hired between January 1, 1984 and June 30, 2011
Arizona	Arizona State Retirement System (DB)	Hired on or after July 1, 2011
Arkansas	Arkansas Teacher Retirement System (DB)	All teachers
California	California State Teachers' Retirement System (DB)	Hired before January 1, 2013
California	California State Teachers' Retirement System (DB)	Hired on or after January 1, 2013
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or before June 30, 2005, and vested on January 1, 2011,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired between July 1, 2005, and December 31, 2006, and vested on January 1, 2011,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or before December 31, 2006, not vested on January 1, 2011; Or hired between January 1, 2007, and December 31, 2010,
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired between January 1, 2011, and December 31, 2016
Colorado	Colorado Public Employees' Retirement Association (DB)	Hired on or after January 1, 2017
CO-Denver	Denver Public Schools Retirement System (DB)	Merged with the Colorado Public Employees Association effective January 1, 2010.
Connecticut	Connecticut Teachers' Retirement System (DB)	All teachers
Delaware	State Employee Pension Plan (DB)	Hired before January 1, 2012
Delaware	State Employee Pension Plan (DB)	Hired on or after January 1, 2012
Georgia	Teachers Retirement System of Georgia (DB)	All teachers
Idaho	Public Employee Retirement System of Idaho (DB)	All teachers

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.4 (cont'd)

Illinois	Teachers' Retirement System of the State of Illinois - Tier 1 (DB)	Hired before January. 1, 2011
Illinois	Teachers' Retirement System of the State of Illinois - Tier 2 (DB)	Hired on or after January. 1, 2011
Iowa	Iowa Public Employees' Retirement System (DB)	Retired before July 1, 2012
Iowa	Iowa Public Employees' Retirement System (DB)	Retired after July 1, 2012
Kansas	Kansas Public Employees Retirement System - Tier 1 (DB)	Hired before July 1, 2009
Kansas	Kansas Public Employees Retirement System - Tier 2 (DB)	Hired between July 1, 2009 and Dec 31, 2014
Kansas	Kansas Public Employees Retirement System - Tier 3 (Cash Balance)	Hired after January 1, 2015
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired before July 1, 2002
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired between July 1, 2002 and June 30, 2008
Kentucky	Kentucky Teachers' Retirement System (DB)	Hired on or after July 1, 2008
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired before July 1, 1999
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired between July 1, 1999 and Dec 31, 2010
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired between January 1, 2011, and June 30, 2015
Louisiana	Teachers' Retirement System of Louisiana (DB)	Hired after July 1, 2015
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 1993, had at least 10 years of service credit, or reached age 60 and had at least a year of service credit.
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 2011, had at least 5 years of service credit or, reached age 62 and had at least a year of service credit immediately prior to reaching age 62.
Maine	Maine Public Employees Retirement System (DB)	Before July 1, 2011, you had less than 5 years of service credit and not reached age 62 with at least a year of service credit.

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.4 (cont'd)

Massachusetts	Massachusetts Teachers' Retirement System -Tier 1 (DB)	Hired before April 2, 2012
Massachusetts	Massachusetts Teachers' Retirement System -Tier 2 (DB)	Hired on or after April 2, 2012
Minnesota	Minnesota Teachers Retirement Association - Tier 1 (DB)	Hired on or before June 30, 1989
Minnesota	Minnesota Teachers Retirement Association - Tier 2 (DB)	Hired after June 30, 1989
Mississippi	Public Employees' Retirement System of Mississippi - Tier 1 (DB)	Hired before July 1, 1992
Mississippi	Public Employees' Retirement System of Mississippi - Tier 2 (DB)	Hired between July 1, 1992, and June 30, 2007
Mississippi	Public Employees' Retirement System of Mississippi - Tier 3 (DB)	Hired between July 1, 2007, and June 30, 2011
Mississippi	Public Employees' Retirement System of Mississippi - Tier 4 (DB)	Hired on or after July 1, 2011
Missouri	Public School & Education Employee Retirement System of Missouri (DB)	All teachers
Montana	Montana Teachers' Retirement System - Tier 1 (DB)	Hired Before July 1, 2013
Montana	Montana Teachers' Retirement System - Tier 2 (DB)	Hired on or after July 1, 2013
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System (DB)	Hired Before July 1, 2013
Nebraska	Nebraska Public Employees Retirement Systems, School Retirement System (DB)	Hired on or after July 1, 2013
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after July 1, 1989, and before January 1, 2010
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after January 1, 2010, and before July 1, 2015
Nevada	Nevada Public Employees' Retirement System (DB)	Hired on or after July 1, 2015

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.4 (cont'd)

New Hampshire	New Hampshire Retirement System (DB)	Hired before July 1, 2011 and vested prior to January 1, 2012
New Hampshire	New Hampshire Retirement System (DB)	Hired before July 1, 2011 and not vested prior to January 1, 2012
New Hampshire	New Hampshire Retirement System (DB)	Hired on or after July 1, 2011
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 1 (DB)	Hired before July 1, 2007
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 2 (DB)	Hired on or after July 1, 2007, and before Nov. 2, 2008
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 3 (DB)	Hired on or after Nov. 2, 2008, and before May 22, 2010
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 4 (DB)	Hired on or after May 22, 2010, and before June 28, 2011
New Jersey	State of New Jersey Teachers' Pension and Annuity Fund- Tier 5 (DB)	Hired on or after June 28, 2011
New Mexico	New Mexico Educational Retirement Board-Tier 1 (DB)	Hired before July 1, 2010
New Mexico	New Mexico Educational Retirement Board-Tier 2 (DB)	Hired on or after July 1, 2010, and before July 1, 2013
New Mexico	New Mexico Educational Retirement Board-Tier 3 (DB)	Hired on or after July 1, 2013
New York	New York State Teachers' Retirement System- Tier 1 (DB)	Hired before July 1, 1973
New York	New York State Teachers' Retirement System- Tier 2 (DB)	Hired on or after July 1, 1973, and before July 27, 1976
New York	New York State Teachers' Retirement System- Tier 3 (DB)	Hired on or after July 27, 1976, and before Sept 1, 1983
New York	New York State Teachers' Retirement System- Tier 4 (DB)	Hired on or after Sept 1, 1983, and before January. 1, 2010
New York	New York State Teachers' Retirement System - Tier 5 (DB)	Hired on or after January. 1, 2010, and before April 1, 2012
New York	New York State Teachers' Retirement System -Tier 6 (DB)	Hired on or after April 1, 2012

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.4 (cont'd)

North Carolina	Teachers' and State Employees' Retirement System (DB)	All teachers
North Dakota	North Dakota Teachers' Fund for Retirement - Tier 1 (DB)	Hired before July 1, 2008
North Dakota	North Dakota Teachers' Fund for Retirement -Tier 2 (DB)	Hired on or after July 1, 2008
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired before July 1, 1992
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired after June 30, 1992, and before November 1, 2011
Oklahoma	Oklahoma Teachers Retirement System (DB)	Hired on or after November 1, 2011
Pennsylvania	Public School Employees' Retirement System - Class TC (DB)	Hired before July 1, 2001
Pennsylvania	Public School Employees' Retirement System - Class TD (DB)	Hired after June 30, 2001, and before July 1, 2011
Pennsylvania	Public School Employees' Retirement System - Class TE (DB)	Hired on or after July 1, 2011
South Dakota	South Dakota Retirement System (DB)	All teachers (but a 2008 law apply to everyone including retirees)
Tennessee	Tennessee Consolidated Retirement System (DB)	Hired on or after July 1, 1976, and before July 1, 2014
Tennessee	Tennessee Consolidated Retirement System (Hybrid)	Hired on or after July 1, 2014
Texas	Teacher Retirement System of Texas - Tier 1 (DB)	Hire before September 1, 2007 and met the 2005 eligibility requirements to be grandfathered: were at least 50 years of age; or age and years of service credit totaled at least 70; or had at least 25 years of service credit as a member of TRS before Sept. 1, 2005
Texas	Teacher Retirement System of Texas - Tier 2 (DB)	Hire before September 1, 2007 but did not meet the 2005 eligibility requirements to be grandfathered:
Texas	Teacher Retirement System of Texas - Tier 3 (DB)	Hire on and after September 1, 2007 and had at least five years of service credit in TRS as of August 31, 2014
Texas	Teacher Retirement System of Texas - Tier 4 (DB)	Current membership starts on and after September 1, 2007, meet the 2005 eligibility requirements to be grandfathered, and had at least five years of service credit in TRS as of August 31, 2014

Source: Author's tabulation from pension-plan-specific information detailed in Table 3.2.

Table 3.5: Weighted Means of Variables

	Benefit Reducing Legislation				No Benefit Reducing			
	(1)		(2)		(3)		(4)	
	Pre-reform		Post-reform		Pre-reform		Post-reform	
Variable	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.	**Mean**	Std. Dev.
Percentage Distribution of Public School Teacher Status								
Leave	**0.07**	0.25	**0.11**	0.31	**0.11**	0.31	**0.17**	0.38
Stay	**0.93**	0.25	**0.89**	0.31	**0.89**	0.31	**0.83**	0.38
Pension Characteristics								
Vesting rules	**5.03**	2.20	**6.82**	4.12	**6.59**	2.41	**5.99**	2.07
Teacher contribution rate	**6.47**	1.96	**7.74**	1.78	**7.00**	2.25	**6.63**	2.25
Pension funding ratio	**86.11**	12.34	**72.58**	10.03	**87.50**	13.38	**83.43**	10.04
Employer contribution rate	**7.55**	4.58	**12.67**	5.96	**11.46**	5.01	**12.70**	4.87
Net Pension Wealth ($1000)	**384.82**	126.33	**278.31**	129.17	**349.81**	86.82	**342.42**	49.34
Outside Options								
Unemployment rate (TFS)	**5.33**	0.75	**7.78**	1.13	**5.77**	0.83	**8.22**	1.25
Alternative teacher pay	**136.09**	36	**140.97**	33.29	**137.71**	33.27	**132.35**	29.92
Teacher Characteristics								
Female	**0.77**	0.42	**0.76**	0.43	**0.80**	0.40	**0.96**	0.20
Age	**28.98**	8.70	**27.31**	6.24	**29.21**	8.48	**28.90**	8.36
Weights	136,354		25,150		71,171		24,395	

Note: Sample is restricted to first-year full time teachers. Statistics of school and teacher characteristics are summarized from the 2003-2004, 2007-2008, and 2011-2012 waves of the SASS, and the 2004-2005, 2008-2009 and the 2012-2013 waves of the TFS.

Table 3.6: The Effects of Pension Reforms on New Teacher Turnover

VARIABLES	(1) Leave
Benefit-Reducing*Post	-0.0260
	(0.0954)
Benefit-Reducing	-0.346**
	(0.138)
Increasing Vesting Rule*Post	0.188
	(0.182)
Increasing Vesting Rule	0.428**
	(0.178)
Teacher Contribution Rate	-0.0141
	(0.0175)
Employer Contribution Rate	0.00544*
	(0.00283)
Pension Funding Ratio	0.00219
	(0.00163)
Alternative Salary Rate	0.000681*
	(0.000353)
Unemployment Rate	-0.0341
	(0.0309)
Weights	257,070
Observations	1,380
R-squared	0.121

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: The Difference in New Teacher Turnover between the Control and Treatment Groups before the Pension Reforms

VARIABLES	(1) Leave
Benefit-Reducing*Post	0.00296
	(0.0632)
Benefit-Reducing	-0.359***
	(0.134)
Increasing Vesting Rule*Post	0.0243
	(0.0631)
Increasing Vesting Rule	0.434**
	(0.175)
Teacher Contribution Rate	-0.0147
	(0.0171)
Employer Contribution Rate	0.00533*
	(0.00285)
Pension Funding Ratio	0.00220
	(0.00174)
Alternative Salary Rate	0.000691*
	(0.000353)
Unemployment Rate	-0.0318
	(0.0332)
Weights	257,070
Observations	1,380
R-squared	0.120

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.8: The Effects of Net Pension Wealth on New Teacher Turnover

VARIABLES	(1) Leave
Log (Net Pension Wealth)	0.0278
	(0.0342)
Vesting Rule	0.000744
	(0.0236)
Employer Contribution Rate	0.00496*
	(0.00263)
Pension Funding Ratio	0.00242
	(0.00162)
Alternative Salary Rate	0.000735**
	(0.000370)
Unemployment Rate	-0.0287
	(0.0295)
Weights	257,070
Observations	1,380
R-squared	0.116

All specifications include a full set of state dummies and year dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

APPENDIX C

FIGURES

Figure 1.1: Net Pension Wealth Change between 2007 and 2016

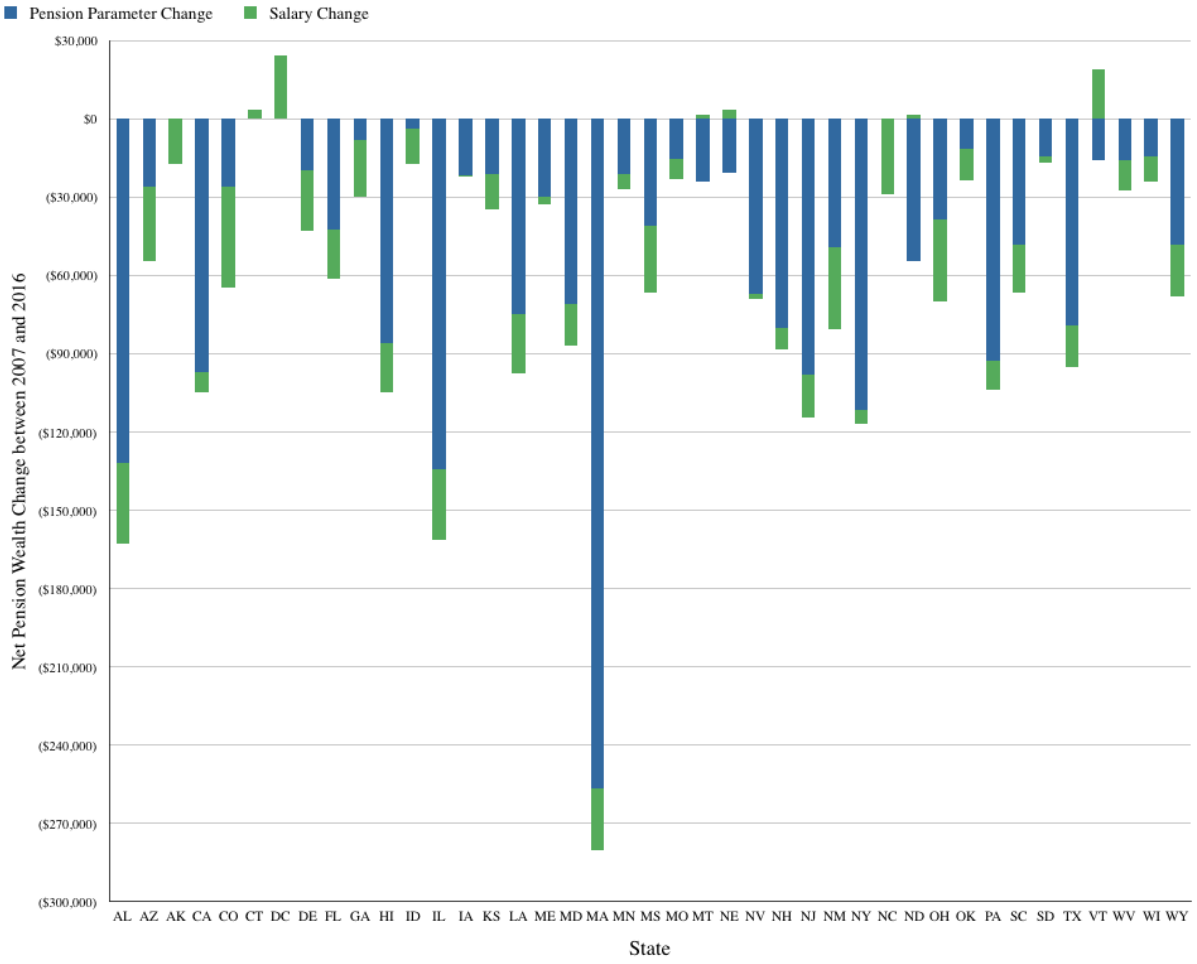


Figure 1.2: Pension Funding Ratio Trends from 2007 through 2016

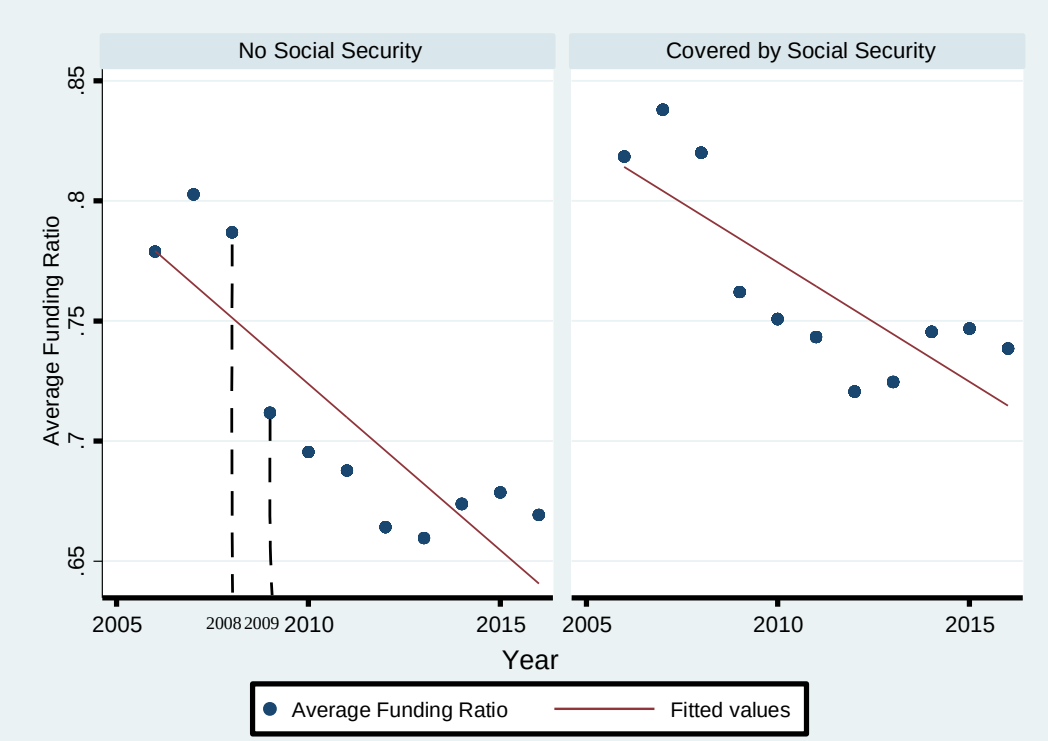


Figure 1.3: Relationships between Net Pension Wealth Cut and Pension Funding Ratio

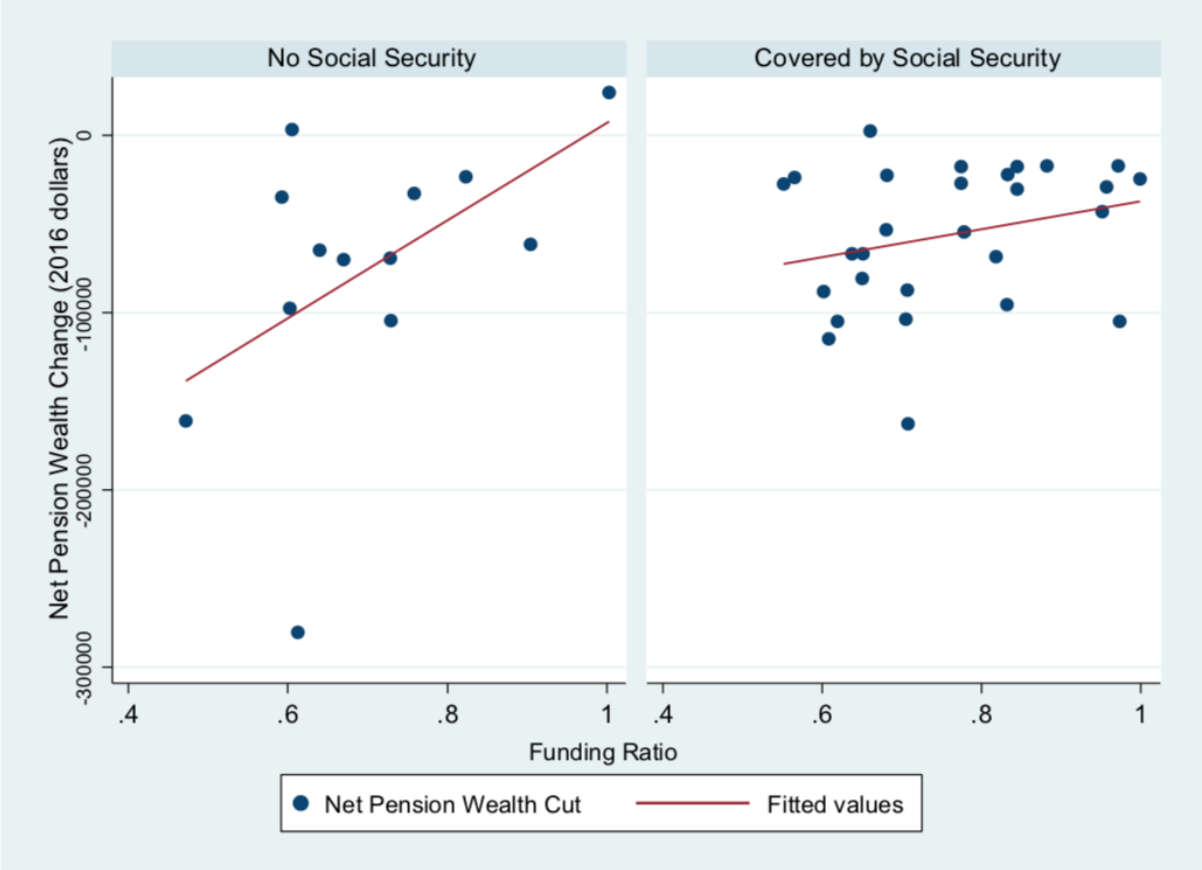


Figure 3.1: Pension Wealth Accrual for a Representative Arkansas Teacher Who Began Her Career at Age 25

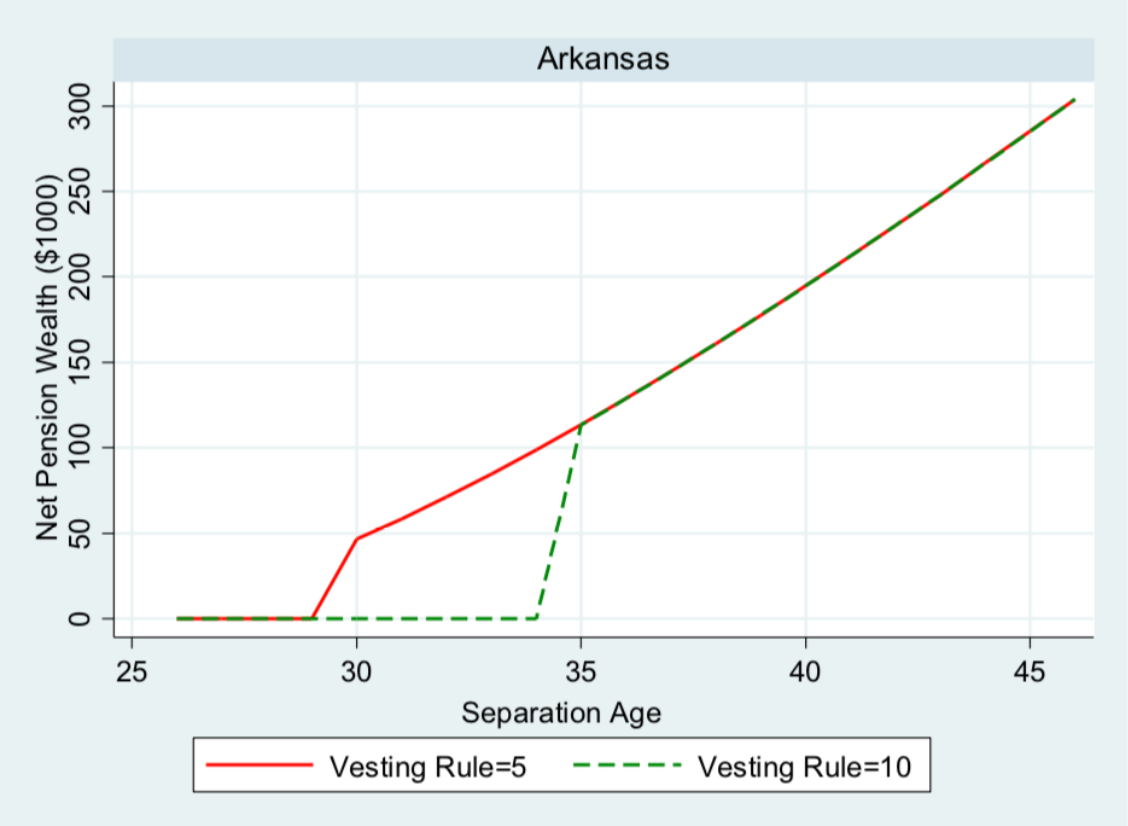


Figure 3.2: Pension Wealth Accrual for a Representative Teacher Who Began Her Career at Age 25

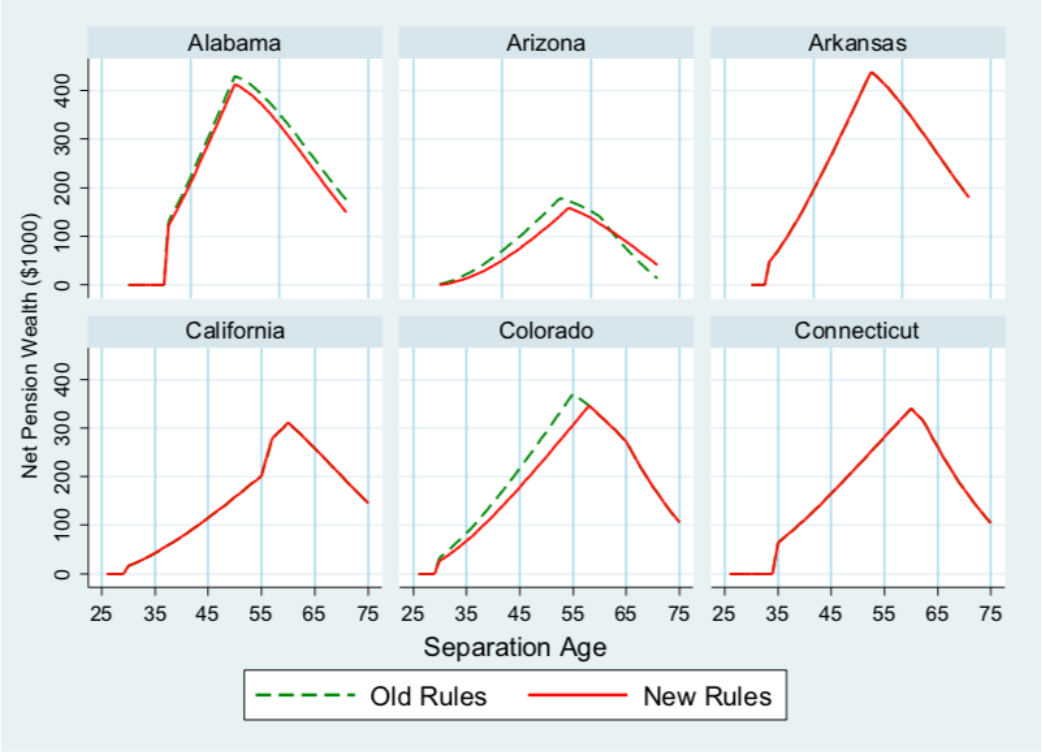


Figure 3.2 (cont'd)

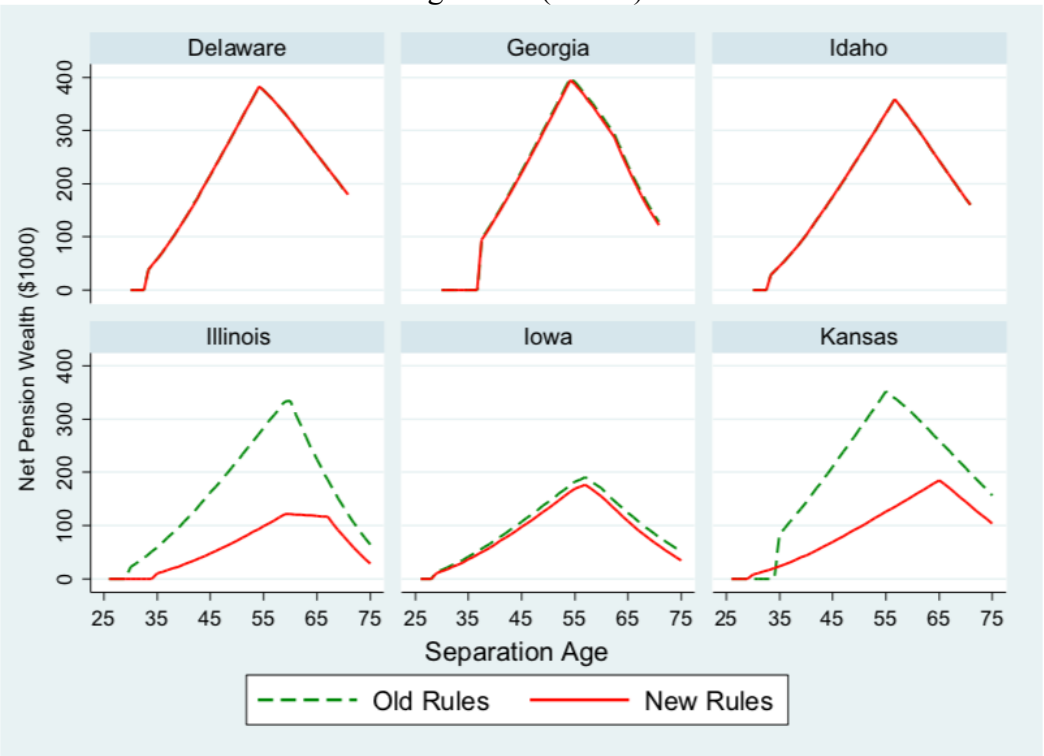


Figure 3.2 (cont'd)

Figure 3.2 (cont'd)

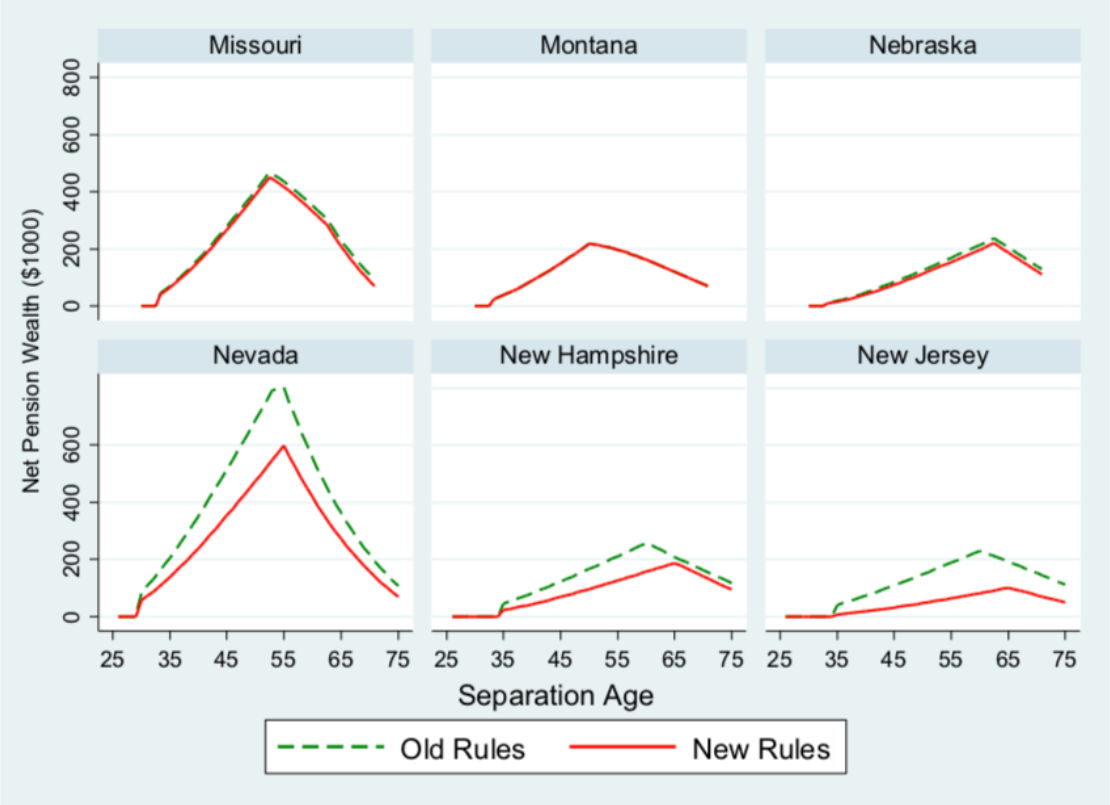


Figure 3.2 (cont'd)

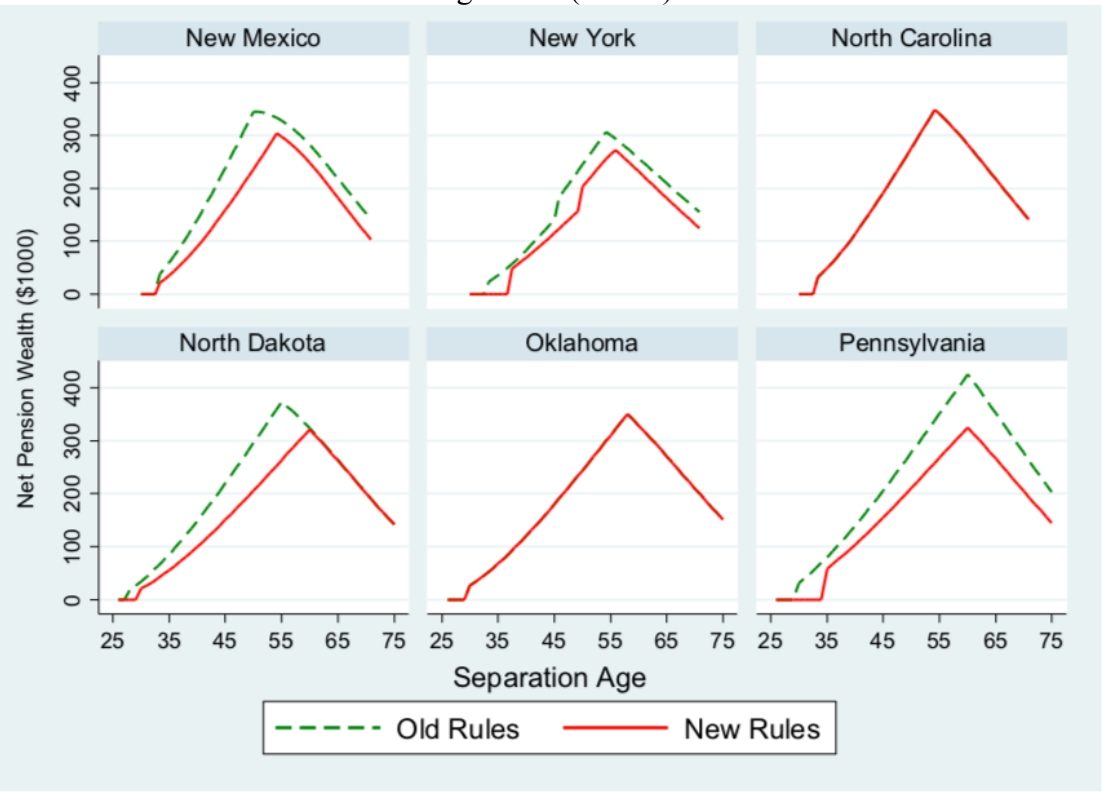
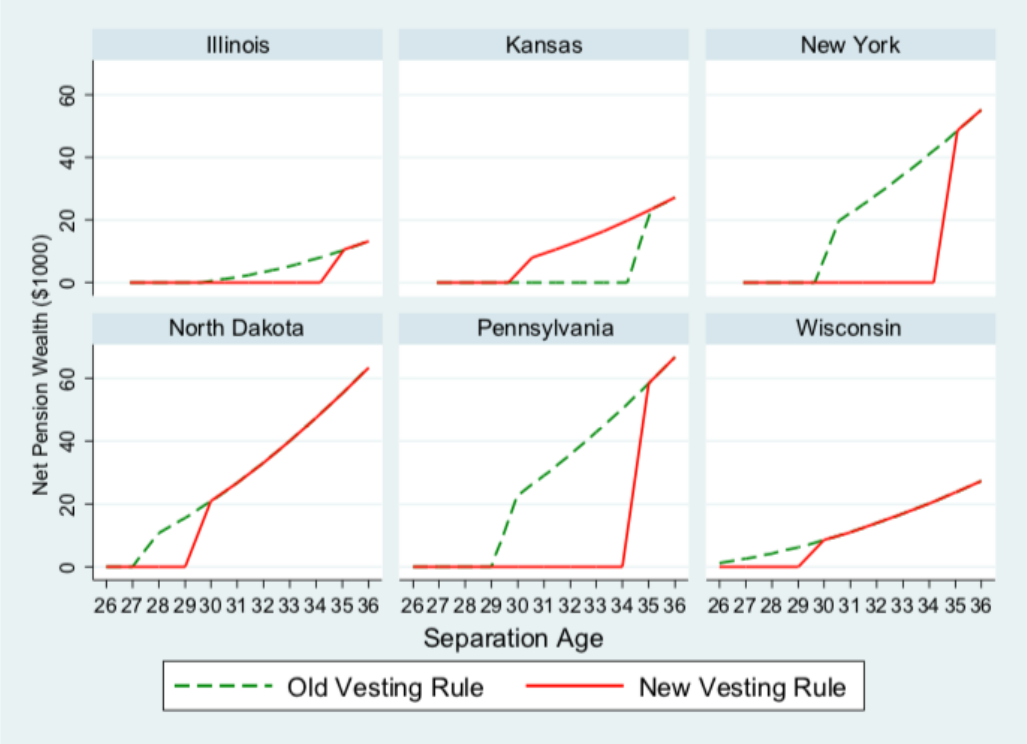


Figure 3.2 (cont'd)

Figure 3.3: Vesting Rules and Pension Wealth Accrual for Teachers Hired in 2011



The simulations are calculated based on a set of assumptions including: 1. the hypothetical teacher works in the same school from age 25. 2. I assume a 4 percent discount rate. All simulations are in 2011 dollars.
Source: Author's calculations.

$$\text{Net Pension Wealth}_{t=1} = \sum_{t=T+1}^{t=T+d} \frac{\mathcal{A}_t * (1+f_t)^{t-(T+1)} \pi_t}{(1+r)^{t-1}} - \sum_{t=1}^{t=T} \frac{C_t}{(1+r)^{t-1}}$$

where $\mathcal{A}_t$ is the capped annual payment in year t >T, C_t is the teacher contribution in year $t \leq T$, f_t is the cost of living adjustment in year t, π_t is the probability of surviving at year t, and r is the discount rate.

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