Interstate Differences in Public Pension Parameters: Effects on Teacher Experience and First Exit

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Abstract:

We study the effects of public sector defined benefit plans on the early years of a teacher's career. We find large cross-state differences in the actuarial present value of pension wealth upon vesting. Using aggregate data we find evidence of a negative relationship between state vesting rules and the experience distribution of a state's teacher population. Finally, we use data from the National Longitudinal Survey of Youth to study the first exit from teaching for young teachers. We find that pension characteristics, such as vesting requirements, Social Security coverage and defined contribution alternatives, significantly influence the first exit from teaching.

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I. Introduction

Recent education reforms in the United States adjust teacher compensation in a number of different ways. While some policies tie teacher compensation to student performance, such as value-added to student test scores, many more legislative actions have focused on reducing state retirement costs -- by increasing the years required before vesting and teacher and employer contribution rates, for example.[1] These changes to the compensation structure for public school teachers have implications both for state budgets and for the composition of the teacher workforce if pensions influence labor market entry and exit decisions, job changes, and mobility across state lines.

While the private sector has moved to defined contribution plans, and pension reform has made some inroads in public plans for general government workers, the vast majority of public sector workers -- K-12 teachers -- continue to be covered by mandatory defined benefit plans with influential pension accrual patterns and limits to portability.[2] These accrual patterns can affect a district's ability to attract and retain younger, more mobile teachers or individuals from the private sector changing jobs mid-career. Legislative changes to pension parameters designed to reduce state pension obligations may have important unintended effects on the distribution of teacher experience across states.

In this paper we highlight differences in vesting rules, portability through service credits, and pension wealth differences across states for public school

[1] Actuarial valuations from state financial reports estimate a total of approximately $325 billion in unfunded liabilities, which the literature considers to be an underestimate due to unrealistic actuarial assumptions (Novy-Marx and Rauh, 2011; Doherty et al., 2012). See the National Conference on State Legislatures' annual review of pension and retirement plan enactments for recent reforms.

[2] States vary in the availability of supplemental defined contribution plans as well as teacher contributions to Social Security. For example, in 2010 there were 15 states (includes the District of Columbia) where teachers were not covered by Social Security (Doherty et al., 2012).

teachers in the early years of their career.[3] Pension vesting rules have received little attention in the literature on teacher experience, yet they may have unintended effects on new teacher retention or teacher preferences for shorter-term employment, particularly for teachers who are forward-looking. For example, in 2012 the New York State Teachers' Retirement System changed the vesting requirement from five years to 10 years for new teachers. Additionally, they now require the teacher to contribute to his or her pension for the length of active membership, as opposed to only the first ten years of employment. There were similar reforms to pension parameters in 21 other states in 2012 alone (Doherty et al., 2012). All else equal, these changes may reduce the incentive for new teachers to stay in teaching for several years. Yet these early years of teaching are critical for teacher effectiveness. Several recent studies find that new teachers are less effective than those with some experience.[4]

Restrictions across state borders on purchasing credits may also reduce young teacher mobility. The formulaic nature of the defined benefit pension calculation implies that teachers who change retirement systems in mid-career can pay a significant penalty in pension wealth if they do not receive credit for prior time as a teacher. Some states allow teachers to purchase credits for prior service, limiting the severity of this penalty. However, other states limit the credits one can purchase or do not allow for purchases at all (Doherty et al., 2012).

We illustrate the magnitude of differences in pension wealth, both across states and at different times in one's teaching career, using a simulation exercise across four states with different vesting rules. We construct the actuarial present

[3] Our results throughout the paper are applicable to public school teachers or charter school teachers if the charter school opts to participate in the state retirement system. Olberg and Podgursky (2011) discuss the different retirement compensation programs for charter school teachers across a number of different states.

[4] For an overview, see Rice (2010), and for individual studies see Kane, Rockoff, and Staiger (2006), Ladd (2008), and Sass (2007).

value of pension liability (or, wealth from the teacher's perspective) that is commonly used in valuing pensions for legal matters, such as Qualified Domestic Relations Orders following divorce.[5] This termination liability, or accrued benefit obligation, is a measure of the pension liability owed at different points through a teacher's career should she separate from service.[6]

Next, we use cross-sectional aggregate data on the state-level experience distribution of teachers to calculate the relationship between key pension parameters, such as vesting requirements, and the composition of teacher experience. Our results suggest a negative relationship between the years required to vest and the percentage of teachers with experience between zero and four years. This finding implies that the current system of teacher retirement compensation is not helping to retain young teachers.

Lastly, we use the variation in characteristics of the state pension system to predict first exit from teaching among a sample of new teachers in the National Longitudinal Survey of Youth of 1997 (NLSY97). We show that vesting requirements and availability of defined contribution alternatives significantly affect the hazard of first exit from teaching. These results imply that adjustments to teacher retirement compensation may significantly affect the composition of the teacher labor force.

The next section briefly reviews the literature on mobility and retirement effects of defined benefit plans with an emphasis on teacher pensions. In section III we discuss our calculations of individual teacher pension wealth and compare wealth for teachers upon vesting across four states as an illustration. Section IV provides evidence that these interstate differences in pension vesting rules may affect the distribution of teacher experience across states. In section V we use

[5] Papke thanks Robert Raasche for providing detailed information about these arrangements.
[6] This is similar to the accrued benefit obligations emphasized in Rauh (2010).

panel data on teachers to calculate the effect of different pension parameters on the hazard of first exit from teaching. Section VI concludes.

II. Related Literature

While a large literature studies the effects of incentives created by pension wealth on retirement behavior, there is virtually no prior literature studying the effects of these incentives on younger workers. As a result, we briefly describe this related literature that focuses on labor market response to retirement incentives, particularly among teachers.

The literature on retirement effects focuses specifically on the incentives created by defined benefit plans (Friedberg and Owyang, 2002; Furgeson, Strauss, and Vogt, 2005; Costrell and Podgursky, 2009; Friedberg and Turner, 2010; Friedberg, 2011; Friedberg and Turner, 2011; Munnel et al., 2012). For example, there was a large increase in teacher retirement in Pennsylvania from 1997-1998 to 1998-1999 in response to more generous retirement benefits (Furgeson, Strauss, and Vogt, 2005). More generally, Friedberg (2011) reviews retirement and mobility implications of defined benefit plans and the related literature for public employees. She finds that defined benefit pension incentives play a significant role in the timing of one's retirement from the labor market. She also notes that empirical evidence suggests that younger workers with defined benefit plans are less likely to switch jobs as pension wealth accrues, although this evidence is not definitive.

Another literature that can inform our analysis focuses on labor market entry and exit (Podgursky et al., 2004; Goldhaber et al., 2010). For example, Podgursky et al. (2004) study the entry and exit decisions of recent college graduates in Missouri. Among their results they find that women are more likely to enter teaching than men and teachers with higher ability scores are more likely to exit teaching.

Lastly, a subset of the teacher retirement literature focuses specifically on cross-state variation in teacher pension wealth and provides simulation evidence of peak wealth (Costrell and Podgursky, 2009; Toutkoushian et al., 2011). These calculations, like ours in Section III, use the characteristics of state pension programs to calculate the present discounted value of a teacher's pension benefits under a number of different assumptions about teacher age, experience, and salary growth. Costrell and Podgursky (2009) focus on six states in their simulation, and show the cross-state variation in spikes in pension wealth. Toutkoushian et al. (2011) calculate a simulation for one identical career teacher in all 50 states, providing a ranking for the most generous pension plans.[7] In the next section we describe our simulation of pension wealth differences across states.

III. Vesting Rules and Teacher Pension Wealth

There are nontrivial differences in pension wealth for teachers in different states driven solely by differences in pension plan parameters. In this section, we provide examples of cross-state differences in the present discounted value of pension wealth, particularly upon vesting for new teachers. The value of this wealth to the individual teacher is subjective since many may already know they will not stay in their jobs long enough to eventually claim this wealth. We do not discuss its behavioral implications here, but use this exercise to illustrate the potential differences across states.

We select four states to illustrate the variability in pension wealth upon vesting. Specifically -- California, Florida, Michigan, and Wisconsin -- all have different vesting rules – some as a result of recent policy changes. Table 1

[7] Because of the large scope of this simulation, they only present results for one type of teacher who spent their entire career in the teaching profession with no salary cap. In addition, they assume one starting salary across all states and a salary growth rate of 3 percent with no cap. These assumptions result in six figure final salaries for lifetime teachers.

describes the state-specific pension parameters. For example, Michigan requires ten years of service before a teacher is vested, while Florida only requires six years. California requires five years for vesting, but teachers do not contribute to Social Security and are no longer allowed to retire prior to the traditional retirement age with full lifetime benefits (Doherty et al, 2012). Prior to 2011 teachers were immediately vested in Wisconsin, but today Wisconsin has a vesting rule of five years. For comparison, the national average for vesting in these plans in 2008 was 5.78. The remainder of Table 1 shows that these states also differ in the age for retirement with full benefits, teacher contribution rates, teacher salaries, and Social Security coverage.[8]

We collect information on pension plan parameters from a number of sources. First, we use data from 2001 to 2010 of the Public Fund Survey, which collects statistics and parameters for public retirement systems. We confirm and supplement these statistics with vesting rules, benefit formulas, and contribution rates from summary plan handbooks as well as portability measures defined by the National Council on Teacher Quality (Doherty et al., 2012).

Based on these pension plan parameter values and assumptions described below, we can calculate the present discounted value of pension wealth at any point in time for a hypothetical teacher. We calculate the annual pension benefit as follows:

$$\text{Benefit} = \text{Final Average Salary} \times \text{Factor} \times \text{Years of Service}$$

We obtain the formula to calculate final average salary and multiplicative factor parameters from state pension plan brochures. We multiply this value by the probability of survival at each age to get the actuarial value of annual benefits, assuming the individual will live until age 100. Lastly, we calculate the present discounted value of pension wealth using a discount rate r as follows:

[8] It is possible that these differences across states are offset by differences in health benefits. We only simulate pension differences here.

$$PDV = \sum_{t=0}^{t=100-C} \frac{A}{(1+r)^t}$$

where A is the actuarial value of annual benefits, t indicates the year at which the calculation is done, and C is the teacher's age at the time of the calculation.

This calculation requires the following assumptions. First, we set the teacher's starting salary equal to the state's average salary for the teacher's level of education from the 2008 SASS. This implies that there is no difference in the starting salaries for individuals who hypothetically begin working in different years. Salaries grow at three percent per year until they reach the top step reported by the SASS.[9] Once the salary reaches the top step for the state, it remains constant. Our reported present value deducts contributions and assumes they are returned if the teacher leaves the system early, but we omit the possible interest payments.[10] We assume a three percent discount rate in our calculations, and use the 2008 female combined-race life tables to estimate the probability of survival to the next year (Arias, 2012). In footnote 12 we illustrate variations due to racial differences in mortality.

Defined benefit plans also typically include cost of living adjustments (COLAs). In some states, such as Michigan, COLAs are a constant predetermined percent of initial benefit. In other states, the legislature votes annually on the possibility of a COLA that year. In other plans, COLAs are linked to an inflation index with a cap. In prior work we show that COLAs do not

[9] These caps ensure that teacher salaries do not grow to unrealistic values.

[10] While teachers typically begin contributing to the pension as soon as they begin working, if the teacher leaves before vesting, these contributions are refunded (sometimes with interest or employer contributions as well). In California, Michigan, and Wisconsin employees who leave receive interest. However, teachers who leave early in Florida receive less than or equal to their own contributions (Doherty et al., 2012). We omit the interest payments due to uncertainty about the specifics by state.

cause a large difference in pension wealth for younger teachers (Papke and Litwok, 2013).

Our focus is on the front end of the career trajectory, specifically the jump in pension wealth when the teacher becomes vested – at different levels of experience in the four states.[11] In Figure 1 we demonstrate this difference graphically. The magnitude of this windfall can be approximately an additional year of salary or more for the young teachers; for example, the windfall of $45,171 for a teacher who begins working at age 25 with a Bachelor's degree in Michigan is approximately 132 percent of a starting teacher's salary. While the pension formulas differ with respect to salary and pension multiplier, the cross-state variation in vesting requirements alone accounts for timing differences in any pension wealth. Recall, several states recently increased the years required before vesting. This policy may reduce the future pension obligation but may also make it harder to retain young teachers.

In Table 2, we calculate pension wealth for various early stages in a teacher's career. For a teacher who started teaching at 25 years old with a Master's degree, we compare the present discounted value of her pension if she quits after two years, five years, and 10 years and also at typical retirement ages. Column (1) highlights interstate differences in the peak value of her pension along with the age at which the peak will occur. The remaining columns include the difference from the peak value in parentheses. This difference is one measure of the opportunity cost of quitting or moving across state (district) boundaries in terms of pension wealth.[12]

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[11] See Papke and Litwok (2013) for a detailed description of the simulation exercise including graphical representations of the accumulation of pension wealth throughout a hypothetical teacher's career.

[12] We can incorporate race into our calculations through differences in life expectancy. If the teacher is white, the peak value of her pension (from Table 2) in California, Florida, Michigan, and Wisconsin, respectively, would be $693,921, $684,392, $666,664, and $372,561. If she is black these values would be $638,249, $634,157, $614,999, and $342,051.

The significant differences between the states highlight the differences in pension wealth that are caused by plan parameters. Many of the parameters in the simulation contribute to these differences, including contribution rates, salary levels, and benefit formulas. For example, consider the calculation of the final average salary used in the defined benefit formula. In Michigan and Wisconsin this number is the average of the highest three years of compensation, in California it is the highest consecutive twelve months, and in Florida it is the average of the highest eight years. Wisconsin's significantly lower present value in Figure 1 is a result of a relatively high contribution rate coupled with a significantly lower salary. At $30,700 the average starting salary for a new Wisconsin teacher with Bachelor's degree is substantially lower than it would be in the other states. Furthermore, the Wisconsin peak salary of $57,100 is the lowest among the four states. Wisconsin's pension plan also includes a relatively high teacher contribution rate of 6.65 percent of salary.

The simulated values of pension wealth in Table 2 indicate that young teachers with a defined benefit pension earn virtually nothing toward their pension wealth before they are vested. In contrast, in the bottom row of Table 2 we also simulate the value of a young teacher's pension if she were contributing to a defined contribution plan, using the Michigan teacher defined contribution plan offered to new hires as of September 2012 as an example.[13] The defined contribution pension wealth steadily grows for this worker, even in the early years. For instance, if a teacher quits after two or five years she still earns $6,341 or $17,322, respectively, a sizable amount of pension wealth if she participates fully in this defined contribution plan. Further, this benefit is portable to other

[13] We assume that a teacher contributes six percent of her salary to the account with a 50 percent match rate (up to three percent) by the employer. We further assume that this account grows at three percent per year.

plans or can be rolled over into an IRA. In the next section, we ask if these seemingly large differences across states affect teachers' years of experience.

IV. Pension plan characteristics and the distribution of teacher experience

We focus on the relationship between two key pension plan characteristics and the distribution of teacher experience across 50 states. We add data from the 2008 and 2011 SASS on experience distribution for teachers as well as starting salary to our data on pension information across states.[14] The SASS provides the percentage of teachers in each state in the following experience categories: fewer than four years of experience, between four and nine years, and 10 to 14 years. Table 3 provides summary statistics that highlight the cross-state variation in the experience distribution of teachers, vesting requirements, the ability to purchase service credits, and starting salary. These statistics show that around 15 percent of teachers in the survey have less than four years of experience and around 27 percent have between four and nine years. The average plan vests its members in more than five years because the vesting requirement in 16 states is 10 years.[15] The variation in the starting salary for young teachers is also striking, ranging from $24,800 to $42,700.

Table 4 reports results from a regression of the state-level experience categories on pension characteristics to see if pension characteristics that affect the early career are related to the distribution of teacher experience. The caveat to the analysis in Table 4 is that it uses cross-sectional variation from two snapshots in time; as a result, one should not try to draw causal inference from these estimates. We focus on years until vesting and the ability to purchase credits in a

[14] Data on starting salary are only available for 2008.

[15] Some states have made changes to their vesting rules. The 16 states we reference vest at 10 years at some point between 2002 and 2010, but not necessarily for the entire period. For example, seven states have raised the vesting rule from five to 10 years between 2008 and 2012 (Doherty et al., 2012).

new district/state. We also include as controls the average age among teachers in the state, the natural logarithm of the starting salary for a teacher with no prior experience, and an estimate of pension wealth for a hypothetical teacher.[16] In the first panel – percentage of teachers with less than four years of full time teaching experience – the vesting coefficient of -.0361 (p-value .015) suggests that for each additional year of waiting time required until any pension wealth is owned, a state will have more than one third a percent fewer new teachers. A vesting period of 5 years is common – 31 of these 50 largest public plans require five years. Those states will have 1.5 percentage points fewer teachers in early career stages. Ten states require 10 years – they are predicted to have 3.6 percentage points fewer newer teachers – almost one standard deviation in the mean of this variable. Vesting rules do not have a statistically significant effect on the percentage of teachers with four to nine years of experience – many of these are already vested and the rest are close.[17] Years to vesting is positively related to the percentage of teachers with 10 to 14 years of experience – since these percentages sum to 100 the vesting coefficients must be of opposite sign at some point, and vesting cannot have any influence at this point in their career.

Credit purchasing has a negative relationship for the younger experience categories and positive for the higher experience categories. The positive relationship with the higher categories makes intuitive sense since the ability to purchase service credits may result in higher retention rates in the teaching field. The negative correlation between the vesting period and teacher experience suggests that there may be a causal relationship between pension parameters and

[16] The estimate of pension wealth, which comes from Table 8 of Toutkoushian et al. (2011), is net of contributions. While we prefer our assumptions for the simulation exercise, their estimates of pension wealth are highly correlated with our results. We use their estimates for this analysis so we have estimates for all states.

[17] Papke (2004) finds that quit rates in public employment drop off steeply right before vesting.

early teacher labor market choices. We examine this possibility in the next section.

V. Evidence from the National Longitudinal Survey of Youth of 1997

In this section we ask if these cross-state difference in pension plan characteristics affect first labor market exit for young teachers. Our data for this analysis come from the NLSY97. This nationally representative survey follows a cohort of respondents age 12 to 16 in 1997 and interviews them every year on topics such as income, employment, family, fertility, and health. We use these data beginning in 2002 to focus on the labor market behavior of young teachers. We are able to include covariates that are not typically available in administrative data used in the retirement compensation literature discussed earlier. We identify all individuals who ever reported teaching between 2002 and 2010 and follow their teaching career over time. We choose to begin our analysis in 2002 because this ensures all respondents are old enough to teach. The Data Appendix describes the data in detail.

We use a discrete time hazard model to isolate the effect of pension characteristics, specifically vesting requirements, measures of portability, and existence of defined contribution alternatives, on the period-specific hazard of the respondent's first exit from teaching given that she hasn't yet exited:

$$\Pr\left(P_{ist} = 1 \middle| X_{ist}, R_{st}, noexit_{is,t-1}\right) = \lambda(X_{ist}\alpha + R_{st}\beta + \delta_t) \quad (1)$$

In this equation we model the hazard of first exit from the labor market in each period (t) as a function of year effects (t), state level covariates (s) including the pension parameters of interest, and individual level covariates (i). Therefore, the vector X_{ist} contains the covariates that vary by individual, state, and year, such as marital status or number of children in the household. The vector R_{st} includes pension plan characteristics, as well as other covariates that only vary at the state

and year level. We describe further details on the definition of each period in the Data Appendix. We present results estimated under standard logit assumptions, although our results are robust to estimating via probit or linear probability modeling. We choose to model the hazard of first exit from teaching because we only see one exit from teaching for the majority of this sample.[18]

Table 5 provides summary statistics for the panel of teachers we construct from the NLSY97. In the top panel of the table we provide demographic statistics on 779 individual teachers. The majority of the population of our teachers is female (66 percent) and white (68 percent). According to the National Center for Education Statistics, in 2011-2012 76 percent of all teachers were female and 81 percent identified as white, not Hispanic (Goldring et al., 2013). The discrepancy between our statistics and the national averages is likely because we focus only on a cohort of younger teachers, while the national averages include the entire distribution of teachers.

These relatively young teachers are single for the majority of the observations. We condition on marital status and children in the household in our analyses because as these covariates change they could significantly contribute to the probability of exit from employment.

The Armed Services Vocational Aptitude Battery (ASVAB) is an ability exam that is given to all respondents in the first round of the NLSY97. Among those teachers who opted to take this exam, the sample of teachers scored in approximately the 69th percentile among all NLSY97 respondents.[19] Prior literature has shown that underlying ability is positively related to exit from teaching (Podgursky et al., 2004).

[18] Of the 779 teachers in the sample, we see 425 exits from teaching. Only 79 individuals, around 10 percent, return to teaching during our sample, and 64 of the 79 move to a new employer. The teachers who leave tend to exit teaching before receiving tenure; 77 percent of those who exit leave before working the number of years required for tenure.

[19] A total of 110 individual teachers, or 14.1 percent of the sample, opted not to take the ASVAB.

The middle panel of Table 5 focuses on characteristics of employment in our teacher sample. For example, the average among those teachers who report a starting salary is $17.43 per hour, or approximately $35,000 per year.[20] Among those who remain teachers for five years or more, the salary grows to $21.28 per hour, or approximately $42,500 per year. Next, we indicate the type of teacher we see in the sample: preschool/kindergarten, elementary/middle school, secondary, postsecondary, and other teacher.[21] Last, we show that the average job tenure from 2002 to 2010 among the teacher sample is 2.16 years. This average falls well below the median vesting requirement of five years.

In the bottom panel of Table 5 we focus on the pension parameters that pertain to our sample between 2002 and 2010.[22] Note that these descriptive statistics reflect all the observations in our panel, not individual teachers. We include the number of years required to vest in the state pension plan, indicators for supplemental defined contribution options, an indicator for a choice between primary defined benefit and defined contribution plans, the retirement factor used in benefit calculations, an indicator for coverage by Social Security, and the required employee pension contribution rate. The average time to vest for respondents in our sample is similar to the national average in Table 3. Note that while 33 percent of our observations are offered a defined contribution add-on option, only 11 percent of these plans offer a choice between primary defined benefit and defined contribution plans -- the defined contribution plan is usually supplemental to the mandatory defined benefit plan. There is little variability in

[20] The NLSY converts all reported earnings and units of time to an hourly wage. Wage data are available for 73 percent of all observations where a teacher is employed.
[21] These categories are not mutually exclusive. They indicate that the individual teacher ever fell into the category between 2002 and 2010. The "other" category includes special education teachers and other teachers and instructors who do not fall into one of the other categories.
[22] We assume that teachers work in the state where they reside. The NLSY geocode data allow us to determine state of residence but not state of employment or any specific information about the employer.

the retirement factor (it typically lies between one and two percent), although plans in states where teachers are not covered by Social Security tend to have higher retirement factors. Lastly, the average employee contribution rate for individuals in contributory plans in our sample is six percent.

The tenure determination may also predict labor market exit early in a teacher's career. As a result, we control for statutory requirements for tenure in each state. Table 5 shows that, on average, our teachers work in states that will tenure a teacher after 3.15 years. Lastly, at the bottom of Table 5 we summarize six indicator variables that describe the portability of the state pension plan. The first three indicate what a teacher receives if he or she withdraws from the plan before vesting: a refund of their contributions, a refund of their contributions with accumulated interest, or a refund of their contributions, accumulated interest, and some of the employer contributions. The last three indicate the ability to purchase credits in the system for prior service: some states allow unlimited purchasing of service credits, while others limit the number of credits one can purchase or do not allow for purchasing of credits (Doherty et al., 2012).

Table 6 reports the average marginal effects and standard errors from the discrete time hazard model described in equation (1) estimated via logit.[23] The dependent variable in each column is a binary variable that equals zero when the individual is teaching and equals one when the individual first exits teaching. In column (1) we control for basic demographic characteristics and year dummies. The estimate for the ASVAB percentile implies that a ten unit increase (about half a standard deviation) in the ASVAB percentile increases the hazard of exit by 0.02. This finding, consistent with prior work in the literature, suggests that teachers with higher ability scores are more likely to exit teaching, although we estimate a small effect and this is the first exit (Podgursky et al., 2004). We also

[23] Appendix Tables A1 and A2 shows the results of Table 6 and Table 7 estimated via ordinary least squares.

find that women are less likely than men to leave teaching, as are respondents who are married relative to singles. Although children in the household are not statistically significant, the positive relationship between fertility and exit from teaching is intuitive.

In column (2) we add pension parameters that determine the timing and amount of a teacher's pension wealth.[24] These variables include a person-specific variable that reflects the number of years until the individual is vested in their retirement system, an indicator for availability of a defined contribution plan, an indicator for choice between a defined benefit and defined contribution plan, the retirement factor from the pension formula, the teacher contribution rate to the plan, an indicator for Social Security coverage, and an indicator for whether the teacher has tenure based on the state's tenure rules.[25]

Years to vest and availability of a defined contribution plan are both positive and significantly related to the hazard of first exit. The coefficient on time to vest implies that a young teacher is 2.3 percentage points more likely to exit teaching for each additional year he or she must work before vesting. This implies that a change in vesting from five to 10 years would increase the hazard of exit by 11.5 percentage points. This effect is large relative to the unconditional mean of 0.556.

The effect of offering a defined contribution add-on is positive, statistically significant, and sizeable. The magnitude of the effect is more than five times as large as the effect of vesting in column (2), suggesting that teachers with portable pension wealth are 13.4 percentage points more likely to exit the

[24] In unreported results we include a lagged measure of hourly wage, when available, in columns (2) and (3) to control for the opportunity cost of leaving teaching. The estimates across these columns are qualitatively similar to the estimates in Table 6. However, the effect of the lagged wage is not statistically different from zero. We drop this analysis because many teachers do not report a wage, significantly reducing our sample size.

[25] In column (2) time to vest remains at zero after the individual is vested.

teaching market or change employers. Teachers are also more likely to exit plans with a higher retirement factor. Perhaps teachers with more generous plans intend to return, but this estimate is no longer statistically significant in our more flexible specification in column (3).

In column (3) we repeat the estimation from column (2) but control for time to vest more flexibly by including dummy variables for one through five or more years until vesting and an indicator after the individual is vested. The omitted category for interpretation is the year the teacher vests. The estimated coefficients imply that teachers are significantly more likely to exit when they remain multiple years from vesting and these are economically large effects. A teacher either four or five or more years from vesting is estimated to have a 14 percent higher probability of exiting teaching than a vested teacher. This effect is similar and negative until the teacher is only one year from vesting. Teachers are 24 percent less likely to leave once they are vested in the state pension system. This makes intuitive sense because teachers should respond to the incentives created by the deferred compensation in their defined benefit plan upon vesting by remaining with their employer. Overall, these results are consistent with forward-looking behavior among these teachers.

Lastly, in Table 7 we show the preferred specification from Table 6 for the subset of teachers in elementary and middle school, and in secondary school. Generally, the estimates in Table 7 are consistent with the prior analyses. Focusing on the pension parameters, the effect of years until vesting is consistent with the results from Table 6 for both populations. However, the availability of a defined contribution option is much more likely to increase the probability of exit for secondary school teachers relative to elementary and middle school teachers and this effect is precisely measured. This estimate suggests that regardless of their vested status in the accompanying DB plan, having a portable DC plan makes it 15 percent more likely that secondary school teachers will seek a better

match. Interestingly, for elementary and middle school teachers, participation in Social Security plays a similar role. This additional annuity promise makes it about 14 percent more likely that these teachers will exit teaching.

Among the other covariates, the effects of marriage and the number of children in the household are positive, sizeable, and statistically significant for secondary school teachers, but do not appear to affect the hazard of first exit for elementary and middle school teachers.

VI. Discussion and Conclusion

By focusing on the early years of a teacher's career, we find that characteristics of public pensions affect not only retirement decisions, but choices made early in careers in an economically meaningful way. There are large cross-state differences in the initial jump in pension wealth that occur upon vesting, and we demonstrate that vesting requirements are related to the experience distribution of the teaching labor force. Further, our econometric work suggests that pension parameters, such as years to vest and availability of defined contribution options, as well as Social Security coverage, have significant effects on the probability of first exit from teaching.

These findings may have implications for teacher retention and student achievement particularly in the current climate of pension reform and experiments with performance-based teacher salaries. [26] Our baseline estimate suggests that requiring an additional year of work prior to vesting increases the hazard of first exit by 0.023. Based on this estimate, we predict that those states that recently increased their vesting requirement from 5 to 10 years increased the probability of their teachers' first exit by 11 percentage points, an estimate that negates roughly one third of the effect of being granted tenure. Further, other types of retirement

[26] See Podgursky and Springer (2011) for an overview.

plans – an accompanying DC plan or Social Security coverage – increase the probability of job change as well for subsets of teachers.

Note that while we control for many personal characteristics with these NLSY data, we cannot control for characteristics of the school work environment. Previous research blames rigid school district salary schedules and seniority-based transfer provisions in the K-12 public system for a concentration of novice teachers in high-poverty schools (Podgursky and Springer, 2011). There is no reason to suspect that omitted school characteristics are correlated with our covariates, but it is a limitation of this work that we cannot compare the relative importance of school and personal characteristics. Further, in examining new teachers, we study first exit but we do not examine whether teachers subsequently returned to teaching or exited having determined that teaching was not a good job match for them.

There are two avenues for promising future work. First, following the labor market decisions of our teacher sample into the next decade will indicate if retirement plans play a role in re-entry or exit and reveal the characteristics of those teachers who remain in teaching. Second, much of the recent action on state public pension policy occurs outside our sample period. Policy makers in 18 states enacted legislation related to teacher pensions in 2012, 24 states in 2013, and 30 states in 2014.[27] Many of these changes involve adding on or substituting a defined contribution plan for new teachers going forward. Extending our analysis through these years with more variation in the pension landscape may allow us to refine our estimates.

Prior research finds that compensation matters in attracting people to the teaching profession, and further, that benefit levels matter too (Munnell and Fraenkel, 2013). Based on our findings, benefits matter for forward-looking

[27] Authors' summary of the National Conference of State Legislatures searchable pension database at http://www.ncsl.org/research/fiscal-policy/pensions.aspx.

young teacher retention as well. Recent policy changes in the states' public pension parameters may have unintended real effects on the composition of their teaching labor force in the short run, and student performance in the future.

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Table 1: State Teacher Pension Parameters

State	Retirement Rule	Factor	Salary (Bachelor's, Experience=0)	Salary (Top Step)	Contribution Rate	Covered by Social Security?
California	60/5 Vesting = 5 FAS = highest year salary	1.4% to 2.4%, depending on age at retirement	$40,100	$75,400	8%	No
Florida	62/6, A/30 Vesting = 6 FAS = average of highest 8 years	1.6%	$33,300	$60,800	3%	Yes
Michigan	60/10, 46/30 Vesting = 10 FAS = average of highest 3 years	1.5%	$34,200	$66,700	$510 + 6.4% of any income over $15,000	Yes
Wisconsin	65/5, 57/30 Vesting = 5 FAS = average of highest 3 years	1.6%	$30,700	$57,100	6.65%	Yes

Source: SASS and state-specific handbooks detailed below.
California: CALSTRS 2013 Member Handbook (available at http://www.calstrs.com/sites/main/files/file-attachments/memberhandbook2013_web_v4.pdf)
Florida: Florida Retirement System Pension Plan Summary Plan Description (available at https://www.rol.frs.state.fl.us/forms/spd-pp.pdf)

Michigan: Michigan Public School Employees Retirement System Member Handbook (available at http://www.michigan.gov/documents/MPSERS1_92795_7.pdf)
Wisconsin: Wisconsin Retirement System Benefit Handbook (available at http://etf.wi.gov/publications/et2119.pdf)
Note: Retirement rule provides the minimum age and minimum years of service required for full retirement benefits. This is written as a fraction: minimum age/minimum years of service. "A" implies full retirement benefits at any age (provided the teacher has the minimum years of service). FAS stands for Final Average Salary.

Table 2: Simulated Cross-State Differences in Pension Wealth:
Individual starts teaching at age 25 with Master's Degree

State	Peak Value	Quit after 2 years	Quit after 5 Years	Quit After 10 Years	Retire at 55	Retire at 60	Retire at 65
California	$691,288	$0	$27,069	$56,223	$487,271	$691,288	$612,237
	Age 60	(-691,288)	(-664,219)	(-635,065)	(-204,017)	(0)	(-79,051)
Florida	$681,595	0	0	49,971	681,595	667,366	616,536
	Age 55	(-681,595)	(-681,595)	(-631,624)	(0)	(-14,229)	(-65,059)
Michigan	$663,788	0	0	65,909	663,788	632,911	561,805
	Age 55	(-663,788)	(-663,788)	(-597,879)	(0)	(-30,877)	(-101,983)
Wisconsin	$370,893	0	11,279	19,237	322,055	354,977	304,814
	Age 57	(-370,893)	(-359,614)	(-351,656)	(-48,838)	(-15,916)	(-66,079)
Michigan (Defined Contribution Plan)	---------	6,341	17,322	40,161	664,480	802,186	927,981

Source: Author's calculations.
Note: Difference from peak value appears in parentheses below the present discounted value.

Table 3: State Teacher Experience and Pension Characteristics

	Mean	Standard Deviation	Minimum	Maximum
% Exper < 4 years	15.39	4.864	6.04	28.30
4 %< exper <= 9%	27.12	4.669	18.60	52.01
10 %<exper <= 14%	17.83	3.690	9.59	27.22
Years until vested	5.78	2.431	0	10
Purchase credits	0.63	0.486	0	1
Starting salary	$33,172	4,181	24,800	42,700

Source: SASS 2008 and 2011 data, and the Pension Fund Survey (2001-10).
Notes: Experience measures the percent of teachers that fall into each experience bin in each state. Purchase credits refers to the ability to purchase credits for prior service as a teacher.

Table 4: Regression Results for Teacher Experience: State Level Percent Experience Distributions

	Percent with fewer than 4 years exper		Percent with 4 to 9 years exper		Percent with 10 to 14 years exper	
Years until vested	-0.361*	-0.377*	0.201	-0.054	0.376**	0.276*
	(0.145)	(0.163)	(0.156)	(0.198)	(0.118)	(0.135)
Purchase credits		-0.812		-2.128*		0.476
		(0.735)		(1.025)		(0.784)
Average age		-0.929**		-1.154**		-0.036
		(0.178)		(0.281)		(0.233)
Log (starting salary)		0.611		15.837**		4.667
		(2.731)		(4.581)		(3.678)
Log (pension wealth)		0.268		-1.999		-2.859+
		(1.788)		(2.101)		(1.675)
Constant	14.227**	44.218	26.365**	-59.696	17.421**	8.750
	(1.014)	(36.421)	(1.360)	(49.864)	(0.884)	(41.301)
Obs.	102	102	102	102	102	102
R^2	0.48	0.62	0.02	0.36	0.29	0.34

Notes: Pension data are from the Public Fund Survey (2001-2010). Dependent variables is the percent of teachers with that range of experience from Schools and Staffing Survey (2008 and 2011). Pension wealth estimates come from Table 8 of Toutkoushian et al. (2011). Regressions also contain year dummies. Robust standard errors are in parentheses. + Significant at 10-percent level; * significant at 5-percent level; ** significant at 1-percent level.

Table 5: NLSY Descriptive Statistics 2002-2010

Variables	Mean	Std. Dev.
Teacher Population (779 individuals)		
Age when Begin Teaching	23.78	2.314
Female	0.66	0.473
Black	0.17	0.372
Hispanic	0.15	0.353
Married	0.20	0.399
Single	0.76	0.426
Separated/Divorced	0.01	0.114
Number of Kids in Household	0.23	0.624
Family Income (Thousands)	$66.51	65.931
ASVAB Percentile	68.72	24.143
Employment Characteristics		
Starting Wage (Hourly)	$17.43	20.599
Wage After 5 Years (Hourly)	$21.28	9.886
Postsecondary Teacher	0.25	0.432
Preschool/Kindergarten Teacher	0.05	0.210
Elementary/Middle School Teacher	0.40	0.490
Secondary School Teacher	0.19	0.390
Other K-12 Teacher	0.41	0.492
Job Tenure	2.16	1.424

Pension Characteristics		
State Vesting Rule	5.88	2.316
DC Plan Available?	0.33	0.469
Choice Between DB and DC?	0.11	0.313
Retirement Factor	0.02	0.004
Covered by Social Security?	0.60	0.490
Employee Contribution Rate	0.06	0.022
Years to Tenure	3.15	0.738
Withdraw: Less or Equal Own Contribution	0.11	0.316
Withdraw: Own and Interest	0.77	0.423
Withdraw: Own, Interest, and Employer	0.12	0.320
Purchase Credits: No	0.29	0.456
Purchase Credits: Limited	0.29	0.456
Purchase Credits: Unlimited	0.41	0.491

Notes: ASVAB is an ability exam administered in the first wave of the NLSY. Other Teacher includes special education teachers and other teachers who do not fall into the other teaching categories. Contribution rate is conditional on rate being nonzero. Withdraw variables describe refund of contributions if the teacher leaves the system before vesting. Service credits (for prior work as a teacher) are available for purchase in some states.

Table 6: NLSY Logit Regression Results:

	(1)	(2)	(3)
Years to Vest		0.023**	
		(0.005)	
5+ Years from Vesting			0.141*
			(0.061)
4 Years from Vesting			0.143*
			(0.063)
3 Years from Vesting			0.109^{+}
			(0.063)
2 Years from Vesting			0.136*
			(0.059)
1 Year from Vesting			-0.030
			(0.068)
Vested 1+ Years			-0.238**
			(0.063)
DC Also		0.134**	0.116**
		(0.030)	(0.030)
Choice between DB/DC		-0.054	-0.070
		(0.046)	(0.047)
Has Tenure		-0.330**	-0.307**
		(0.024)	(0.028)
Retirement Factor		0.117*	0.072
		(0.055)	(0.056)
Covered by Social Security		0.034	0.041
		(0.038)	(0.038)
Employee Contribution Rate		-0.800	-0.375
		(0.851)	(0.862)
ASVAB Percentile	0.002**	0.002**	0.002**
	(0.000)	(0.001)	(0.001)
Age	0.002	0.015^{+}	0.016^{+}
	(0.008)	(0.009)	(0.009)
Female	-0.047*	-0.048^{+}	-0.054*
	(0.023)	(0.024)	(0.025)
Black	0.011	0.033	0.032
	(0.031)	(0.033)	(0.034)
Hispanic	0.060^{+}	0.054	0.042
	(0.033)	(0.037)	(0.037)
Married	-0.049^{+}	-0.046	-0.036
	(0.027)	(0.029)	(0.029)

Number of Kids in HH	0.019	0.013	0.023
	(0.018)	(0.019)	(0.020)
N	2479	2479	2479

Notes: Dependent variable is the hazard of first exit from teaching. Reported values are average marginal effects and standard errors after logit estimation. All regressions contain year dummies. Regressions in columns (2) and (3) also contain reported family income, indicator for mixed race, indicator for marital status unknown, indicator for separated/divorced, and indicators for pension portability. Standard errors in parentheses. + Significant at 10-percent level; * significant at 5-percent level; ** significant at 1-percent level.

Table 7: NLSY Regression Results by Teacher Type

	(1) Elementary & Middle	(2) Secondary
Years to Vest	0.024**	0.028*
	(0.007)	(0.013)
DC Also	0.053	0.151*
	(0.048)	(0.073)
Choice between DB/DC	-0.067	0.157
	(0.067)	(0.147)
Has Tenure	-0.381**	-0.347**
	(0.032)	(0.049)
Retirement Factor	-0.102	0.017
	(0.092)	(0.125)
Covered by Soc Security	0.135*	-0.027
	(0.054)	(0.089)
Employee Contrib Rate	1.247	0.756
	(1.446)	(2.018)
ASVAB Percentile	0.000	-0.000
	(0.001)	(0.001)
Age	0.025^{+}	0.100**
	(0.014)	(0.025)
Female	-0.103*	-0.088^{+}
	(0.043)	(0.051)
Black	0.092^{+}	-0.045
	(0.051)	(0.071)
Hispanic	0.277**	0.220**
	(0.060)	(0.088)
Married	-0.002	-0.120*
	(0.043)	(0.054)
Number of Kids in HH	0.015	0.079*
	(0.027)	(0.040)
N	999	483

Notes: Dependent variable is the hazard of first exit from teaching for the specific population. Reported values are average marginal effects and standard errors after logit estimation. Regressions also contain year dummies, reported family income, indicator for mixed race, indicator for marital status unknown, indicator for separated/divorced, and indicators for pension portability. Standard errors in parentheses. + Significant at 10-percent level; * significant at 5-percent level; ** significant at 1-percent level.

Data Appendix

The NLSY allows respondents to report multiple jobs for each year on a weekly basis. To identify teachers we use industry and occupation codes across all reported job lines in all years: we identify someone as a teacher if they are in the "Educational Services" industry and in the "Education, Training, and Library" occupations on any job line within any year. Next, we build a balanced panel for those who report being a teacher between 2002 and 2010 (age falls between 18 and 31) using the responses from these teachers. Using their recall in the interviews, where they provide their employment status by week, we fill in the panel with the time they report working as a teacher. We calculate the number of weeks worked as a teacher in the calendar year as well as the number of weeks worked in the fall. We also separately calculate the total number of weeks worked in each school year (school year is defined between week 32 of one year and week 32 of the next year—sometime around August 1). In the event of multiple employers within the same year, we choose the employer with the most time. In the event that someone spent the same amount of time with two employers, we assume their employer for the year is the employer where they began working first.

We use state of residence to determine pension parameters for the teacher, implying that state of residence is the same as state of employment. It is not possible to determine state of employment or any specific information about the employer other than a numerical identifier in the NLSY Geocode Data. In addition, if state of residence is missing in any given year but available in years before and after the missing observation, we assume the state of residence has not changed if state of residence is constant for the adjacent non-missing observations. If there is any discrepancy between the non-missing observations we keep state of residence missing.

The hazard of first exit from teaching goes from missing to zero once a teacher begins working--we consider a teacher to have worked if they report working at least 12 weeks in the school year. Once they exit teaching for the first time the variable becomes one for the remainder of the panel. If they change employers but do not exit teaching the binary variable remains equal to one. This happens in 262 individual by year observations, roughly 3.7 percent of our observations.

We merge a number of covariates with these data. The covariates include marital status, number of biological or unrelated children in the household, gender, age, race, ethnicity, ability score, census region, and family income. We generate indicators for female, black, Hispanic, and mixed race. We also generate indicators for married, single, and separated/divorced. To create these indicators we aggregated the number of months in each year that an individual reported being married, single, and separated/divorced. We consider them married for that year if they spent six or more months married. We consider them single or separated/divorced for the year if they spent more than six months single or separated/divorced.

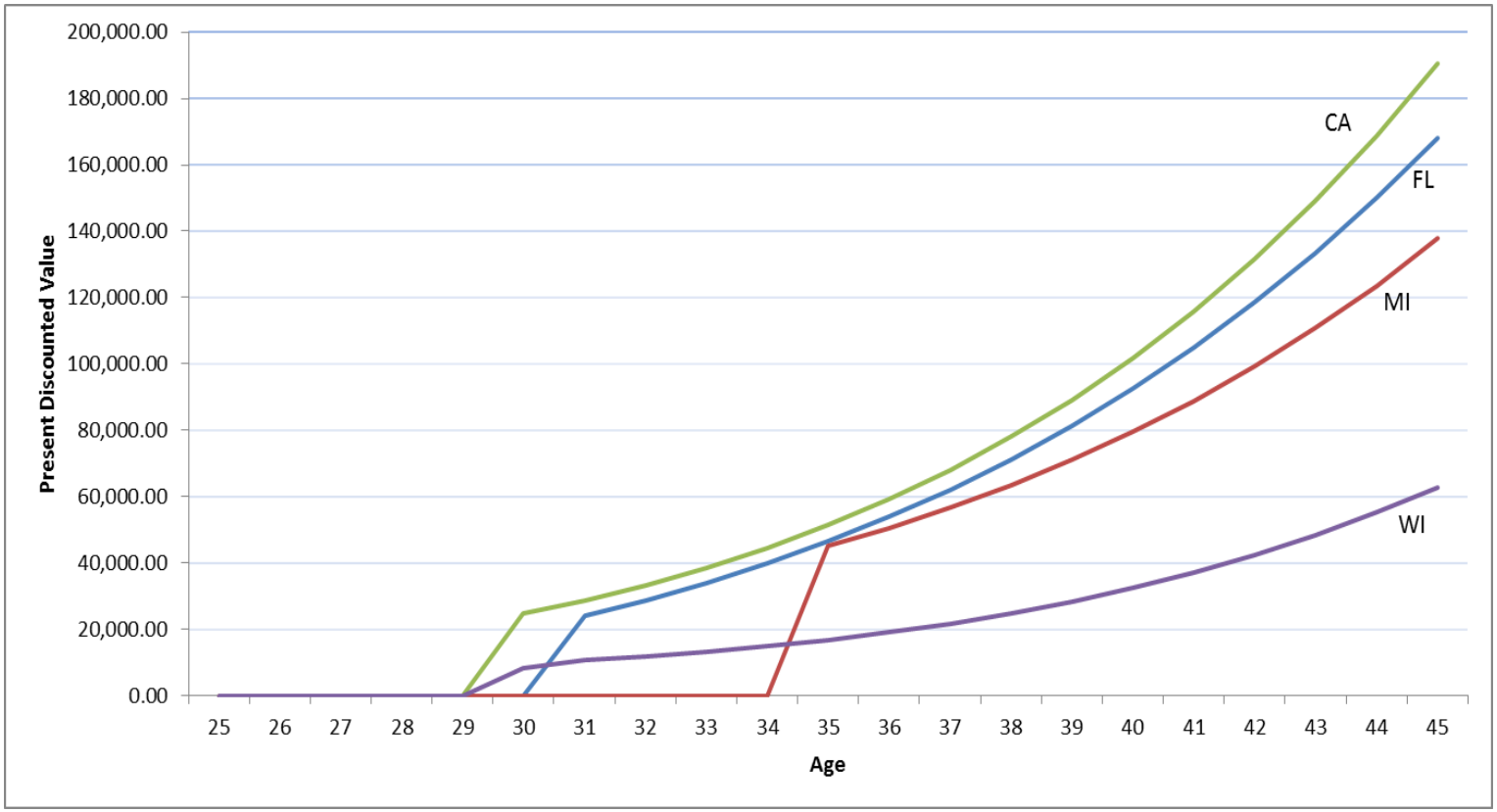
Next, we add the specifics of the pension system using data from 2001 to 2011 in the Public Fund Survey. We supplement/update these data using Doherty et al. (2012), National Education Association's *Characteristics of Large Public Education Pension Plans*, and our own research into plan handbooks. We merge the fiscal year of the plan onto the same year in the NLSY data. For example, we merge the 2005 fiscal year data with a respondent's survey results for 2005. The variables we include are: plan name, state information (name, numeric identifier), fiscal year, years to vest, indicator for DC plan available, indicator for choice between DB and DC plan, retirement factor, indicator for Social Security coverage, and employee contribution rate. We assume the vesting rule remains

the same as the year when the teacher entered so policy changes do not affect participants retroactively.

We also create a separate variable that reflects the rule for teacher tenure. Note there is no time variation in this variable.

Lastly, we create indicators for pension portability based on Doherty et al. (2012). These variables indicate what a teacher receives if he or she withdraws funds (contributions, contributions plus interest, or contributions, interest, and some or all of the employer's contributions) as well as the ability to purchase service credits in the state.

Figure 1: Pension Wealth Early in the Teaching Career



Source: Authors' calculations from 2013 CAFRs.
Notes: Calculations assume teacher was hired at age 25 with a Bachelor's degree and no prior experience.

Appendix Table A1: NLSY Linear Regression Results:

	(1)	(2)	(3)
Years to Vest		0.027**	
		(0.007)	
5+ Years from Vesting			0.162**
			(0.060)
4 Years from Vesting			0.126*
			(0.051)
3 Years from Vesting			0.124**
			(0.047)
2 Years from Vesting			0.111*
			(0.043)
1 Year from Vesting			0.029
			(0.045)
Vested 1+ Years			-0.225**
			(0.042)
DC Also		0.074*	0.063^{+}
		(0.035)	(0.035)
Choice between DB/DC		0.005	-0.009
		(0.061)	(0.062)
Has Tenure		-0.146**	-0.143**
		(0.025)	(0.028)
Retirement Factor		0.108^{+}	0.080
		(0.060)	(0.061)
Covered by Social Security		0.058	0.058
		(0.047)	(0.046)
Employee Contribution Rate		-0.782	-0.539

		(0.926)	(0.930)
ASVAB Percentile	0.002*	0.002*	0.002**
	(0.001)	(0.001)	(0.001)
Age	0.018	0.023+	0.026*
	(0.013)	(0.012)	(0.012)
Female	-0.028	-0.027	-0.029
	(0.039)	(0.038)	(0.038)
Black	0.067	0.067	0.066
	(0.052)	(0.049)	(0.049)
Hispanic	0.041	0.038	0.027
	(0.053)	(0.052)	(0.054)
Married	-0.008	-0.011	-0.007
	(0.031)	(0.031)	(0.030)
Number of Kids in HH	-0.017	-0.011	-0.002
	(0.021)	(0.019)	(0.019)
N	2479	2479	2479

Notes: Dependent variable is the hazard of first exit from teaching. All regressions contain year dummies. Regressions in columns (2) and (3) also contain reported family income, indicator for mixed race, indicator for marital status unknown, indicator for separated/divorced, and indicators for pension portability. Robust standard errors in parentheses. + Significant at 10-percent level; * significant at 5-percent level; ** significant at 1-percent level.

Appendix Table A2: NLSY Linear Regression Results by Teacher Type

	(1) Elementary & Middle	(2) Secondary
Years to Vest	0.034**	0.038*
	(0.009)	(0.019)
DC Also	0.035	0.093
	(0.055)	(0.079)
Choice between DB/DC	-0.015	0.213
	(0.103)	(0.143)
Has Tenure	-0.162**	-0.159**
	(0.032)	(0.055)
Retirement Factor	0.057	0.075
	(0.104)	(0.124)
Covered by Soc Security	0.143*	0.038
	(0.069)	(0.085)
Employee Contrib Rate	-0.113	0.241
	(1.840)	(1.717)
ASVAB Percentile	0.000	0.000
	(0.001)	(0.002)
Age	0.037*	0.087**
	(0.017)	(0.028)
Female	-0.073	-0.038
	(0.065)	(0.076)
Black	0.113+	-0.010
	(0.067)	(0.134)
Hispanic	0.196*	0.206+
	(0.083)	(0.110)
Married	0.010	-0.042
	(0.039)	(0.050)
Number of Kids in HH	-0.019	0.054
	(0.024)	(0.045)
N	999	483

Notes: Dependent variable is the hazard of first exit from teaching for the specific population. Regressions also contain year dummies, reported family income, indicator for mixed race, indicator for marital status unknown, indicator for separated/divorced, and indicators for pension portability. Standard errors in parentheses. + Significant at 10-percent level; * significant at 5-percent level; ** significant at 1-percent level.