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Pension Structure and Employee Turnover: Evidence from a Large Public Pension System

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Contents

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Abstract

Public pension systems in many U.S. states face large funding shortfalls. Movement toward defined contribution (DC) pension structures may reduce the likelihood of future shortfalls. We address some limitations of the existing literature by studying public-sector employees who are enrolled in either a defined benefit (DB) plan or hybrid DB-DC plan, and who at some points have been able to choose between these plans. We find little evidence that the introduction of the hybrid plan increased employee turnover and that turnover is significantly lower among those who transferred from the DB plan to the hybrid plan.

Public pension systems in many U.S. states face large funding shortfalls as the accrual of retirement benefits promised in the form of defined benefit (DB) pensions has out-paced the accrual of assets in states' pension funds.[1] Consequently, there is interest in moving public pension systems toward defined contribution (DC) structures which are by definition fully funded and would reduce the likelihood of future shortfalls (see, for example, Institutional Investor, 2013; Munnell et al., 2014).[2]

An important motivation for employer-provided DB pensions is that the provision of a pension helps to reduce employee turnover by having employees accrue benefits more rapidly toward the ends of their careers, or in other words, by "backloading" employee compensation (Gustman et al., 1994). Thus, one concern associated with moving toward DC pension structures is that it will have the undesirable effect of increasing employee turnover. The backloading of DB plans is thought to incentivize lower employee turnover in two ways. First, the foregone DB pension wealth associated with exiting employment mid-career creates financial incentives that will directly influence employees' propensity to quit (Ippolito, 1987, 2002).[3] Second, the presence of these financial incentives will influence the types of workers who select into employment – backloaded compensation will attract employees who are less likely leave prematurely (Salop & Salop, 1976; Ippolito, 2002).

Despite these theoretical arguments, evidence on the relationship between pension structure and turnover is somewhat mixed, and extremely limited in the case of public sector pensions.[4] And as discussed below, the existing empirical literature is subject to a number of

[1] The shortfall of pension assets relative to accrued liabilities is estimated to be in the trillions of dollars (Pew Center on the States, 2010, 2012; Novy-Marx & Rauh, 2011).

[2] A DB pension plan provides an employee with an annuity in retirement that is formulaically determined as a function of years of service, highest average salary level (e.g. over 3 consecutive years), and retirement age. In many plans, employees can retire at younger ages with the accumulation of enough years of service (e.g. 20 or 30 years of service). DB pension plans are typically funded by both employee and employer contributions, which are invested by the pension system. When contributions and/or investment returns are lower than what is needed to meet the pension system's obligations, the employer is responsible for covering the shortfall. DC pension plans are also typically funded by employer and employee contributions, but contributions are placed in individual investment accounts (such as 401(k)'s), at which point employer's pension obligations are satisfied.

[3] As characterized by Ippolito (2002), "Workers sacrifice wages in exchange for a 'stay' pension but are awarded a lower 'quit' pension if they depart prematurely" (p. 275).

[4] One reason that public-sector evidence is limited is that relatively few public employees are enrolled in DC

limitations. Several studies find evidence of lower turnover under DB pension structures than under DC pension structures. In the only existing public sector analysis, Ippolito (2002) studies employee turnover following a 1984 reform to the Federal Employee Retirement System and finds results consistent with the notion that moving from a traditional DB pension structure toward a DC pension structure lead to higher rates of employee turnover. Using data from the Survey of Income and Program Participation, Haverstick et al. (2010) find that employees enrolled in DC plans with between 5 and 10 years of tenure are significantly more likely to change jobs than employees enrolled in DB plans.[5] A recent working paper finds that first-year employee retention rates fell when Utah replaced its traditional DB plan with less generous hybrid and DC options in 2011 (Clark et al., 2015). Lastly, using data from the Retirement Attitude Survey, Nyce (2007) finds that employees enrolled in DB pension plans are significantly more likely than DC plan participants to indicate a high probability of staying with their employers.

Several other studies suggest a weaker relationship between pension structure and employee turnover. Gustman and Steinmeier (1993, 1995) find that firms that provide employer-sponsored pensions to their employees have lower turnover, and that the effect on turnover is similar under both DB and DC plan structures. Even and Macpherson (1996) also find a negative relationship between pension plan provision and turnover for both DB and DC plans. While they do not directly compare turnover rates under DB and DC plans, they do find that the negative relationship between firm size and turnover is stronger among firms providing DC pension plans than it is among firms providing DB plans. Finally, in an analysis of a single employer (a large public university) transitioning from a DB pension plan to a DC plan, Goda et al. (2013) report the counterintuitive finding of a negative relationship between DC plan enrollment (relative to DB

pension plans. While the private sector moved away from DB pensions in the 1980s and 1990s (Buessing & Soto, 2006), the great majority of state-level public sector employees remain enrolled in traditional DB plans (Pew Center on the States, 2010).

[5] The authors do not find significant differences between DB and DC turnover among employees with less than 5 years experience.

enrollment) and employee turnover among employees given the choice of staying in the DB plan or transitioning to the new DC plan.

These mixed findings are not terribly surprising given the empirical challenges associated with identifying the influence of pension plan structure on employee turnover. Most analyses of plan structure rely on cross-firm comparisons because firms do not tend to offer multiple pension plans to employees (e.g., Gustman & Steinmeier, 1993; Even & Macpherson, 1996; Nyce, 2007; Haverstick et al., 2010). Cross-firm comparisons are problematic if the relationship between firms' pension structures and the level of employee turnover is endogenous. Only two of the studies discussed above take advantage of within-employer variation in pension structure: Ippolito (2002) and Goda et al. (2013). Ippolito's analysis is limited by the fact that it compares the behavior of employees during time periods roughly a decade apart and does not account for the influence of U.S. labor market conditions that changed during that time period.[6]

The analysis presented in this paper addresses some of the limitations in the existing pension literature by studying a single class of public-sector employees (teachers). Specifically, we study the Teacher Retirement System in Washington State which since July 1996 (the 1997 school year) has simultaneously operated a traditional DB plan (TRS2) and a hybrid DB-DC plan (TRS3). As described below, employees have enrolled in these plans under a variety of contexts and we are able to observe patterns of behavior during extended periods of time. The recent pattern of public pension reforms, in which a number of states moved from traditional DB plans to hybrid DB-DC systems (see Munnell et al., 2014), makes evidence from Washington State's experience under TRS2 and TRS3 particularly relevant to the current debate around public-sector pension reform and its implications for workforce composition.

We find little evidence that the introduction of the hybrid plan in Washington is significantly associated with an increased level of employee turnover.[7] We are unable to identify significant

[6] The study uses a one-year longitudinal data set spanning December 1986 to December 1987, and a second set of longitudinal data spanning March 1996 to February 1998.

[7] In this paper, we use the terms quit and turnover interchangeably to define employees exiting employment in

changes in the pattern of turnover among teachers hired just before and after the introduction of TRS3 that can be attributed to plan structure. Similarly, among newly hired teachers able to choose between the two plans, the pattern of turnover among those enrolled in the hybrid plan is not significantly different than that of teachers choosing the traditional DB plan. Moreover, we find that experienced teachers who chose to transfer from the traditional DB plan to the hybrid plan during a transfer period in 1996-1997 exit employment at a significantly *lower* rate than teachers who chose to stay in the DB plan. These findings cast doubt on the conventional wisdom that movement toward DC pension structures will necessarily result in greater employee turnover.

The remainder of the paper proceeds as follows: Section I provides background on Washington's Teacher Retirement System and the pattern of pension wealth accrual under TRS2 and TRS3; Section II describes the data; Section III presents our empirical approach; Section VI presents our results, and Section V discusses the results and concludes.

I. Background

a) Washington State's Teacher Retirement System

Washington's Department of Retirement Services (DRS) currently operates three plans under its Teacher Retirement System: TRS1, TRS2, and TRS3. The plan in which an employee is enrolled depends on when he or she was hired. Prior to 1977, new hires were enrolled in TRS1, a traditional DB plan. Between 1977 and 1996, new hires were enrolled in TRS2, which, like TRS1, is a traditional DB plan, but increased the age at which an employee could retire with full benefits.[8] In 1996 the state created TRS3, a hybrid DB-DC plan. All new hires between 1996 and 2007 were enrolled in TRS3, and existing TRS2 employees were given the option to transfer from TRS2 to TRS3.[9] In 2007 TRS2 was reopened to new hires, who can choose to enroll in either TRS2 or TRS3.[10]

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public education in Washington State.

[8] Under TRS1, an employee can retire with full benefits at any age with the accumulation of 30 years of service (YOS), at age 55 with 25 or more YOS, or at age 60 and 5 or more YOS. Under TRS2, an employee can retire with full benefits at age 62 with the accumulation of 30 YOS or at age 65 with 5 or more YOS. TRS2 also increased the number of years over which final average salary is calculated from 2 years to 5 years.

[9] Employees who transferred between July 1, 1996 and December 31, 1997 received a "transfer bonus payment"

Our analysis focuses on teachers enrolled in TRS2 or TRS3; key features of these plans are outlined in **Table 1** below.[11] TRS2 provides a lifetime annuity in retirement based on accumulated years of service (YOS) and final average salary (FAS): $Annual\ Benefit = 0.02 * YOS * FAS$. FAS is calculated over a teacher's 60 highest-paid consecutive months of employment. An employee becomes eligible to receive retirement benefits (or becomes "vested") with the accumulation of five years of service. Any vested teacher may retire (i.e., began collecting benefits) at age 65. With the accumulation of 20 years of service an employee may retire as early as age 55, but with reduced benefits. With the accumulation of 30 years of service, an employee can retire with full benefits at age 62.

Like TRS2, the DB component of TRS3 provides a lifetime annuity in retirement, but it is half as large: $Annual\ Benefit = 0.01 * YOS * FAS$. An employee becomes vested in TRS3 with the accumulation of 10 years of service. With the accumulation of 20 or more years of service, the nominal value of the DB increases by approximately 3 percent during each year between separation from employment and retirement. The DB component of TRS3 is funded exclusively by employer contributions and all employee contributions are placed into an individual DC account. The value of an employee's DC assets upon retirement is determined by asset allocation decisions (employees can choose from a limited menu of options), investment performance, and contribution levels. Employees can choose from among six contribution plans which range from 5 to 15 percent of salary.

equal to 65 percent of their accrued contributions to TRS2 (as of January 1, 1996). Employees with 5 or more YOS as of the end of the 1996 school year had their vesting status grandfathered in under TRS3; the 10 year vesting period applied to less experienced employees. Approximately 75 percent of eligible employees chose to transfer to TRS3 during this period. For more about pension choice in Washington State, see Goldhaber and Grout (2014).

[10] New hires who do not indicate a choice within 90 days are defaulted into TRS3.

[11] Since few active employees are currently enrolled in TRS1, we restrict the analysis in this paper to those enrolled in TRS2 or TRS3.

Table 1. Key Features of TRS2 and TRS3

	TRS2	TRS3	
Membership Definition	Hired 1977 – 1996 (*default*) Hired 2007 – pres. (*opt in*)	Hired 1977 – 1996 (*option to transfer*) Hired 1996 – 2007 (*mandated*) Hired 2007 – pres. (*default*)	
Type	Traditional Defined Benefit	DB Component	DC Component
Vesting Period	5 years	10 years	N/A
Employee Contributions	Set by legislature depending on status of pension fund	N/A	5% - 15% (employee's choice)
Employer Contributions	Set by legislature depending on status of pension fund	Identical to TRS2 contributions	N/A
Annual Benefit Formula	*0.02* *(AFC)*(SCY)	*0.01* *(AFC)*(SCY)	N/A
Retirement Eligibility	65 yrs. of age, or 62 yrs. of age & 30 SCY (full benefit), or 55 yrs. of age & 20 SCY (reduced benefit)	65 yrs. of age, or 62 yrs. of age & 30 SCY (full benefit), or 55 yrs. of age & 10 SCY (reduced benefit)	Withdrawal ages and penalties for early withdrawal dependent on Federal tax rules.

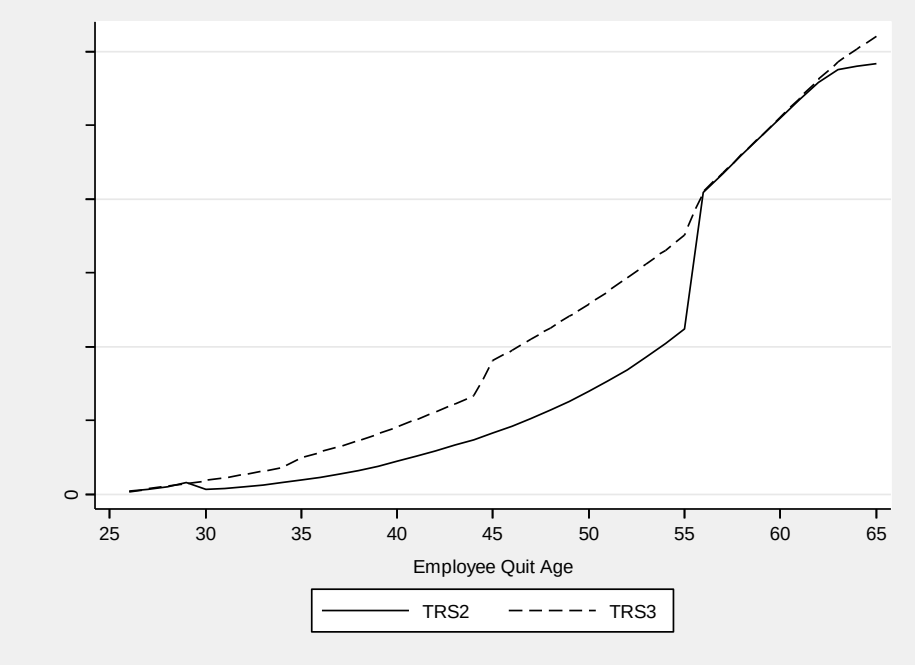
b) Pension Wealth Accrual under TRS2 and TRS3

As noted above, backloaded DB pension structures create financial incentives to stay rather than quit because employees accrue benefits more rapidly toward the ends of their careers. Here, we illustrate this point by presenting the accrual of pension wealth under TRS2 and TRS3 for a representative teacher and discuss how the plans' features make it more or less costly to quit. We calculate the present value of pension wealth at each potential exit age for a representative female teacher who begins her career at age 25. The pension wealth calculations, which are detailed in a technical appendix, are presented in **Figure 1.**[12] The point above age 45, for instance, represents the present value (at age 45) of the stream DB annuity payments received in retirement and the

[12] We assume a discount rate of 4 percent, and a nominal rate of return on DC account assets of 8 percent, which is consistent with the long-term rate of return assumed by the Washington Department of Retirement Services during the study period.

additional value (in the case of TRS3) of the assets in the teacher's DC account (which are assumed to continue accruing interest until the age at which they retire).

Figure 1. Pension Wealth for Hypothetical Individuals that Leave the Washington State Pension System by Age at Separation



The plots in **Figure 1** demonstrate that the representative teacher accumulates pension wealth more rapidly toward the end of her career under both TRS2 and TRS3, and that the proportion of benefits accumulated toward the end of her career is larger under TRS2. The slopes of the pension wealth accrual plots steepen as tenure accumulates, and at two points we observe discontinuous shifts in pension wealth. The first shift occurs with the accumulation of 20 YOS (age 45) under TRS3, when she becomes eligible for an increase in the nominal value of the DB annuity by approximately 3 percent each year between exit and retirement. The second shift occurs with the accumulation of 30 YOS when she can begin drawing reduced benefits earlier due to more generous early reduction factors (ERFs), and begin drawing full benefits at age 62.[13]

In addition to the rules related to the accumulation of 20 and 30 YOS, three other factors make it costly to quit prematurely. The first is related to vesting rules: teachers who separate from a

[13] With 20 YOS, a teacher who retires at age 55 has an ERF of 0.358 applied to the value of the DB annuity. The ERF increases each year that retirement is delayed and is 0.896 if the teacher retires at age 64. With 30 YOS, the ERF ranges from 0.80 at age 55 to 1.00 at age 62.

pension system before becoming vested are not entitled to any defined benefit. The vesting periods for TRS2 and TRS3 are 5 and 10 years, respectively.[14] A second is that the DB annuity is vulnerable to inflation. When a teacher leaves a DB plan before retirement, the *nominal value* of her DB annuity stays fixed. Therefore, the *real value* of that annuity will be eroded by inflation until the teacher begins retirement. For example, under 2.5 percent inflation, a $20,000 annuity as defined by a teacher's FAS and YOS upon separating in the year 2000 would have a real value of less than $14,000 if retirement began fifteen years later in 2015. Third, a teacher who quits prematurely may forego real wage growth (which would contribute toward a larger DB annuity) that would have been experienced had she stayed.

Overall, these factors related to the backloaded structures of TRS2 and TRS3 tend to exert a stronger influence on the pension wealth accrual pattern of TRS2. While the 3 percent annual increase in the value of TRS3's DB component shifts pension value upward relatively late into one's career, this feature also has the effect of flattening the accrual curve between 20 and 30 YOS. The upward shifts that occur with the accumulation of 30 YOS, as well as the effects of inflation, affect the value of TRS2 more dramatically simply because the size of the TRS2 annuity is twice as large as the TRS3 annuity. For these reasons, the financial incentives to stay rather than quit tend to be larger under TRS2 than TRS3. As such, one could reasonably expect to observe lower rates of attrition under TRS2, due to both the direct effect of these financial incentives and the self-selection of employees with lower propensities to quit into employment under TRS2.

In comparing the present value calculations for TRS2 and TRS3 presented in **Figure 1**, it is important to consider the division of the overall value of the DB and DC components of TRS3. A substantial proportion of the value is in the DC account, but this value is uncertain because it is dependent on investment returns. As noted above, the TRS3 plot in **Figure 1** assumes a nominal rate of return of 8 percent. Any particular individual is likely to assume an expected rate of return that is

[14] TRS2 employees who quit prior to becoming vested can withdraw their own contributions to the plan, plus interest (5.5 percent). Employees who accumulated 5 YOS as of the 1996 school year and transferred to TRS3 had their vesting status grandfathered into TRS3.

different than that of the representative teacher in the figure, and TRS2 would look relatively attractive to an individual holding lower expectations of investment returns. A second factor that may affect an individual's valuations of the two plans is the extent to which he or she is risk averse. An employee who is more risk averse will place a lower utility value on the expected value of TRS3's DC account than an employee who is less risk averse.

A final point worth noting is that the financial incentives against quitting are small early in an individual's career. For example, if the representative teacher in **Figure 1** quits after 2 years and takes a teaching position in a different state, she will have time to reach the steeper parts of the pension wealth accrual curve under her new position. On the other hand, if she makes that move after 10 years, she will be less likely to reach the steeper parts of the pension wealth accrual curve in her new state.

II. Data

Our analysis relies primarily on two state-level data sets from Washington State. The first is confidential Teacher Retirement System (TRS) data maintained by the Department of Retirement Services (DRS). These data are used to determine each teacher's plan enrollment (TRS2 or TRS3) and enrollment context (i.e., transfer, mandate, or choice as new hire). The DRS data cover dates prior to January 2010 for teachers actively employed at any point during July 1, 1996 – December 31, 2009.[15] These data are merged with the second data set, administrative records from the Office of the Superintendent of Public Instruction (OSPI) S-275 personnel reporting system, which provides information on teacher characteristics, assignment type, assignment location (school and district), salary, and experience level. The S-275 records allow us to construct a panel of observations for each year in which an individual is employed as a public school teacher in Washington during the school years ending between 1985 and 2014. These administrative records are supplemented with school

[15] Teachers hired after 1977 who leave the profession prior to July 1996 are categorized as TRS2 enrollees, as they would not have had the opportunity to transfer to TRS3.

and district-level data from the National Center for Education Statistics' Common Core of Data (CCD), including school and district size, school level, and school demographics.

The study sample is restricted to teachers who were hired between July 1985 and September 2008,[16] were employed by a public school district in Washington state during at least one year between the school years ending in 1986 and 2014 (allowing us to identify them in the S-275 data), and enrolled in either TRS2 or TRS3. Teachers are distinguished from other employee classifications using assignment codes in the S-275 data, and individuals whose primary position assignment is not associated with a teaching position in at least one year are excluded from the analysis in our primary model specifications.[17] Furthermore, we exclude teacher observations in years where too few hours are worked to accumulate a full year of service credit as well as teachers over 55 years of age. The latter exclusion is intended to avoid conflating attrition from the profession in Washington State with attrition from the workforce in general as individuals approach retirement age.[18] In other words, we are interested in studying the plans' "pull" incentives (e.g., backloaded compensation) rather than their "push" incentives (e.g., early retirement opportunities). The study sample consists of 70,456 unique teachers and 671,748 teacher-year observations, though as discussed below, our analyses utilize a series of subsets of this panel of data.

Teachers are identified as "separating" in school year x if they are not observed in the S-275 records in year $x + 1$. As we describe below, we allow teachers who exit and reenter the workforce to inform our model estimates.[19] The overall quit propensities in our study sample are presented in **Figure 2** by years of service and pension plan enrollment. Among teachers in both plans, the

[16] We exclude teachers employed before 1985 because we do not have information on the employment status of teachers prior to the 1984–1985 school year.

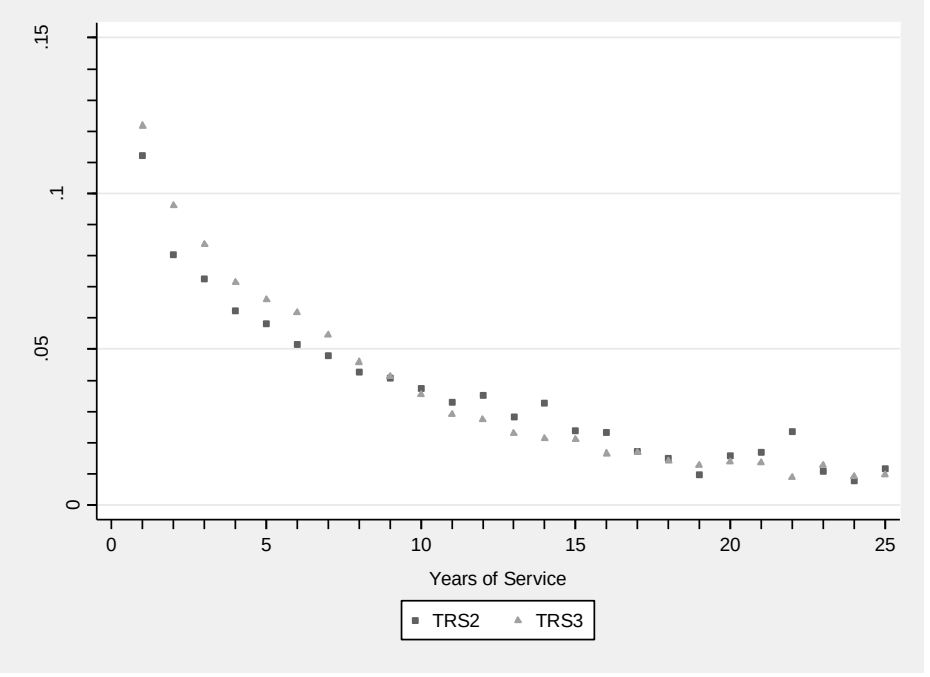
[17] Classroom teaching positions do not include positions such as counselor or administrator, which we consider to be distinct types of professions. As a robustness check, we estimate models with and without classroom teaching restrictions in place and find qualitatively similar results.

[18] We have also estimated our models without these restrictions and the results are qualitatively similar.

[19] It is quite common to observe a teacher exit and then return in a later year (Beaudin, 1993; Grissom & Reininger, 2012), and we observe this in our data as well; over 23 percent of first-time exits in our sample re-appear in the sample within 3 years. The likelihood of returning, however, levels off relatively quickly. For example, 70 percent of teachers who are observed returning over a 15-year window (i.e., looking at those who separate prior to 2000) do so within 3 years and fewer than 10 percent of first time separators are observed returning after an absence of 8 or more years.

propensity to quit steadily declines with years of experience. In the context of **Figure 2**, comparing quit rates across plans is problematic as varying enrollment contexts and time periods are not accounted for. That said, the attrition profiles of employees in TRS2 and TRS3 are quite similar.

Figure 2. Proportion Exiting Employment by Pension Plan and Year of Service



III. Empirical Approach

The objective of our empirical analysis is to provide a better understanding of how a shift in the public sector away from traditional DB pension structures and toward DC pension structures might influence employee turnover. As noted above, our data provide several advantages over previous empirical analyses. First, we observe variation in pension structure within a single employer, allowing us to avoid the likely endogeneity between employer characteristics and pension structure. Second, we analyze a single type of employee (public educators) and do not risk confounding pension structure and employee type effects. Third, we observe employee behavior during overlapping periods of time and are able to limit the confounding influence of variation in labor market

conditions over time. Finally, we observe employees who enter into TRS2 and TRS3 under several different contexts, allowing us to approach the research question from several directions.

As previously discussed, pension structure may influence employee turnover through two underlying mechanisms: 1) Financial incentives that make it relatively more or less costly to quit under a particular plan (e.g., Ippolito, 2002), and 2) The self selection of more (less) mobile employees into employment with firms providing more (less) portable pensions (e.g., Salop & Salop, 1976). Unfortunately, in most contexts these mechanisms operate simultaneously and our data are not suited to identifying the extent to which each mechanism is independently driving employee behavior. That said, the fact that both mechanisms point in the same direction *does* allow us to identify the following: 1) whether *at least one of the two* mechanisms is driving behavior (if we find that TRS3 has a positive effect on employee turnover), or 2) whether *neither* mechanism is driving behavior (if we find that TRS3 has no effect, or a negative effect, on employee turnover). Evidence that at least one mechanism is influencing employee behavior would suggest that a shift in the public sector away from traditional DB pension structures would be likely to increase employee turnover. On the other hand, evidence that neither mechanism is influencing behavior would suggest that the public sector can move toward DC structures without necessarily experiencing higher rates of turnover.

To analyze the influence of pension structure on turnover, we model teachers' propensity to quit under four different contexts: 1) Comparing early-career quit rates among teachers hired in the years before and after the introduction of TRS3 in 1996, 2) Comparing the quit propensities of teachers hired in 1996 (who could stay in TRS2 or transfer to TRS3) to the quit propensities of teachers hired in 1997 (who were mandated into TRS3), 3) Comparing the quit propensities of teachers who could choose between TRS2 and TRS3 as new hires, and 4) Comparing the quit propensities of teachers who transferred from TRS2 to TRS3 to the quit propensities of teachers who chose to stay in TRS2. Each of these comparisons is discussed in more detail in the sub-sections below.

a) Comparison 1: Early-career quit rates before and after the introduction of TRS3

If either the financial incentive mechanism or selection mechanism is driving employee behavior, early-career quit rates should shift upward after the introduction of TRS3 following the 1996 school year. Similarly, early-career quit rates should shift downward with the re-introduction of TRS2 following the 2007 school year. To test this proposition, we specify the following simple logit model:

$$Quit_i = \sum_{t=1987}^{2009}(\sigma_t 1(FY = t)) + \beta_1' T_i + \beta_2' S_i + \varepsilon_i, \quad (1)$$

where σ_t is a vector of parameters to be estimated and $1(FY = t)$ is a vector of indicator variables equal to 1 if an individual was hired in year t, and T_i and S_i are vectors of teacher and school characteristics. The dependent variable $Quit_i = 1$ if the teacher exits after the first year of employment, and zero otherwise. We also estimate specifications where $Quit_i = 1$ if the teacher exits within 2, 3, and 4 years of employment. For each model we test the differences $\sigma_t - \sigma_{t-1};\ t = 1988, 1989, \ldots 2009$. Of particular interest are the differences $\sigma_{1997} - \sigma_{1996}$ and $\sigma_{2008} - \sigma_{2007}$.[20]

An important reason for adopting the flexible year-indicator specification in equation (1) is that estimating models specified with linear time trends or a single indicator of being hired post-1997 may conflate variation in quit rates driven by the introduction of TRS3 with the influence of other time-varying macro-economic factors and policy changes. For example, the average annual unemployment rate in Washington State was 6.5 percent during 1987-1996 and 5.7 percent during 1996-2007 (source: Bureau of Labor Statistics). The year-indicator approach allows us to compare the behavior of teachers hired in subsequent years, when other factors related to turnover are less likely to be dramatically different.[21] The disadvantage is that the identification of these models rests on the

[20] To account for the possibility that non-random selection into the pension system (by teachers with particular backgrounds or who teach at particular types of schools) may be related to differences in the propensity to quit, we also estimate models without controls for teacher and school characteristics. However, as we describe below, our results are little changed based on the inclusion or exclusion of teacher and school covariates.

[21] It is natural to want to pursue a regression discontinuity approach around the cut points of July 1, 1996 and July 1, 2007, as teachers commencing employment just before and after those points were exposed to different pension plan options. While our data identifies the day on which a teacher commences employment, very few start in the months of June or July in those years (less than 1 percent).

admittedly strong assumption that variation in other time-related factors does not influence early-career quit rates from one year to the next. Fortunately, this assumption is easy to test, as we observe extended periods of time where pension structure does not change. Finding significant differences between σ_t and σ_{t-1} where $t \neq 1997$ or 2008 would invalidate the approach.

b) Comparison 2: Quit propensities of teachers hired before and after the introduction of TRS3

If either the financial incentive or selection mechanisms are influencing teacher behavior, teachers hired in 1996 (who either stayed in TRS2 or transferred to TRS3) should exhibit a lower pattern of turnover than teachers hired in 1997 (all of whom were mandated into TRS3). To test this proposition, we specify the following discrete hazard model:

$$p_{it} = \frac{e^{\sum_{t=1}^{T}(\sigma_t 1(YOS=t))+\sum_{t=1}^{T}(\gamma_t 1(YOS=t)*1997_i)+\beta_1' T_i+\beta_2' S_i}}{1+e^{\sum_{t=1}^{T}(\sigma_t 1(YOS=t))+\sum_{t=1}^{T}(\gamma_t 1(YOS=t)*1997_i)+\beta_1' T_i+\beta_2' S_i}} \quad (2)$$

where p_{it} is the probability that teacher i quits in year-of-service t, $1(YOS = t)$ is a vector of indicator variables equal to 1 if $YOS = t$, 1997_i is a variable equal to 1 if an individual was hired in 1997, and σ_t and γ_t are vectors of parameters to be estimated. The estimated coefficients $\hat{\gamma}_t$ test whether the propensity to quit in year-of-service t is significantly different among teachers in the 1997 cohort. As individuals are observed multiple times in the panel of data, error terms are clustered at the individual level. As noted above, teacher and school characteristics may be correlated with both selection into a pension plan and the propensity to quit, and we also estimate specifications without these controls.

Similar to the previous comparison, the identification of this model rests on the assumption that unobserved time-related factors do not differentially influence the pattern of turnover among 1996 hires and 1997 hires. As in Comparison 1, an advantage of this approach is that it compares the behavior of teachers hired in subsequent years, when other factors related to the pattern turnover during a teachers' careers are less likely to be dramatically different. A second advantage is that we are able to model the pattern of turnover over an extended period of time (17 years of service). A limitation of comparing the 1996 and 1997 cohorts is that 70 percent of teachers hired in 1996

transferred to TRS3 by the end of the 1998 school year. As such, the model's ability to detect differences in turnover driven by the financial incentive mechanism will be limited.

c) Comparison 3: Quit propensities of new hires who can choose between TRS2 and TRS3

As described in Section I, teachers hired since the 2008 school year have been able to choose between TRS2 and TRS3 as new hires. Teachers must indicate a choice within 90 days, and those who do not indicate a choice are defaulted into TRS3. As in the first two comparisons, if either the financial incentive mechanism or selection mechanism is driving employee behavior, turnover should be higher among TRS3 enrollees. To compare the pattern of turnover between TRS2 enrollees and TRS3 enrollees, we specify the following discrete hazard model:

$$p_{it} = \frac{e^{\sum_{t=1}^{T}(\sigma_t 1(YOS=t))+\sum_{t=1}^{T}(\gamma_t 1(YOS=t)*TRS3_i)+\beta_1' T_i+\beta_2' S_i}}{1+e^{\sum_{t=1}^{T}(\sigma_t 1(YOS=t))+\sum_{t=1}^{T}(\gamma_t 1(YOS=t)*TRS3_i)+\beta_1' T_i+\beta_2' S_i}} \quad (3)$$

where $TRS3_i = 1$ indicates enrollment in TRS3 and the other variables are as specified above. Similar to equation (2), the estimated coefficients $\hat{\gamma}_t$ test whether the propensity to quit in year-of-service t is significantly different among teachers who chose TRS3 as new hires. Because teachers are observed in multiple school years, errors are clustered at the individual level.

The advantage of this comparison is that it mimics an interesting choice context – where a new employee is choosing between two employers who provide differently structured pension plans, but are otherwise identical. We observe the behavior of teachers in both plans who are hired in the same school years (2008 and 2009) and by the same employers, making it unnecessary to control for employer characteristics and time-related factors related to turnover. That the new hire's plan choice is endogenous is not a concern given that we are trying to measure the joint effects of the selection and financial incentive mechanisms to gain insight into how overall retention rates differ across plan types. Two limitations of this comparison are that the sample size is small and the number of years over which we observe employee behavior is relatively short (6 years of service).

d) Comparison 4: Quit propensities of teachers who could transfer from TRS2 to TRS3

As described in Section I.A, teachers were given the option to transfer from TRS2 to TRS3 following the introduction of TRS3 in the 1997 school year.[22] To be clear, this enrollment context is quite different from that analyzed in Comparison 3. First, we are modeling a decision to transfer from one plan to another rather than an initial choice between two plans. Second, the teachers choosing between TRS2 and TRS3 are relatively experienced – roughly three-quarters had 3 or more YOS as of the end of the 1996 school year. Third, the decision period is a decade earlier than in Comparison 3; here, TRS3 is a newly introduced plan.[23] Finally, the default setting is different than in Comparison 3; here, a teacher who does not indicate a preference will simply stay in TRS2.

As in the previous comparisons, both selection and financial incentive mechanisms point to an expectation of a greater propensity to quit among teachers choosing to transfer to TRS3. To test this proposition, we specify the following discrete hazard model:

$$p_{it} = \frac{e^{\sum_{t=1997}^{2013}(\sigma_t 1(YEAR=t))+\sum_{t=1997}^{2103}(\gamma_t 1(YEAR=t)*TRS3_i)+\beta_1' T_i+\beta_2' S_i}}{1+e^{\sum_{t=1997}^{2013}(\sigma_t 1(YEAR=t))+\sum_{t=1997}^{2103}(\gamma_t 1(YEAR=t)*TRS3_i)+\beta_1' T_i+\beta_2' S_i}} \quad (4)$$

where $1(YEAR = t)$ is a vector of indicator variables equal to 1 if the school year is equal to t and other variables are specified as above. The vector of coefficients $\hat{\gamma}_t$ tests whether the quit propensity of teachers transferring to TRS3 is significantly different than that of teachers staying in TRS2 in school year t.

Model (4) is estimated on the entire sample of teachers eligible to transfer from TRS2 to TRS3 as well as two subsamples defined by a teacher's accumulated years of service as of the 1996 school year: teachers with 1 to 5 YOS and teachers with 5 or more YOS. The subsample estimations account for the possibility that transfer decisions and quit propensities are both related to

[22] As of the 1998 school year, 77 percent of eligible teachers in the study sample had transferred to TRS3. Very few transferred after that point in time.

[23] Note that TRS3 was not established in response to funding shortfalls. Rather, it was established in a time of surplus and with the support of teachers who desired a plan balancing flexibility with stability and increased control over investments (House Bill 2016, Laws of 1995).

experience level and allow us to compare patterns of attrition among employees with similar levels of experience.

An advantage of this comparison is that it provides insight into an important policy question: if an employer introduces a less backloaded pension plan for its employees, what are the implications of allowing existing employees to transfer into the new plan? As in the previous comparison, identification of this model does not require any assumptions about the influence of employer characteristics or time-varying factors related employee turnover.

IV. Results

a) Comparison 1: Early-career quit rates before and after the introduction of TRS3

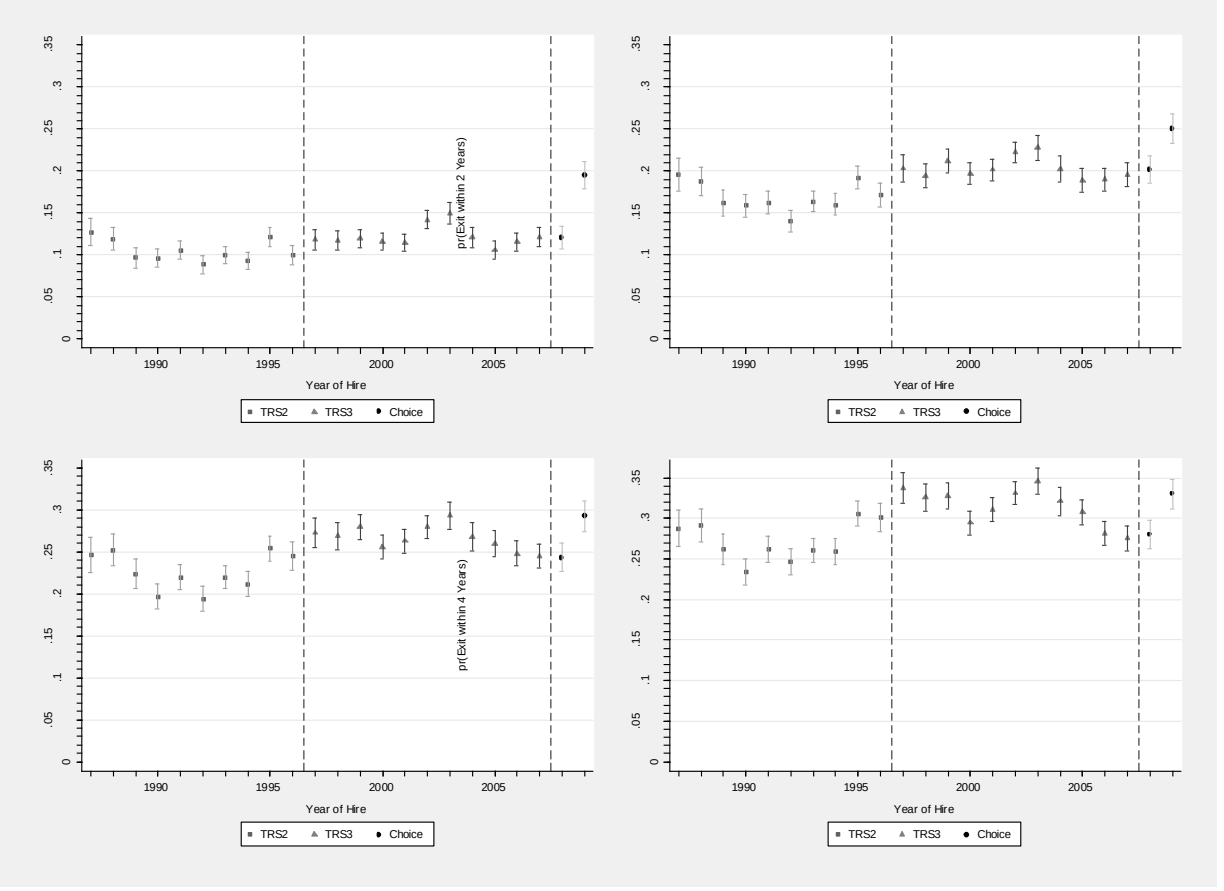
We look for evidence of a shift in the pattern of early-career turnover following the introduction of TRS3 in the 1997 school year, and the re-introduction of TRS2 as an option for new hires in the 2008 school year. The results from the estimation of the model in equation (1) are presented in the four panels of **Figure 3.** Year-of-hire is represented on the horizontal axis and the predicted probability of exit within 1, 2, 3, and 4 years is represented on the vertical axis. The probability of exiting within 1 year of service is significantly higher among 1997 hires than 1996 hires ($p = 0.040$), as are the probabilities of exiting within 2, 3, and 4 years. There is no statistically significant difference between 2007 and 2008 hires in the probability of exiting.[24]

As discussed above, the identification of this model relies on the assumption that unobserved variation in other time-related factors does not influence early-career quit rates from one year to the next. The plots in **Figure 3** clearly demonstrate that this assumption is problematic – the propensity to quit is significantly different in numerous adjacent years when pension structure does *not* change. For instance, we find statistically significant differences between both $\sigma_{1995} - \sigma_{1994}$ and $\sigma_{2002} - \sigma_{2001}$, in spite of the fact that pension structure did not change during that time period.

[24] When these models are estimated without controls for teacher and school characteristics, the results are very similar.

As such, it would be inappropriate to attribute the differences between σ_{1996} and σ_{1997} to the introduction of TRS3. This issue cannot be addressed by adjusting the specification of the model unless those adjustments are able to fully account for the other time-varying factors that appear to be influencing year-to-year quit rates.[25]

Figure 3. Predicted Probability of Early-Career Exit by Year of Hire



While these results invalidate our approach to identifying differences in the pattern of turnover attributable to pension structure, they do have interest in their own right. Previous analyses have compared the behavior of employees hired at different points in time (notably Ippolito (2002)) and attributed observed differences in behavior to changes in pension structure. Our findings suggest that this approach is problematic as year-to-year variation in early-career turnover is substantial even

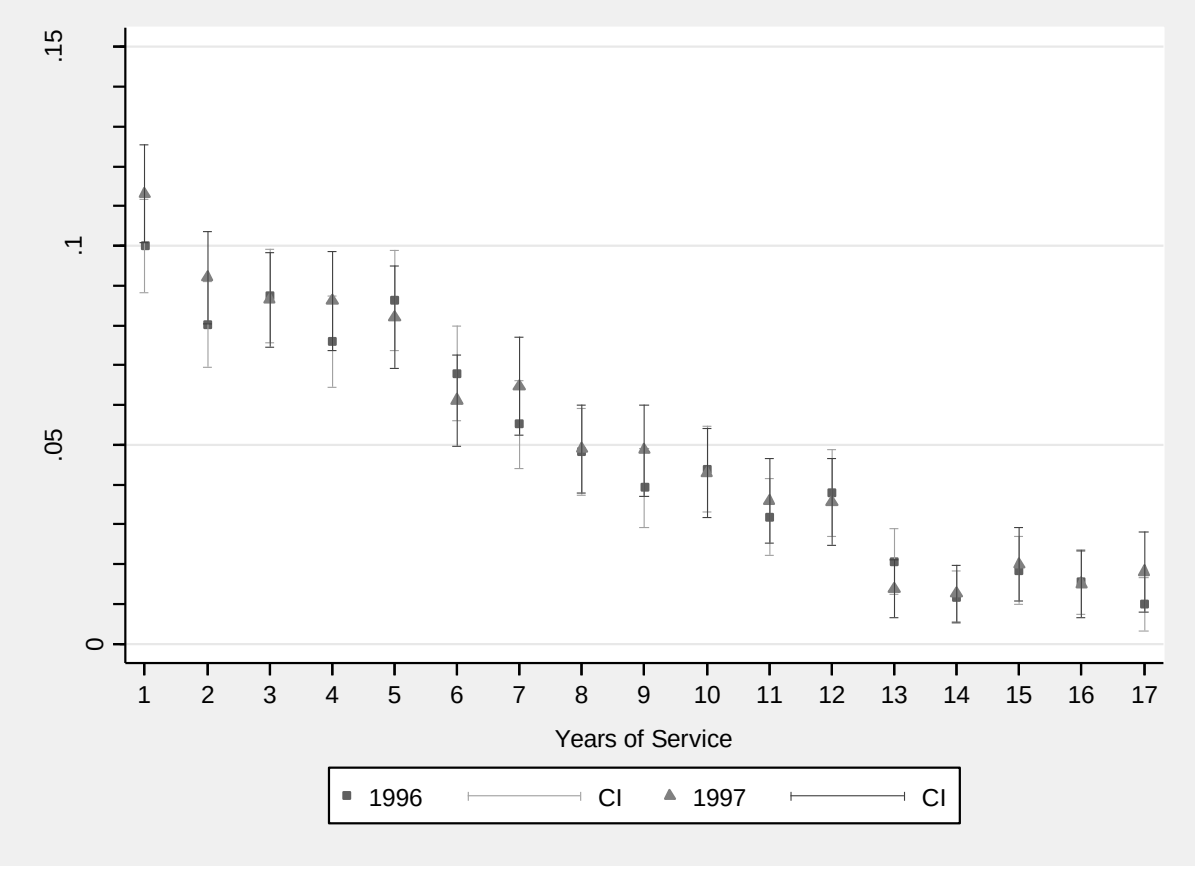
[25] When the model is estimated using a single indicator for belonging to a post-1997 cohort, the coefficient on that indicator is positive and significant. The average predicted probability of quitting after one year of service is 2.2 percentage points higher among the post-1997 cohorts, but as discussed above, it would be difficult to attribute this to the introduction of TRS3 with a great deal of confidence.

when pension structure and compensation levels are stable. Future analyses of employee turnover should be cautious in interpreting findings from comparisons of employees employed in different years.

b) Comparison 2: Quit propensities of teachers hired before and after the introduction of TRS3

Here we compare the pattern of turnover of employees hired just before the introduction of TRS3 (the 1996 cohort) to the pattern of turnover of those hired just after (the 1997 cohort). As noted above, the former group was initially enrolled in TRS2 and given the option to transfer to TRS3 (approximately 70 percent did so). The latter group was mandated into TRS3. Both selection and financial incentive mechanisms point to an expectation of a higher propensity to quit among teachers in the 1997 cohort. Results from the estimation of **model (2)** are represented in **Figure 4**.

Figure 4. Predicted Probability of Exit by Years of Service for 1996 and 1997 Cohorts



Teachers in the 1997 cohort are marginally more likely to exit in the first year of service, but we find no statistically significant differences the propensity to quit in any other year-of-service (see **Table A2** in the appendix). The results from this comparison should be interpreted with restraint for two reasons. First, the results from Comparison 1 demonstrate that early-career quit rates can exhibit significant variation from one cohort to the next independent of any changes to pension structure. It is possible that year effects are obscuring pension structure effects.[26] Second, as indicated by the 95 percent confidence intervals in **Figure 4**, the predicted quit propensities are not terribly precise. For instance, in the 3rd year of service we cannot rule out the possibility that the propensity to quit among the 1997 cohort is anywhere between 2.4 percentage points lower and 2.6 percentage points higher than the propensity to quit among the 1996 cohort.

To obtain more precise estimates we estimate two alternative specifications of **model (2)**. First, we estimate a model were the 1997 cohort indicator is *not* interacted with each service year (see column (4) of **Appendix Table A2**). The coefficient on the 1997 cohort indicator is positive and statistically significant (p-value = 0.05). The corresponding graphical output from the model is presented in **Appendix Figure A1**. These point estimates are noticeably more precise, but in any given school year are not significantly different. Second, we expand the number of cohorts included in the regression by comparing teachers hired in 1995 and 1996 to those hired in 1997 and 1998 (see column (5) of **Appendix Table A2**). When including the two additional cohorts, we find that the propensity to quit is significantly *lower* among the 1997 and 1998 cohorts for a number service years. The corresponding graphical output from the model is presented in **Appendix Figure A2**. When this second model is estimated with a non-interacted cohort indicator, the coefficient on the 1997-1998 cohort indicator is small and statistically insignificant (p-value = 0.99), demonstrating the model's sensitivity to year-effects.

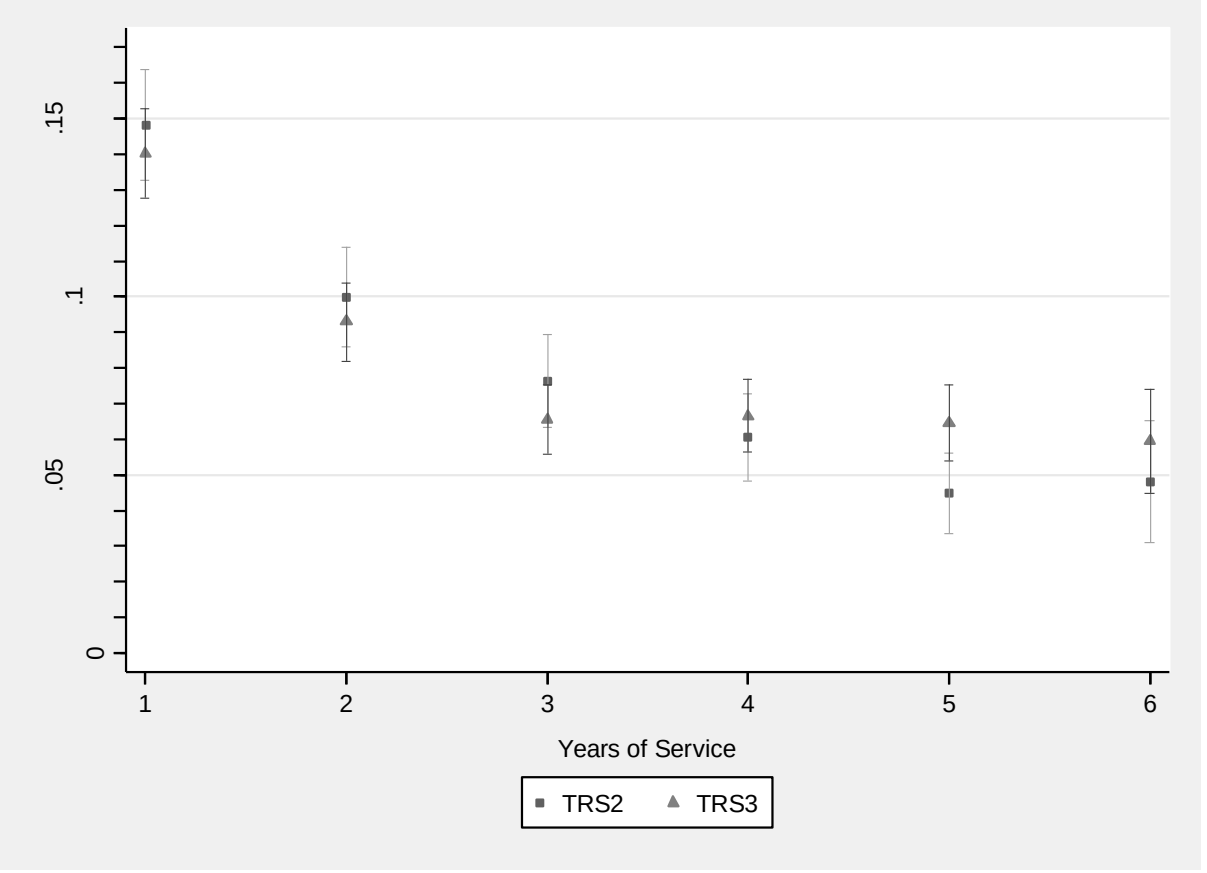
[26] As a placebo test, we estimate **model (1)** on teachers hired in 1997 and 1998, all of whom were mandated into TRS3. We find qualitatively similar results, with a statistically significant difference in the propensity to quit in the first year of service, and insignificant differences in all other years.

Overall, due to the limitations of this comparison, we cannot rule out the possibility that the introduction of TRS3 has resulted in slightly higher rates of turnover (e.g., 1 percentage point) than would have existed had all teachers remained in TRS2. That said, we fail to find evidence in this comparison that consistently supports the notion that the introduction of TRS3 resulted in an increased level of turnover.

c) Comparison 3: Quit propensities of new hires who can choose between TRS2 and TRS3

Teachers hired since the 2008 school year have been able to choose between TRS2 and TRS3 as new hires. As discussed above, both selection and financial incentive mechanisms point to an expectation of a higher propensity to quit among employees enrolled in TRS3. Results from the estimation of **model (3)** are presented in **Figure 5**.

Figure 5. Probability of Exit for 2008 and 2009 Hires by Plan Type and Years of Service



The results are not generally consistent with expectations of a higher rate of attrition under TRS3. In each of the first three years of service, teachers enrolled in TRS3 are slightly *less* likely to quit (by between 0.7 and 1.1 percentage points), and with 4 and 6 YOS, TRS3 teachers are slightly more likely to quit (by between 0.6 and 1.1 percentage points).[27] However, teachers with 5 YOS in TRS3 are significantly more likely to quit than teachers in TRS2 (by 2.0 percentage points).

As in the previous comparison, the point estimates presented in **Figure 5** are not terribly precise. For instance, in the 3rd year of service we cannot rule out the possibility that the propensity to quit among TRS3 enrollees is anywhere between 3.4 percentage points lower and 1.2 percentage points higher than the propensity to quit among TRS2 enrollees. We again estimate an alternative model specification where the indicator variable $TRS3_i$ is not interacted with the year-of service indicator variables YOS_{it}. The results from the estimation of this alternative specification are presented in column (5) of **Appendix Table A3**. The coefficient on the non-interacted TRS3 indicator is statistically insignificant (p-value = 0.98). The corresponding graphic output is presented in **Appendix Figure A3**.

While we cannot rule out the possibility that the level of turnover might be *slightly* different under TRS2 and TRS3 in any particular school year , we again fail to find evidence that supports the notion that the introduction of TRS3 has resulted in generally increased levels of turnover.

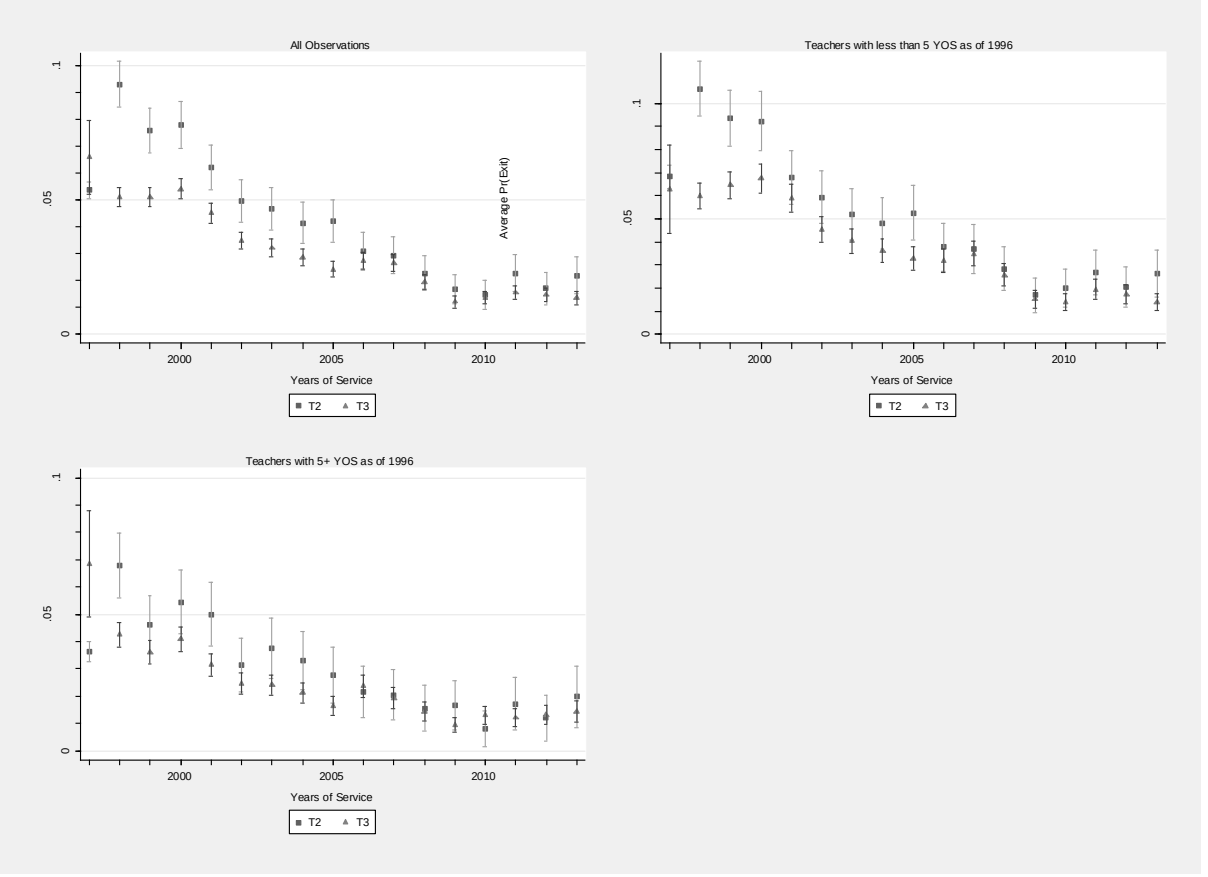
d) Comparison 4: Quit propensities of teachers who could transfer from TRS2 to TRS3

Teachers initially enrolled in TRS2 were given the opportunity to transfer to TRS3 following its introduction in the 1997 school year, and as of the 1998 school year 77 percent of eligible teachers in the study sample had chosen to transfer. Again, both selection and financial incentive mechanisms point to an expectation of higher rates of turnover among the teachers transferring to TRS3. Results from the estimation of **model (4)** are presented in **Figure 6** for all teachers, and

[27] When individuals who defaulted into TRS3 rather than indicating a choice are excluded from the estimation sample, the first-year quit propensity of TRS3 enrollees is marginally lower than the TRS2 quit propensity (see column (4) of appendix Table A2).

separately for teachers with less than 5 YOS (as of the 1996 school year) and teachers with 5 or more YOS.

Figure 6. Probability of Exit among Teachers with the Opportunity to Transfer to TRS3



The results are quite *inconsistent* with the expectations implied by the selection and financial incentive mechanisms. During the period 1998-2005, the teachers who stayed in TRS2 are significantly more likely to exit in each year. In each of those years, the predicted propensity to quit is between 1.3 and 4.2 percentage points *lower* among teachers who transferred to TRS3. The 1997 school year is the only year in which the predicted probability of exit is higher among teachers who transferred to TRS3.[28] The results for the sub-sample estimations on the samples of teachers with less than 5 YOS and 5 or more YOS are quite similar.

[28] Less than 5 percent of teachers had transferred to TRS3 as of the end of the 1997 school year, and a significant number of them may have been motivated to transfer to TRS3 early because they knew they were quitting at the

V. Discussion and Conclusion

Large funding shortfalls currently being experienced by many public pension systems have generated interest in pension reforms that could decrease the likelihood of future funding shortfalls (Novy-Marx & Rauh, 2009). Such reforms tend to consist of movement away from traditional DB pension structures toward DC pension structures. The conventional wisdom is that moving toward DC pension structures will have the undesirable effect of increasing employee turnover. This notion is supported by theoretical arguments about employee behavior, but the empirical record is somewhat mixed. Some analyses have found evidence of higher levels of turnover under DC pension structures, while others have found that employer-sponsored pension plans elicit higher levels of employee retention regardless of whether they have DB or DC structures. The analysis presented in this paper addresses a number of limitations of the existing empirical literature by studying a single class of public-sector employees (teachers) who are enrolled in a traditional DB plan or hybrid DB-DC plan.[29]

Overall, we find little evidence to support the conventional wisdom that movement toward a DC pension structure will necessarily increase employee turnover. More specifically, the pattern of turnover during the first 17 years of service among employees hired just before and after the introduction of the hybrid plan is not consistently different. Similarly, the quit behavior of new hires able to choose between the two plans is quite similar across plans. Finally, among teachers given the opportunity to transfer to the hybrid plan following its introduction in the 1997 school year, we find that those choosing to transfer exhibit significantly *lower* rates of turnover than those choosing to stay in the traditional DB plan.

While these findings run counter to conventional wisdom, they are not without precedent. Gustman and Steinmeier (1993) and Even and McPherson (1996) both find that employees in employer-sponsored pension plans have lower rates of turnover regardless of pension structure. And in analyzing the behavior of employees transferring from a DB plan to a DC plan, Goda et al. (2013)

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end of the school year

[29] While differing in structure, the two plans have similar actuarial costs and garner identical pension fund contributions from employers.

also find lower rates of turnover among transferring employees. Gustman and Steinmeier (1993) posit that pension-covered jobs pay higher levels of compensation than workers could find elsewhere and it is this compensation premium, not backloaded pension structures, that drive lower turnover rates. Our findings are consistent with this notion. Regarding the teachers given an opportunity to transfer from the DB plan to the hybrid plan, the 77 percent of teachers who chose to transfer revealed a preference for the hybrid plan over the traditional DB plan. By extension, those transferring teachers must have valued the compensation provided by the hybrid plan more highly than the compensation provided by the DB plan, thereby experiencing an improvement in utility.[30] By comparison, the teachers staying in the DB plan would have been no better or worse off than before the introduction of the hybrid plan, thereby experiencing no change in utility. This may explain the counterintuitive finding that the transferring teachers quit at significantly lower rates than stayers in each school year from 1998 to 2005.

The data we employ do not allow us to directly test the extent to which teachers value different types of pensions, but there are several reasons why they might place greater value on enrollment in the hybrid plan. For instance, they might have high expectations of the likely returns on DC account assets, leading to the expectation of greater pension wealth under the hybrid plan than the pure DB plan,[31] or simply value the greater potential upside (Brown & Weisbenner, 2014).[32] They also might view the hybrid plan as more flexible given its portability. Finally, the contributions made toward the DC assets of the hybrid plan may simply be more salient to employees because they are provided with more direct information about their value. By contrast, DB members do not have

[30] As noted above, TRS3 was not established in response to funding shortfalls. Rather, it was established in a time of surplus and with the support of teachers in the state, who desired a plan balancing flexibility with stability and increased control over investments (House Bill 2016, Laws of 1995).

[31] Indeed, new hires were significantly less likely to choose TRS3 following the financial crisis (Goldhaber & Grout, 2014).

[32] Other empirical evidence suggests that DB pension benefits may not be highly valued by teachers. Survey evidence from DeArmond and Goldhaber (2010) indicates that many Washington State teachers, particularly less experienced teachers, know relatively little about their pension plans. And in an analysis of the Illinois Teacher Retirement System, Fitzpatrick (2014) finds evidence suggesting that on the margin, teachers value additional DB benefits at as little as 20 cents on the dollar. Finally, McGee and Winters (2015) demonstrate that many teachers fail to earn significant retirement benefits from DB pensions because relatively few work long enough to benefit from those plans' most generous provisions.

anything akin to the DC plan's "individual account" component, and thus may be less aware of the value of their retirement benefits.[33] Gaining a better understanding of precisely what features of pensions are valued is an important area for future research as it would help to structure plans that are effective in attracting and retaining employees.

Overall, our analysis raises questions about whether the feature of pension plans that has received the most attention in scholarly research that examines plans' effects on employee retention – the degree of backloading in DB pensions – is in fact a significant driver of employee behavior in this regard.

[33] TRS3 members receive quarterly reports showing the value of accrued DC assets and annual growth rates. By contrast, those enrolled in the pure DB plan only receive notice of their status once per year.

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Appendix

Table A1 Early-Career Quit Propensities Before and After Introduction of TRS3

	(1) Exit within 1 Year	(2) Exit within 2 Years	(3) Exit within 3 Years	(4) Exit within 4 Years
Year Hired				
1987	0.112	-0.011	-0.051	-0.037
	(0.095)	(0.079)	(0.073)	(0.070)
1988	0.034	-0.068	-0.018	-0.017
	(0.089)	(0.073)	(0.067)	(0.064)
1989	-0.210**	-0.247***	-0.180***	-0.171***
	(0.092)	(0.074)	(0.067)	(0.064)
1990	-0.212**	-0.273***	-0.352***	-0.325***
	(0.085)	(0.069)	(0.064)	(0.061)
1991	-0.106	-0.246***	-0.204***	-0.172***
	(0.081)	(0.067)	(0.061)	(0.058)
1992	-0.306***	-0.427***	-0.367***	-0.255***
	(0.087)	(0.071)	(0.064)	(0.060)
1993	-0.172**	-0.236***	-0.204***	-0.177***
	(0.080)	(0.065)	(0.059)	(0.056)
1994	-0.248***	-0.264***	-0.254***	-0.187***
	(0.082)	(0.066)	(0.061)	(0.058)
1995	0.054	-0.033	-0.008	0.055
	(0.076)	(0.063)	(0.058)	(0.055)
1996	-0.169**	-0.180***	-0.057	0.031
	(0.086)	(0.069)	(0.062)	(0.059)
1997	0.020	0.035	0.091	0.210***
	(0.083)	(0.068)	(0.062)	(0.059)
1998	0.013	-0.020	0.072	0.154***
	(0.079)	(0.065)	(0.059)	(0.056)
1999	0.033	0.094	0.128**	0.163***
	(0.077)	(0.062)	(0.057)	(0.054)
2000	(Reference)	(Reference)	(Reference)	(Reference)
	-	-	-	-
2001	-0.014	0.026	0.041	0.079
	(0.076)	(0.061)	(0.056)	(0.053)
2002	0.239***	0.154***	0.129**	0.179***
	(0.071)	(0.058)	(0.053)	(0.051)
2003	0.306***	0.188***	0.197***	0.250***
	(0.075)	(0.062)	(0.057)	(0.054)
2004	0.047	0.030	0.066	0.132**
	(0.083)	(0.066)	(0.060)	(0.058)
2005	-0.108	-0.057	0.023	0.064
	(0.081)	(0.064)	(0.058)	(0.055)
2006	-0.004	-0.049	-0.042	-0.068
	(0.079)	(0.063)	(0.058)	(0.056)
2007	0.049	-0.010	-0.059	-0.098*
	(0.079)	(0.064)	(0.058)	(0.056)
2008	0.048	0.028	-0.067	-0.076
	(0.084)	(0.067)	(0.062)	(0.059)
2009	0.636***	0.315***	0.194***	0.171***
	(0.078)	(0.066)	(0.061)	(0.059)
Age at Hire	0.026***	0.011***	-0.001	-0.009***

	(0.001)	(0.001)	(0.001)	(0.001)
Female	0.040	0.147***	0.247***	0.307***
	(0.029)	(0.024)	(0.022)	(0.021)
Ethnicity				
Asian	0.177**	0.156***	0.141**	0.183***
	(0.073)	(0.060)	(0.055)	(0.052)
Black	0.131	0.202***	0.286***	0.301***
	(0.095)	(0.077)	(0.070)	(0.067)
Hispanic	-0.037	-0.009	-0.075	-0.103*
	(0.080)	(0.065)	(0.060)	(0.057)
Native American	-0.059	-0.129	-0.182	-0.234**
	(0.144)	(0.121)	(0.111)	(0.107)
White	(Reference)	(Reference)	(Reference)	(Reference)
	-	-	-	-
Advanced Degree	-0.581***	-0.705***	-0.793***	-0.866***
	(0.026)	(0.021)	(0.019)	(0.018)
Salary ($10,000s)	-0.432***	-0.251***	-0.147***	-0.083***
	(0.018)	(0.015)	(0.014)	(0.013)
School Level				
Elementary	(Reference)	(Reference)	(Reference)	(Reference)
	-	-	-	-
Middle	0.263***	0.234***	0.212***	0.209***
	(0.033)	(0.027)	(0.025)	(0.024)
High	0.381***	0.402***	0.421***	0.426***
	(0.039)	(0.032)	(0.030)	(0.028)
Other	0.317***	0.287***	0.286***	0.275***
	(0.064)	(0.053)	(0.049)	(0.048)
Pct. Under- Rep. Minor.	0.096	0.035	0.039	0.040
	(0.064)	(0.052)	(0.048)	(0.046)
Students (100s)	-0.003	-0.008***	-0.010***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	65,190	65,190	65,190	65,190
Psuedo-R^2	0.0411	0.0356	0.0385	0.0444
Log-Likelihood	-22565	-30670	-35264	-37852

*Note: *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Coefficients are reported as log-odds ratios. Standard errors in parenthesis.*

Table A2. Quit Patterns among Teachers Hired Before and After Introduction of TRS3

	(1)	(2)	(3)	(4)	(5)
	96 vs 97	96 vs 97	96 vs 97	96 vs 97	95-96 vs 97-98
Years of Service					
1	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
	-	-	-		
2	-0.249***	-0.249***	-0.245**	-0.240***	-0.397***
	(0.096)	(0.097)	(0.098)	(0.068)	(0.063)
3	-0.165*	-0.165*	-0.150	-0.227***	-0.390***
	(0.100)	(0.099)	(0.101)	(0.071)	(0.066)
4	-0.341***	-0.341***	-0.306***	-0.308***	-0.535***
	(0.106)	(0.106)	(0.107)	(0.075)	(0.070)
5	-0.215**	-0.213**	-0.166	-0.263***	-0.398***
	(0.106)	(0.106)	(0.108)	(0.076)	(0.069)
6	-0.489***	-0.486***	-0.427***	-0.552***	-0.518***
	(0.117)	(0.117)	(0.118)	(0.084)	(0.073)
7	-0.720***	-0.718***	-0.652***	-0.638***	-0.750***
	(0.127)	(0.127)	(0.128)	(0.089)	(0.080)
8	-0.866***	-0.862***	-0.793***	-0.858***	-0.982***
	(0.138)	(0.139)	(0.139)	(0.098)	(0.089)
9	-1.088***	-1.086***	-1.012***	-0.969***	-1.148***
	(0.150)	(0.150)	(0.151)	(0.104)	(0.096)
10	-0.974***	-0.971***	-0.896***	-0.978***	-0.922***
	(0.147)	(0.148)	(0.148)	(0.107)	(0.090)
11	-1.306***	-1.302***	-1.231***	-1.241***	-1.291***
	(0.173)	(0.173)	(0.174)	(0.122)	(0.108)
12	-1.132***	-1.128***	-1.050***	-1.152***	-1.409***
	(0.166)	(0.166)	(0.167)	(0.121)	(0.116)
13	-1.750***	-1.745***	-1.675***	-1.923***	-1.808***
	(0.221)	(0.222)	(0.223)	(0.172)	(0.142)
14	-2.330***	-2.326***	-2.254***	-2.291***	-2.023***
	(0.298)	(0.298)	(0.299)	(0.210)	(0.161)
15	-1.863***	-1.863***	-1.794***	-1.824***	-2.204***
	(0.246)	(0.247)	(0.248)	(0.175)	(0.180)
16	-2.031***	-2.031***	-1.969***	-2.055***	-2.256***
	(0.278)	(0.278)	(0.279)	(0.204)	(0.191)
17	-2.494***	-2.495***	-2.425***	-2.173***	-2.238***
	(0.362)	(0.362)	(0.362)	(0.230)	(0.198)
18	-2.793***	-2.794***	-2.705***	-2.745***	-2.450***
	(0.454)	(0.454)	(0.455)	(0.453)	(0.235)
1997 Cohort				0.068*	
				(0.040)	
(1997 Cohort)*(YOS = 1)	0.166*	0.163*	0.157*		0.009
	(0.091)	(0.091)	(0.092)		(0.059)
(1997 Cohort)*(YOS = 2)	0.163	0.160	0.167		0.112
	(0.104)	(0.104)	(0.105)		(0.070)
(1997 Cohort)*(YOS = 3)	-0.013	-0.014	0.004		0.095
	(0.109)	(0.109)	(0.109)		(0.074)
(1997 Cohort)*(YOS = 4)	0.139	0.137	0.155		0.138*
	(0.117)	(0.117)	(0.117)		(0.080)
(1997 Cohort)*(YOS = 5)	-0.056	-0.059	-0.038		-0.190**
	(0.120)	(0.120)	(0.121)		(0.083)
(1997 Cohort)*(YOS = 6)	-0.112	-0.116	-0.098		-0.266***
	(0.141)	(0.141)	(0.141)		(0.092)

(1997 Cohort)*(YOS = 7)	0.165	0.165	0.187		-0.005
	(0.150)	(0.150)	(0.151)		(0.099)
(1997 Cohort)*(YOS = 8)	0.014	0.012	0.030		-0.021
	(0.173)	(0.173)	(0.173)		(0.115)
(1997 Cohort)*(YOS = 9)	0.220	0.219	0.243		0.177
	(0.185)	(0.185)	(0.186)		(0.120)
(1997 Cohort)*(YOS = 10)	-0.038	-0.037	-0.008		-0.362***
	(0.192)	(0.192)	(0.194)		(0.128)
(1997 Cohort)*(YOS = 11)	0.108	0.107	0.139		-0.236
	(0.225)	(0.225)	(0.226)		(0.152)
(1997 Cohort)*(YOS = 12)	-0.075	-0.076	-0.048		-0.159
	(0.223)	(0.223)	(0.225)		(0.163)
(1997 Cohort)*(YOS = 13)	-0.427	-0.429	-0.397		-0.348
	(0.342)	(0.342)	(0.343)		(0.214)
(1997 Cohort)*(YOS = 14)	0.057	0.054	0.086		-0.216
	(0.411)	(0.411)	(0.411)		(0.237)
(1997 Cohort)*(YOS = 15)	0.066	0.068	0.100		0.075
	(0.337)	(0.337)	(0.338)		(0.248)
(1997 Cohort)*(YOS = 16)	-0.060	-0.060	-0.018		-0.012
	(0.396)	(0.396)	(0.398)		(0.275)
(1997 Cohort)*(YOS = 17)	0.583	0.584	0.628		0.181
	(0.459)	(0.459)	(0.460)		(0.350)
Age in First Year (YOS = 1)			-0.019***	-0.019***	
			(0.003)	(0.003)	
Female			0.431***	0.431***	
			(0.048)	(0.048)	
Ethnicity					
White			(Reference)		
			-		
Asian			0.126	0.125	
			(0.113)	(0.113)	
Black			0.206	0.207	
			(0.132)	(0.132)	
Hispanic			0.162	0.161	
			(0.127)	(0.127)	
Native American			-0.167	-0.167	
			(0.222)	(0.222)	
Advanced Degree Holder			-0.757***	-0.757***	
			(0.041)	(0.041)	
School Level					
Elementary		(Reference)	(Reference)		
		-	-		
Middle		0.040	0.137***	0.137***	
		(0.051)	(0.051)	(0.051)	
High		0.079	0.195***	0.195***	
		(0.061)	(0.063)	(0.063)	
Other		-0.151	-0.023	-0.022	
		(0.115)	(0.116)	(0.116)	
Percent Under-Represented Minority		-0.072	-0.115	-0.114	
		(0.111)	(0.115)	(0.115)	
School Size (100s students)		-0.003	-0.003	-0.003	
		(0.005)	(0.006)	(0.006)	
Observations	51,442	51,442	51,442	51,442	114,506

Psuedo-R^2	0.0454	0.0456	0.0689	0.0449	0.0435
Log-Likelihood	-11107	-11105	-10834	-11113	-24937

*Note: *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Coefficients are reported as log-odds ratios. Standard errors in parenthesis, clustered at the individual level. For the model in column (5) the variable label "1997 Cohort" is an indicator of belonging to the 1997 or 1998 cohorts.. Each other column is estimated on the sample including only the 1996 and 1997 Cohorts.*

Table A3. Quit Propensities of New Hires Who Can Choose between TRS2 and TRS3

	(1)	(2)	(3)	(4)	(5)
Years of Service					
1	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
	-	-	-	-	-
2	-0.450***	-0.449***	-0.443***	-0.450***	-0.452***
	(0.099)	(0.099)	(0.099)	(0.099)	(0.065)
3	-0.745***	-0.744***	-0.727***	-0.745***	-0.787***
	(0.113)	(0.113)	(0.113)	(0.113)	(0.074)
4	-0.992***	-0.991***	-0.967***	-0.992***	-0.871***
	(0.126)	(0.126)	(0.126)	(0.126)	(0.078)
5	-1.310***	-1.309***	-1.284***	-1.310***	-0.996***
	(0.149)	(0.149)	(0.149)	(0.149)	(0.086)
6	-1.237***	-1.236***	-1.192***	-1.237***	-1.020***
	(0.201)	(0.201)	(0.201)	(0.201)	(0.117)
Choice = TRS3					-0.002
					(0.050)
(Plan = TRS3)*(YOS = 1)	-0.065	-0.064	-0.058	-0.156*	
	(0.083)	(0.083)	(0.083)	(0.091)	
(Plan = TRS3)*(YOS = 2)	-0.080	-0.079	-0.073	-0.120	
	(0.104)	(0.104)	(0.104)	(0.114)	
(Plan = TRS3)*(YOS = 3)	-0.165	-0.164	-0.162	-0.101	
	(0.124)	(0.124)	(0.125)	(0.133)	
(Plan = TRS3)*(YOS = 4)	0.100	0.101	0.100	0.082	
	(0.138)	(0.138)	(0.138)	(0.148)	
(Plan = TRS3)*(YOS = 5)	0.387**	0.388**	0.389**	0.380**	
	(0.162)	(0.162)	(0.162)	(0.172)	
(Plan = TRS3)*(YOS = 6)	0.226	0.227	0.211	0.186	
	(0.232)	(0.232)	(0.233)	(0.248)	
Age in First Year		0.001	0.003		0.003
		(0.003)	(0.003)		(0.003)
Female			0.303***		0.303***
			(0.062)		(0.062)
Ethnicity					
White			(Reference)		
			-		
Asian			-0.007		-0.009
			(0.127)		(0.127)
Black			0.125		0.127
			(0.196)		(0.196)
Hispanic			0.041		0.039
			(0.135)		(0.135)
Native American			-0.970**		-0.974**
			(0.381)		(0.381)
Advanced Degree Holder			-0.167***		-0.167***
			(0.050)		(0.050)
School Level					
Elementary			(Reference)		
			-		
Middle			0.068		0.069
			(0.069)		(0.069)
High			0.350***		0.350***
			(0.080)		(0.080)

Other			0.376***		0.382***
			(0.126)		(0.126)
Percent Under Represented Minority			-0.196*		-0.197*
			(0.110)		(0.110)
School Size (100s students)			-0.004		-0.004
			(0.007)		(0.007)
Observations	22,183	22,183	22,183	18,229	22,183
Psuedo-R^2	0.0222	0.0222	0.0277	0.0211	0.0270
Log-Likelihood	-6434	-6434	-6397	-5235	-6402

*Note: *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Coefficients are reported as log-odds ratios. Standard errors in parenthesis, clustered at the individual level. The regression in column (4) excludes individuals who defaulted into TRS3 rather than indicating an active preference for the plan.*

Table A4. Quit Propensities of Teachers Who Could Transfer from TRS2 to TRS3

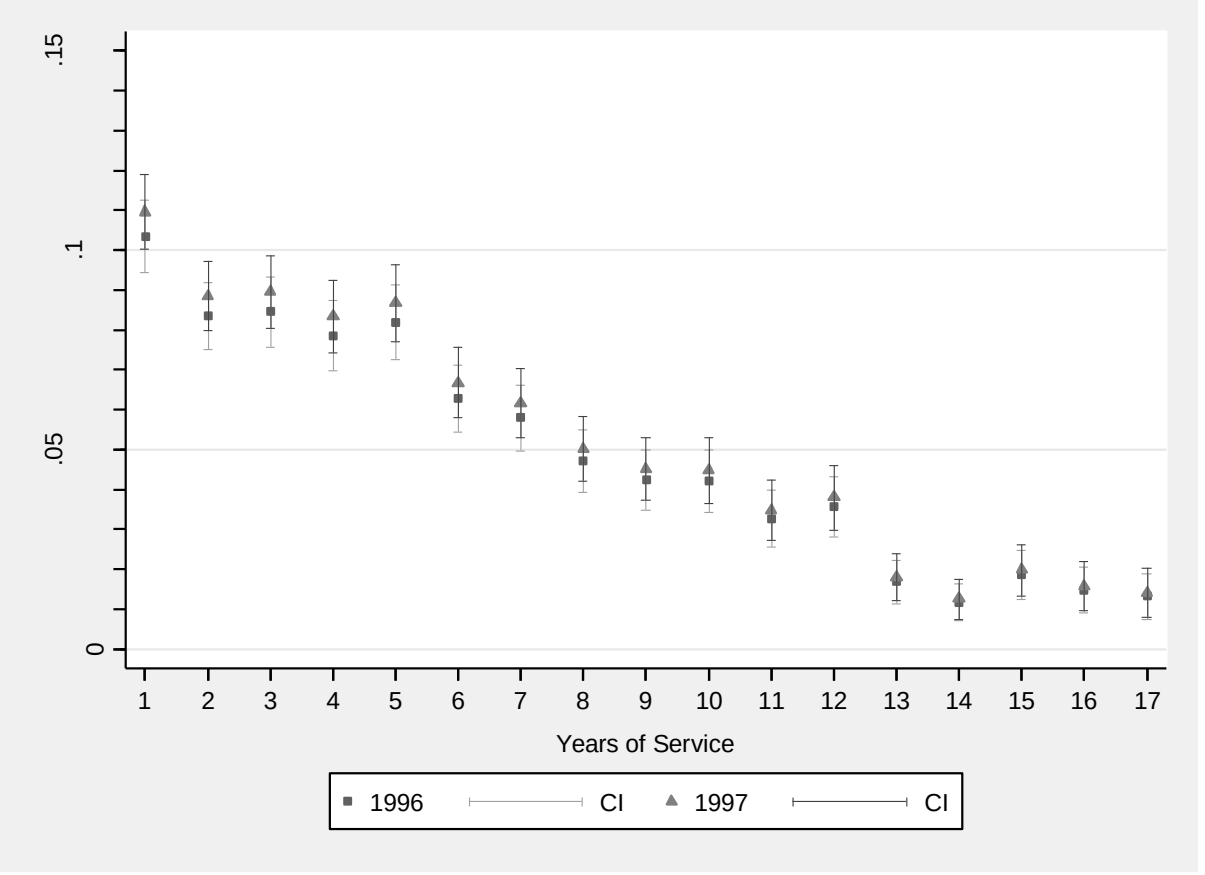
	(1)	(2)	(3)	(4)	(5)
School Year					
1998	0.576***	0.580***	0.544***	0.467***	0.620***
	(0.060)	(0.060)	(0.062)	(0.074)	(0.108)
1999	0.337***	0.341***	0.317***	0.287***	0.228*
	(0.066)	(0.066)	(0.069)	(0.081)	(0.128)
2000	0.377***	0.384***	0.354***	0.278***	0.444***
	(0.068)	(0.068)	(0.071)	(0.084)	(0.121)
2001	0.156**	0.159**	0.111	-0.031	0.358***
	(0.077)	(0.077)	(0.081)	(0.099)	(0.131)
2002	-0.087	-0.104	-0.130	-0.196*	-0.108
	(0.087)	(0.087)	(0.091)	(0.108)	(0.165)
2003	-0.148	-0.183**	-0.191**	-0.320***	0.049
	(0.092)	(0.092)	(0.096)	(0.116)	(0.161)
2004	-0.271***	-0.320***	-0.312***	-0.425***	-0.053
	(0.100)	(0.101)	(0.103)	(0.127)	(0.171)
2005	-0.221**	-0.289***	-0.291***	-0.297**	-0.214
	(0.101)	(0.101)	(0.106)	(0.123)	(0.190)
2006	-0.524***	-0.613***	-0.610***	-0.658***	-0.398*
	(0.121)	(0.121)	(0.126)	(0.149)	(0.217)
2007	-0.563***	-0.671***	-0.655***	-0.647***	-0.525**
	(0.125)	(0.126)	(0.130)	(0.151)	(0.237)
2008	-0.763***	-0.891***	-0.918***	-0.873***	-0.689***
	(0.142)	(0.143)	(0.150)	(0.173)	(0.265)
2009	-0.965***	-1.112***	-1.230***	-1.421***	-0.428*
	(0.160)	(0.161)	(0.177)	(0.228)	(0.244)
2010	-1.220***	-1.386***	-1.365***	-1.231***	-1.460***
	(0.187)	(0.187)	(0.191)	(0.215)	(0.413)
2011	-0.689***	-0.873***	-0.907***	-0.889***	-0.521*
	(0.151)	(0.151)	(0.159)	(0.189)	(0.275)
2012	-0.949***	-1.149***	-1.203***	-1.096***	-0.890***
	(0.176)	(0.177)	(0.186)	(0.215)	(0.341)
2013	-0.716***	-0.937***	-0.945***	-0.888***	-0.409
	(0.164)	(0.164)	(0.170)	(0.200)	(0.286)
(Plan = TRS3)*(Year = 1997)	0.243**	0.214*	0.253**	-0.065	0.680***
	(0.117)	(0.118)	(0.120)	(0.172)	(0.163)
(Plan = TRS3)*(Year = 1998)	-0.616***	-0.620***	-0.557***	-0.592***	-0.434***
	(0.062)	(0.063)	(0.065)	(0.080)	(0.108)
(Plan = TRS3)*(Year = 1999)	-0.392***	-0.395***	-0.327***	-0.354***	-0.219*
	(0.070)	(0.070)	(0.073)	(0.087)	(0.132)
(Plan = TRS3)*(Year = 2000)	-0.379***	-0.385***	-0.301***	-0.295***	-0.336***
	(0.071)	(0.072)	(0.074)	(0.090)	(0.125)
(Plan = TRS3)*(Year = 2001)	-0.327***	-0.331***	-0.249***	-0.116	-0.484***
	(0.082)	(0.082)	(0.086)	(0.106)	(0.137)
(Plan = TRS3)*(Year = 2002)	-0.382***	-0.372***	-0.274***	-0.286**	-0.270
	(0.095)	(0.096)	(0.099)	(0.120)	(0.175)
(Plan = TRS3)*(Year = 2003)	-0.407***	-0.388***	-0.296***	-0.284**	-0.482***
	(0.101)	(0.102)	(0.105)	(0.130)	(0.172)
(Plan = TRS3)*(Year = 2004)	-0.392***	-0.369***	-0.294**	-0.275*	-0.492***
	(0.111)	(0.111)	(0.114)	(0.141)	(0.187)
(Plan = TRS3)*(Year = 2005)	-0.547***	-0.517***	-0.489***	-0.459***	-0.497**
	(0.114)	(0.114)	(0.120)	(0.140)	(0.209)

(Plan = TRS3)*(Year = 2006)	-0.133	-0.093	-0.035	-0.174	0.039
	(0.130)	(0.131)	(0.136)	(0.166)	(0.227)
(Plan = TRS3)*(Year = 2007)	-0.114	-0.072	-0.019	-0.052	-0.066
	(0.136)	(0.137)	(0.142)	(0.167)	(0.251)
(Plan = TRS3)*(Year = 2008)	-0.225	-0.174	-0.070	-0.132	-0.203
	(0.156)	(0.157)	(0.165)	(0.193)	(0.285)
(Plan = TRS3)*(Year = 2009)	-0.397**	-0.343*	-0.240	-0.035	-0.747***
	(0.181)	(0.181)	(0.199)	(0.255)	(0.274)
(Plan = TRS3)*(Year = 2010)	-0.081	-0.021	0.010	-0.343	0.512
	(0.204)	(0.204)	(0.209)	(0.246)	(0.429)
(Plan = TRS3)*(Year = 2011)	-0.454***	-0.390**	-0.313*	-0.339	-0.467
	(0.169)	(0.170)	(0.179)	(0.215)	(0.300)
(Plan = TRS3)*(Year = 2012)	-0.264	-0.199	-0.071	-0.265	-0.045
	(0.194)	(0.195)	(0.204)	(0.242)	(0.361)
(Plan = TRS3)*(Year = 2013)	-0.467**	-0.395**	-0.409**	-0.611***	-0.301
	(0.183)	(0.184)	(0.193)	(0.235)	(0.307)
Age in 1996		-0.029***	-0.033***		
		(0.002)	(0.002)		
Experience in 1996		-0.084***	-0.084***		
		(0.005)	(0.005)		
Female			0.486***		
			(0.030)		
Ethnicity			(Reference)		
White			-		
Asian			0.019		
			(0.082)		
Black			0.401***		
			(0.090)		
Hispanic			0.076		
			(0.078)		
Native American			-0.116		
			(0.145)		
Advanced Degree Holder			-0.673***		
			(0.025)		
School Level					
Elementary			(Reference)		
			-		
Middle			0.094***		
			(0.032)		
High			0.213***		
			(0.040)		
Other			0.144**		
			(0.068)		
Percent Under-Represented Minority			-0.232***		
			(0.068)		
School Size (100s of students)			-0.008**		
			(0.003)		
Observations	248,081	248,081	235,594	117,965	124,412
Psuedo-R^2	0.0254	0.0394	0.0582	0.0297	0.0198
Log-Likelihood	-38299	-37748	-34836	-21402	-15381

*Note: *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Coefficients are reported as log-odds ratios. Standard errors in parenthesis, clustered at*

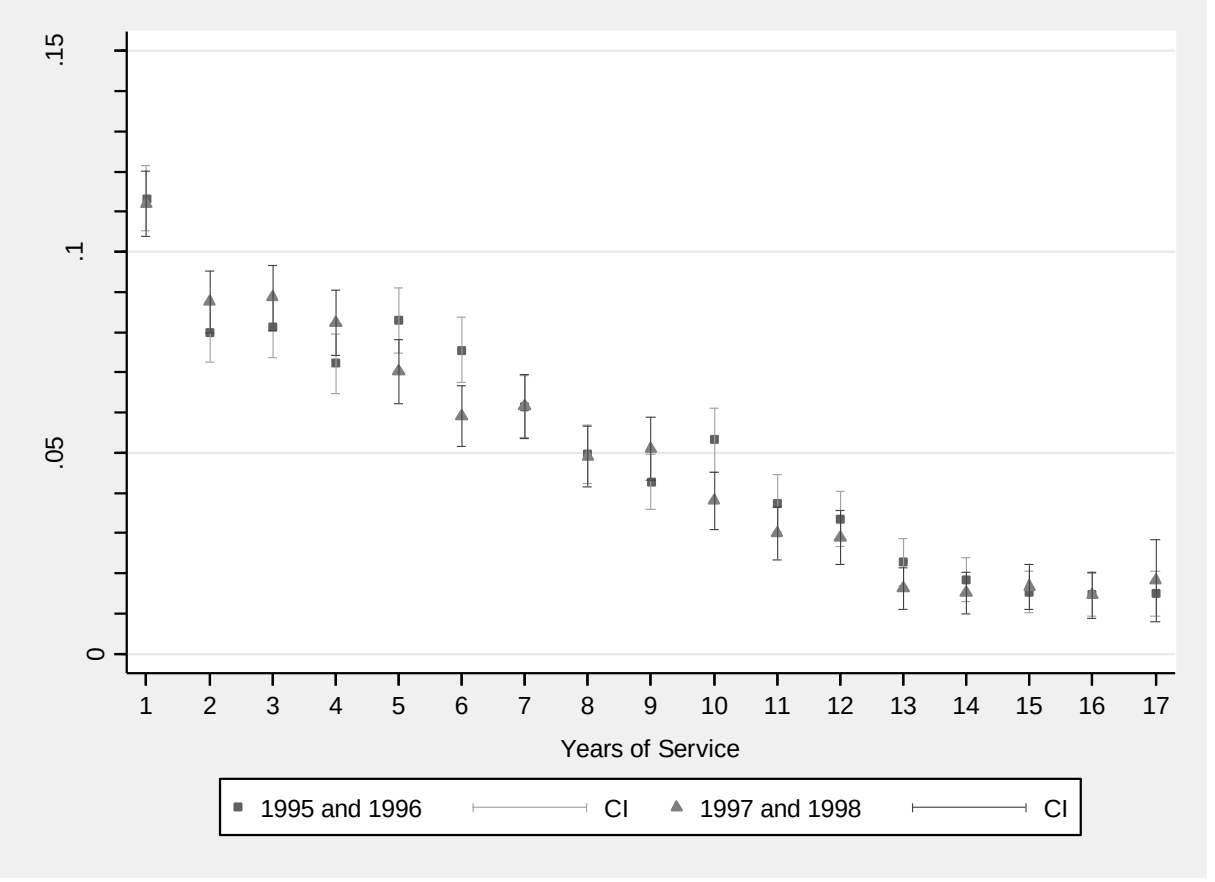
the individual level. Column (4) restricts the estimation sample to teachers with less than 5 YOS. Column (5) restricts the estimation sample to teachers with 5 or more YOS.

Figure A1. Predicted Probability of Exit by Years of Service for 1996 and 1997 Cohorts



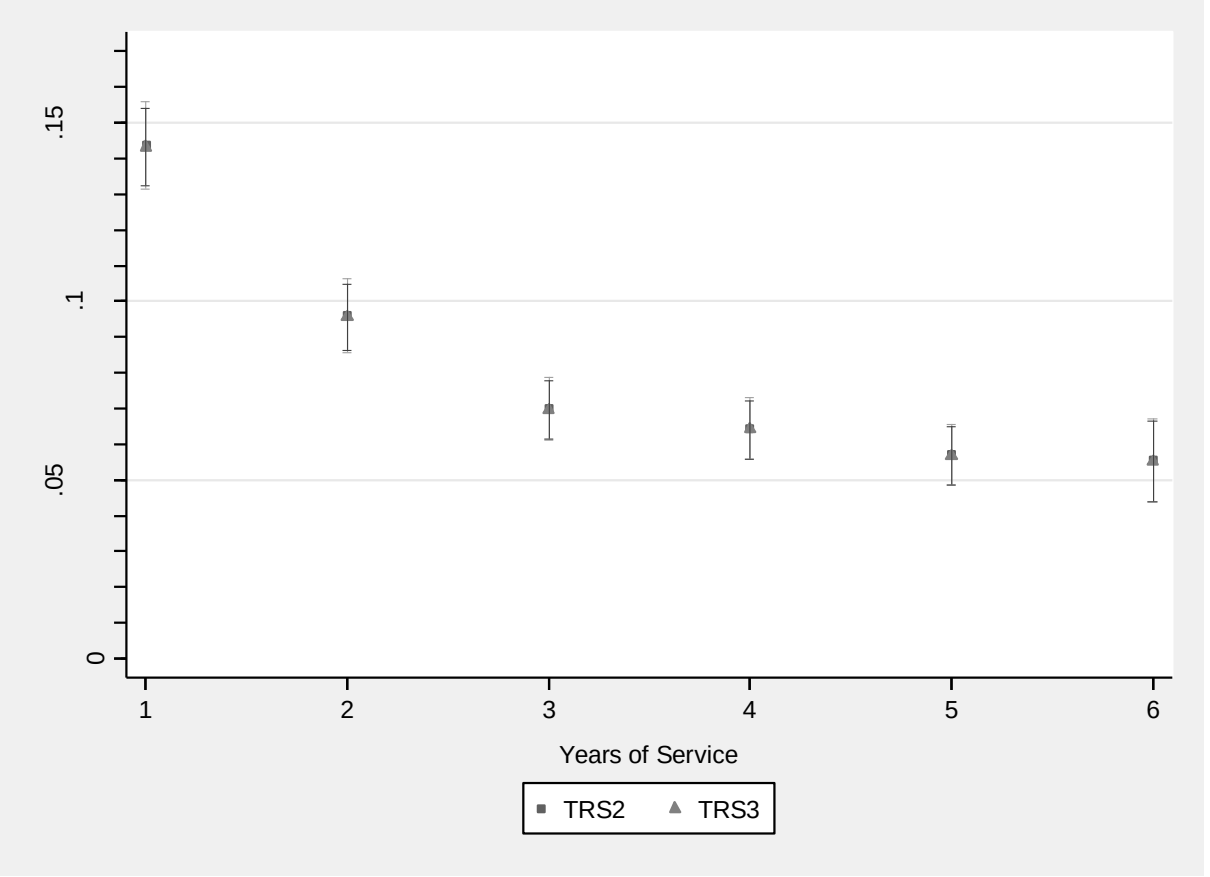
Note: Figure is produced using the model estimates in column (4) of Appendix ***Table A2****.*

Figure A2. Predicted Probability of Exit by Years of Service for 1995-1996 and 1997-1998 Cohorts



Note: Figure is produced using the model estimates in column (5) of Appendix ***Table A2****.*

Figure A3. Probability of Exit for 2008 and 2009 Hires by Plan Type and Years of Service



Note: Figure is produced using the model estimates in column (5) of Appendix ***Table A3****.*

Technical Appendix: Pension Wealth Calculations

This appendix describes the pension wealth calculations used to generate **Figure 1**. We begin by describing the calculation of the annual payment for the DB components of the TRS plans, and then present our method for calculating the present value of the expected stream of DB payments. Lastly, we discuss the calculation of TRS3 DC wealth.

In the Washington State pension system, monthly benefits are the product of a benefit factor, an early retirement factor, average final salary, years of service, and a cost of living adjustment:

$$Annual\ payment = b * ERF * FAS * YOS * COLA$$

The benefit factor b is 0.02 for TRS2 teachers, and 0.01 for TRS3 teachers. Early retirement factors ($ERFs$) reduce the benefit for teachers who elect to begin drawing retirement benefits before age 65 according to the following schedule:

Table 1. Early retirement factors by age, YOS and year

	$20 \leq YOS < 30$	$30 \leq YOS$	
Age	All years	Pre-2008	Post-2008
55	0.358	0.7	0.8
56	0.395	0.73	0.83
57	0.435	0.76	0.86
58	0.481	0.79	0.89
59	0.531	0.82	0.92
60	0.588	0.85	0.95
61	0.652	0.88	0.98
62	0.724	0.91	1
63	0.805	0.94	1
64	0.896	0.97	1

For example, a teacher that retires at age 55 with 25 YOS will have a benefit factor of 0.358 applied to the value of the DB annuity. As evident from the table, benefit factors are far more generous when teachers reach 30 YOS, regardless of age. We find that retirement prior to age 65 with less than 30 YOS is not pension-wealth maximizing. Final average salary (FAS) is calculated as the average annual salary during an employee's highest paid 60 consecutive months of employment. Years of service (YOS) increases by one for each year where more than 810 hours are worked;

fractions of YOS are awarded for less time. Lastly, a cost of living adjustment (COLA) is applied to the value of the annual benefit in retirement. It is based on the Consumer Price Index and is capped at 3%. TRS3 teachers with 20 or more *YOS* have their DB annuities increased by approximately 3% each year between separation from employment and the commencement of retirement, up to age 65.

Eligibility for annual payments are dependent on teachers vesting in TRS2 and TRS3. Vesting generally happens after 5 years for TRS2 and 10 years for TRS3.[34] We assume that TRS2 teachers who separate before becoming vested withdraw their contributions plus interest. TRS3 teachers may withdraw the balance of their DC accounts if they separate before vesting.[35]

To determine pension wealth for the DB component of both pensions, we take the present value of the stream of expected pension payments:

$$PV_{DB}(\mathrm{A}, A_R) = \sum_{t=A_R}^{110} (1+r)^{(A-A_R)} * f(A_t|\mathrm{A}) * b * ERF * AFS * YOS * COLA_{A_t}$$

This gives the pension wealth of an individual who separates at age A. The first term inside the summation, $(1+r)^{(A-A_R)}$, discounts the value of the payment to the age at separation and r is the teacher's assumed discount rate. The second term, $f(A_t|\mathrm{A})$, is the probability of survival, conditional on surviving to the current age.[36] Survival probabilities are calculated using CDC mortality tables.

The equation for pension wealth depends on the assumed retirement age A_R through the index on the summation, discounting, and the benefit factor b. For simplicity, we assume an individual chooses the retirement age that maximizes pension wealth; this assumption implies that teachers who quit before 30 YOS will retire at age 65. With the accumulation of 30 YOS, it is optimal to retire as soon as possible due to the more generous ERFs (see **Table 1**).

[34] Some TRS3 teachers are grandfathered into a five-year vesting period; we assume our representative TRS3 teacher has a ten-year vesting period.

[35] We assume that withdrawn TRS2 contributions are invested at the same interest as the TRS3 DC plan until retirement to make calculations comparable between both plans.

[36] We assume that survival probability prior to retirement is equal to 1.

The nominal balance in the DC account depends on the size of the teacher's contributions (C), and the return to investment (i). Prior to separation from employment, the DC balance is calculated recursively as:

$$DC_1 = C_1$$

$$DC_2 = DC_1 * (1 + i_t) + C_2$$

…

$$DC_s = DC_{s-1} * (1 + i_s) + C_s$$

After separation, we assume that the DC account continues to accumulate interest until retirement, but with no contributions:

$$DC_{s+1} = DC_s * (1 + i_{s+1})$$

$$DC_{s+2} = DC_{s+1} * (1 + i_{s+2})$$

…

$$DC_r = DC_{r-1} * (1 + i_r)$$

To find the present value of the DC account, we discount the nominal value of the DC account back to the teacher's age at separation:

$$PV_{DC} = (1 + r)^{(A - A_R)} * DC_r$$

Table 2 Economic assumptions for pension wealth calculations

Discount rate	0.04
Wage growth/inflation	0.02
COLA	0.03
Employee Contribution	0.05
Interest paid for withdraw	0.055
Investment return	0.08
Teacher Education level	Masters
Survival probabilities	CDC