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Should I Stay or Should I Go Now? An Analysis of Pension Structure and Retirement Timing

Dan Goldhaber

Cyrus Grout

Kris Holden

Josh B. McGee

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Abstract: Over the last two decades, twenty-two states have moved away from traditional defined benefit (DB) pension systems and toward pension plan structures like the defined contribution (DC) plans now prevalent in the private sector. Others are considering such a reform as it is seen as a means of limiting future pension funding risk. It is important to understand the implications of such reforms for end-of-career exit patterns and workforce composition. Empirical evidence on the relationship between pension plan structure and retirement timing is currently limited, primarily because, most state pension reforms are so new that few employees enrolled in those alternative plans have reached retirement age. An exception, and the subject of our analysis, is the teacher retirement system in Washington State, which introduced a hybrid DB-DC plan in 1996 and allowed employees in its traditional DB plan to transfer into the new plan. Our analysis focuses on a years-of-service threshold, the crossing of which grants employees early retirement eligibility and, in many cases, a large upward shift in retirement wealth. The financial implications of crossing this threshold are far greater under the state's traditional DB plan than under the hybrid plan. We find that employees are responsive to crossing the years-of-service threshold, but we fail to find significant evidence that the propensity to exit the workforce varies according to plan enrollment.

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1. Introduction

The majority of state and local public sector employees in the United States are enrolled in defined benefit (DB) pension plans under which the benefit payments promised in retirement are based on an employee's final average salary and years of service (National Education Association, 2016). This is changing, however. In response to rising costs driven by large funding shortfalls (Backes et al., 2016) and questions about whether traditional plan structures suit the current public sector workforce (McGee & Winters, 2015), states have increasingly explored the adoption of alternative plan structures that are more similar to the defined contribution (DC) plans now prevalent in the private sector (Aubry & Crawford, 2017).[1]

Understanding how pension plan design affects labor force behavior is important because these plans create strong incentives for employees to continue working or exit employment at different points in a career. The conventional wisdom is that the perceived benefit security provided by traditional DB plans tends to attract workers who are somewhat more risk averse and that the high financial cost of exiting before reaching important age-service thresholds strongly encourages retention across these thresholds (Ippolito, 2002; Salop & Salop, 1976). Alternative retirement plan designs, like DC plans and cash balance plans, tie benefits more closely to contributions and investment earnings. As a result, benefits tend to accrue more smoothly over the course of an employee's career. A concern, then, is that movement away from DB plans will result in higher rates of employee turnover.[2]

[1] Public sector DC plans, hybrid plans with both DB and DC features, and/or cash balance plans have been introduced in at least 22 states, including Alaska, Colorado, the District of Columbia, Florida, Illinois, Indiana, Kansas, Kentucky, Michigan, Montana, New York, North Dakota, Ohio, Oregon, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, and West Virginia.

[2] Regarding the teaching profession in particular, the National Education Association has maintained that "Defined benefit plans are a proven tool for retaining accomplished public sector professionals'' (National Education Association, 2011).

Interestingly, while the theory about the retention effects of different types of pensions is clear, the empirical evidence on this is relatively sparse.[3] Ippolito (2002) studied the introduction of the Federal Employees Retirement System (FERS) in 1984 that provided new hires with a smaller DB plan along with inclusion in Social Security and a 401k plan with employer-matched contributions. He found that the 1984 reform resulted in higher levels of employee turnover among employees enrolled in FERS relative to previously hired employees who were enrolled in the pure DB plan.[4] Similarly, Quinby (2020) found that when Michigan began placing state employees in a DC plan and lowered the value of retiree health benefits, employee turnover increased. Clark et al. (2016) also found an increase in turnover following a shift in from a traditional DB plan to choice been a hybrid DB-DC plan and a DC plan. In contrast, Goldhaber et al. (2017) found little evidence that the introduction of a hybrid pension plan with DB and DC features increased turnover among teachers in Washington State and that rates of turnover were significantly lower among experienced teachers who transferred from the existing DB plan to the new hybrid plan.

Regarding the likely relationship between public sector pension structure and *end-of-career* exit decisions (the focus of our analysis), the empirical evidence is limited, with the most compelling analyses relying on simulation approaches. These analyses use within-plan variation to parameterize the relationship between the financial incentives embedded in DB plans and employees' exit propensities, and several papers use such parameter estimates to simulate the effects of changing to alternative plan structures (Costrell & McGee, 2010; Knapp et al., 2021;

[3] A few older studies compare employee attrition across firms (see Friedberg & Webb, 2005; Gustman et al., 1994; Gustman & Steinmeier, 1993). A limitation of cross-firm analyses is that it is challenging to disentangle the influence of pension structure from the influence of other firm-level characteristics that may also influence employee turnover.

[4] As noted by Goldhaber et al. (2017), a limitation of Ippolito's analysis is that it compared the exit behavior of employees during two different time periods, roughly a decade apart.

Ni et al., 2022; Ni & Podgursky, 2016). Their forecasts show end-of-career exit patterns that exhibit a more normal distribution, with less concentration around age and years-of-service thresholds related to retirement eligibility.

A concern about using simulations to assess how a change in pension structure would affect retirement timing is that the simulation models, which focus primarily on the influence of financial incentives, may fail to account for other factors that play an important role in workers' retirement decisions. Several recent papers lend weight to this concern. Seibold (2021), for instance, found that statutory retirement ages served as reference or anchoring points for retirement timing, and that these anchors were much more influential than specific financial incentives. Vermeer et al. (2019) find that in addition to the anchoring effects of statutory retirement ages on workers' retirement decisions, social interactions with family, friends and co-workers also play an important role. Finally, papers by Brown et al. (2016) and Behaghel and Blau (2012) highlight the important role that framing plays in workers' Social Security benefit claiming decisions.

The lack of more direct empirical evidence on the relationship between pension structure and end-of-career exit decisions than that provided by simulation models is due to the fact that the alternative public sector pension plans that have been introduced in a growing number of states are relatively new. Therefore, few employees enrolled in those plans are of retirement age and those who are eligible to retire have accrued relatively few years of service. In this paper, we seek to address that gap in the literature.

We take advantage of the fact that in 1996, the Washington State Teacher Retirement System (TRS) introduced a hybrid pension plan with DB and DC features and gave members of the existing DB plan (hired between 1977 and 1995) the option to transfer into the new plan.

This allows us to provide *direct* empirical evidence on the relationship between pension plan structure and retirement timing by comparing the end-of-career exit patterns of one group of employees (public school teachers) enrolled in two different types of plans over the same period of time (2011 to 2017). We also use parameter estimates from Ni, Podgursky, and Wang (2020) to model exit-probabilities under the two plans and compare these simulation-based results to our empirical estimates.

We find that teachers in the DB and hybrid DB-DC plans are similarly responsive to crossing a threshold for early retirement eligibility despite the financial implications of crossing that threshold being quite different across the two plans. This suggests that the magnitude of large, end-of-career increases in pension wealth could be reduced while maintaining desired retention effects. Our findings also suggest that simulation-based approaches to investigating the implications of pension reform may be misleading if they fail to account for the anchoring effects of plan rules associated with retirement eligibility.

2. Background

In this section we describe features of the pension plans that enroll public educators in Washington State and compare patterns of pension wealth accrual under these plans.

2.1 The Teacher Retirement System in Washington State

Traditional DB pension plans base workers' benefits on a formula that includes their years-of-service and end-of-career salary:

$$Annual\ benefit = \mathrm{B} * \mathrm{YOS} * \mathrm{FAS}$$

The formula multiplies years-of-service (YOS) by the plan's benefit multiplier B, which is often between 1% and 2.5%, to yield the worker's replacement rate. The replacement rate is then multiplied by the worker's final average salary (FAS) calculated over a specific number of years.

For example, a 30-year veteran teacher with a 2% multiplier would be eligible for a 60% replacement rate. If the teacher's average pre-retirement salary was $70,000, then her annual retirement benefit would be $42,000. Workers may choose to retire and begin receiving benefit payments once they meet retirement eligibility requirements, which typically require that they have reached a set of age and years-of-service thresholds.

Public school teachers in Washington State are currently enrolled in one of three pension plans operated by the Department of Retirement Systems: TRS1, TRS2, or TRS3. Prior to 1977 teachers in Washington State were enrolled into TRS1 a traditional DB plan with a 2% multiplier and a normal retirement age of 60. Starting in 1977, new hires were enrolled in TRS2, which increased the normal retirement age to 65. In 1996, the state introduced TRS3, a hybrid plan with both traditional DB and DC features. Active TRS2 members were able to transfer to TRS3 and approximately three-quarters of TRS2 members exercised that option.[5] Teachers enrolled after June 30, 1996 were mandated into TRS3 until July 1, 2007. Since then, new enrollees have been able to choose between TRS2 and TRS3. The analyses presented in this paper focus on TRS2 and TRS3.[6]

Key features of TRS2 and TRS3 are described in **Table 1**. Key to the analyses presented here are the benefit formulas and rules defining retirement eligibility. TRS2 has a benefit formula with a 2% multiplier, which pays a TRS2 teacher who retires with 30 years of service (YOS) an annuity equal to 60% of her final average salary. If enrolled in TRS3, which has a 1% multiplier, that same teacher would receive an annuity equal to 30% of her final average salary in

[5] For further discussion of the development of TRS3 and an analysis of members choices to enroll in TRS2 or TRS3, see Goldhaber and Grout (2016b).
[6] We do not study TRS1 in this paper because the great majority of members had reached normal retirement age as of the beginning of the study period. As described in Section 3, the study period is 2011 to 2017, the period of time for which we were able to obtain data.

addition to retirement income withdrawn from her DC account.[7] However, TRS3 members who exit with 20 or more YOS benefit from an inflation protection provision that increases their FAS by approximately 3% each year between their exit year and the year they begin drawing retirement benefits.[8]

Feature	***TRS2***	***TRS3***	
Membership definition	Hired 1977–96 (default) Hired 2007–present (opt in)	Hired 1977–96 (option to transfer) Hired 1996–2007 (mandated) Hired 2007–present (default)	
Type	Traditional FAS	FAS component	DC component
Vesting period	5 years	10 years	N/A
Employee contributions	Set by legislature	N/A	5%–15% (employee's choice)
Benefit formula	$0.02 * (FAS) * (YOS)$	$0.01 * (FAS) * (YOS)$	N/A
FAS period	5 consecutive highest paid years	5 consecutive highest paid years	N/A
Retirement eligibility	65 years of age, or 62 years of age & 30 YOS (full benefit), or 55 years of age & 20 YOS (reduced benefit)	65 years of age, or 62 years of age & 30 YOS (full benefit), or 55 years of age & 10 YOS (reduced benefit)	Withdrawal ages and penalties for early withdrawal dependent on federal tax rules

Table 1. Key Features of Washington State's Teacher Retirement System
Notes: DB is defined benefit; DC is defined contribution; FAS is final average salary; YOS is years of service.

The rules defining retirement eligibility are similar for TRS2 and TRS3. The normal retirement age for both plans is 65, and members can retire as early as age 55 with reduced

[7] All contributions to TRS3 made by employees are placed in a personal investment account. Employees can choose from a discrete menu of contribution rate options ranging from 5% to 15%. For more information, see Goldhaber and Grout (2016a).
[8] For example, a teacher with 20 YOS and an FAS of $50,000 who exited employment at age 50 and began collecting retirement benefits at age 65 who receive an annual benefit of $0.01 * 20\,YOS * \left(50{,}000 * 1.03^{(65-50)}\right) = \$15{,}580$ rather than an unadjusted benefit of $0.01 * 20\,YOS * 50{,}000 = \$10{,}000$.

benefits at 20 YOS (for TRS2) or 10 YOS (for TRS3). Early retirement factors are used to determine how much benefits are reduced for TRS2 and TRS3 members who opt to retire early. These factors become more generous when a member reaches 30 YOS, at which point members hired prior to 2008 can draw unreduced benefits as early as age 62.[9]

2.2 Pension Wealth Accrual

As noted above, pension wealth accrual patterns under traditional DB plans create financial incentives to continue working until reaching retirement eligibility, at which point there is an incentive to leave employment in order to collect retirement benefits. Here, we consider how members of the TRS plans accrue pension wealth over the course of a career to better understand how the benefit formulas and retirement rules described above affect the magnitude and timing of the financial incentives embedded in the TRS plans.

Following earlier work (Costrell & Podgursky, 2009; Goldhaber et al., 2017), we define pension wealth as the present value of the stream of future benefits a member is entitled to given his or her current age and years of service:

$$PV_{PW} = \sum_{A=A_S}^{110} \left(\frac{1}{1+r}\right)^{(A-A_S)} * f(A|A_S) * b * FAS * YOS * ERF * COLA_A, \qquad (1)$$

where A_S is age at separation, r is the discount rate, $f(A|A_S)$ is the probability of surviving to age A given separation age A_S, b is the benefit multiplier, and $COLA_A$ is a cost-of-living adjustment. We calculate PV_{PW} at each potential starting age and year of separation. The pension wealth calculations for a representative teacher starting her career at age 25 are presented in

[9] With 30 YOS, a member's benefit is reduced by a factor of 0.98 if she retires at age 61 and by an additional 0.03 for each year between retirement age and age 61 (the early retirement factor for age 55 is 0.80). For documentation on the early retirement factors for TRS2 and TRS3, see https://www.drs.wa.gov/publications/member/multisystem/p23earlyretirement.htm.

Figure 1,[10] which plots TRS3 DB pension wealth as well as total TRS3 pension wealth assuming the representative teachers makes the minimum 5% contribution to her DC account and a earns a 5.5% annual rate of return on DC account assets.[11]

In **Figure 1**, we see that the rate of pension wealth accrual increases as the teacher gains experience so that the additional pension wealth earned during an additional year of service becomes quite large as an employee approaches eligibility for retirement.[12] In comparing the defined benefits provided by TRS2 and TRS3 (represented by the solid blue line and the dashed red line, respectively), there is relatively little difference in accumulated wealth between the two plans for teachers who separate with between 20 and 29 YOS; this is because of the inflation protection provision in TRS3 described above. However, end-of-career pension wealth – once the teacher has reached early retirement eligibility at 30 YOS – is much larger under TRS2.

[10] We assume a 4% discount rate, a 2% COLA, and survival probabilities from the CDC. We discount to age of separation instead of starting age to reflect the perspective of the teacher deciding whether to retire in the current school year. Note that employees can choose to delay retirement after separating employment. Conditional on each potential point of separation, we assume that employees choose the retirement timing that maximizes pension wealth, and generally refer to separation instead of retirement.

[11] The value of the DC component of TRS3 will vary according to employees' contribution rate choices and returns earned on their investments. Given the assumed contribution rate (5%) and rate of return (5.5%), **Figure 1** reflects a conservative estimate of total pension wealth accrual under TRS3.

[12] As an employee continues to work, DB pension wealth eventually begins to decline when the cost of foregoing retirement benefits outweighs the value of the larger annuity obtained by gaining an additional YOS and higher FAS (see **Figure 2**).

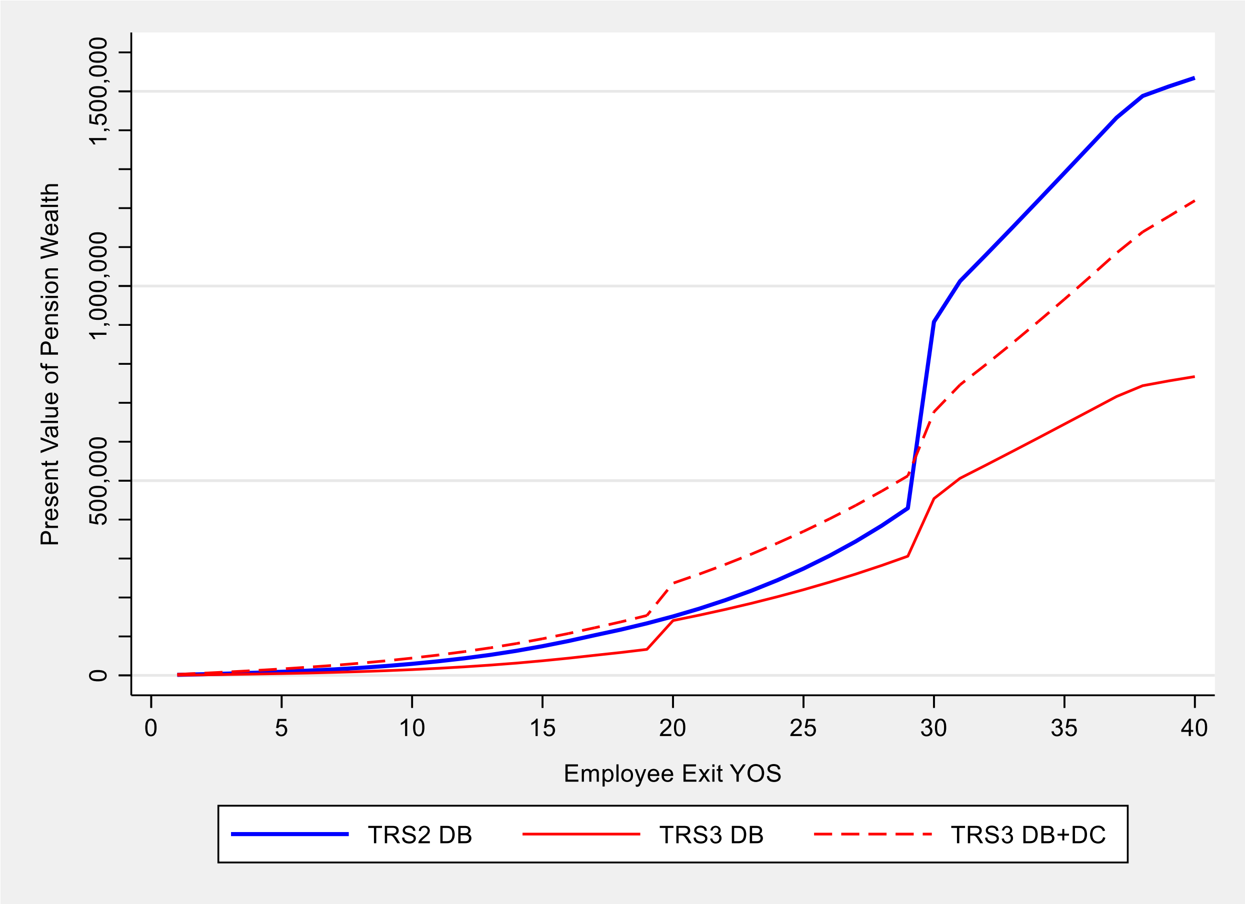

Figure 1. Pension Wealth Accrual for an Age 25 entrant in TRS2 and TRS3
Notes: Pension wealth calculations are derived from equation (1) for a representative teacher. We assume a 5.5% discount rate and a 2.75 percent COLA based on the assumptions of the pension plan. We use the 2013 static mortality table based on the RP-2000 Mortality Tables Report adjusted for mortality improvement using Projection Scale AA. The mortality table can be found at http://www.irs.gov/pub/irs-drop/n-08-85.pdf. For TRS3, we assume a 5% contribution rate to the DC plan, and a 5.5% rate of return. Lastly, salary values come from Washington teacher salary schedules in 2012-13 for a teacher with a Master's degree.

It is the 30-YOS early retirement eligibility rule that is the focus of our empirical analysis. Under both TRS2 and TRS3, a member who begins employment at a young age experiences a large increase in pension wealth when she accrues 30 YOS (note the kink in both the TRS2 and TRS3 pension wealth accrual lines). Reaching 30 YOS allows her to retire with full benefits 3 years earlier (at age 62) than if she had separated from employment with 29 YOS (at age 65).[13] Key to our analysis is the fact that *the magnitude of the increase in pension wealth when an employee crosses the 29-30 YOS threshold is much larger for TRS2 than for TRS3*. In the case of the representative employee depicted in **Figure 1**, pension wealth increases by $478,635 upon reaching 30 YOS under TRS2 compared to an increase in the value of the DB component of TRS3 of $147,898.[14] A limitation of the representation in **Figure 1** is that it reflects the pension wealth effects of crossing the 29-30 YOS threshold at a specific age.

Figures 2A and **2B** illustrate how pension wealth accrual patterns differ across a range of starting ages. We see that the peak level of pension wealth is much larger for employees who enter the system at a younger age; for instance, a TRS2 member starting at age 25 can accrue a maximum of about $1.6 million in pension wealth, while a TRS2 member starting at age 50 can accrue a maximum of around $500,000. Moreover, for both TRS2 and TRS3, the pension wealth effect of crossing the 29-30 YOS threshold decreases with entry age and is a non-factor for members who enter at age 35 or later – they will be eligible for full retirement (age 65) before they accrue 30 YOS. The rate of pension wealth accrual begins to plateau when an employee reaches eligibility for full retirement (age 65, or age 62 with 30 or more YOS).

[13] In fact, because the early retirement factors for employees who separate with 30 or more YOS are relatively generous (see discussion in preceding sub-section), it is optimal for those exiting teachers to begin collecting a reduced benefit as soon as possible (as early as age 55) rather waiting to collect an unreduced benefit at age 62.

[14] The value of crossing this threshold for TRS3 employees is estimated to be $164,272 in total, but this includes the DC component which is not affected by the early retirement eligibility rules associated with the 29-30 YOS threshold.

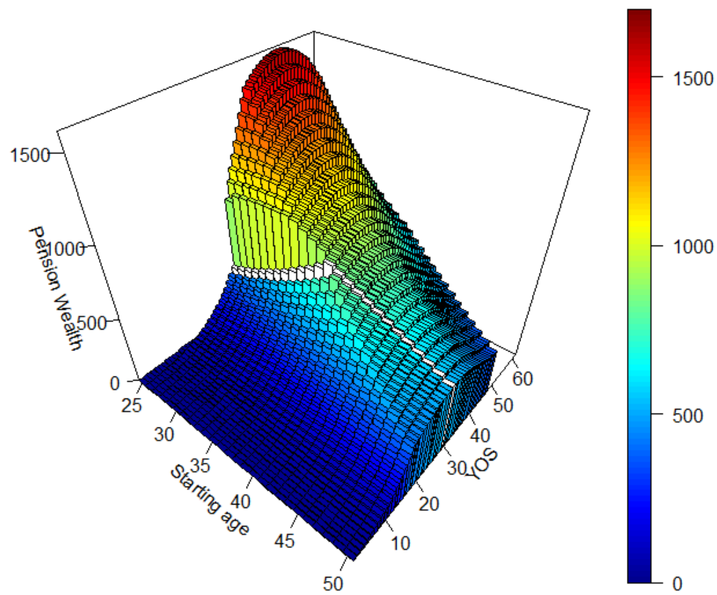

Figure 2A. Pension Wealth Accrual TRS2 by Starting Age and YOS

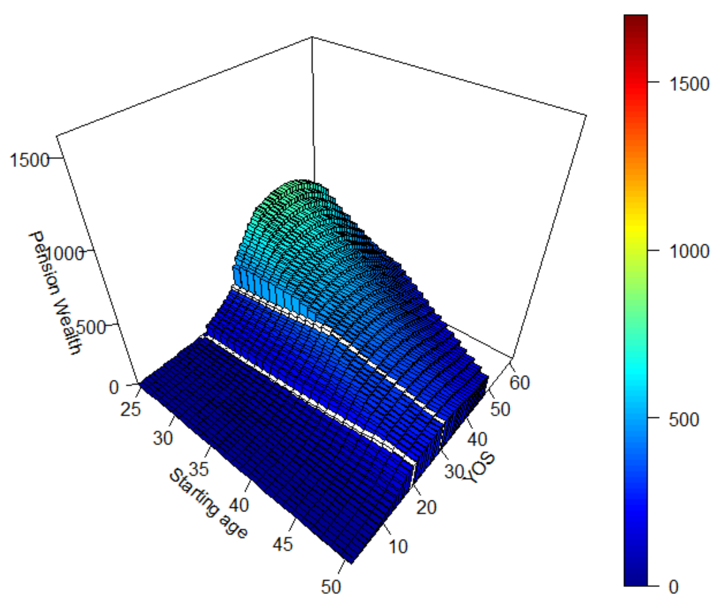

Figure 2B. Pension Wealth Accrual TRS3 by Starting Age and YOS
Notes: Pension wealth calculations are derived from equation (1) for a representative teacher. These figures use the same assumptions reported in the note for Figure 1.

There are two key takeaways from the above discussion. First, the increase in pension wealth as one crosses the 29-30 YOS threshold is much larger for TRS2 than it is for TRS3 – over 3 times larger for a 25-year-old entrant.[15] Second, the change in pension wealth upon reaching 30 YOS decreases as entry age increases. Therefore, how employees respond to the 29-30 YOS threshold would also be expected to vary according to age. Below, we focus on this variation around the 29-30 YOS threshold to examine how end-of-career exit patterns were affected by the introduction of an alternative pension plan structure in the form of TRS3.

3. Data

Our analysis relies on two data sets. The first consists of records maintained by the Department of Retirement Services (DRS) on active (i.e., currently employed) members of TRS, obtained through a public records request. The active member records span the fiscal years 2010-11 to 2017-18 and provide data on member name, employer (i.e., school district), pension plan, total- and in-year accrual of YOS, and each employee's status at the start and end of the fiscal year. The second data set consists of personnel records from the Washington State Office of the Superintendent of Public Instruction (OSPI) S-275 personnel reporting system for public school employees. The S-275 records include information on teacher characteristics (including age and experience), position type, position location (school and district), and salary. The DRS and OSPI data are linked by matching on school district ID and individuals' full names.[16] We also link the DRS records to district and school-level data maintained by OSPI.

[15] Note that while exiting at 30 YOS versus 29 YOS yields higher pension wealth for younger entrants, it does not yield peak pension wealth. In fact, the year-over-year rate of pension wealth accrual at 30 YOS (if the employee continues working) is greater than at most other points (the rate at 29 to 30 YOS being a notable exception).
[16] We were able to match over 92% of classroom teachers in the S-275 data during the 2011-2017 study period to corresponding records for the same year in the DRS data. The match rate is 95% percent among retirement-age teachers (age 55+).

A technical challenge in linking this data is that the DRS and OSPI calendar years are not perfectly synchronized, so that it is common in the data for TRS members to have non-integer levels of YOS. This stems from teacher contracts tending to begin in September while DRS data are reported for the fiscal year running from July 1st to June 30th. For example, in their first year of service, teachers often accrue 10/12 months (i.e., September through June) = 0.83 years of service credit. Among TRS members in our study sample with $YOS \in [29, 30]$, 53% are reported as having precisely 29.83 YOS. It is also common for teachers who do not appear in the S-275 administrative in September of year t+1, and who are therefore identified as exiting employment in year t, to continue accruing service credit during July and August of year t+1 of the DRS data. Among the 186 teachers in our study sample who exit employment with between 29.83 and 29.99 YOS and are under age 64, 86% retire with 30+ YOS. Given these patterns in the data, we round up YOS values to the next integer when the decimal value of YOS is greater than or equal to 0.83.

In **Table 2**, we present summary statistics as 2011 for members of TRS2 and TRS3 who were hired prior to 1996 – the first year in our panel of data. As noted above, the pre-1996 hires were able to choose whether to stay in TRS2 or transfer into TRS3 when TRS3 was introduced in 1996. Consistent with prior work that analyzed that transfer decision (Goldhaber & Grout, 2016b), we observe a number of differences in the characteristics of TRS2 and TRS3 members. TRS2 members are older but slightly less experienced, more likely to be female, and less likely to hold an advanced degree. They are also far less numerous – roughly three quarters of teachers eligible to transfer to TRS3 did so (Goldhaber et al., 2017).

	TRS2	TRS3	TRS2-TRS3
Teacher characteristics			
Age	54.08	52.34	1.74***
YOS	18.79	22.07	-3.28***
Exits employment	0.07	0.05	0.02***
Female	0.74	0.66	0.08***
Advanced degree	0.67	0.77	-0.10***
Ethnicity			
American Indian	0.01	0.01	0.00*
Asian	0.02	0.02	0.01*
Black	0.02	0.01	0.01***
Hispanic	0.02	0.02	0.00
White	0.92	0.95	-0.03***
School characteristics			
Ethnicity			
American Indian	0.02	0.02	0.00***
Asian	0.07	0.06	0.01***
Black	0.05	0.04	0.01***
Hispanic	0.18	0.17	0.00**
White	0.62	0.65	-0.03***
Percent Free/Reduced Lunch	0.35	0.33	0.02***
Observations	4,276	14,286	

Table 2. Descriptive Statistics

Notes: Statistics are calculated as of the 2010-11 school year for teachers who were hired prior to 1996 and were eligible to transfer from TRS2 to TRS3. The stars represent the p-values of a t-test of the difference in the mean values for TRS2 and TRS3: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In **Figure 3**, we consider a descriptive comparison of the raw proportion of teachers who separate from employment under TRS2 and TRS3 conditional on having a given level of service.[17] We focus on "exits" rather than "retirements" because we are interested in teachers' decisions to remain in or exit from the public educator workforce; "retiring" in the context of TRS means a worker has begun drawing retirement benefits, which often occurs several years after exiting employment as a teacher. Each vertex in the figure represents the ratio of the

[17] We suppress output under 10 YOS and over 33 YOS. Few teachers hired prior to 1996 have fewer than 10 YOS during the period covered by our data (2011 to 2017) and cell sizes are small above 33 YOS.

number of teachers exiting with a given level of service to the total number of teachers observed with that level of service. Consistent with the financial implications associated with crossing the 29-30 YOS threshold, we see a large upward shift in the propensity to exit at 30 YOS and that the shift is larger among members of TRS2 than among members of TRS3. A limitation of this descriptive comparison (which will be addressed in the more formal analysis below) is that it does not account for an employee's age. As shown in **Table 2**, the average TRS2 member is older than the average TRS3 member and the gap in the exit probability at 30 YOS shown in **Figure 3** may be age-driven rather than plan-driven.

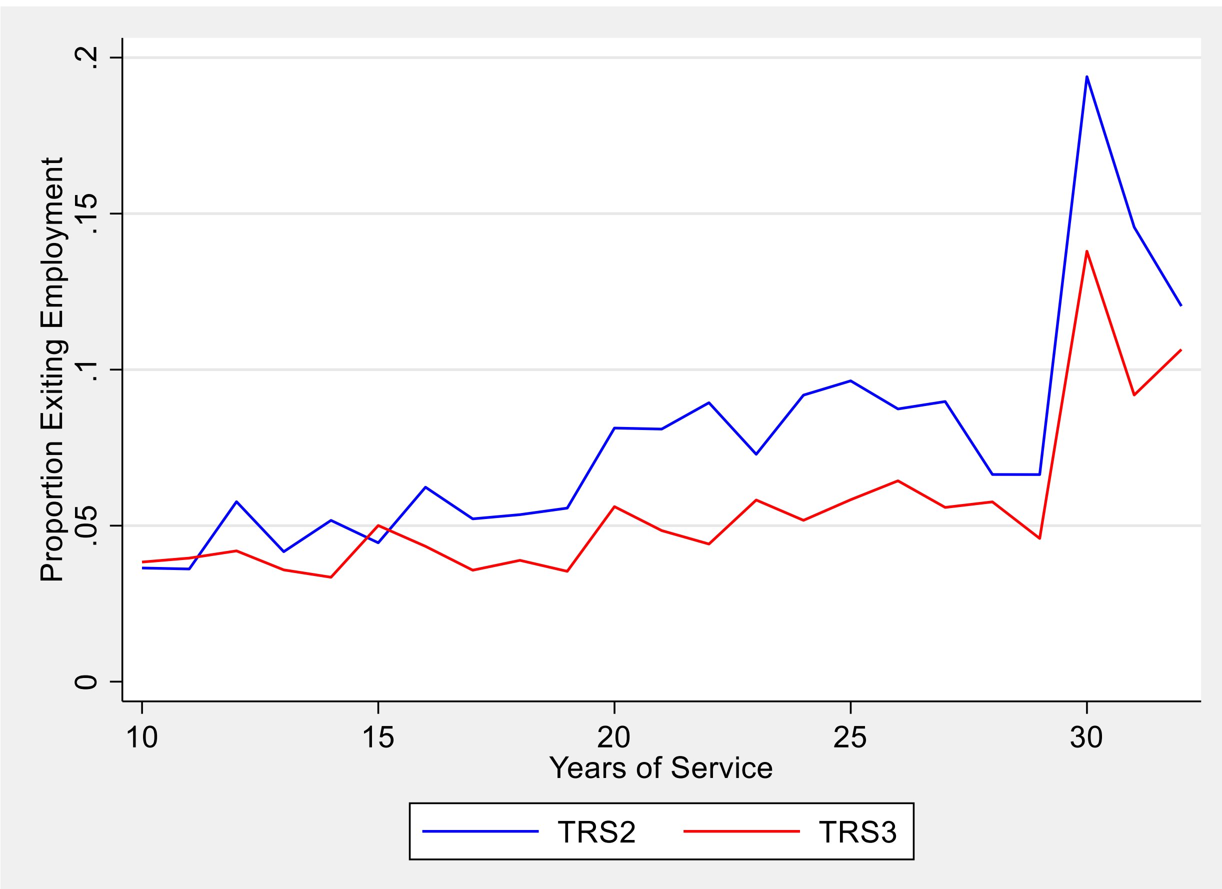

Figure 3. Separation Probabilities for Teachers, by YOS and Plan Type
Notes: Each vertex represents the ratio (The number of teachers exiting with X YOS)/ (The number of teachers observed with X YOS) during the period 2010-11 to 2016-17. Observations = 100,190.

4. Empirical Approach

We are interested in understanding how substantial differences in the financial incentives created by employer-sponsored pension plans may influence employees' end-of-career exit decisions. In comparing TRS2 and TRS3, we observe large differences in the magnitude of the opportunity cost of exiting. As discussed above, this difference is particularly stark around the 29-30 YOS threshold, which is the focus of our analysis.

We begin by considering whether the propensity to exit increases as employees cross the 29-30 YOS threshold, regardless of plan enrollment. We do this to determine whether teachers are in fact responsive to the corresponding increase in pension wealth; if they are not generally responsive, it would be difficult to interpret a finding of differential behavior between TRS2 versus TRS3 teachers. We estimate the following logistic regression model on the sample of teachers with 29 or 30 YOS:

$$Exit_{it} = \alpha_{Age,YOS} + X\beta + \gamma_t + \varepsilon_{it}, \qquad (2)$$

where $Exit_{it}$ is an indicator for whether teacher i exits in year t. Because the financial implications of exiting with a particular level of YOS vary substantially with age, we fully interact indicators for Age and YOS to generate the vector of indicator variables α.[18] This allows us to compare $Pr(Exit = 1|YOS = 30)$ to $Pr(Exit = 1|YOS = 29)$ given employee age. The model controls for a vector of employee characteristics which prior work has shown to be predictive of retirement timing, including gender, having an advanced degree, and ethnicity (Coile & Gruber, 2007). We also include school characteristics (including percent FRL and the ethnic composition of the school) that have been shown to be related to teacher attrition (Lankford, Loeb, & Wyckoff, 2002), and school-year fixed effects (γ_t) to control for time-

[18] The variable Age represents an employees age as of June 30th in the current year. The variable YOS is rounded down to the nearest integer.

varying factors that may influence the odds of exiting (e.g., changing economic conditions or stock market fluctuations). Hence, the identification of the coefficients of interest (the vector of indicators $\hat{\alpha}$) comes from within-year variation in the propensity to exit.[19]

Our primary hypothesis is that, because the financial implications of the decision to stay or exit around the 29 to 30-YOS threshold are much larger under TRS2 than TRS3, exit patterns around that threshold will differ according to plan enrollment. To test this, we modify the vector of indicators α in equation (2) by adding an interaction for plan enrollment:

$$Exit_{it} = \alpha_{Plan,Age,YOS} + X\beta + \gamma_t + \varepsilon_{it}. \tag{3}$$

We can then test whether the increase in the propensity to exit as employees move from 29 YOS to 30 YOS is greater under TRS2 than it is under TRS3:

$$\begin{aligned} &[Pr(Exit = 1|TRS2, YOS\ 30) - Pr(Exit = 1|TRS2, YOS\ 29)] - \\ &[Pr(Exit = 1|TRS3, YOS\ 30) - Pr(Exit = 1|TRS3, YOS\ 29)] > 0. \end{aligned} \tag{4}$$

It is important to note that differing exit behavior among members of TRS2 and TRS3 identified by these models is likely to reflect the influence of the financial incentives created by the pension plans as well as the self-selection of employees into each plan. As noted above, the members of TRS3 observed in our study sample opted to transfer from TRS2 to TRS3 when it was introduced in 1996 and the differing financial incentives created by the two plans would have played a role in the transfer decision. In the context of our analysis, the selection and financial incentive effects reinforce one another. For instance, a teacher who anticipated exiting employment with 29 YOS would have had a financial incentive to self-select into TRS3 when given the option to do so in 1996. Hence, we would interpret the finding of a positive difference

[19] Reaching important eligibility thresholds under Social Security and Medicare are also likely to influence employees' exit decisions. All employees in our study sample are subject to the same eligibility rules, which are age dependent and controlled for by the vector of indicators α.

in the inequality described in equation (4) as an upper bound on the true plan-driven difference (i.e., absent the influence of any sorting effects).

5. Results

In this section, we examine whether employees are generally responsive to the 29-30 YOS threshold and then explore the main research question of this paper: whether responsiveness to the 29-30 YOS threshold is different between TRS2 and TRS3.

Figure 4 plots the predicted probability of exiting employment by age and YOS. We see a great deal of variation in the propensity to exit across both age and YOS. That said, at every age, the probability of exit is higher among teachers with 30 YOS than among teachers with 29 YOS. This pattern could be due to the high opportunity cost of exiting when relatively young. To see this, consider the pension wealth plot in **Figure 2a**, which shows that a TRS2 member who reaches 30 YOS at age 55 can gain roughly $500,000 in pension wealth by staying in the workforce for an additional seven years.

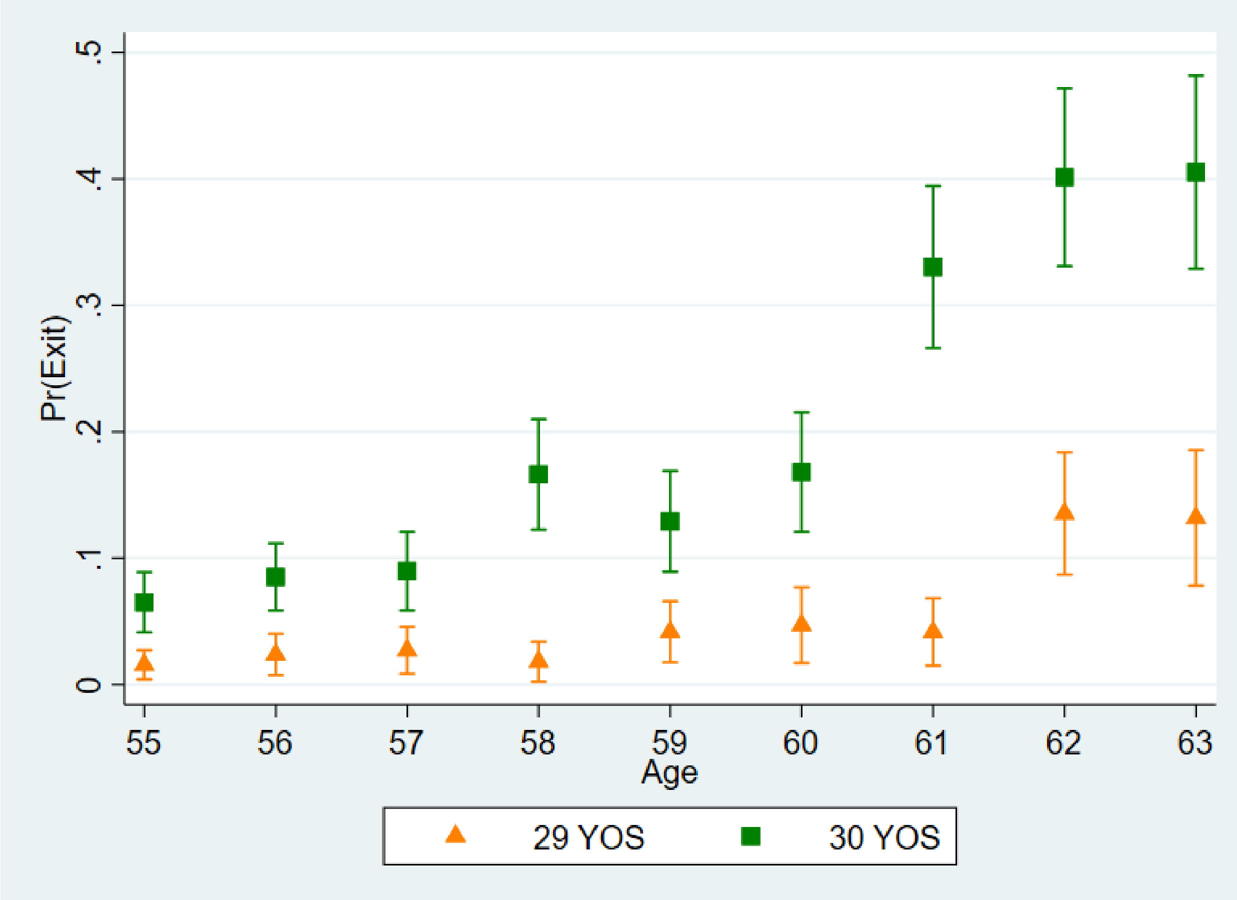

Figure 4. Marginal Exit Probabilities for Teachers With 29 and 30 YOS, by Age
Notes: The figure represents output generated from the estimation of equation (2). There are 5,459 teacher-year observations in the regression model, and standard errors are estimated using the delta method. The graphical output is restricted to the 55 to 63 age range for presentation purposes.

In **Table 3**, we look at the *increase* in the propensity to exit as employees cross the 29-to-30 YOS threshold and test the difference $\Pr(Exit = 1|YOS\ 30) - \Pr\ (Exit = 1|YOS\ 29)$. For example, at age 55, the probability of exit is 4.8 percentage points higher among teachers with 30 YOS than among teachers with 29 YOS. This difference in the probability of exit is statistically significant at every age level, ranging between 4.8 percentage points at age 55 and 28.7 percentage points at age 61. Broadly speaking, these results indicate that employees are generally responsive to the pension incentives present at the 29-30 YOS threshold and that the degree to which the propensity to exit increases upon reaching 30 YOS is highly dependent on age.

Estimated Effect and Standard Error for

Pr(Exit = 1 | 30YOS) – Pr(Exit = 1 | 29YOS) = 0		Lower CI	Upper CI
Age 55	0.048*** (0.013)	0.023	0.074
Age 56	0.060*** (0.016)	0.029	0.091
Age 57	0.061*** (0.018)	0.026	0.097
Age 58	0.145*** (0.023)	0.099	0.191
Age 59	0.087*** (0.024)	0.041	0.133
Age 60	0.119*** (0.028)	0.063	0.174
Age 61	0.287*** (0.036)	0.217	0.356
Age 62	0.265*** (0.044)	0.179	0.351
Age 63	0.275*** (0.048)	0.182	0.369

Table 3. Difference in the Predicted Probability of Exit Between 29 and 30 YOS
Notes: Estimates test differences in predicted probabilities derived from the estimation of equation (3). The reported effect is (Pr(Exit = 1 | 30YOS) – Pr(Exit = 1 | 29YOS)). There are 5,459 teacher-year observations in the regression model. Standard errors are estimated using the delta method.

Turning to the question of whether the propensity to exit around the 29-30 YOS threshold varies by plan, **Figure 5** presents predicted probabilities derived from the estimation of equation (3), which interacts indicators for age and YOS with an indicator for plan enrollment. The left-hand panel shows the predicted probability of exit at 29 YOS for TRS2 and TRS3, and the right-hand panel shows an equivalent plot at 30 YOS. Generally, this figure suggests that the exit patterns among members of TRS2 and TRS3 are similar to one another (the confidence intervals for the two plans clearly overlap).

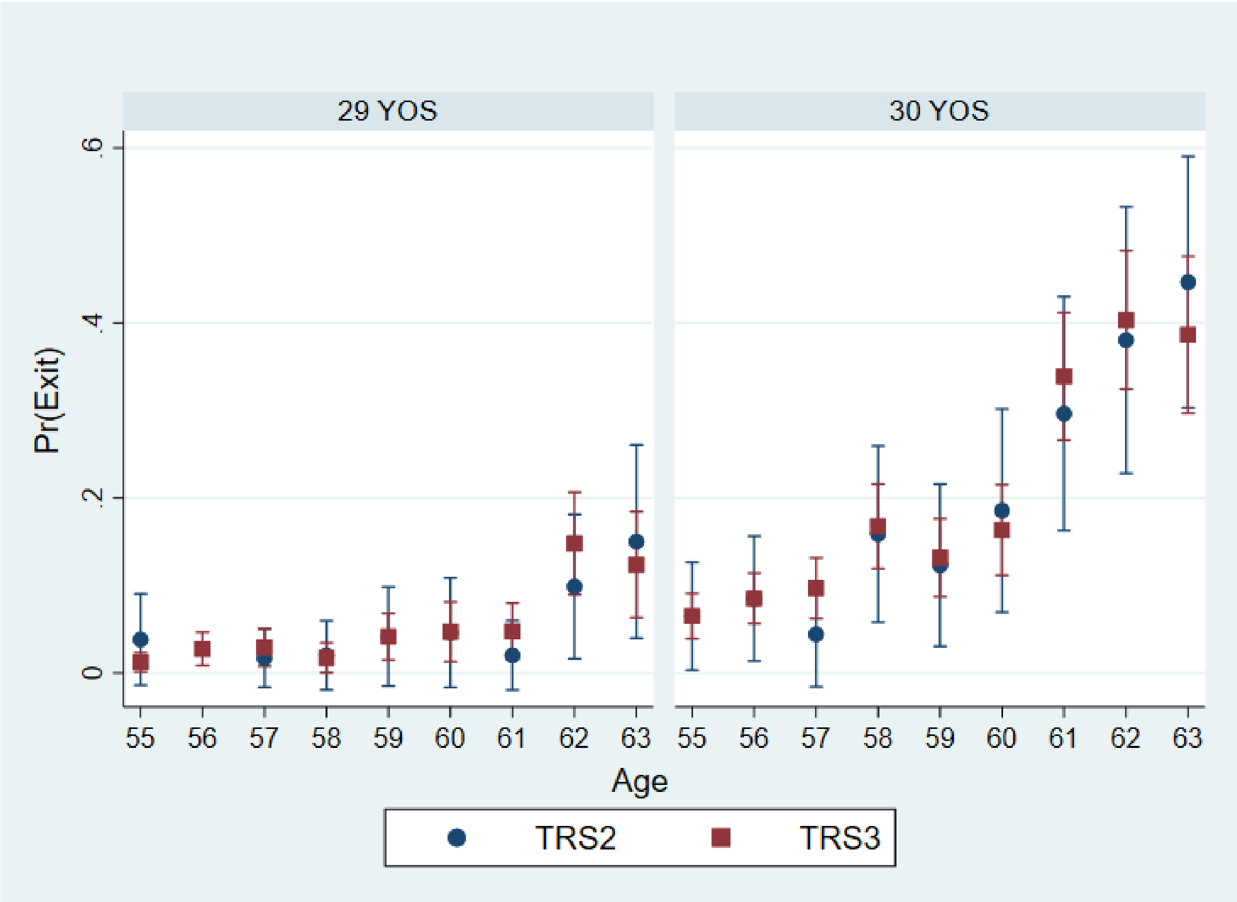

Figure 5. Marginal Exit Probabilities for Teachers With 29 and 30 YOS, by Age and Plan
Notes: The plots present predicted probabilities derived the estimation of equation (3). There are 5,400 teacher-year observations in the model, and standard errors are estimated using the delta method.

In **Table 4**, we test whether the *increase* in the propensity to exit upon accruing 30 YOS is higher among members of TRS2 than it is among members of TRS3. Specifically, we perform a one-tailed test of significance on the inequality expressed in equation (4) by age level:

$[Pr(Exit = 1|TRS2, YOS\ 30) - Pr(Exit = 1|TRS2, YOS\ 29)] -$

$[Pr(Exit = 1|TRS3, YOS\ 30) - \Pr\ (Exit = 1|TRS3, YOS\ 29)] > 0.$[20] The estimated effect sizes are generally close to zero (ranging from -0.039 to 0.035) and contrary to expectations, the increase in the propensity to exit upon reaching 30 YOS is *smaller* for TRS2 than for TRS3 for

[20] Note that indicator coefficients for TRS2 29 YOS at ages 57 and 59 cannot be estimated because no teachers were observed exiting within these bins, and thus, are treated as precise zeros for calculating predicted probabilities. Age-YOS-Plan bin sizes range from 34 to 58 for TRS2 and from 90 to 413 for TRS3. The bins with no exits have 49 and 46 observations at age 57 and age 59, respectively.

six of the nine age levels considered. In no case do we find that the increase in exit propensity among TRS2 employees is significantly higher than among TRS3 employees. and at some age levels, the upper bound of the difference (at a 95% level of confidence). However, at most age levels, the upper bound of the estimated effect is quite large, resulting in some ambiguity about what we can conclude from this model specification.

Estimated Effect and Standard Error for [Pr(Exit = 1 |TRS2 30YOS) – Pr(Exit = 1 | TRS2 29YOS)] – [Pr(Exit = 1 | TRS3 30YOS) - Pr(Exit = 1 | TRS3 29YOS)]		Upper Bound (95% level of confidence)
Age 55	-0.025 (0.043)	0.045
Age 56	-0.010 (0.047)	0.068
Age 57	-0.039 (0.04)	0.026
Age 58	-0.011 (0.06)	0.088
Age 59	-0.009 (0.06)	0.091
Age 60	0.023 (0.074)	0.144
Age 61	-0.016 (0.082)	0.119
Age 62	0.025 (0.102)	0.194
Age 63	0.035 (0.108)	0.213

Table 4. Difference in Probability of Exit between TRS2 and TRS3, by Age
Notes: Estimates test the difference represented in equation (4). Predicted exit probabilities are derived from the estimation of equation (3). There are 5,400 teacher-year observations in the model, and standard errors are estimated using the delta method. Output is truncated to the age 55-63 age range for presentation purposes.

To improve statistical power, we take advantage of a pattern exhibited in **Figure 5** – that the relationship between age and quit propensity is similar for TRS2 and TRS3. We modify equation (3) so that age is no longer interacted with plan:

$$Exit_{it} = \alpha_{Plan,YOS} + \delta_{Age,YOS} + X\beta + \gamma_t + \varepsilon_{it}. \quad (5)$$

The estimated effect described by equation (4), now pooled across age levels, is presented in **Table 5** for the overall sample in column (1) and for teachers aged 60 to 63 in column (2).[21] In both models, the sample is restricted to teachers under the age of 64 because we estimate a single pension plan effect across ages ($\hat{\alpha}$) and reaching 30 YOS does not have implications for early retirement eligibility beyond age 64.

	All Ages (1)	Age 60+ (2)
Effect	-0.011 (0.035)	0.007 (0.048)
Upper Bound (95% level of confidence)	0.047	0.086
Teacher-year Observations	4,873	1,534

Table 5. Pooled-model specifications

Notes: Each column reports results from a logistic regression reported in equation (5). In column (2), the sample is restricted to teachers age 60+. The model also includes controls for teacher characteristics (gender, ethnicity, and Master's degree) and school characteristics (percent ethnicity and FRL), and school year fixed effects. The reported Effect is [Pr(Exit = 1 |TRS2 30YOS) – Pr(Exit = 1 | TRS2 29YOS)] – [Pr(Exit = 1 | TRS3 30YOS) - Pr(Exit = 1 | TRS3 29YOS)].

As before, we fail to find evidence that the increase in the propensity to exit upon reaching 30 YOS is for TRS2 than for TRS3. In the pooled models, the estimated effect sizes are close to zero (between -0.011 and 0.007) and are more precise. The upper bounds on these estimates exclude effect sizes of 4.7 percentage points (all ages) and 8.6 percentage points (age 60+). The *general* effect sizes of crossing the 29-30 YOS threshold (presented in **Table 3**) average 15.0 percentage points (across all ages) and 23.7 (age 60+).

[21] We also estimated specifications replacing the age indicators with a quadratic in age and found similar results.

6. Applying a Simulation Approach to Modeling TRS2 and TRS3 Exit Probabilities

As previously discussed, prior analyses of the relationship between pension structure and retirement timing have tended to adopt a simulation approach to studying the implications of changing pension plan structures. To help consider our findings in the context that literature, we apply a simulation-based approach to predicting exits under TRS2 and TRS3; for this we use the Stock-Wise model and parameter estimates from Ni and Podgursky (2016) and Ni, Podgursky and Wang (2022)[22]. In this model, a teacher chooses to either continue working or exit by comparing their expected utility from leaving with their expected utility from continuing to work. When a teacher's expected utility from leaving exceeds their expected utility from continuing to work, the teacher leaves.[23] Our implementation of the model accounts for retirement wealth accrued under TRS2 and TRS3 as well as the value of Social Security benefits.[24]

We assume that teachers' pension benefits, salaries, and Social Security benefits are predictable. This leaves only two sources of uncertainty: mortality and preference shocks. For mortality, we use the tables dictated for use under the Employment Retirement Income Security Act (ERISA) that are compiled and updated by the IRS.[25] Following Ni, Podgursky and Wang (2022), we model preference shocks as an AR(1) process with normally distributed annual errors.[26] To estimate the probability of exit using the structural model, we run 1,000,000

[22] Specifically we use the parameters estimated pooled sample in Ni and Podgursky (2016). To improve the fit for Washington's teachers, we increased the disutility of work parameter, κ to equal one.
[23] See section 6 of Ni, Podgursky and Wang (2022) for a detailed description of the model.
[24] The value of Social Security benefits is calculated using the method described in Equation 1 and the Social Security benefit formula described in the Social Security Annual Statistical Supplement in Appendix D.
[25] Specifically we use the 2013 static mortality table based on the RP-2000 Mortality Tables Report adjusted for mortality improvement using Projection Scale AA. The mortality table can be found at http://www.irs.gov/pub/irs-drop/n-08-85.pdf.
[26] See Section 6 of Ni, Podgursky and Wang (2022) for a more thorough description of preference shocks.

simulations for each plan and relevant entry age allowing for varying preference shocks and calculate the probability of exiting in each year across simulation runs.

We simulate exit probabilities for both TRS2 and TRS3 to understand how well the model predicts exit patterns for the traditional DB and hybrid DB-DC plans. We expect the structural model to peform well in predicting exit probabilities for TRS2 because previous research has demonstrated strong performance in DB plan contexts (Kim et al., 2021; Ni et al., 2022; Ni & Podgursky, 2016). For the hybrid plan, we expect the simulation model – which is primarily focused on the influence of financial incentives – to predict a response to crossing the 29-30 YOS threshold that is substantially smaller than that predicted for TRS2. And given our empirical results, which failed to find any significant difference in exit behavior between TRS2 and TRS3 around the 29-30 YOS threshold, we expect that the simulation model will not peform as well for TRS3.

In **Figure 6**, we compare the exit probabilities forecast by the simulation model to the actual exit probabilities presented in **Figure 5**. The upper panel compares simulated and actual exit probabilities for TRS2 and the lower panel does the same for TRS3. While there are moderate deviations between forecast and actual exit probabilities for both plans, the largest deviations between forecast and actual exit probabilities are occur under TRS3.

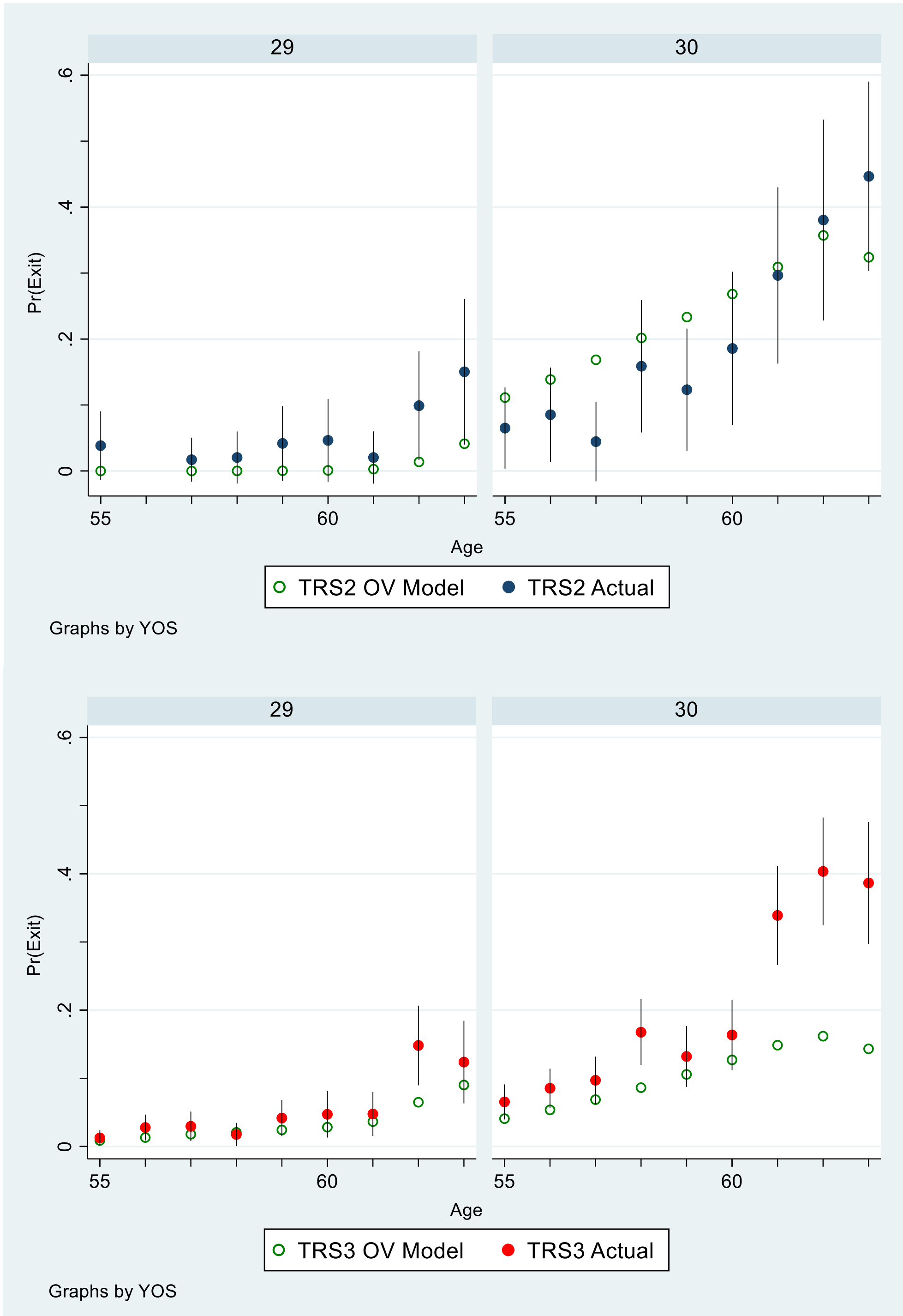

Figure 6. Comparison of Option Value Model and Actual Exit Probabilities
Notes: Hollow points represent a simulated probability of exit using the Stock-Wise OV model described above and solid points replicate the empirical estimates presented in **Figure 5**.

To think about the simulation results in the context of our empirical analysis, it is worth revisiting the hypothesis motivating that analysis: *Because the financial implications of the* *decision to stay or exit around the 29 to 30-YOS threshold are much larger under TRS2 than TRS3, exit patterns around that threshold will differ according to plan enrollment*. In **Section 5**, we evaluated this hypothesis by testing the inequality expressed in **equation (4)**.

$$[Pr(Exit = 1|TRS2, YOS\ 30) - Pr(Exit = 1|TRS2, YOS\ 29)] - [Pr(Exit = 1|TRS3, YOS\ 30) - Pr(Exit = 1|TRS3, YOS\ 29)] > 0. \tag{4}$$

Here, we calculate the quantity on the left-hand side of **equation (4)** using the exit probabilities forecast by the OV model for each age level between 55 and 63. The results are presented in **Table 6** alongside our primary empirical results from **Table 4**.

	Empirical Estimates		Option Value Model
	Difference	Upper Bound	Difference
Age 55	-0.025 (0.043)	0.045	0.079
Age 56	-0.010 (0.047)	0.068	0.098
Age 57	-0.039 (0.04)	0.026	0.118
Age 58	-0.011 (0.06)	0.088	0.136
Age 59	-0.009 (0.06)	0.091	0.152
Age 60	0.023 (0.074)	0.144	0.169
Age 61	-0.016 (0.082)	0.119	0.194
Age 62	0.025 (0.102)	0.194	0.250
Age 63	0.035 (0.108)	0.213	0.230

Table 6. Comparison of Empirical Estimates and Option Value Simulation Results
Notes: The reported "difference" refers to the left-hand quantity expressed by ***equation (4)****:*
$[\Pr(Exit)_{TRS2,30\ YOS} - \Pr(Exit)_{TRS2,29\ YOS}] - [\Pr(Exit)_{TRS3,30\ YOS} - \Pr(Exit)_{TRS3,29\ YOS}]$.

The exit probabilities forecast by the simulation model reflect an expectation that exit patterns around the 29-30 YOS threshold *will* differ according to plan enrollment, and substantially so. The simulation model forecasts that the shift in the propensity to exit as a teacher crosses the 29-30 YOS threshold will be 7.9 to 23.0 percentage points higher among TRS2 members than among TRS3 members, depending on age. This stands in contrast to our empirical results, which did not find any systematic difference between TRS2 and TRS3 on that measure.

In fact, the differences between TRS2 and TRS3 implied by the simulation results fall outside of the upper bounds of our empirical estimates at every age level. The discrepancy between the simulation results and those based on observed behavior suggest that simulation-based approaches to modeling exit behavior may struggle to predict how significant changes in pension plan structures will affect employee retention, especially in the presence of influential eligibility thresholds.

7. Discussion and Conclusions

Pension plans can create strong incentives for employees to continue working or exit employment. With a growing number of states consider the adoption of alternative pension plan structures, it is important to understand how such change may impact the probability of exiting the workforce. However, direct evidence on the relationship between pension plan structure and retirement timing is limited since most of the states that *have adopted* alternative pension plan structures did so relatively recently such that few employees enrolled in those plans have reached retirement age.

The introduction of a hybrid DB-DC plan (TRS3) to Washington State's Teacher Retirement System in 1996 – and the ability of previously hired employees to transfer (from

TRS2) into that plan – has provided us a unique opportunity to empirically address the question of how moving to alternative plan structures might influence end-of-career exit patterns. Our analysis focuses on the point at which members of both TRS2 and TRS3 obtain eligibility for early retirement at 30 YOS and experience a large increase in pension wealth. Importantly, the increase in pension wealth upon reaching 30 YOS is much larger for members of TRS2 than TRS3. While employees in both plans are indeed responsive to crossing the 29-30 YOS threshold – they are far more likely to exit after reaching 30 YOS than at 29 YOS – we fail to find evidence that the propensity to exit varies according to plan enrollment. We also present evidence that this observed pattern of exit behavior differs substantially from the patterns of exit behavior forecast by simulation models, which predicted that TRS3 employees would be significantly less responsive to reaching the 30 YOS threshold than would TRS2 employees.

Our findings suggest that while the financial incentive created by the 30 YOS has a large impact on employees' propensity to exit, the *marginal* effect of the financial incentive on the propensity to exit is negligible in the space between TRS2 and TRS3. Two mechanisms may be driving this result. First, consistent with a literature that has found that social norms, statutory retirement ages, and co-worker peer effects can influence retirement timing independent of any financial incentive to retire at a particular age (Behaghel & Blau, 2012; Brown & Laschever, 2012; Lumsdaine et al., 1996; Vermeer et al., 2019), employees may be anchoring to the 30 YOS early retirement rule independent of the financial implications of that threshold. Second, it is possible that the magnitude of the financial incentive created by the 30 YOS threshold is large enough that the marginal effect of changing it is negligible. In other words, the financial incentive effect may have plateaued.

While our analysis is quite narrow in its focus on the 30 YOS early retirement threshold, the findings are quite relevant to the broader debate around the role pensions play in employee retention. It is common for members of public-sector DB plans to experience enormous increases in pension wealth upon reaching a particular threshold of age and service (Costrell and Podgursky, 2009). But beyond their (intended) effect on employee retention, such large increases in pension wealth do not appear to have a clear policy purpose, while presenting significant downsides to employees who exit prematurely (see, for example, McGee and Winters (2019)). Taken at face value, our findings suggest that the magnitude of pension wealth increases created by retirement eligibility rules could be significantly reduced (in the case of TRS2 versus TRS3, by as much as half) while maintaining desired retention effects. Of course, this would represent a significant change to the system which could induce different behavioral responses due to new norms, or the messages that teachers receive (e.g., from labor groups) about the system.

Importantly, our findings also suggest that simulation-based approaches to modeling how shifts in pension structure will influence employee exit patterns may be misleading if they fail account for the anchoring effects created by plan rules and potential plateaus in financial incentive effects. More specifically, such models will tend to overstate the influence of changes in financial incentives that arise from shifts in pension plan structures.

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