TEACHER PENSION INCENTIVES, RETIREMENT BEHAVIOR, AND POTENTIAL FOR REFORM IN ARKANSAS

Abstract
The authors analyze the Arkansas teacher pension plan and empirically gauge the behavioral response to incentives embedded in that plan and to possible reforms. The pattern of pension wealth accrual creates sharp incentives to work until eligible for early or normal retirement, often in one’s early fifties, and to separate shortly thereafter. We estimate the effect of pension wealth accrual on teacher separation decisions using a new longitudinal data set of Arkansas teachers and find a significant impact. We then simulate the response to eliminating early retirement and raising the service requirement for normal retirement. We also simulate a shift to a constant accrual retirement plan. The response to both reforms is complex, as some would leave earlier and others stay longer. A constant accrual plan smooths the pattern of retirement behavior as individuals tailor decisions to their own preferences instead of those built into the pension formula.
1. INTRODUCTION

The structure of retirement benefits creates large incentives for the timing of teacher retirement decisions through the pattern of pension wealth accrual. The empirical question this raises is the magnitude of the behavioral response to these incentives. This article examines the retirement incentives embedded in Arkansas’s teacher pension formula and exploits a new longitudinal data set to gauge the behavioral response. We gain further purchase on the magnitude of the response by simulating the effect of changes in the plan’s eligibility conditions for early and normal retirement. Finally, we simulate a more dramatic shift to a system with a constant rate of accrual, as in a cash balance plan.

There is a substantial labor economics literature discussing the effect of pensions on retirement decisions, surveyed in section 4 of Friedberg and Turner’s contribution to this issue. The literature, primarily on private sector employees, established a consistent link between defined benefit (DB) pension accrual and retirement behavior (representative articles include Kotlikoff and Wise 1987; Ippolito 1997; Stock and Wise 1990). It also found that the rise of DB plans reduced the labor force participation of older workers (Kotlikoff and Wise 1987), and, conversely, that the decline of such plans (and conversion to defined contribution or cash balance) contributed to the rise of retirement ages since the 1980s (Friedberg and Webb 2005).

Relatively little, however, has been written on the effects of teacher pension plans, which continue to be DB. Prior to the 2009 National Center for Performance Incentives (NCPI) conference, the only published microlevel empirical investigation of which we are aware was Furgeson, Strauss, and Vogt (2006) on Pennsylvania. There are several reasons why it is important to extend the prior literature to the public teacher retirement systems. First, it is sometimes asserted that teachers, after entering the profession primarily for nonpecuniary reasons, may also be unresponsive to pecuniary incentives for retirement. Hence it is worth examining the data to see if this is true. The teacher retirement system is also of special interest because the incentives embedded in these pension plans (like those in other public plans) are considerably more pronounced than those in private plans previously studied. Thus the impact of the system must be large, either on the behavior of teachers (if they respond to the incentives) or on the distribution of benefits (if they do

2. If so, they would differ not only from private employees but also federal workers (see Asch, Haider, and Zissimopoulos 2005).
3. Costrell and Podgursky (2009, p. 193) find that spikes in teacher pension wealth accrual dwarf those found in Kotlikoff and Wise’s exhaustive study of private pension accrual in the 1980s, typically by an order of magnitude.
not respond but passively accept the penalties for not timing retirement to
the incentives). A third reason to examine the teacher retirement system is
the public interest in the composition of the teacher workforce; for example,
we can test whether teachers are more or less likely to retire early from poor
districts and/or low-achieving ones.

Finally, given the enormous stress that public pension systems are cur-
rently experiencing, some governors and legislatures are considering funda-
mental reforms for fiscal reasons. The question then arises as to the labor
market impact of such reforms. Unlike the private sector, there is little or no
experience in the teaching profession with conversions to cash balance (CB)
or defined contribution (DC) systems, with their very different patterns of ac-
crual. Hence it may be worth exploring simulations of such conversions, using
estimated behavioral coefficients.

The data to perform such investigations are not often available because
states do not link their administrative data on teachers with pension system
data. Upon the request of the authors, such a linked data set was created by the
Arkansas Teacher Retirement System (ATRS) and the Arkansas Department
of Education (ADE). That provides the basis for this article.

We begin by explaining the current configuration of the Arkansas teacher
pension plan. We then turn our attention to the incentive structure the plan
creates. The following section presents empirical evidence from the linked data
set regarding the impact of retirement plan incentives on teachers’ behavior.
Finally, using that estimating equation, we simulate the possible response to
changes in the plan’s eligibility conditions for early and normal retirement
and to a constant accrual pension plan, such as those found under many CB
formulas.

2. THE ARKANSAS TEACHER RETIREMENT PLAN
Arkansas public school teachers are covered by a traditional DB pension sys-
tem, the ATRS. Employees contribute 6 percent of their salary while employers
contribute 14 percent, for a total of 20 percent. There was a period when an
employee could choose to be noncontributory (with lower benefits), but since
1999 all new full-time employees have been contributory by requirement. Over
the school years 2000–1 to 2007–8 (the period covered by our data), nearly 80

4. This includes 5.7 percent for amortization of unfunded actuarial accrued liabilities, as of fiscal year
2009.
5. Teachers in Arkansas are also covered by Social Security. Therefore contributions to ATRS are
in addition to the 12.4 percent combined employer-employee contribution to the Social Security
system.
percent of teachers in Arkansas were contributory. For the remainder of this article, we focus our attention on the pension plan parameters for this group.6

An ATRS member becomes vested after five years, entitling her to receive an annuity (a regular retirement check for life) upon reaching a certain age or length of service. She is eligible for “normal” retirement upon reaching age sixty or twenty-eight years of service, drawing a pension equal to:

\[
\text{Standard annuity} = 900 + 2.15\% \times \text{YOS} \times \text{FAS},
\]

where \( \text{YOS} \) denotes years of service and \( \text{FAS} \) is an average of the last 3 years. Thus, a teacher with twenty-eight years of service would earn 60.2 percent of her final average salary plus $900. She can start drawing the pension earlier, after twenty-five, twenty-six, or twenty-seven years of service but with an adjustment of 85 percent, 90 percent, or 95 percent, respectively. If a vested teacher were to separate from service prior to being eligible to receive the pension, the first draw would be deferred until she reached age sixty. Once the pension draw begins, a 3 percent simple cost of living allowance (COLA) applies.7

This set of rules implies a grid of starting annuities that depends on age and service. Table 1 presents this grid as a percent of FAS (excluding the extra $900). In this table, the blank rectangle, for age < 60 and YOS < 25, indicates no pension eligibility. The section with bold figures is the region of normal retirement, with age \( \geq 60 \) or YOS \( \geq 28 \). In this region, the figures simply represent 2.15 percent times YOS.8 The section with italicized figures is the region of early retirement, where the pension is reduced by the adjustment factors given above. (The shaded cells are discussed below.)

As we will see in the next section, the incentive to retire after twenty-eight YOS is strong. This would often occur in one’s early or mid-fifties. Such incentives to retire at a relatively young age have led many states to enact various provisions for reemployment after retirement. One such provision is particularly important in Arkansas: the T-DROP system (Teacher Deferred Retirement

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6. Including both groups would provide some variation in pension parameters, but the plan selection choices among those who entered prior to 1999 would likely contaminate the estimated response to the different parameters. There may still be a selection issue in our approach, by omitting those who chose the noncontributory plan, but it is likely to be of a less troublesome type. Our participants may, for example, be those who are more attached to the labor force and thus have lower average exit rates, but this would primarily bias the intercept term. Any impact on the pension accrual coefficients would seem to be less serious than the selection problem resulting from including both groups.

7. Occasionally the legislature will enact a one-time compounding of the COLA.

8. Columns not shown with age > 65 are identical to those depicted for age \( \geq 60 \). Rows not shown with YOS > 40 increment by 2.15 percent per row, just like the rows shown for YOS \( \geq 28 \).
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Notes: YOS = years of service. Figures in italics = early retirement; bold = normal retirement. Shaded cells = first draw of 25-year-old female entrant.
Option Plan). Under this plan, a teacher with twenty-eight or more YOS can keep working after “retirement” for up to ten years, with 60–70 percent (depending on the YOS at which she enters T-DROP) of her pension check going into an interest-bearing retirement account. When she actually leaves teaching, she receives the amount accumulated in her account and begins to collect 100 percent of her pension check. For pension calculation purposes, her final average salary is frozen at the time she enters T-DROP, except for the annual COLA. She makes no contributions to ATRS after entering T-DROP. For those who choose to work beyond twenty-eight years, T-DROP is clearly advantageous, as we shall see below, and many Arkansas teachers avail themselves of this program. In our data set, approximately 10 percent of contributory members are in T-DROP. The proportion of an entering cohort that will ultimately enter T-DROP is larger, although it is hard to estimate from the data.

3. ACCUMULATION OF PENSION WEALTH

To demonstrate the powerful incentive effects of this system, we use the plan parameters to examine how teachers accumulate pension wealth with each year of employment. Pension wealth is the expected present value of the stream of annual payments to which an individual is entitled upon retirement, a measure that can be readily determined using standard actuarial methods. Pension wealth not only reflects the size of annual payments—a common but incomplete measure of benefits—but it also reflects how long these benefits are received, a variable of great significance.

Formally, consider an individual’s pension wealth, $PW$, at some potential age of separation, $A_s$. The stream of expected payments may begin immediately or may (perhaps must) be deferred until some later retirement age. The present value of those payments is:

$$PW(A_s) = \sum_{A \geq A_s} (1 + r)^{(A_s-A)} f(A | A_s) \cdot B(A | A_s),$$

where $B(A | A_s)$ is the defined benefit one will receive at age $A$ given that one has separated at age $A_s$, $f(A | A_s)$ is the conditional probability of survival to that age, and $r$ is the discount rate.

9. As in other systems, reemployment has also been allowed after a short separation period (thirty days), subject to earnings limitations. (In 2009 the separation period was raised to 180 days, and other provisions also made non-T-DROP reemployment more difficult; at the same time, the earnings limitation was repealed.) By our estimate, the number of such “double dippers” averaged 641 during the sample years. This is under 2 percent of active teachers and constitutes a far less important channel for reemployment than T-DROP, which averaged 3,109 participants (2,520 contributory). These relatively few individuals are excluded from our analysis below.

10. In Arkansas (unlike some other states), the best choice (to maximize present value) is simply to receive benefits as soon after separation as possible.
In principle, $PW(A_t)$ represents the market value of the annuity. If instead of providing a promise to pay annual benefits, the employer were to provide a lump sum of this magnitude upon separation, the employee could buy the same annuity on the market. Equivalently, one may think of the teacher’s pension wealth, $PW(A_t)$, as the size of the 401(k) balance that could be annuitized to match the pension she is due upon separation at age $A_t$.

Figure 1 depicts the pension wealth, in inflation-adjusted dollars, for a twenty-five-year-old entrant to the Arkansas teaching force who works continuously until leaving service. The salary schedule assumed is that of the state capital (Little Rock), under which teachers receive annual step increases as well as lane increases as they move from a bachelor’s to a master’s degree. The entire salary grid is assumed to increase at 2.5 percent inflation. We assume a 5 percent interest rate and use the most current female mortality tables from the Centers for Disease Control and Prevention (Arias 2007).

The accumulation of pension wealth is smooth and steady up to age forty-nine but not thereafter. During her first twenty-four years in the classroom, this teacher accumulates about $283,000 in pension wealth. Her pension wealth then jumps by $268,000 at age fifty upon completing her twenty-fifth YOS and becoming eligible for early retirement. The jump is due to the fact that she is now eligible for ten extra years of pension benefits, beginning immediately, instead of deferring to age sixty. Over the next three years, her pension wealth continues to grow rapidly due to the phase-down of the early retirement penalty. After she reaches eligibility for normal retirement at twenty-eight YOS and age fifty-three, the growth in her pension wealth levels off. The pattern for net pension wealth (netting out employee contributions, with interest) is similar.
Figure 2. Present Value at Entry of Future Pension Wealth

Figure 2 depicts the accumulation of pension wealth evaluated at a single point in time (the date of entry at age twenty-five in this example). The dollar amounts in figure 1, pension wealth as of the date of separation, are discounted back to a common date to facilitate comparison across years. This presentation allows a very forward-looking entrant to conclude that the pension wealth-maximizing age of separation is fifty-three upon completion of twenty-eight YOS. Similar graphs can be constructed to represent the present value of future pension wealth from the vantage point of any age during one’s career. This illustrates the peak value calculation that we will be modeling formally below.

A less forward-looking individual might simply look at the one-year accrual of pension wealth at each point in time. This is the difference between pension wealth one year from now, if one continues to work, and the pension wealth upon separation today, netting out the interest on current pension wealth (depicted in figure 3). This is a measure of deferred income earned from an additional year of work, directly comparable to the salary earned in that year. This component of income rises gradually through the first twenty-four YOS, up to about $15,500 per year, net of employee contributions.\(^\text{11}\) A particularly sharp spike occurs at age fifty (twenty-fifth YOS for a twenty-five-year-old entrant). In that year our teacher would earn an increase in pension wealth of nearly $260,000, almost five times her salary, before the rate of accrual drops off precipitously the next year. The reason, as discussed above in conjunction with figure 1, is that she is now eligible for ten extra years of pension payments.

\(^{11}\) The gross figures are about $3,000 higher. They are not depicted here because they are visually indistinguishable.
because she qualifies for early retirement immediately after twenty-five YOS instead of having to defer to age sixty.

Table 1 illustrates what is going on behind figure 3. The shaded cells depict the best choices for first pension draw of a twenty-five-year-old entrant with continuous service. As the table shows, age sixty is the earliest she can collect up through her twenty-fourth YOS. Upon her twenty-fifth year, she maximizes pension wealth by taking the ten extra years of pension eligibility, jumping from the shaded cell at (24, 60) to the one at (25, 50), despite the fact that the pension she could earn from deferral is 53.8 percent of FAS versus 45.7 percent for immediate draw.

For service beyond this point, her first pension draw is immediate upon separation, so the shaded cells move diagonally to the southeast. For ages 51–53, the one-year accrual is about $27,000, effectively adding about 50 percent to salary. This is due to the phase-down of the penalty for early retirement over these years, from 15 percent to zero. Upon reaching twenty-eight YOS, she qualifies for normal retirement, and beyond that point—age fifty-three for a twenty-five-year-old entrant—her accrual turns negative each year, as shown in figure 3. This is because the rise in annual pension does not outweigh the loss of a year’s pension payment.

Figure 3’s spike in pension wealth accrual at twenty-five YOS serves as a “pull” factor rewarding teachers who stay in service at least until that point. The negative accrual after twenty-eight YOS serves as a “push” factor, discouraging those who stay longer. T-DROP reduces the pension penalty for continuing to work after twenty-eight YOS by reducing negative accrual, as illustrated in figure 4. The “No T-DROP” accrual is reproduced from figure 3 for ages 51–65. The accrual under T-DROP is superimposed on the diagram for teachers
who enter T-DROP at twenty-eight, twenty-nine, and thirty YOS (ages 53–55 for those who start teaching at age 25). The curves are higher for entering T-DROP at thirty versus twenty-nine versus twenty-eight YOS because the deposit rates are 70 percent, 65 percent, and 60 percent, respectively. In any case, T-DROP eliminates most of the pension penalty for continuing to teach beyond twenty-eight years.

4. DESCRIPTIVE ANALYSIS: RETIREE DATA

In the previous section we discussed the incentives created by the pension parameters in Arkansas. To gain a first glimpse at the behavioral response to these incentives, we examine two data sets: ATRS member data and ADE-ATRS linked longitudinal data. In this section we consider the former, a snapshot of ATRS members as of 2008. These data cover all living retirees as well as active and inactive members. For retirees we have the date of retirement, age, and YOS at retirement. Thus we can examine retrospectively the distribution of retirements to see if they were concentrated around the early and normal retirement eligibility points, as we would expect. Specifically, for most Arkansas teachers, eligibility is governed by YOS rather than age, so we examine the distribution of retirements by YOS. In addition, we can examine the change in that distribution because the dates of retirement among current retirees include a change in the pension parameters. In 1997 the Arkansas legislature changed the normal retirement eligibility requirement from thirty to twenty-eight YOS.
Figure 5 depicts the distribution by YOS of Arkansas’s 5,664 living retirees (as of 2008) who retired in the period 1984–96. As one might expect, there are spikes at YOS = 25, the point of early retirement eligibility, where pension wealth accrual spikes, and at YOS = 30, the point of normal retirement eligibility, after which pension wealth accrual turns negative. This is not to say that the service eligibility conditions entirely determine retirement dates: the histogram depicts many retirements after thirty YOS (incurring negative wealth accrual) and also before twenty-five YOS. This latter group includes late-starting teachers and teachers with interrupted spells of employment who met the age requirement for eligibility before the YOS requirement. It also includes teachers who stopped teaching before age or service eligibility for any number of non-pension reasons and were thus required to defer the pension until age sixty. Still, the pattern certainly indicates that retirement decisions are influenced by pension rules.

Figure 6 provides an informative comparison based on the 6,742 retirees (as of 2008) who retired over the period 1998–2008. This diagram includes 2,700 participants in T-DROP, so the years of service include not only those credited toward retirement but also those served while in T-DROP (which do not count toward the annuity). This program, initiated in 1995, played little role in figure 5 (since that period ends in 1996), but it does affect figure 6 and is important to include for purposes of comparison. Teachers comparable

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12. As stated above, we exclude noncontributory members. Figure 5 includes thirteen retired T-DROP members, a category discussed further below.
to those who worked beyond normal retirement in the earlier period would typically have enrolled in T-DROP in the later period. The right tails in figures 5 and 6 are quite similar because the right tail of figure 6 includes the many T-DROP participants.

Comparing the rest of figures 5 and 6, we see that the normal retirement spike shifts from thirty YOS to twenty-eight YOS. Clearly the change in pension rules had an effect on retirement decisions. Both figures show a response to the system’s incentives, with unmistakable spikes at the points of early and normal retirement, and a shift in the latter, responding to the policy change. That said, one may ask whether the overall effect is large or small. A simple calculation shows that the two-year shift in the normal retirement spike reduces the mean YOS at retirement by only 0.14 years, assuming no other change in the distribution. As we will see below, however, the behavioral response to a change in parameters is a bit more complex than a simple shift in the spike, and a single summary statistic for mean YOS does not capture the whole story.

13. The program requires a minimum of twenty-eight YOS (reduced from thirty YOS in 1999), and participants put in an average of 4–5 years of additional teaching while in T-DROP. The median T-DROP teacher works for 32–33 years.
14. In addition, we see at the left tail the effect of reducing the vesting period from ten years to five.
15. The spike represents about 12 percent of retirements. Since the frequency of retirements in the surrounding years is about 5 percent, the spike represents 7 percent in extra retirements at the normal retirement point. Shifting this 7 percent to the left by two years reduces the mean YOS at retirement by $2 \times 0.07 = 0.14$ years.
16. The mean retirement age actually rose between these two histograms, from 26.59 to 26.86, indicating that other factors beyond the eligibility rules were changing.
5. DESCRIPTIVE ANALYSIS: LONGITUDINAL SEPARATION DATA

Another view of the data is based on longitudinal teacher records, provided by the Arkansas Department of Education (ADE) and linked to the ATRS data discussed above. The ADE data are observations on all teachers working in the state from the 2000–1 school year through the 2007–8 school year. These data provide us with the opportunity to look at separations from teaching that may precede formal retirement (i.e., the collection of a pension), as would occur for those who separate prior to meeting the YOS requirement and must defer the pension until meeting the age requirement. In addition, while the ATRS data discussed above considered the distribution of retirements retrospectively, these longitudinal employment records allow us to consider separation probabilities from the front end, from entry on forward, which is more useful for labor market analysis. These data are also well suited to regression analysis to estimate the effect of pension wealth accrual on the separation decisions of teachers.

Specifically, we used the ADE data for our eight-year panel on working teachers, linked to the ATRS data, to construct a series of person-year observations with an indicator variable for whether the teacher is working or separated from service. A teacher was considered to have separated in the year after her last working record, or if ATRS records her as retired. Table 2 provides a summary of the data. There are 36,657 teachers covered over this period, for a total of 209,721 observations, of which 8,194 were separations. The demographic composition is 80.5 percent female and 89.6 percent white, with mean age 42.4 and 12.2 YOS. We distinguish between those teachers who enter T-DROP at some point during the panel (10.1 percent of the total, accounting for 13.6 percent of separations) and those who do not. Those who enter T-DROP are 12.4 years older with 18.2 years more of service. They are similar in other respects, including the district’s size and percent free or reduced price lunch (FRL). (The pension accrual variables in table 2 are defined below.)

Figure 7 depicts the estimated separation rates for an entering cohort, excluding those who eventually enter T-DROP during our panel period (discussed below). The conditional exit rate for each YOS is estimated as the number of separations divided by working teachers. These conditional exit rates are applied sequentially to the declining cohort survivor rate to generate

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17. Ideally we would like to exclude breaks in service, which have been shown by DeAngelis and Presley (2007) to account for one-quarter to one-third of five-year attrition rates for new teachers in Illinois. However, their data set was much better suited to measure breaks in service because it could track the earliest cohorts up to thirty-five years. We attempted to exclude short-term separations by limiting ourselves to five-year separations, but due to the nature of our data set these exclusions resulted in unrealistically low estimated attrition rates for new entrants. Where relevant below, we will indicate how the results from using the five-year separations differed from those using one year.
Table 2. Summary Statistics on Longitudinal Data Set

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>Non-TDROP</th>
<th>TDROP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of teachers</td>
<td>36,657</td>
<td>32,970</td>
<td>3,687</td>
</tr>
<tr>
<td>Number of separations</td>
<td>8,194</td>
<td>7,081</td>
<td>1,113</td>
</tr>
<tr>
<td>Number of records</td>
<td>209,721</td>
<td>183,081</td>
<td>26,640</td>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>Grand Mean</th>
<th>Non-TDROP Mean</th>
<th>TDROP Mean</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Female</td>
<td>80.5%</td>
<td>80.0%</td>
<td>84.6%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>White</td>
<td>89.6%</td>
<td>90.2%</td>
<td>84.1%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Age</td>
<td>42.4</td>
<td>40.8</td>
<td>53.2</td>
<td>20</td>
<td>81</td>
</tr>
<tr>
<td>Service</td>
<td>12.2</td>
<td>9.9</td>
<td>28.1</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>District size</td>
<td>5,387</td>
<td>5,396</td>
<td>5,326</td>
<td>–</td>
<td>25,095</td>
</tr>
<tr>
<td>Percent free/reduced price lunch</td>
<td>53.2%</td>
<td>53.1%</td>
<td>54.6%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

One-year accrual $14,077 $13,302 $19,405 $51,471 $379,176
Five-year peak value $72,376 $74,249 $59,504 $0 $535,713
Pension wealth $182,634 $113,040 $660,914 $0 $1,094,521
Earnings $47,301 $45,861 $57,197 $32,385 $57,202

the frequency distribution depicted. As in other states, separation rates are elevated for the first several years of teaching. However, the picture is dominated by the spike at YOS = 28, along with a hint of a smaller peak at YOS = 25, similar to the distribution of retirements in figure 6.18

We have less confidence in our estimated separation rates for TDROPpers,19 which exhibit some erratic behavior, possibly attributable to their smaller numbers, but we have nonetheless used them to construct weighted-average aggregate cohort separation rates. One reason to do so is to make sure we have not given a misleading impression of the spike at YOS = 28 by virtue of excluding the TDROPpers. The resulting weighted-average separation rates (not shown) exhibit a very similar pattern to those in figure 7. The spike is modestly diminished from 12 percent to 10 percent but remains dominant.

It seems unlikely that the spike is due to a natural retirement clock that happens to strike at YOS = 28. The classical hypothesis of natura non saltum facit suggests that age and service would more smoothly affect retirement decisions,18 restrictions on separations to those of five years or more, as discussed in a previous note, raises the spike at YOS = 28 from 12 percent to 18 percent but almost entirely misses the elevated early career separation rate.19 They imply median years in T-DROP of nine, which is clearly too high. In other words, the estimated separation rates appear to be too low.
absent discontinuous incentives. The fact that pension accrual patterns, which also spike at YOS = 28, provide such incentives may therefore be more than coincidental. To explore this more rigorously, we now turn to an econometric investigation of these data to see if pension accrual variables can account for the spikes in behavior while controlling smoothly for age and service.

6. EMPIRICAL METHODOLOGY

In this section we present the empirical method used to estimate the impact of pension plan parameters on teacher retirement/separation decisions. Pension plan parameters affect retirement decisions through two main pathways. The first, and primary, one is through accrual effects—the subject of our previous analysis. Individuals weigh the additional pension wealth to be gained through additional years of work against the value of additional years of retirement, so larger accrual would be expected to induce later retirement. A second possible pathway is wealth effects. Higher pension wealth will increase the ability to consume in retirement and therefore would be expected to induce individuals to retire earlier.

The model we chose is known as the peak value model, presented by Coile and Gruber (2000a, 2000b). It is a forward-looking approach that has been used several times in the literature, including by Friedberg and Webb (2005) and Coile and Gruber (2007). Specifically, we focus on two main variables that model different aspects of the accrual effect.

20. Asch, Haider, and Zissimopoulos (2005) point to an earlier literature on retention of military and federal civil service workers that uses annualized cost of leaving models. Others have used option value models (Stock and Wise 1990), which require one to specify a utility function over work and leisure.
The first variable of interest is peak value (PKV), defined as the difference between current pension wealth and the maximum present value of future pension wealth across all possible future separation dates. Formally, peak value is defined as follows:

\[ \text{Let:} \]

\[ PW_t \text{ denote pension wealth in year } t \]

\[ PW_m \text{ denote the maximum present value } PW \text{ occurring in future year } m, \text{ evaluated at year } t: \]

\[ PW_m = \max_k \left[ \frac{PW_k}{(1+r)^{k-t}} \right] \forall k > t \]

Then \( PKV_t \) denotes peak value in year \( t \):

\[ PKV_t = \max(0, PW_m - PW_t). \] (3)

Peak value represents the incentive a worker has to continue working. It measures the maximum accrual a teacher can attain if she continues to work until her pension wealth is maximized. Figure 2, for example, depicted peak value as of age \( t = 25 \), looking forward to age \( m = 53 \). When a teacher has reached her maximum present value of pension wealth, peak value reaches zero.

The results we present below employ a peak value variable modified to impose a finite horizon, specifically five years. In practice this makes little difference to our estimates, and in fact it slightly improves the log likelihood of our estimates, consistent with the idea that horizons may in fact be limited. More importantly, for our simulations later in the article, a constant accrual pension system does not exhibit a peak value over an unlimited horizon. Imposing a finite horizon to allow for such simulations does not distort the estimations reported here.

It is likely that workers, in addition to considering the maximum pension wealth they could attain (over a five-year horizon), are also influenced by the immediate future. We include one-year accrual (OYA) in our model to capture this single-year effect. OYA is similar to peak value but looks forward only one year. OYA was discussed above and is depicted in figure 3 for a twenty-five-year-old entrant. One advantage of including this variable is that it allows for a disincentive to work. In years after a teacher has reached her maximum

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21. The term “peak value” is potentially confusing because it more accurately describes the maximum future wealth than the difference between that and current wealth. However, we follow conventional usage here.

22. The five-year horizon also generates a slightly better log-likelihood than a ten-year horizon, which in turn is better than an infinite horizon.
pension wealth, peak value takes on a value of zero while OYA becomes negative. OYA captures the fact that forgoing a year of pension is costly. One can think of peak value representing a pull effect, in the years prior to the pension wealth peak, and OYA representing a push effect immediately afterward. In addition to these two pension accrual variables, we include pension wealth itself (PW), as discussed above, and earnings to capture the direct incentive to continue working.23

Variables pertaining to the individual include race and sex. In addition, we include an indicator variable designating those teachers who chose to enter T-DROP at some point in our observation period. Including a separate intercept term for the “T-DROP types” allows us to control, somewhat crudely, for differences in behavior between those who self-select into the program and those who do not. We also model the T-DROP decision as endogenous, in a variant discussed below, to examine the sensitivity of our pension accrual coefficients.

We include district size to see if retirement patterns differ between small and large districts. In addition, we include district variables for poverty (FRL) and math scores to see if retirement patterns are affected by nonpecuniary dimensions of the work environment.

Our dependent variable is a dichotomous indicator, valued at one for separation or retirement and zero for continued work. As discussed in notes above, we have calculated both one-year separation rates and five-year separation rates. The one-year separation rates have the advantage of accurately representing early career attrition rates but also include breaks in service. The five-year rates exclude short-term breaks in service but also exclude the vast majority of early career separations. In other words, the five-year rates focus attention on later career separations, which are more sensitive to pension parameters, but at the expense of misrepresenting early career attrition. Thus, by focusing on one-year separation rates below, we will be conservatively estimating the impact of pension parameters on separations. We will also point out how the results differ using five-year rates.

We use a probit specification of the following form:

\[
\text{Pr}(\text{separate} = 1)_{it} = \Phi(\beta_0 + \beta_1 \text{OYA}_{it} + \beta_2 \text{PKV}_{it} \\
+ \beta_3 \text{PW}_{it} + \beta_4 X_{it} + \beta_5 D_{it} + v_i)
\]

where \(\Phi(.)\) is the cumulative normal distribution, \(X_{it}\) includes teacher-level explanatory variables for teacher \(i\) at time \(t\), including earnings, race, gender, 23. Our data set does not include some other relevant variables, such as spousal earnings and non-pension wealth.
age, service, and ultimate T-DROP status, while $D_{it}$ denotes district-level variables for that teacher, and $v_i$ represents the individual teacher random effects, which are individually and identically distributed $N(0, \sigma^2_v)$. All dollar valued variables are in millions of 2008 dollars.

7. RESULTS

In this section we present results from our regression analysis to estimate the response of teachers’ retirement/separation decisions to pension variables. Our sample includes all contributory teachers who worked in the state of Arkansas from 2000–1 through 2007–8. We have 209,721 observations on 36,657 individual teachers, with an average of 5.7 observations per teacher over the eight-year study period. The dependent variable was assigned a value of one for observations one year after a teacher’s last working record. There were 8,194 separations in our study period. The values of the independent variables are summarized in table 2.

We estimated the model with random effects at the individual level, under various specifications. Table 3 presents the estimated marginal effects on the exit rate, with standard errors adjusted for individual-level clustering. All regressions also include a constant, age, service, age$^2$, service$^2$, and age $\times$ service (i.e., all second-degree variables in age and service). Column 1 includes the pension variables and earnings but no other individual or district controls. Column 2 adds the T-DROP indicator, column 3 adds the other individual variables (female, white), and column 4 adds district variables (size, FRL, math). (Columns 5 and 6 are discussed below.)

The two accrual variables have negative effects, as expected, and are stable in magnitude across specifications 1–4. An increment of $10,000 in peak value reduces the exit rate by 1 percentage point, and an increment of $10,000 in the one-year accrual reduces it by 0.6 percentage points. Earnings also has the anticipated effect, as a $1,000 rise in earnings reduces the exit rate by about 5 percentage points, across specifications. Current pension wealth has the unexpected sign, a result we consider spurious (and that is reversed in our estimate of five-year separation rates). Prior literature has found the effect of pension wealth to be “economically quite small,” and that is the case here too.26

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24. The number of five-year separations was much lower at 4,580.
25. The exit rates, conditional on age and service, are to be distinguished from the cohort separation probabilities depicted in figure 7 and similar diagrams below, which are percentages of the entering cohort.
Table 3. Estimated Marginal Effects on Exit Rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6) 5-year separation</th>
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<tbody>
<tr>
<td>One-year accrual</td>
<td>-0.00677**</td>
<td>-0.00597**</td>
<td>-0.00619**</td>
<td>-0.00613**</td>
<td>-0.00933**</td>
<td>-0.02050**</td>
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<tr>
<td>($10,000)</td>
<td>(0.00137)</td>
<td>(0.00128)</td>
<td>(0.00132)</td>
<td>(0.00131)</td>
<td>(0.00149)</td>
<td>(0.00225)</td>
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<tr>
<td>Peak value</td>
<td>-0.01010**</td>
<td>-0.00970**</td>
<td>-0.00984**</td>
<td>-0.00984**</td>
<td>-0.01140**</td>
<td>-0.01020**</td>
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<tr>
<td>($10,000)</td>
<td>(0.00075)</td>
<td>(0.00089)</td>
<td>(0.00088)</td>
<td>(0.00089)</td>
<td>(0.00068)</td>
<td>(0.00122)</td>
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<tr>
<td>Pension wealth</td>
<td>-0.00414**</td>
<td>-0.00172**</td>
<td>-0.00166**</td>
<td>-0.00173**</td>
<td>0.00325**</td>
<td>0.00045</td>
</tr>
<tr>
<td>($10,000)</td>
<td>(0.00025)</td>
<td>(0.00023)</td>
<td>(0.00024)</td>
<td>(0.00024)</td>
<td>(0.00063)</td>
<td>(0.00523)</td>
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<td>Earnings</td>
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<td>-0.04690**</td>
<td>-0.04790**</td>
<td>-0.04740**</td>
<td>-0.05730**</td>
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<tr>
<td>($1,000)</td>
<td>(0.00226)</td>
<td>(0.00296)</td>
<td>(0.00294)</td>
<td>(0.00296)</td>
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<tr>
<td>T-DROP participant</td>
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<td>-0.31367**</td>
<td>-0.34881**</td>
<td>-0.26336**</td>
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<tr>
<td></td>
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<td>(0.01674)</td>
<td>(0.01697)</td>
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<td>-0.00455</td>
<td>-0.00173**</td>
<td>-0.03314**</td>
<td>0.00681</td>
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<td>(0.00383)</td>
<td>(0.00397)</td>
<td>(0.00024)</td>
<td>(0.00024)</td>
<td>(0.00063)</td>
<td>(0.00523)</td>
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<td>White</td>
<td>-0.00198</td>
<td>0.01098*</td>
<td>0.01098*</td>
<td>-0.03314**</td>
<td>0.00538</td>
<td>0.00681</td>
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<td>(0.00471)</td>
<td>(0.00528)</td>
<td>(0.00397)</td>
<td>(0.00024)</td>
<td>(0.00063)</td>
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<td>District size</td>
<td>-0.00755**</td>
<td>-0.00755**</td>
<td>-0.01920**</td>
<td>-0.01920**</td>
<td>0.00425**</td>
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<td>(10,000 students)</td>
<td>(0.00240)</td>
<td>(0.00240)</td>
<td>(0.00240)</td>
<td>(0.00240)</td>
<td>(0.00063)</td>
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<td>Percent FRL</td>
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<td>-0.00007</td>
<td>-0.00080**</td>
<td>-0.00080**</td>
<td>0.00016**</td>
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<td>(Range = 0 to 1)</td>
<td>(0.00009)</td>
<td>(0.00009)</td>
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<td>(0.00016)</td>
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<td>Math score</td>
<td>-0.04776**</td>
<td>0.07633**</td>
<td>-0.07633**</td>
<td>-0.07633**</td>
<td>0.01105**</td>
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<td>(std. dev. units)</td>
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<td>(0.00746)</td>
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<td>(0.001105)</td>
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Log-likelihood                -31,718.95    -31,091.80  -31,090.58  -31,043.72  -31,105.70  -17,336.23

Notes: Dependent variable = 1 for one-year separation or retirement. Constant only model log-likelihood = −34,599.828. Marginal effects are calculated at age = 53 and service = 28 for a white female. All models include a constant and the second degree expansion of age and service. Stata uses quadrature to estimate the panel data random effects form of the probit model. We estimated our model using 24 quadrature points. We used the quadchk command to ensure that the coefficient estimates were stable. FRL = free or reduced price lunch.

*significant at 5%; **significant at 1%

As columns 2–4 indicate, T-DROP types have a much lower probability of separation (31 percentage points).27 Race and gender have little or no discernible effect. Larger districts appear to command greater attachment, as do districts with higher math scores. Interestingly, no effect of poverty (FRL) was detected.

Do the pension variables explain the observed spike in separations? We have, in effect, replaced the forty-odd YOS indicator variables in figure 7 with smoothly varying second-degree age and service variables, plus the pension accrual variables in column 5.28 Using these coefficients, we model the

27. We have also estimated the model for non-T-DROPpers alone, and the results are very similar, as might be expected given the T-DROPpers’ small share of total observations.

28. This estimate has dropped the pension wealth variable with the spurious sign, but since the effect of that variable was small, the resulting simulation is not much affected.
separation rates for a cohort of twenty-five-year-old entrants. The result, depicted in figure 8, reproduces in moderately attenuated form the separation patterns depicted in figure 7 for non-T-DROPpers.\textsuperscript{29} This suggests to us that it is the pension variables, rather than service and/or age, that accounts for the spiky separation pattern.

Column 6 provides estimated marginal effects on five-year separation probabilities. As mentioned above, this attempt to eliminate breaks in employment underestimates early career attrition and focuses more attention on the later separation rates. Since the separation decision in those later years is likely to be more sensitive to pension considerations, it is not surprising that the one-year accrual effect is quite a bit larger than for the one-year separation estimates. The effect of the more forward-looking peak value accrual is unchanged. The effect of pension wealth flips from negative to positive, the theoretically expected sign, but it is still small. The estimated effect of gender rises by an order of magnitude in the five-year separation estimates and achieves statistical significance. This suggests that females are more attached to their teaching jobs late in their career, but since the reverse is likely the case early on, the one-year separation estimates masked that effect. Using the column 6 estimates

\textsuperscript{29} One difference is that there is no peak at YOS = 25. There is a sharp jump up at twenty-five, but no decline in predicted separations for the years between twenty-five and twenty-eight. It is the “valley” that is missing, but it was a modest valley in figure 7, so this seems a relatively minor shortcoming of the model. We have also calculated a weighted average of T-DROPpers and non-T-DROPpers, which results in a slightly lower peak with slightly greater out-year separations.
to model the cohort separation rates yields a pattern (not shown) similar to figure 7, but since it misses the early career attrition, the pension-related peak at YOS = 28 is higher, rather than lower as in figure 8. Again, we consider the one-year estimates of pension effects to be the more conservative ones, and those are the ones we use in our simulations below.

Finally, we also estimated an endogenous version of the T-DROP variable to test for sensitivity of our estimates to the implied assumption that this variable was primarily representing exogenous taste for long careers. To do so, we performed a two-stage procedure, first estimating the probability of entering T-DROP from the age, service, and demographic variables and then using the fitted values of that probability in the separation estimating equation. The resulting estimates for the pension accrual effects were not much affected.

8. SIMULATING POTENTIAL REFORM

We now use our estimated coefficients to predict teacher separation behavior under different pension regimes. It is important to note here that a weakness of our longitudinal data is that the study period does not include variation in the pension parameters, so any simulation of different parameters is an exercise in out-of-sample extrapolation. With that important caveat, this type of simulation may provide some indication about the general behavioral impact of changes to the plan.

First we consider modest changes to the current structure of the ATRS plan: eliminating the early retirement provision and raising the normal retirement condition to thirty YOS (as it was prior to 1997). The results of this simulation are presented in figure 9. The solid line reproduces figure 8, the distribution of retirements under current eligibility rules; the dotted line represents the shift upon eliminating early retirement at YOS = 25 and raising the normal retirement requirement to YOS = 30.

One might expect such a policy shift to unambiguously raise the retirement age, and indeed it does for those who would take normal retirement at the earliest opportunity (the spike shifts right from YOS = 28 to 30), and the tail beyond also rises. For others, however, the impact varies. That is, this policy affects both the pull and push features discussed earlier. The pull in the years immediately preceding early retirement eligibility—the depressed separation rates prior to YOS = 25—is now moved to the right, to the years immediately preceding normal retirement at YOS = 30.30 Thus separation rates rise for YOS

30. We also ran a simulation of ending early retirement but keeping normal retirement at YOS = 28. The interval of depressed separation rates shifts less, to the period preceding YOS = 28 rather than 30. The spike at twenty-eight becomes sharper (no ramp-up from twenty-five to twenty-eight), and the peak is higher. The right tail is also higher, but not as high as in the simulation depicted. In general this simulation lies between the two depicted in both figure 9 and figure 10.
in the early twenties: fewer teachers in this range “hang on” for early retirement benefits. This effect, taken alone, tends to reduce length of service. The rise in separations for these two different segments—YOS < 25 and YOS > 29—are drawn from the early retirement years, twenty-five to twenty-seven (where the separation rates naturally drop), and the first years, twenty-eight and twenty-nine, of the old normal retirement. That is, some of these separations from twenty-five to twenty-nine have shifted left and some have shifted right.

The cumulative distribution of separations, depicted in figure 10, helps illustrate the different effects. At the 40th percentile the policies reduce YOS from about twenty-five to twenty-two, and at the 60th percentile YOS rises from about twenty-eight to thirty. The cumulative distributions cross at YOS = 26. For those to the left of the crossover (YOS ≤ 26), mean service declines 0.29 years (from 11.15 to 10.86), and for those to the right (YOS > 26), mean service rises by 1.68 years (from 30.34 to 32.02). These different effects of the push and pull mean that there is only a modest effect on the overall mean length of service for an entering cohort. It rises, on this simulation by half a year, from 21.37 to 21.87.31 However, the point of this analysis is that this grand mean masks important effects, reducing the tenure of those who are only putting in their time until early retirement and lengthening the tenure of those who stick it out for normal retirement.

Finally, we simulate a more dramatic change. Consider a constant rate of accrual pension plan, such as the cash balance (CB) plans that many private employers have adopted in recent decades. In such a plan, the teacher has a notional retirement account that grows with the contributions and a guaranteed rate of return, typically comparable to a risk-free long-term bond yield. Figure 11 depicts the accumulation of pension wealth under a constant accrual CB plan compared with the ATRS plan (reproduced from figure 1). The CB plan offers smooth pension wealth accrual over the teacher’s working life instead of rewarding certain years of service with dramatic jumps in pension wealth.

Figure 12 presents the simulated separation probabilities under the CB plan alongside the current system. The peak has been reduced and smoothed following the elimination of the spike in pension wealth accrual. That is, the CB plan would tend to spread out separation decisions rather than concentrating them so sharply at YOS = 28. In addition, CB eliminates the “valley” immediately preceding YOS = 25. That is, by eliminating the accrual spike at

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32. The contribution rate depicted (27.6 percent) is calculated to be fiscally neutral. This exceeds the 20 percent statutory rate for joint contributions of employer and employee in Arkansas because we use a 5 percent discount rate as opposed to the 8 percent rate used in actuarial valuations.

33. It is puzzling that the lower, more rounded peak still occurs at twenty-eight since we hypothesized that the peak was an artificial creation of the eligibility rules. Although our estimating equation moved much of the explanation for the observed peak in figure 7 off the age and service variables per se and onto the accrual variables, much of the peak is still loaded onto age and service. We view this as an artifact of imperfect estimation rather than a finding that the natural retirement age occurs at that point.
Figure 11. Pension Wealth under ATRS and CB (25-Year-Old Entrant; Adjusted for Inflation)

Figure 12. Predicted Separation Probabilities, Constant Accrual (CB)

Early retirement, CB eliminates the pull to that spike. Conversely, by eliminating the negative accruals beyond YOS = 28, CB also eliminates the push, thereby elevating the right tail. Finally, early career attritions are reduced a bit due to the one-year accrual of pension wealth under CB over this interval versus zero accrual prior to vesting under the DB plan.

Figure 13 shows the effects using the cumulative distribution of separations. Again, one can readily see CB’s elimination of the pull and push as well as the mitigation of early attrition. Length of service rises for those below the 35th
percentile and above the 65th percentile, while it falls for those in between. Overall, the net effect on mean length of service is a one-year increase, from 21.37 to 22.43. Again, this type of result should be taken with multiple caveats, as discussed above. The main finding that these simulations illustrate is the important variation in individuals’ behavioral response rather than the specific finding of a rise in mean length of service.34

9. CONCLUSIONS
In this article we have analyzed the incentives embedded in the Arkansas teacher pension plan and provided empirical evidence, from a new longitudinal data set, on the behavioral response to those incentives. The evidence does appear to be strong that these incentives matter. Teachers, it turns out, are no different in this regard from other employees studied previously.

The public interest in this matter, however, is arguably much greater in the case of teachers. If private employers wish to use pension benefits to steer employees to specific ages of retirement, that is their prerogative, and if they later choose to switch to more neutral (and less costly) plans—as they have in fact done—it is fair to assume that these are efficient choices. For public plans decided in the political process, this assumption is not necessarily warranted: it is at least an open question whether teacher retirement plans are designed efficiently in order to optimize teacher quality for any given program cost.

34. The rise in mean service may or may not be robust under different modeling techniques, but within the purview of the current article—for example, using five-year separation rates rather than one-year rates—the result does seem to hold.
That question is given further definition by our findings. It is not simply a matter of whether the pension system leads teachers to retire too early or too late: the socially optimal retirement date surely varies by individual. Some teachers are pushed out of the system early—as our evidence clearly indicates—and these may well include teachers who still have much to offer. But some teachers who should depart early hang on for the pension. Anecdotal evidence on the cost of this effect is commonplace. A most striking, and important, class of such cases can be found in turnaround schools, failing schools where new leadership is brought in to try something new. Usually these new leaders try to “counsel out” those teachers who will not fit into the new approach. According to those involved in such efforts, it is not uncommon to run into resistance from teachers who are vested but a few years shy of pension eligibility and are determined to stay on for that reason. These are often teachers who are unhappy in their jobs and detrimental to team morale but whose financial incentive to stay on is dominant. Our simulations confirm a strong pull effect of the current system—depressed separation rates prior to the pension spike—and also that a constant accrual alternative mitigates this effect.

The estimated magnitude of the behavioral responses to pension reform and the corresponding policy implications should be taken as suggestive, especially for the constant accrual simulation, which extends well beyond the historical experience. That said, the analysis suggests that teachers would respond to the elimination of early retirement (albeit with conflicting effects that mitigate the overall rise in the retirement age), and smoother accrual would lead to smoother separation patterns, arguably allowing teachers to better tailor their career plans to their own diverse preferences. The question of whether this would improve teacher quality depends in part on how teachers of different effectiveness respond to the different pension incentives, a subject for further research with these and similar data in other states. However, the question also turns on how the quality of new entrants would be affected by a constant accrual system, which offers greater rewards to mobile and career-changing young teachers. Unfortunately, that question cannot be fully answered from this type of data set.

The authors would like to express their great appreciation to the Arkansas Department of Education and the Arkansas Teacher Retirement System for linking their data sets and providing them to us. The usual disclaimers apply.

REFERENCES


