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Teacher Pension Incentives, Retirement Behavior, and Potential for Reform in Arkansas

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Abstract:

In this paper we present an analysis of the Arkansas Teacher Retirement System (ATRS) pension plan and an empirical investigation of the behavioral response to that plan, as well as to a possible reform plan. We begin by describing the plan parameters and discussing the sharp incentives these parameters create to work until service eligibility requirements are met, often in one's early fifties, and to separate shortly thereafter. We then estimate the effect of pension wealth accrual on teacher separation decisions using a new longitudinal dataset of Arkansas teachers. The resulting coefficients are subsequently used to compare predicted separation probabilities under the current regime versus a constant accrual retirement plan. We find evidence that teachers' retirement decisions are sensitive to pension wealth accrual. Our simulations suggest that a constant accrual plan could notably smooth the pattern of retirement behavior from that currently observed.

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Introduction

The structure of retirement benefits likely plays a sizable role in the timing of teacher retirement decisions. This paper examines the teacher pension plan in Arkansas. We provide an analysis of the retirement incentives embedded in the pension formula, by virtue of the pattern of pension wealth accrual. We then provide an empirical investigation of a new longitudinal data set to gauge the behavioral response to these incentives. Finally, we simulate the behavioral response to a reformed formula, based on a constant rate of accrual, as in a cash balance plan.

While there is a substantial labor economics literature discussing the effect of pensions on retirement decisions (Friedberg and Webb, 2005; Asch, Haider, and Aissimopoulos, 2005; Ippolito, 1997; Stock and Wise, 1990), relatively little has been written regarding the effects of teacher pension plans. Prior to the 2009 NCPI conference, the only published micro-level empirical investigation of which we are aware was Furgeson, Strauss, and Vogt (2006) on Pennsylvania.[1]

Indeed, the data to perform such investigations are not often available, since states do not generally link their administrative data on teachers with pension system data. Upon 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 paper.

The first section is devoted to 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

[1] Micro-level studies presented at the 2009 NCPI conference include Brown (2009) on California and Ni, Podgursky, and Ehlert (2009) on Missouri.

simulate the possible response to a constant accrual pension plan, such as those found under many cash balance formulas.

The Arkansas Teacher Retirement Plan

Arkansas public school teachers are covered by a traditional defined benefit (DB) pension system. When a teacher is hired, she is enrolled in the ATRS. There was a period when an employee could choose to be either a contributory or non-contributory member of the state pension system (with lower benefits for non-contributory members), but since 1999 all new full-time employees have been contributory. In the eight school years from 2000-01 to 2007-08 nearly 80 percent of teachers in Arkansas were contributory members. For the remainder of the paper we will focus our attention on the pension plan parameters for this group.

The ATRS pension plan requires that both teachers and employers make yearly contributions to a pension trust fund while the teacher is employed. Employees contribute 6 percent of their salary while employers contribute 14 percent,[2] for a total contribution of 20 percent.[3] Upon their retirement, the ATRS has an obligation to provide an annuity -- a regular retirement check for life -- to the employee.

An ATRS member becomes vested after 5 years. Once she reaches age 60 or 28 years of service, she can draw a pension equal to

$$Standard\ Annuity = \$900 + 2.15\% * YOS * FAS, \quad (1)$$

where *YOS* denotes years of service and final average salary *(FAS)* is an average of the last 3 years. Thus, a teacher with 28 years of service would earn 60.2 percent of her final average

[2] This includes 5.5 percent for amortization of unfunded actuarial accrued liabilities, as of fiscal year 2008.

[3] 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.

salary plus $900. She can start drawing the pension earlier, after 25, 26, or 27 years of service, but with an adjustment of 85%, 90% or 95%, 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 an eligible age and the amount of the pension would be frozen until that time. Once the pension draw begins, a 3 percent simple COLA applies.[4]

This set of rules implies a grid of starting pensions 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 ≥ 60 or YOS ≥ 28. In this region, the figures simply represent 2.15% times YOS. 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 will be discussed below.)

As we will see in the next section, the incentive to retire after 28 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 re-employment after retirement. One such provision is particularly important in Arkansas, and that is the "T-DROP" system ("Teacher Deferred Retirement Option Plan").[5] Under this plan, a teacher with 28 or more YOS can keep working after "retirement" for up to ten years, with 60-70% (depending on the YOS at which she enters T-DROP) of her pension check going into a retirement account and accumulating interest. When she actually leaves teaching, she receives 100% of her pension check. For pension

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[4] Occasionally the legislature will enact a one-time compounding of the COLA.

[5] As in other systems, re-employment has also been allowed after a short separation period (30 days), subject to earnings limitations. (In 2009, the separation period was raised to 180 days, and other provisions also made non-T-DROP re-employment 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 re-employment than T-DROP, which averaged 3,109 participants (2,520 contributory). These individuals are excluded from our analysis below.

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 28 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 -- a figure that we will be interested in below -- is larger, although it is hard to estimate from the data.

Accumulation of Pension Wealth

To demonstrate the powerful incentive effects of this system, we use the plan parameters to examine the way in which teachers accumulate pension wealth with each year of employment. Pension wealth is the 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. 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.[6] The present value of those payments is:

$$PW(A_s) = \sum_{A \geq A_s} (1+r)^{(A_s - A)} f(A \mid A_s) \cdot B(A \mid A_s), \tag{2}$$

[6] The benefit stream may itself be a choice among alternative streams open to the individual, based upon the choice of when to begin receiving payments. In Arkansas (unlike some other states), the best choice (i.e. the one that maximizes present value) is simply to receive benefits as soon after separation as possible.

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

In principle, $PW(A_s)$ 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. The teacher's pension wealth, $PW(A_s)$, is the size of the 401(k) that would be required to generate the same stream of payments she would be owed upon separation at age A_s.

Figure 1 depicts the pension wealth, in inflation-adjusted dollars, for a 25-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 B.A. to a master's degree. The entire salary grid is assumed to increase at 2.5% inflation. We assume a 5% interest rate, and use the most current female mortality tables from the Centers for Disease Control and Prevention (U.S. Department of Health and Human Services (2007).

The accumulation of pension wealth is smooth and steady up to age 49, but not thereafter. During her first 24 years in the classroom, this teacher accumulates about $283,000 in pension wealth. At age 50, her pension wealth jumps by $268,000, upon attaining her 25th YOS and eligibility for early retirement. The jump is due to the fact that she is now eligible for 10 extra years of pension benefits, beginning immediately, instead of deferring to age 60. 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 28 YOS and age 53, the growth in her pension wealth levels off. The pattern for net pension wealth (netting out employer contributions, with interest) is similar.

Figure 2 depicts the accumulation of pension wealth from a single point in time, the date of entry at age 25 in this example, unlike Figure 1, which depicted pension wealth as of the date of separation. So a very forward-looking 25-year-old entrant would conclude that the pension-wealth-maximizing age of separation is 53, upon completion of 28 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. This is 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 24 YOS, up to about $15,500 per year, net of employee contributions.[7] A particularly sharp spike occurs at age 50 (25th year of service for a 25-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, since she qualifies for early retirement immediately after 25 YOS, instead of having to defer to age 60.

Table 1, introduced above, illustrates what is going on behind Figure 3. The shaded cells depict the best choices for first pension draw of a 25-year-old entrant with continuous service. As the table shows, age 60 is the earliest she can collect up through her 24th year of service, and that does in fact maximize pension wealth. Upon her 25th year, she maximizes pension wealth

[7] The gross figures are about $3,000 higher -- they are not depicted here, since they are visually indistinguishable.

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 vs. 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% to salary. This is due to the phase-down of the penalty for early retirement over these years. Upon reaching 28 YOS, she qualifies for normal retirement, and beyond that point -- age 53 for a 25-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 25 YOS serves as a "pull" factor rewarding teachers who stay in service at least until that point, and the negative accrual after 28 YOS serves as a "push" factor, discouraging those who stay longer. T-DROP, however, reduces the pension penalty for continuing to work after 28 YOS, 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 28, 29, and 30 YOS (ages 53-55 for those who start teaching at age 25). The curves are higher for entering T-DROP at 30 vs. 29 vs. 28 YOS because the deposit rates are 70%, 65%, and 60% respectively. In any case, T-DROP eliminates most of the pension penalty for continuing to teach beyond 28 years.

Data and Descriptive Analysis

In the previous section we discussed the incentives created by the retirement plan parameters in Arkansas. We now turn to the question: Do teachers respond to these incentives in a meaningful way? The aim of the remainder of this paper is to take this question to the data.

We constructed a longitudinal dataset of teacher records using data provided by both the ATRS and ADE. The ATRS provided us with observations for all members, both retired and not-retired, in their system as of 2008, while ADE provided us with observations on all teachers working in the state from the 2000-01 school year through the 2007-08 school year.

These data provide us with the opportunity to look at our question in a few different ways. First, we can look at the pattern of retirements over different YOS to see if actual retirements follow the pattern indicated by the plan incentives. This can be done with ATRS data alone, which includes all living retirees. Second, we can look at patterns of separation and retirement, using the merged ATRS-ADE longitudinal data for the eight-year period. Finally, we can use regression analysis on the longitudinal data set to estimate the effect different pension wealth accrual measures have on the separation decisions of teachers.

One advantage of the ATRS retirement data is that it covers a period that includes change in the pension parameters. In 1997 the Arkansas State Legislature changed the normal retirement YOS requirement from 30 to 28. Based on the previous section, we would expect retirements to be concentrated in the YOS around the early and normal retirement eligibility points. For most Arkansas teachers, eligibility is governed by YOS rather than age, so we examine the distribution of retirements by YOS.

Figure 5 depicts this distribution for the period 1984-1996. As one might expect, there are spikes at YOS=25, the point of early retirement, where pension wealth accrual spikes, and at YOS=30, the point of normal retirement, after which pension wealth accrual turns negative.[8] This is not to say that the service eligibility conditions entirely determine retirement dates, since the histogram depicts many retirements after 30 YOS (incurring negative wealth accrual) and also before 25 YOS. This latter group includes late-starting teachers, or teachers with interrupted

[8] Prior to 1997 the vesting period was 10 years, as the diagram indicates.

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 60. Still, the pattern certainly indicates that retirement decisions are influenced by pension rules.

Figure 6 provides additional evidence from the period 1998-2008. The spikes here are particularly pronounced, indicative of the "pull" factor from the wealth accrual spike. Moreover, the normal retirement spike shifts from 30 YOS to 28 YOS. Clearly the change in pension rules had a marked effect on retirement decisions, moving the distribution to shorter terms of service.

The sharp drop-off in retirements after 28 YOS in Figure 6 would also seem to be consistent with the system's "push" to retire once accrual turns negative. However, this diagram overstates that effect, because it excludes T-DROP participants. T-DROP participants work more years than non-T-DROP participants. The program requires a minimum of 28 YOS[9] 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. Adding those retirees from 1998-2008 who were in T-DROP to those who were not gives us figure 7. This figure gives the distribution of YOS, plus, for T-DROP participants, years in T-DROP, since these are also teaching years (but not credited as YOS for pension benefits).

In comparing figures 7 and 6, one should be cautious in causally attributing all of the longer employment spans to the T-DROP program; no doubt T-DROP participants self-select from among those who would work longer anyway. In this respect, figure 6 overstated the effect of the pension formula's incentives for early retirement, by omitting the T-DROP participants. Figure 7, however, does not have that problem, and it still shows a behavioral response to the system's incentives, with unmistakable spikes at 25 and 28 YOS.

[9] From the program's inception in 1995 until 1999, the minimum was 30 YOS.

Figures 5-7 have considered the distribution of retirements from the back end, as percentages of retirements. For labor force analysis, it is more useful to consider separation probabilities from the front end, from entry on forward. To this end, 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.[10] Prior to our econometric analyses of these data in the remainder of this paper, we present raw estimates of the cohort separation rate pattern, by YOS.

Figure 8 depicts the estimated separation rates for an entering cohort, excluding those identified as eventually entering T-DROP during our panel period. 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 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.[11]

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[10] 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 dataset was much better suited to measure breaks in service, since it could track the earliest cohorts up to 35 years. We attempted to exclude short-term separations by limiting ourselves to 5-year separations, but due to the nature of our dataset these exclusions resulted in unrealistically low estimated attrition rates for new entrants. Where relevant below, we will indicate how the results from using the 5-year separations differed from those using one year.

[11] Restricting 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 for non-TDROPpers and also raises the spike for the aggregate in Figure 9, below.

We have less confidence in our estimated separation rates for T-DROPpers,[12] 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, depicted in Figure 9. The weights here are the cohort survival rates simulated for T-DROP and non-T-DROP separately, assuming 20 or 30 percent of an entering cohort will eventually enter T-DROP (they will constitute a much larger share of the cohort surviving to the point of T-DROP eligibility).[13] The mode at YOS=28 is diminished, but remains dominant. There is significant separation activity in the out-years -- years dominated by T-DROPpers -- as there was in the retirement distribution of Figure 7. However, no significance should be attached to the peak at YOS=41, which is purely an artifact of small numbers in that cell.[14]

It seems unlikely that the sharp spike in Figures 8-9 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, 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.

[12] 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.

[13] The assumption that 20-30 percent of entrants ultimately enter T-DROP was chosen to replicate the observed split of about 50-50 sometime during the years immediately preceding T-DROP eligibility.

[14] Three of the five T-DROPpers in that cell constitute the separations.

Empirical Methodology

In this section we develop an empirical model which allows us 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 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.

We chose to use a model which employs a simple forward looking approach and avoids strong assumptions about worker utility functions and other explanatory variables. The hope is that this straightforward and parsimonious approach will yield crisp and unambiguous results. A form of this model was first developed by Coile and Gruber (2000a and 2000b) as an alternative to the option value analysis of Stock and Wise (1990) which relies on an indirect utility function over work and leisure. This type of forward looking approach has been used several times in the literature including Friedberg and Webb (2005) and Coile and Gruber (2007).

We focus on two main variables that model different aspects of the accrual effect. The first variable of interest is "peak value" (PKV). Peak value is defined as the difference between current pension wealth and the maximum present value of future pension wealth across all possible future separation dates.[15] Formally, peak value is defined as follows:

[15] The term "peak value" is potentially confusing, since it more accurately describes the maximum future wealth than the difference between that and current wealth. However, we abide by conventional usage here.

Let:
PW_t $denote\ pension\ wealth\ in\ year\ t$
PW_m $denote\ the\ maximum\ present\ value\ PW\ occuring\ in\ future\ year\ m,$
$evaluated\ at\ year\ t$:

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

$Then\ PKV_t\ denotes\ peak\ value\ in\ year\ t$:

$$PKV_t = \max\left(0, PW_m - PW_t\right) \tag{3}$$

Peak value represents the incentive a worker has to continue working. This variable 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. One can easily see that as *t* approaches *m* the peak value will shrink, reducing the incentive to work. When peak value reaches zero a teacher has reached her maximum present value pension wealth.

The results we present below employ a peak value variable modified to impose a finite horizon, specifically 5 years. In practice this makes little difference to our estimates, and in fact, slightly improves the log likelihood of our estimates, possibly consistent with the idea that horizons are in fact limited.[16] More importantly, for our simulations of a constant accrual pension system later in the paper, there is no 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 5-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 only looks forward one year. OYA was discussed above and is depicted in Figure 3 for a 25-year-old entrant. One advantage of including this variable is that it allows for a disincentive to

[16] The 5-year horizon also generates a slightly better log likelihood than a 10-year horizon.

work. In years after a teacher has reached her maximum 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 afterwards..

In addition to these two pension accrual variables, we include pension wealth itself (PW), as discussed above. We also include earnings to capture the direct incentive to continue working.

Variables pertaining to the individual include race (white) and sex (female). In addition, we include an indicator variable to designate 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, although somewhat crudely, for differences in behavior between those who self-select into the T-DROP 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 a district variable for size to see if retirement patterns differ between small (rural) and large (urban) districts. In addition, we include district variables for poverty (FRL) and math scores, to see if retirement patterns are affected by non-pecuniary 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 1-year separation rates and 5-year separation rates. The 1-year separation rates have the advantage of accurately representing early-career attrition rates, but also include breaks in service. The 5-year rates exclude short-term breaks in service, but also exclude the vast majority of early-career separations. In other words, the 5-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 1-year separation rates below, we will be conservatively estimating the impact of pension parameters on separations. Where relevant, we will also point out how the results differ using 5-year rates.

We use a probit specification of the following form:

$$\Pr(\text{separate} = 1)_{it} = \Phi(\beta_0 + \beta_1\, \text{OYA}_{it} + \beta_2\, \text{PKV}_{it} + \beta_3\, \text{PW}_{it} + \beta_4\, X_{it} + \beta_5\, D_{it}), \qquad (4)$$

where $\Phi(.)$ is the cumulative normal distribution, X_{it} includes teacher level explanatory variables for teacher *i* at time *t* including: earnings, race, gender, age, service, and ultimate T-DROP status, and D_{it} denotes district level variables for that teacher. All dollar valued variables are in millions of 2008 dollars. We estimated various specifications of this model using a panel data estimator with random effects. The estimated standard errors, reported in the next section, are adjusted for individual level clustering.

Results

In this section we present the 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 the 2000-2001 school year through the 2007-2008 school year. We have 209,721 observations on 36,657 individual teachers with an average of 5.7 observations per teacher over the 8 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.[17]

[17] The number of 5-year separations was much lower, 4,580.

Table 2 presents the estimated marginal effects on the exit rate, with standard errors reported in parenthesis.[18] All regressions also include a constant, age, service, age^2, service^2, and age×service (i.e. all 2nd-degree variables in age and service). The first column includes the pension variables (OYA, PKV, and PW) 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). (Column (5) will be discussed below.)

The two accrual variables have negative effects, as expected, and are stable in magnitude across specifications in columns (1)-(4). An increment of $10,000 in peak value (5-year horizon) 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 as will be discussed below, in conjunction with column (5).

As columns (2)-(4) indicate, T-DROP types have much lower probability of separation (31 percentage points). Race has little or no discernible effect. Nor does gender, but we will revisit this in column (5). 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 previously observed spike in retirement decisions? We have, in effect, replaced the 40-odd YOS indicator variables in Figures 8-9 with smoothly varying second-degree age and service variables, plus the pension variables in column (2). Using these coefficients, we model the separation rates for a cohort of 25-year-old entrants.

[18] The "exit rate," conditional on age and service, is to be distinguished from the cohort separation probabilities, depicted in Figures 8-9, and similar diagrams below, which are percentages of the entering cohort.

Figure 10 reproduces, in moderately attenuated form, the separation patterns depicted in Figures 8-9 for non-T-DROPpers and a weighted average.[19] This suggests to us that it is the pension variables, rather than service and/or age itself which accounts for the spiky separation pattern.

Column (5) provides estimated marginal effects on 5-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 1-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, which is the theoretically expected sign. One possible explanation could be that for the one-year separation estimates, the early career attrition was not fully captured by the smoothly varying age and service variables, but that the pension wealth variable -- which carries a value of zero prior to vesting -- was spuriously proxying for early-career separations. If so, then the 5-year separation estimates would be more likely reveal the true effect of pension wealth on separations, which is positive, but in any case is small. Similarly, the estimated effect of sex rises by an order of magnitude in the 5-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 1-year separation estimates masked that effect.

Figure 11 depicts the estimated 5-year separation patterns, corresponding to Figure 10. Clearly the pattern captures the greater sensitivity of 5-year separation rates to pension variables,

[19] The weighted average curve in Figure 10 assumes 25 percent of entrants will enter T-DROP, midway between the 20 percent and 30 percent assumptions depicted in Figure 9.

and the corresponding underestimate of early-career attrition. As discussed earlier, we consider the one-year estimates of pension effects to be the more conservative ones.

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. For example, in the two-stage estimate corresponding to column (3) of Table 2, the effects of the accrual variables were -0.00518 and -0.00956, which do not differ appreciably from Table 2's estimates of -0.00606 and -0.00964 respectively.

<u>Simulating Potential Reform</u>

Assuming our estimated coefficient values represent the structural equation that governs a teacher's separation decision, we might use these coefficients to predict behavior under a different pension regime. It is important to note here that a weakness of our longitudinal data is that our study period does not include variation in the pension parameters, and therefore, any simulation based on different pension parameters is an exercise in out-of-sample extrapolation. With that important caveat, perhaps this type of simulation may provide some indication about the general behavioral impact of a different system.

Specifically, we consider a constant rate-of-accrual pension plan, such as the cash balance (CB) plans that many private employers switched to over recent decades. In such a plan, the teacher has a notional retirement account which grows with the contributions and a guaranteed rate of return, typically comparable to a risk-free long-term bond yield. Figure 12 presents the accumulation of pension wealth for the ATRS plan versus a constant accrual CB plan to illustrate the difference in accrual. This graph is identical to Figure 1 except for the addition of the CB curves, under two different contribution rates -- 20 percent and 30 percent.[20] The constant accrual plans smooth pension wealth accrual over the teacher's working life instead of rewarding certain years of service with dramatic jumps in pension wealth.

We are able to simulate behavior under constant accrual using our estimating equations in Table 2, since we have placed a finite horizon on the peak value accrual variable (constant accrual plans exhibit no peak value otherwise). Constant accrual plans also eliminate the need for a T-DROP option given that pension wealth accrual under such a plan is never negative, but the T-DROP indicator variable is still relevant, since we take it to distinguish between unobserved types. Figure 13 presents the predicted one-year separation probabilities for a 25 year old entrant under the CB plan at 30 percent contributions, using our estimated coefficients, for non-T-DROPpers and a weighted average. Compared with Figure 10, the peak has been reduced and smoothed, following the elimination of the spike in pension wealth accrual. The CB plan would, under this simulation, tend to spread out separation decisions around the previous peak, while preserving an attenuated concentration of separations at about 30 YOS.[21]

Figure 14 compares the separation patterns for ATRS and a constant accrual CB plan in the form of the cumulative separation distributions for 25-year-old entrants. The diagram depicts non-T-DROPpers alone, for clarity of presentation, but the weighted average curves, which

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[20] The 20 percent rate represents the statutory joint contributions of employer and employee in Arkansas. The 30 percent rate is closer to the fiscally neutral plan, using the 5 percent discount rate, as opposed to the 8 percent rate used in actuarial valuations.

[21] Our estimated coefficients also imply that a more generous CB plan -- with higher rates of accrual -- leads to slightly longer employment.

would lie below them, are quite similar. The effects of the constant accrual alternative around the spike year of 28 are readily seen. In the years immediately preceding, where the spike under ATRS would exert a strong disincentive to separate, the "pull" to the spike is mitigated by the smoother incentives under CB. In other words, as the "pull" of ATRS is eliminated, those who would stay for the jump in pension benefits no longer do so. Conversely, in the years following the spike, when accrual turns negative under ATRS, accrual remains positive under CB, inducing more teachers to stay on the job. This diagram also suggests that early career attrition may be reduced, by virtue of the significantly greater pension wealth accrual during those years under CB. However, this pattern does not show up for 5-year separations, depicted below.

Finally, Figures 15-16 depict predicted 5-year separation probabilities. Comparing Figure 15 to Figure 11,[22] we again see the peak reduced and smoothed. Figure 16, depicting the cumulative separation probabilities, indicates, once again that CB mitigates the "pull" and "push" effects of the ATRS spike, and this mitigation appears to be stronger than we saw for the 1-year separation rates. It is in this sense that we consider the 1-year separation rates, which include temporary breaks in service, to provide a more conservative estimate of the possible impact of pension reform.

Conclusions

In this paper, we have analyzed the incentives embedded in the Arkansas teacher pension plan, and provided empirical evidence from a new longitudinal data set, regarding the behavioral response to those incentives. The evidence does appear to be strong that these incentives matter. The magnitude of the behavioral response to pension reform and the corresponding policy

[22] Vertical scales in both go to 16%, rather than the 14% maximum in other diagrams.

implications should be taken as suggestive, given that our simulations extend well beyond the historical experience. That said, this analysis provides new evidence that the incentive to keep teachers in service up to 28 YOS is strong, and that pension reform toward more neutral incentives would be expected to reduce the effect of this "pull." Similarly, although Arkansas' T-DROP system provides a significant alternative to the sharp "push" of the regular ATRS plan, we have seen that a cash balance plan might still extend service beyond 28 years among some of those who do not choose to enter T-DROP.

In general, the analysis suggests that 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 or not depends in part on how teachers of different effectiveness respond to 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 answered from this type of dataset.

References

Asch, Beth, Steven J. Haider, and Julie Zissimopoulos. 2005. "Financial Incentives and Retirement: Evidence from Federal Civil Service Workers." Journal of Public Economics. Vol. 89 Nos. 2-3, pp. 427-440.

Brown, Kristine. 2009. "The Link Between Pensions and Retirement Timing: Lessons from California Teachers." National Center for Performance Incentives, Conference Paper 2009-12. http://www.performanceincentives.org/data/files/news/ConferencePapers2009News/Brown_200912.pdf

Coile, Courtney, and Jonathan Gruber. 2000a. "Social Security Incentives for Retirement." *Themes in the Economics of Aging.* ed. David Wise, 311-341. Chicago: University of Chicago Press.

Coile, Courtney, and Jonathan Gruber. 2000b. "Social Security and Retirement." Working Paper 7830. Cambridge, MA.: NBER.

Coile, Courtney and Jonathan Gruber. 2007. "Future Social Security Entitlements and the Retirement Decision." Review of Economics and Statistics. Vol. 89 No. 2, pp. 234-246.

DeAngelis, Karen and Jennifer Presley. 2007. Leaving Schools or Leaving the Profession: Setting Illinois' Record Straight on New Teacher Attrition. Illinois Education Research Council. Policy Report IERC 2007-1.

Furgeson, Joshua, Robert Strauss, and William Vogt. 2006. "The Effects of Defined Benefit Pension Incentives and Working Conditions on Teacher Retirement Decisions." Education Finance and Policy. Vol. 1 No. 3 (Summer), pp. 316-348.

Friedberg, Leora, and Anthony Webb. 2005. "Retirement and the Evolution of Pension Structure." Journal of Human Resources. Vol. 40. No. 2, pp. 281-308.

Ippolito, Richard A. 1997. Pension Plans and Employee Performance: Evidence, Analysis, and Policy. Chicago: University of Chicago Press.

Ni, Shawn, Michael Podgursky and Mark Ehlert. 2009. "Teacher Pension Incentives and Labor Market Behavior: Evidence from Missouri Administrative Teacher Data." National Center for Performance Incentives, Conference Paper 2009-11.
http://www.performanceincentives.org/data/files/news/ConferencePapers2009News/NEW_Ni_Podgursky_Ehlert_200911.pdf

Stock, James H. and David A. Wise. 1990. "Pensions, the Option Value of Work, and Retirement." Econometrica. 1990. Vol. 58 No. 5, pp. 1151-1180.

U.S. Department of Health and Human Services. National Vital Statistics Division. (2007) United States Life Tables, 2004.
http://www.cdc.gov/nchs/data/nvsr/nvsr56/nvsr56_09.pdf

<u>Table 1: Starting Annuity, as Percent of Final Average Salary</u>

(YOS = Years of Service. *italics*: "early" retirement; **bold**: "normal" retirement. Shaded cells: 1st draw of 25-year-old F entrant.)

YOS/Age	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
5																**10.8**	**10.8**	**10.8**	**10.8**	**10.8**	**10.8**
6																**12.9**	**12.9**	**12.9**	**12.9**	**12.9**	**12.9**
7																**15.1**	**15.1**	**15.1**	**15.1**	**15.1**	**15.1**
8																**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**
9																**19.4**	**19.4**	**19.4**	**19.4**	**19.4**	**19.4**
10																**21.5**	**21.5**	**21.5**	**21.5**	**21.5**	**21.5**
11																**23.7**	**23.7**	**23.7**	**23.7**	**23.7**	**23.7**
12																**25.8**	**25.8**	**25.8**	**25.8**	**25.8**	**25.8**
13																**28.0**	**28.0**	**28.0**	**28.0**	**28.0**	**28.0**
14																**30.1**	**30.1**	**30.1**	**30.1**	**30.1**	**30.1**
15																**32.3**	**32.3**	**32.3**	**32.3**	**32.3**	**32.3**
16																**34.4**	**34.4**	**34.4**	**34.4**	**34.4**	**34.4**
17																**36.6**	**36.6**	**36.6**	**36.6**	**36.6**	**36.6**
18																**38.7**	**38.7**	**38.7**	**38.7**	**38.7**	**38.7**
19																**40.9**	**40.9**	**40.9**	**40.9**	**40.9**	**40.9**
20																**43.0**	**43.0**	**43.0**	**43.0**	**43.0**	**43.0**
21																**45.2**	**45.2**	**45.2**	**45.2**	**45.2**	**45.2**
22																**47.3**	**47.3**	**47.3**	**47.3**	**47.3**	**47.3**
23																**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**
24																**51.6**	**51.6**	**51.6**	**51.6**	**51.6**	**51.6**
25	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	*45.7*	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**
26	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	*50.3*	**55.9**	**55.9**	**55.9**	**55.9**	**55.9**	**55.9**
27	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	*55.1*	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**
28	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**	**60.2**
29	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**	**62.4**
30	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**	**64.5**
31	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**
32	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**	**68.8**
33	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**
34	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**	**73.1**
35	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**	**75.3**
36	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**	**77.4**
37	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**	**79.6**
38	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**	**81.7**
39	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**	**83.9**
40	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**	**86.0**

Table 2: Estimated Marginal Effects on Exit Rates

Dependent variable = 1 for 1-year separation or retirement.

Constant only model Log-Likelihood = -34,646.711

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.

Variables					5yr Sep
One Year Accrual ($10,000)	-0.00663** (0.00136)	-0.00584** (0.00127)	-0.00606** (0.00130)	-0.00600** (0.00130)	-0.02160** (0.00228)
Peak Value ($10,000)	-0.01000** (0.00078)	-0.00949** (0.00092)	-0.00964** (0.00091)	-0.00964** (0.00092)	-0.01060** (0.00120)
Current Pension Wealth ($10,000)	-0.00421** (0.00025)	-0.00179** (0.00022)	-0.00174** (0.00023)	-0.00180** (0.00023)	0.00308** (0.00049)
Earnings ($1,000)	-0.05410** (0.00251)	-0.04560** (0.00315)	-0.04670** (0.00315)	-0.04610** (0.00316)	-0.04730** (0.00517)
T-DROP Participant		-0.31136** (0.01837)	-0.31553** (0.01797)	-0.31408** (0.01821)	-0.28150** (0.02979)
Female			-0.00534 (0.00374)	-0.00428 (0.0037)	-0.03422** (0.00710)
White			-0.00204 (0.00462)	0.01065* (0.00518)	0.00560 (0.00914)
District Size (10,000 students)				-0.00727** (0.00235)	-0.02020** (0.00441)
Percent Free or Reduced Lunch (Range - 0 to 1)				-0.00005 (0.00009)	-0.00081** (0.00017)
Average Math Score (standard deviation units)				-0.04616** (0.00743)	-0.0806** (0.01136)
Log-Likelihood	-31,750.298	-31,126.199	-31,125.035	-31,078.430	-

** denotes statistical significance at the 1 percent level.

* denotes statistical significance at the 5 percent level.

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.

Figure 1. Pension Wealth at Age of Separation
(25-year old entrant. pension wealth adjusted for inflation)

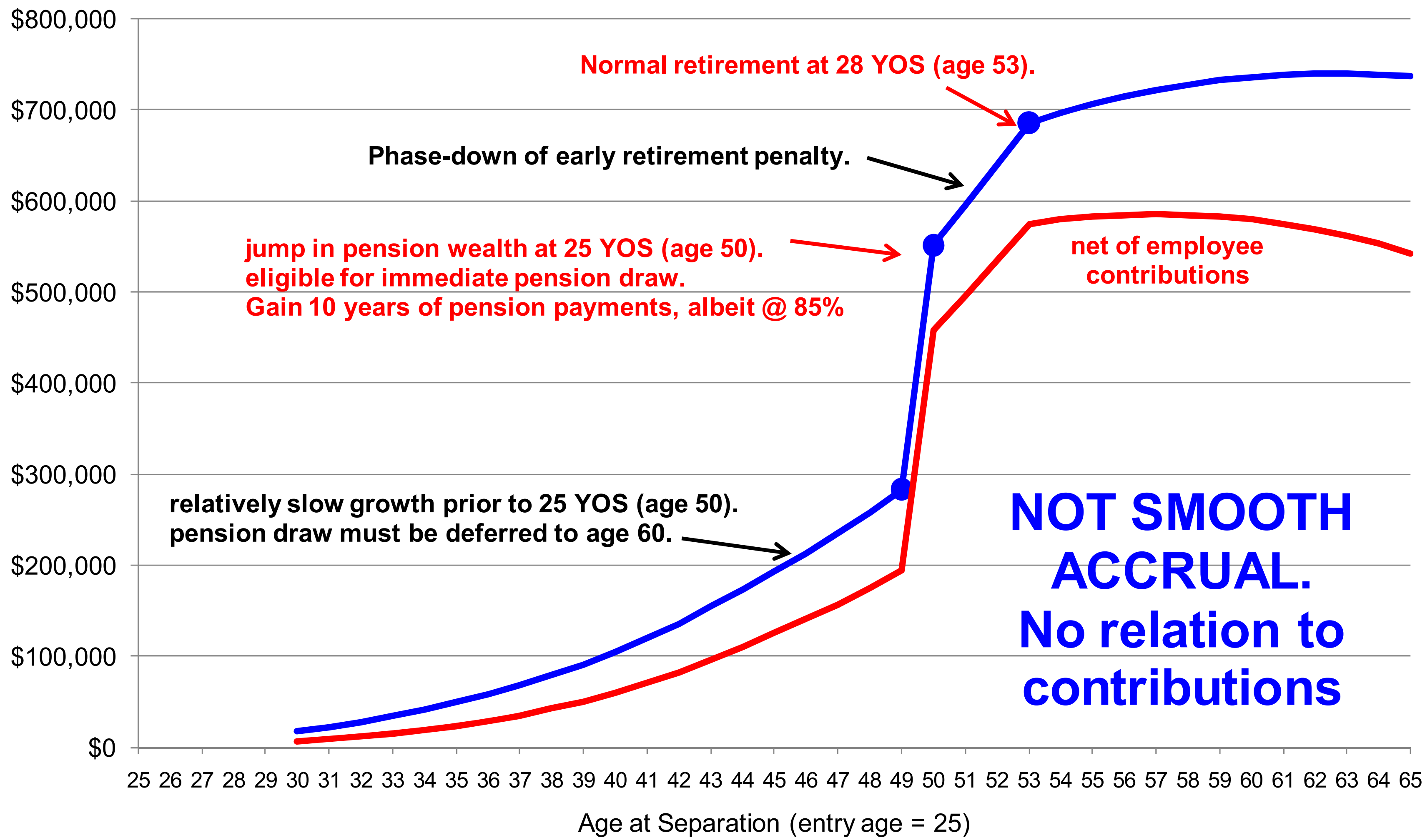


Figure 2. PV at Entry of Future Pension Wealth

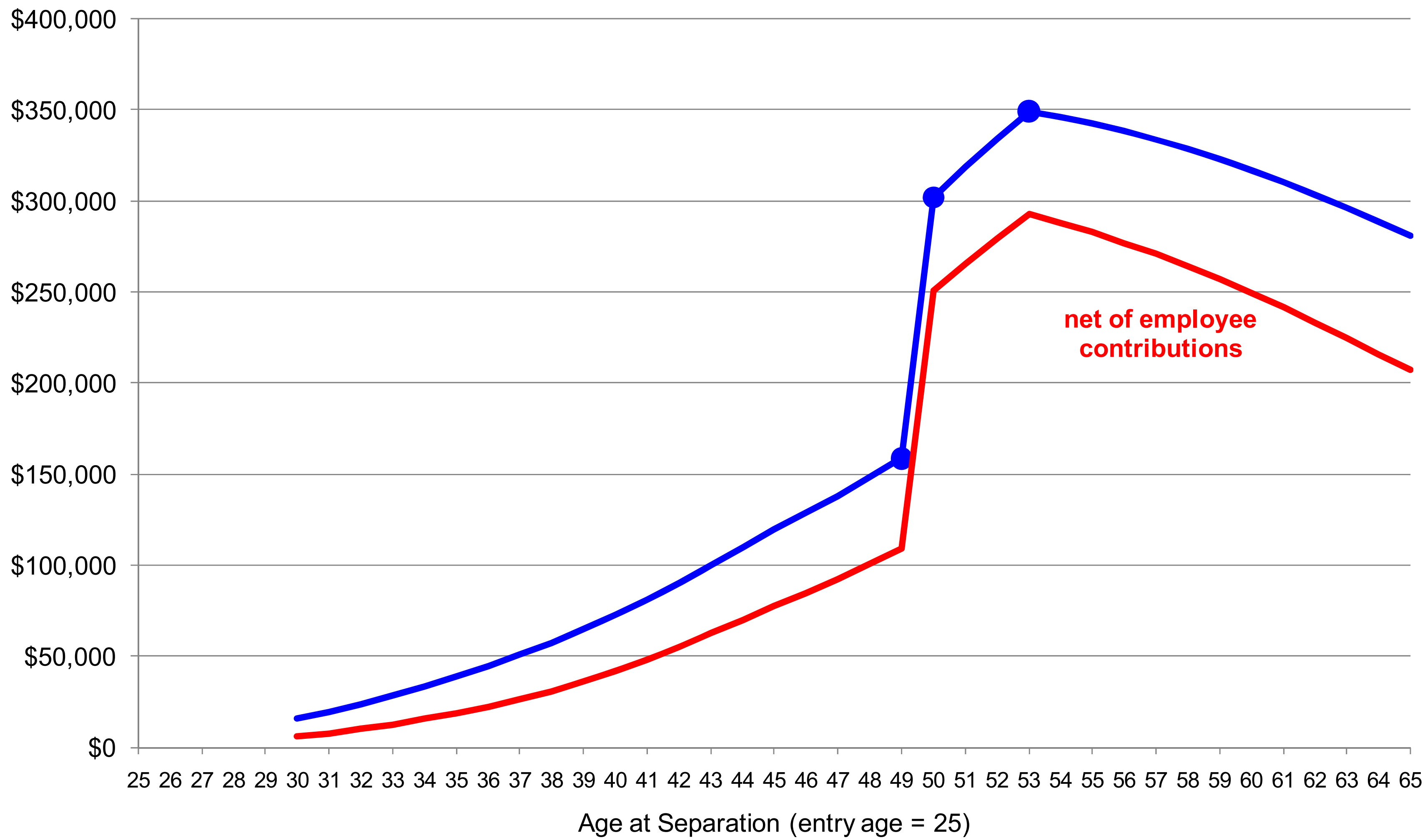


Figure 3. One-Year Accrual of Pension Wealth

(net of interest and employee contributions; adjusted for inflation)

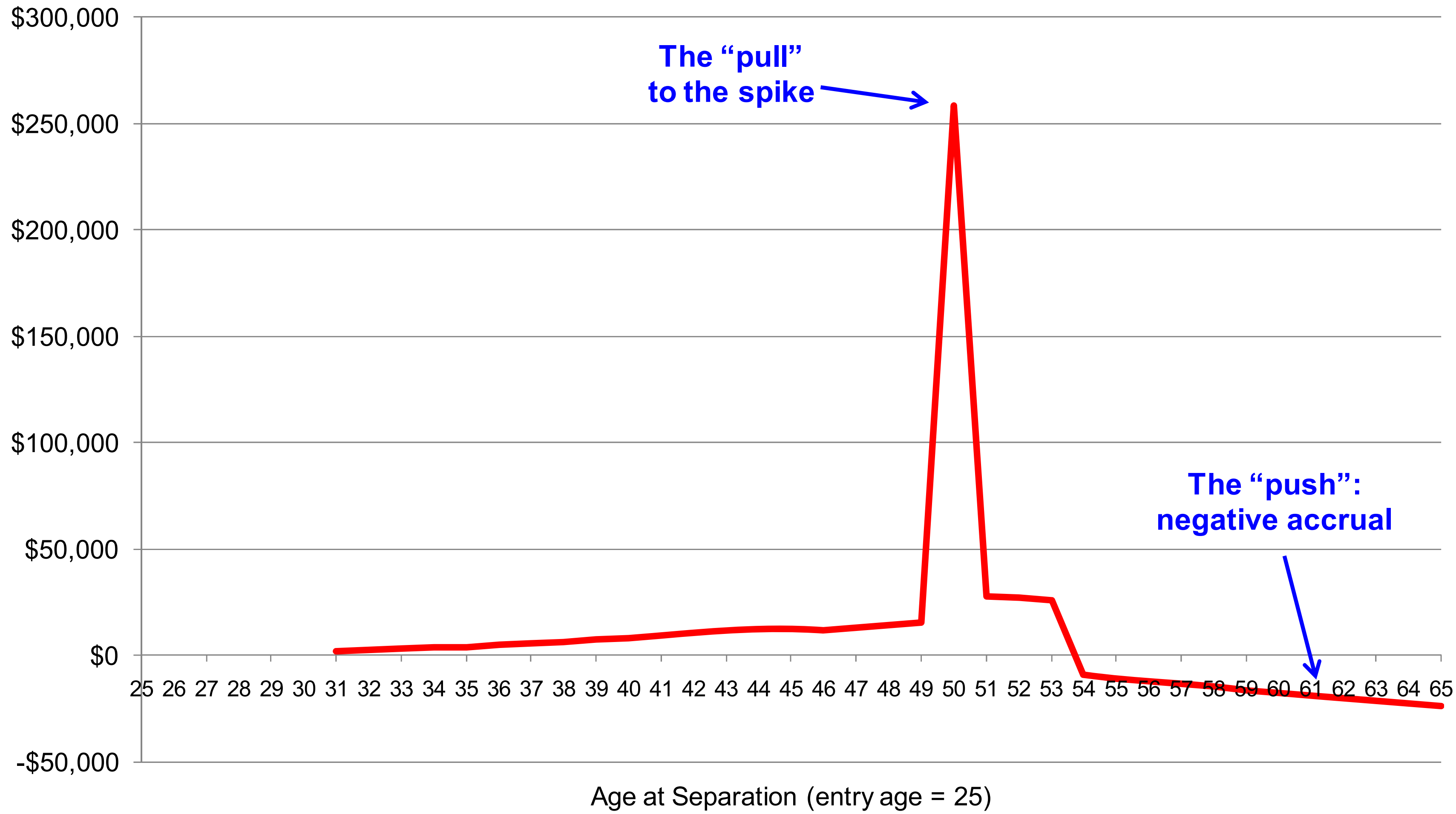


Figure 4. One-Year Accrual of Pension Wealth with T-DROP
(net of interest and employee contributions; adjusted for inflation)

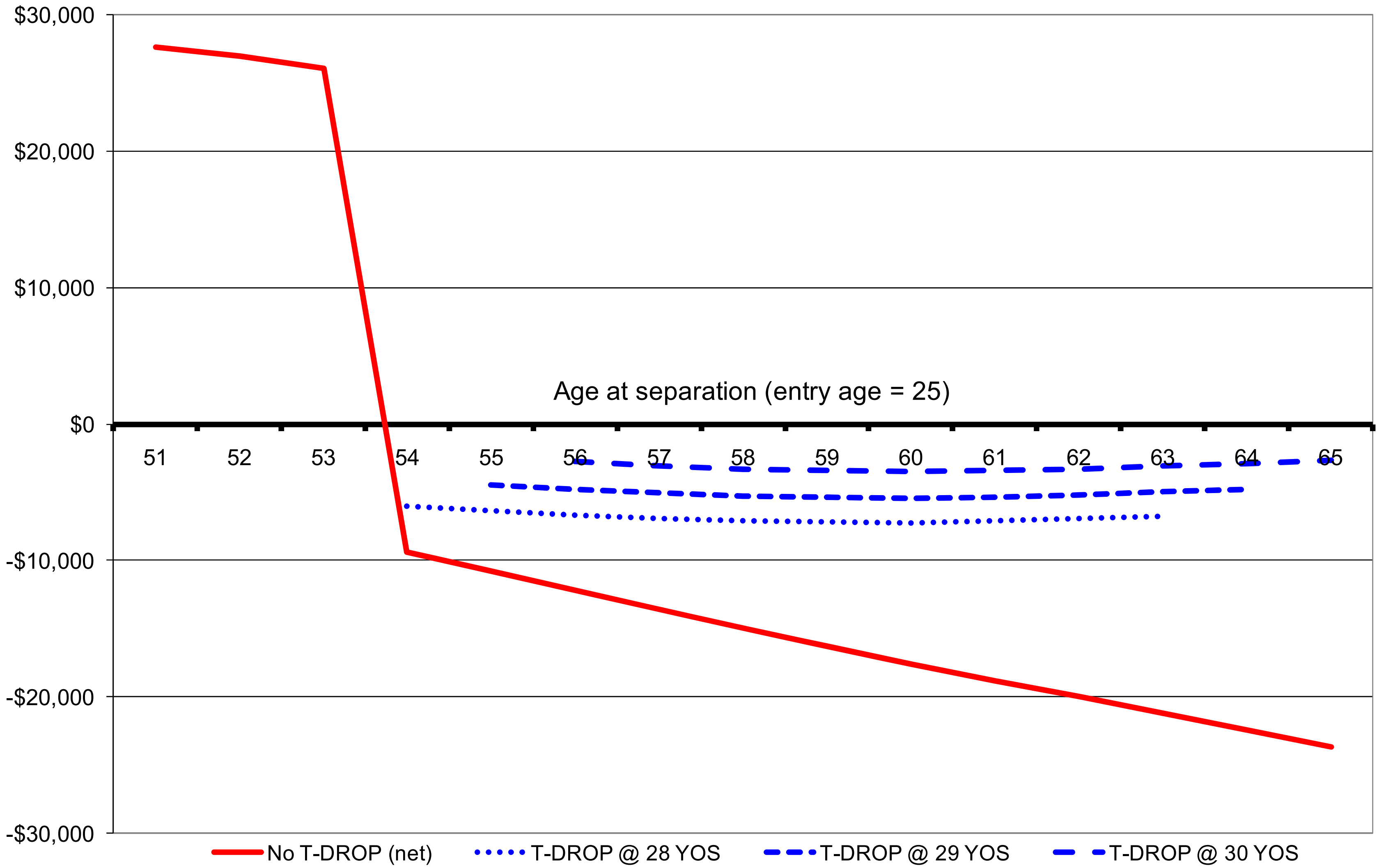
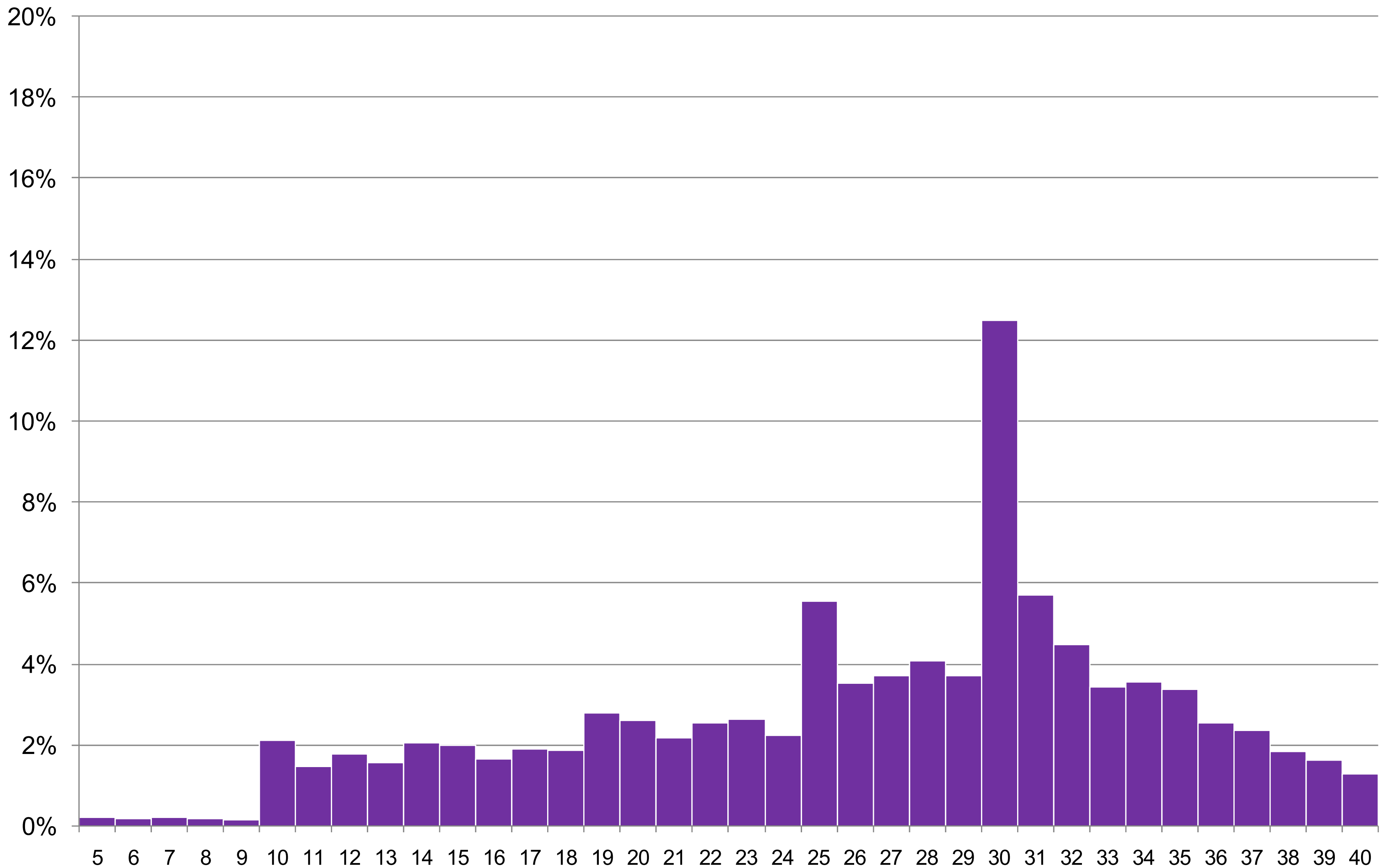
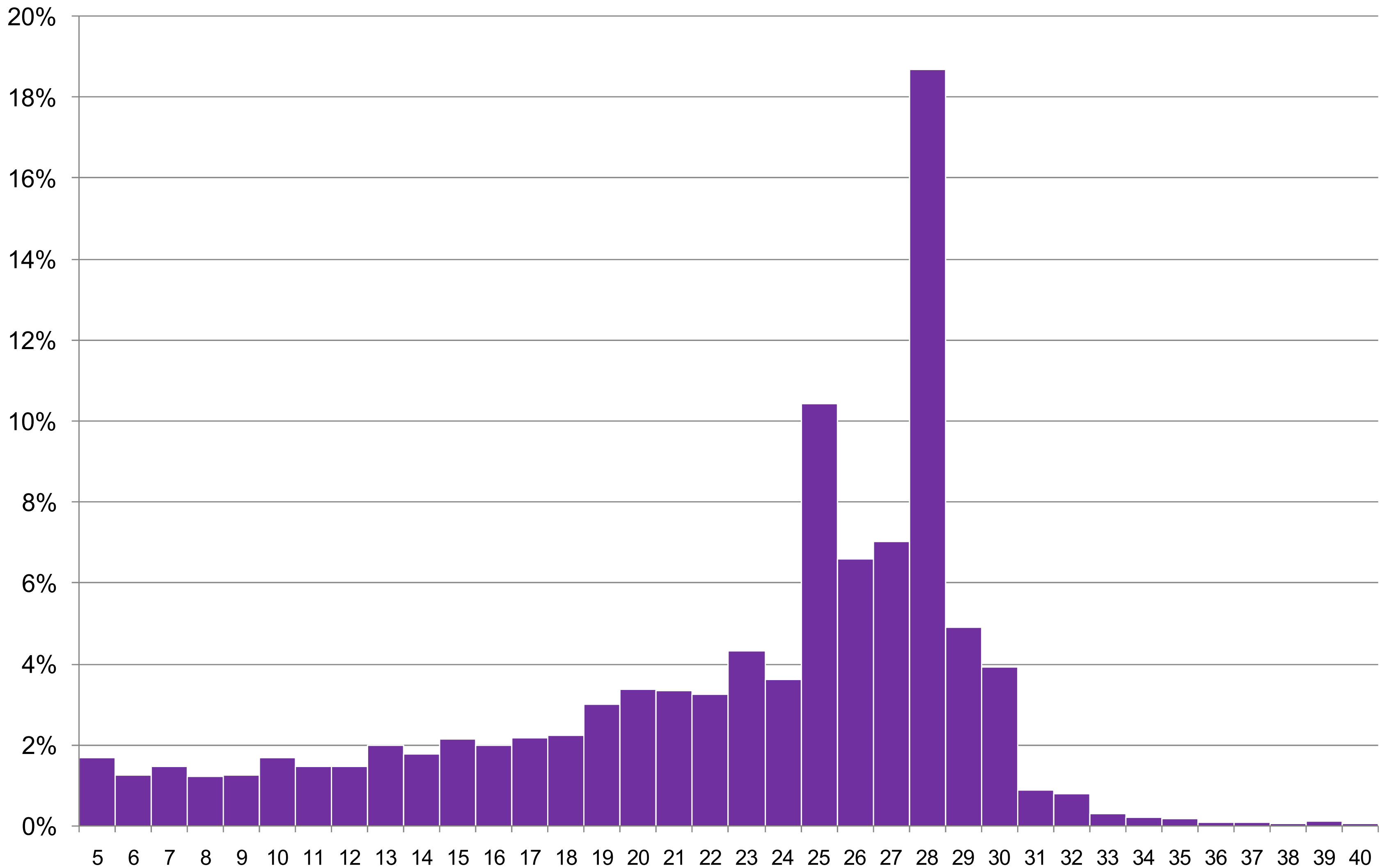


Figure 5: Distribution of Arkansas Retirements by YOS, 1984-1996



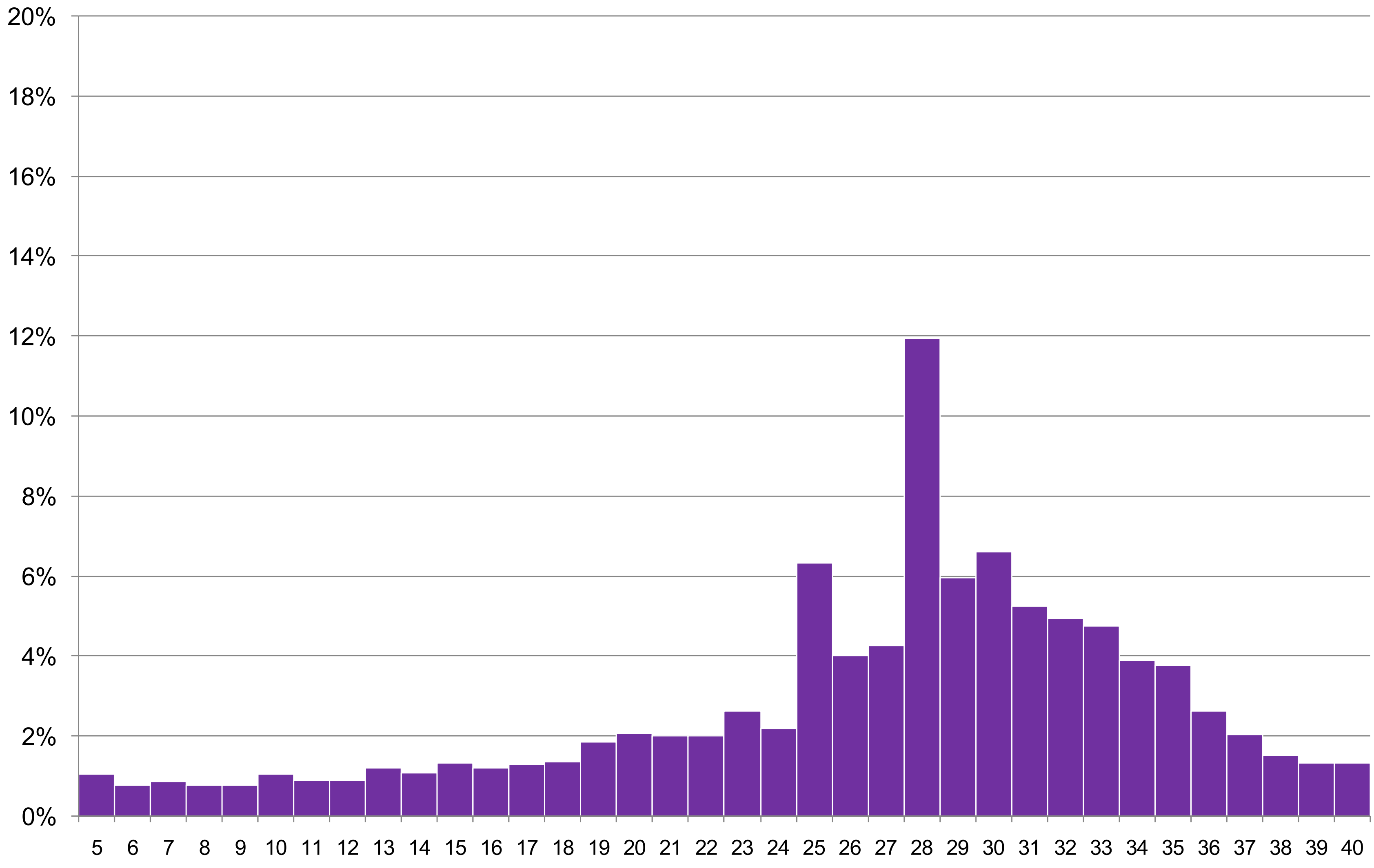
contributory only; excludes T-DROP participants. n=5,651.
Data source: Arkansas Teacher Retirement System

Figure 6: Distribution of Arkansas Retirements by YOS, 1998-2008



contributory only; excludes T-DROP participants. n=4,042.
Data source: Arkansas Teacher Retirement System

Figure 7: Distribution of Arkansas Retirements, with T-DROPs, 1998-2008



contributory only. Data source: Arkansas Teacher Retirement System. n=6,742.

Figure 8. Raw Cohort 1-year Separation Rates, non-TDROP

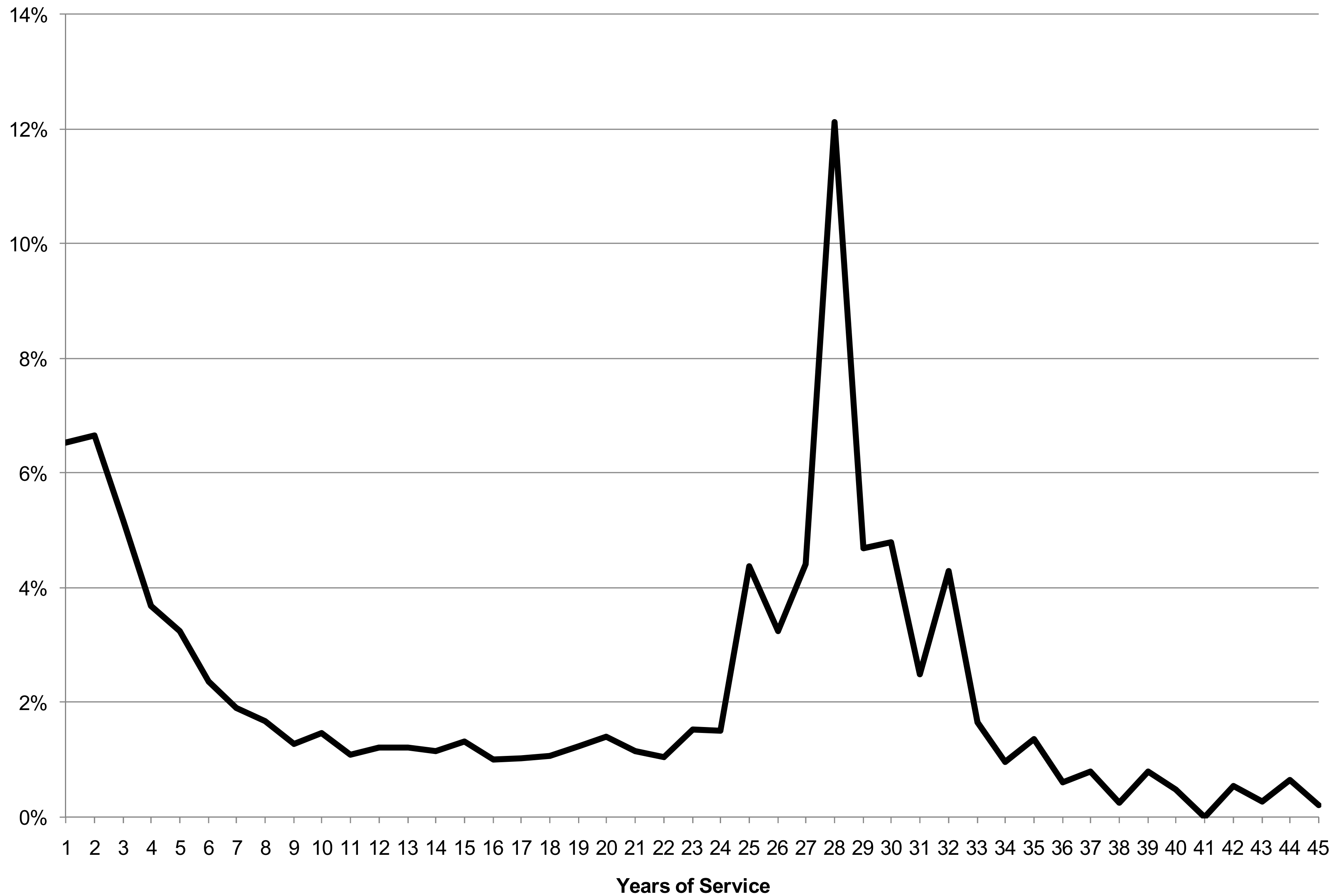


Figure 9. Weighted-Average 1-Year Cohort Separation Rates

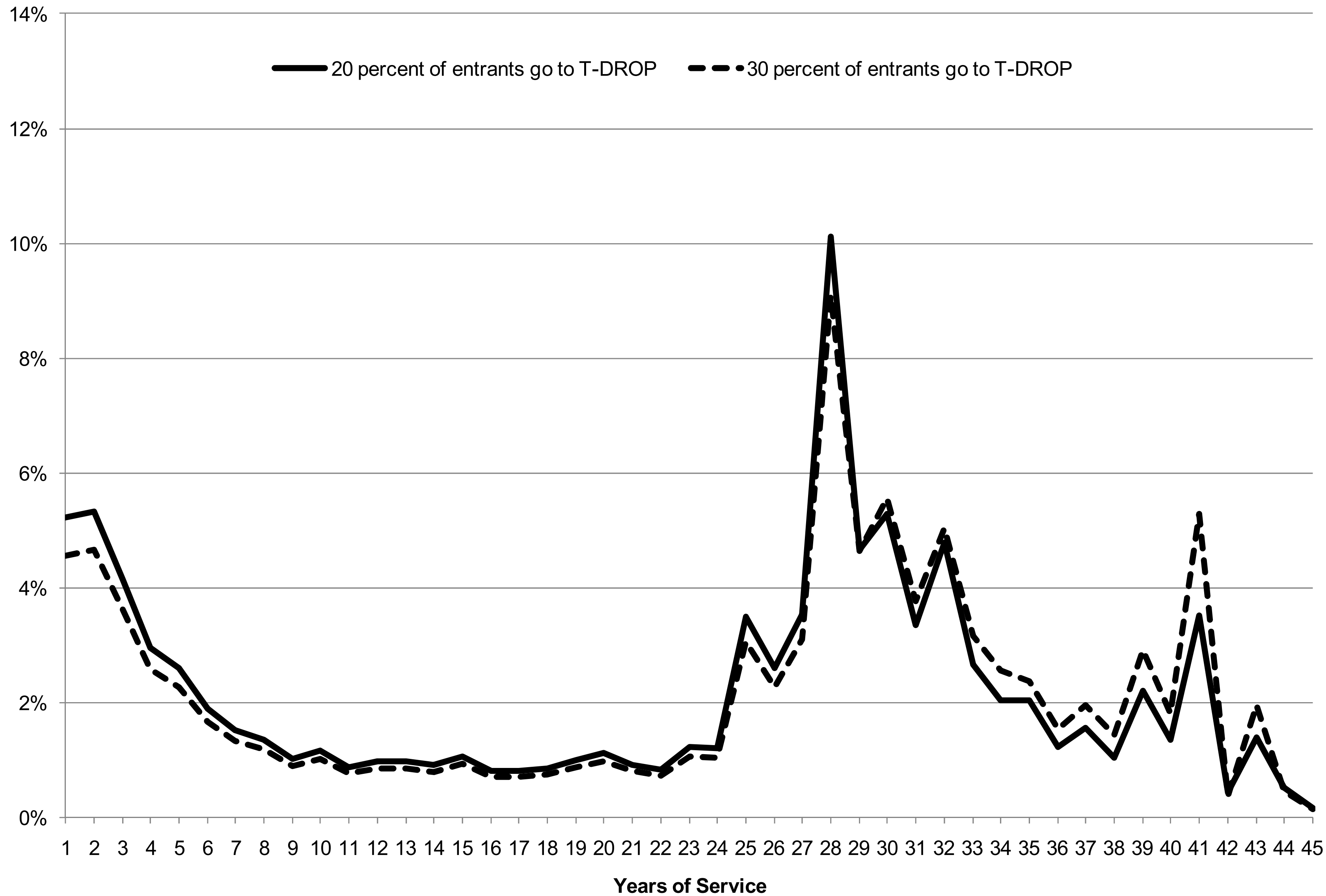


Figure 10: Predicted 1-year Separation Probabilities, ATRS Accrual
(25 year old entrant. Estimated from Column 2, Table 2)

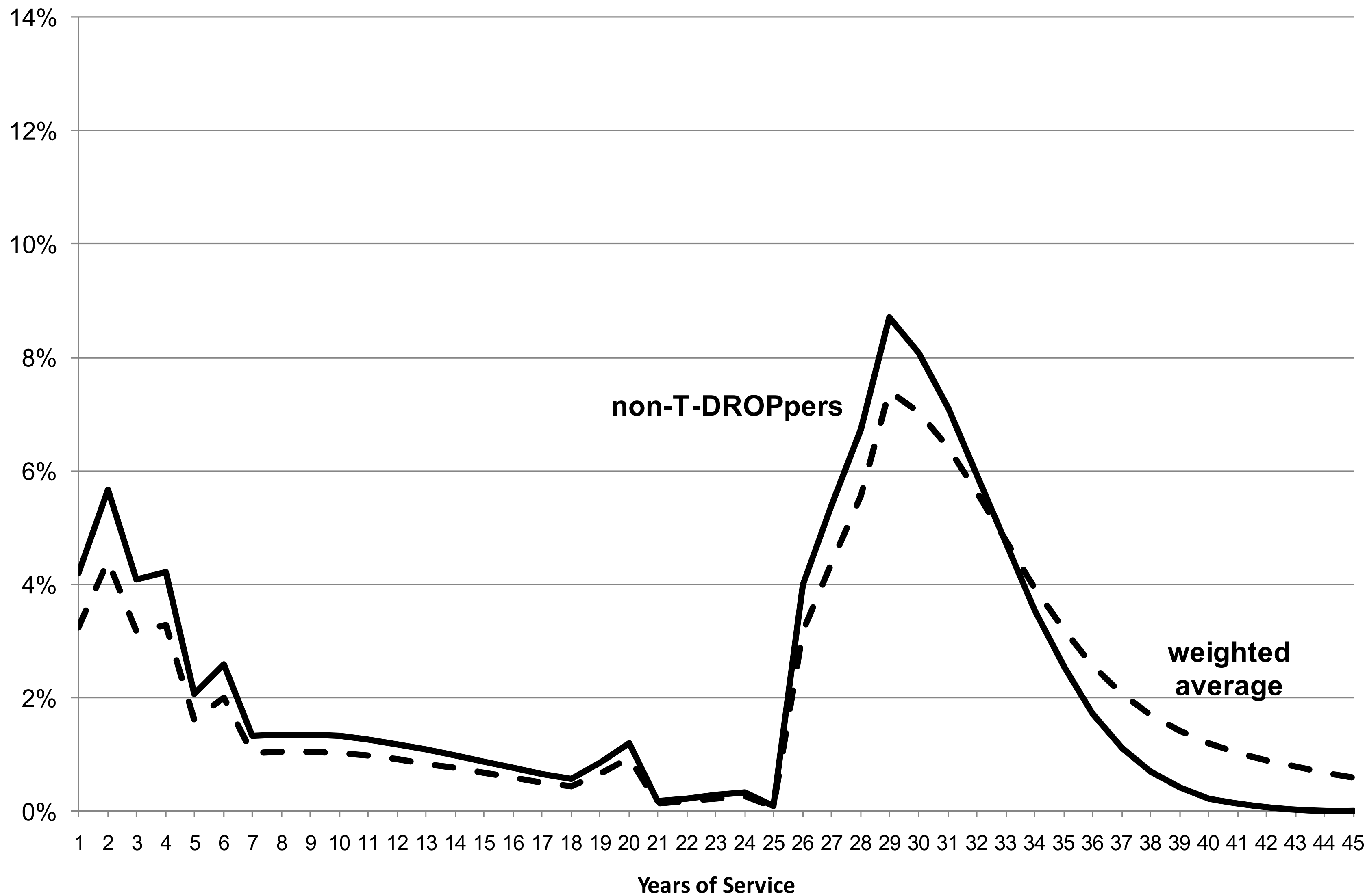


Figure 11: Predicted 5-year Separation Probabilities, ATRS Accrual

(25 year old entrant. Estimated from equation corresponding to Column 2, Table 2)

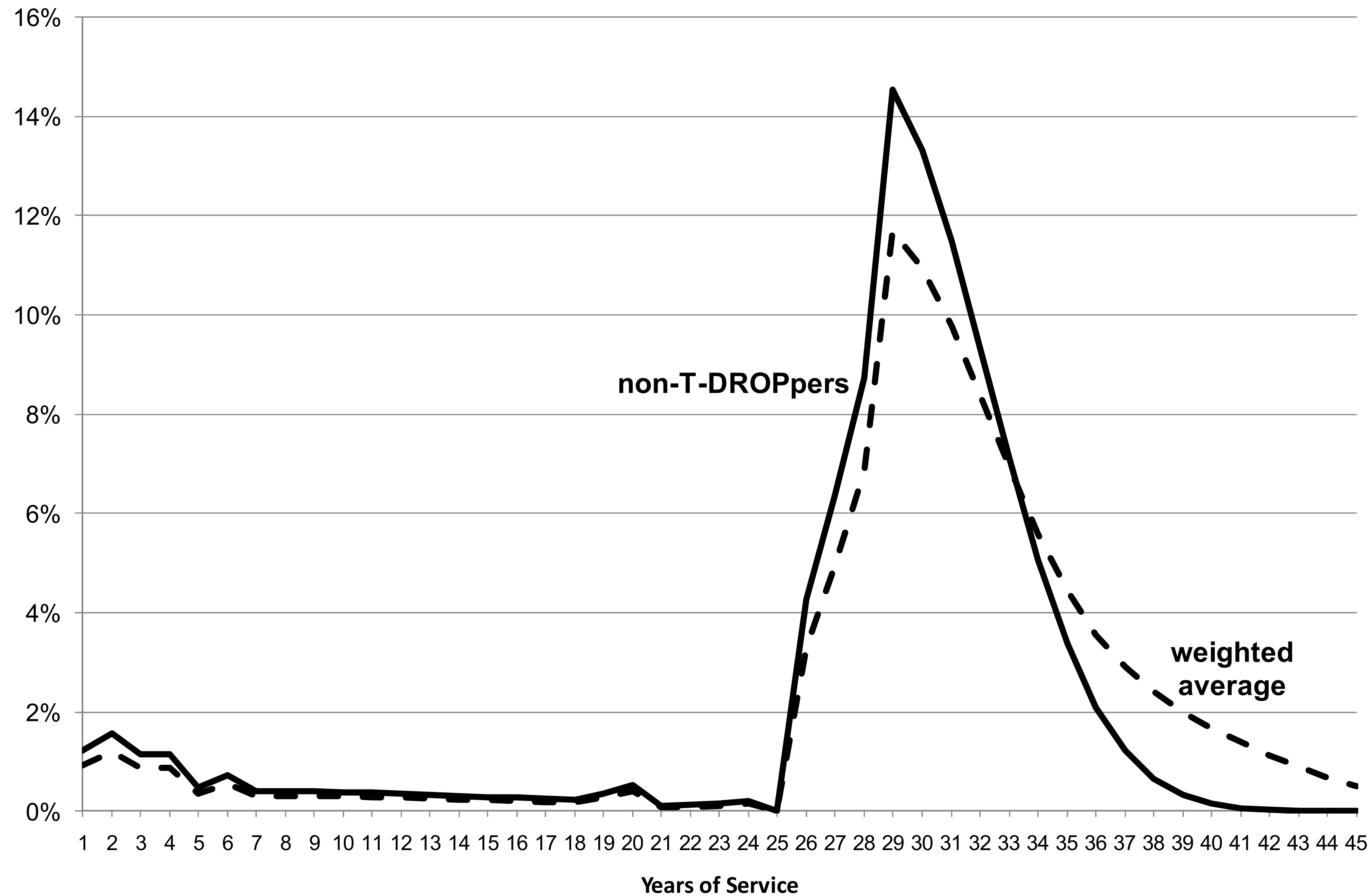


Figure 12. Pension Wealth Under ATRS and CB

(25-year old entrant. pension wealth adjusted for inflation)

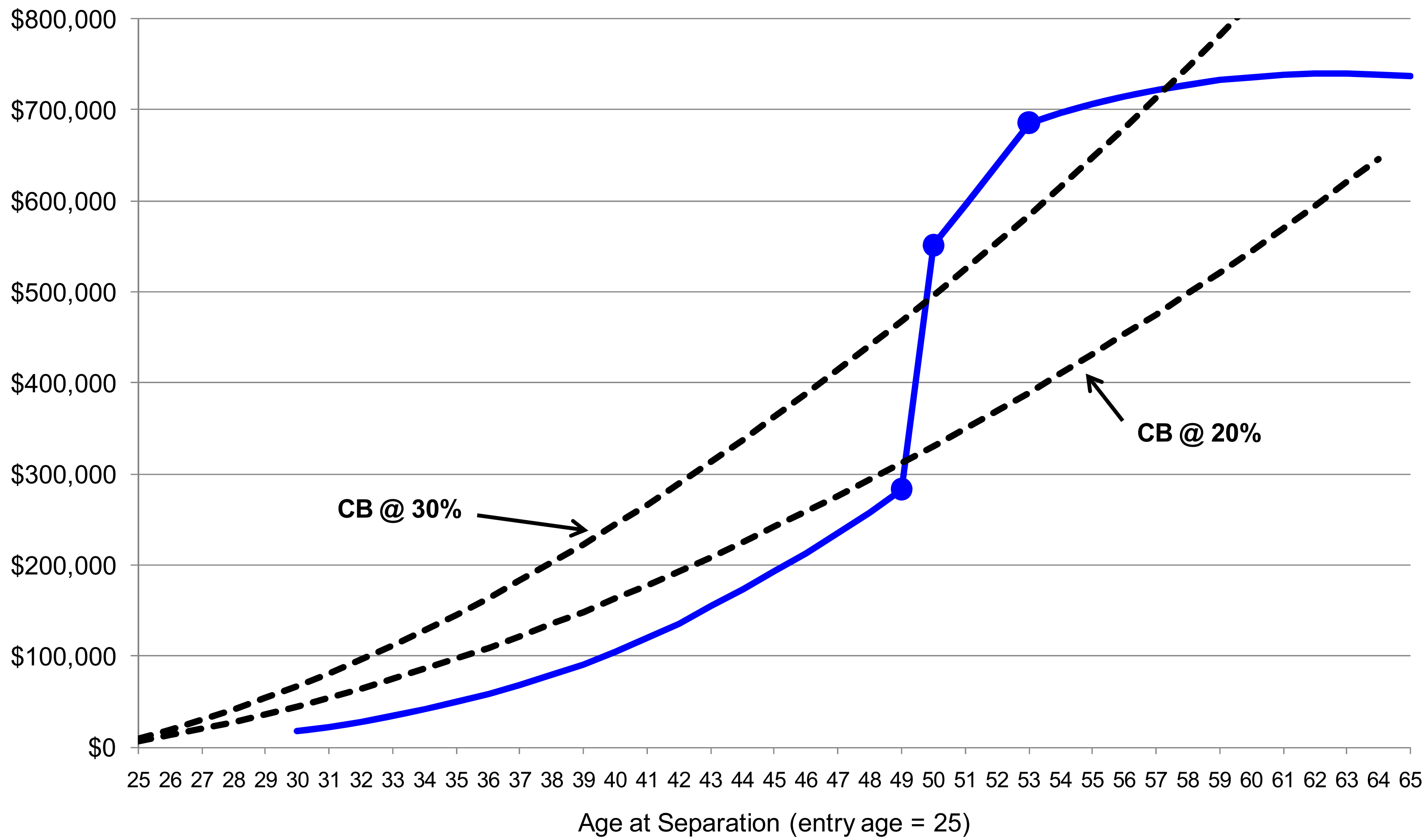


Figure 13: Predicted 1-year Separation Probabilities, Constant Accrual

(25 year old entrant. Estimated from Column 2, Table 2)

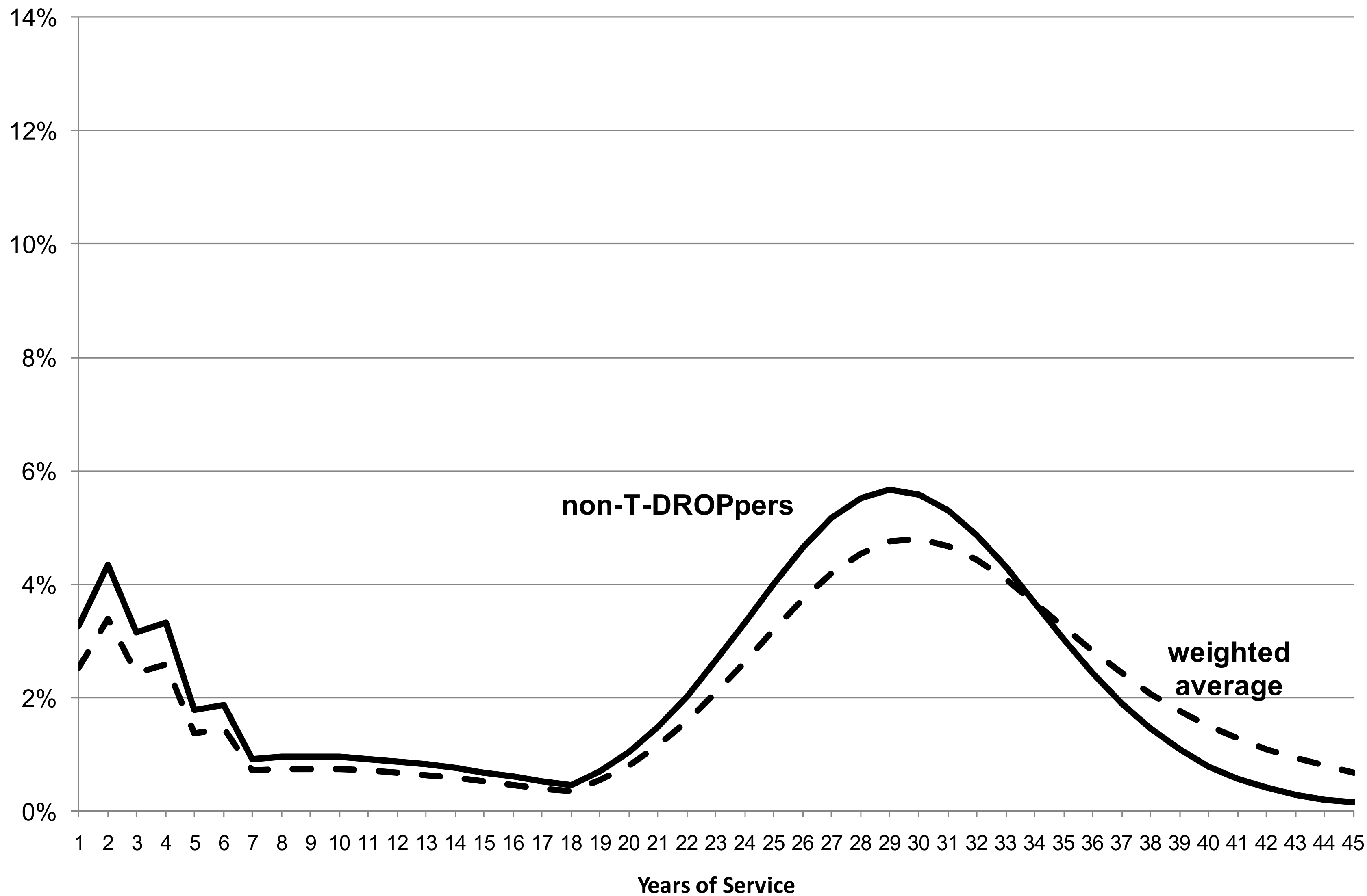


Figure 14: Predicted 1-year Cumulative Separation Probabilities, non-TDROP

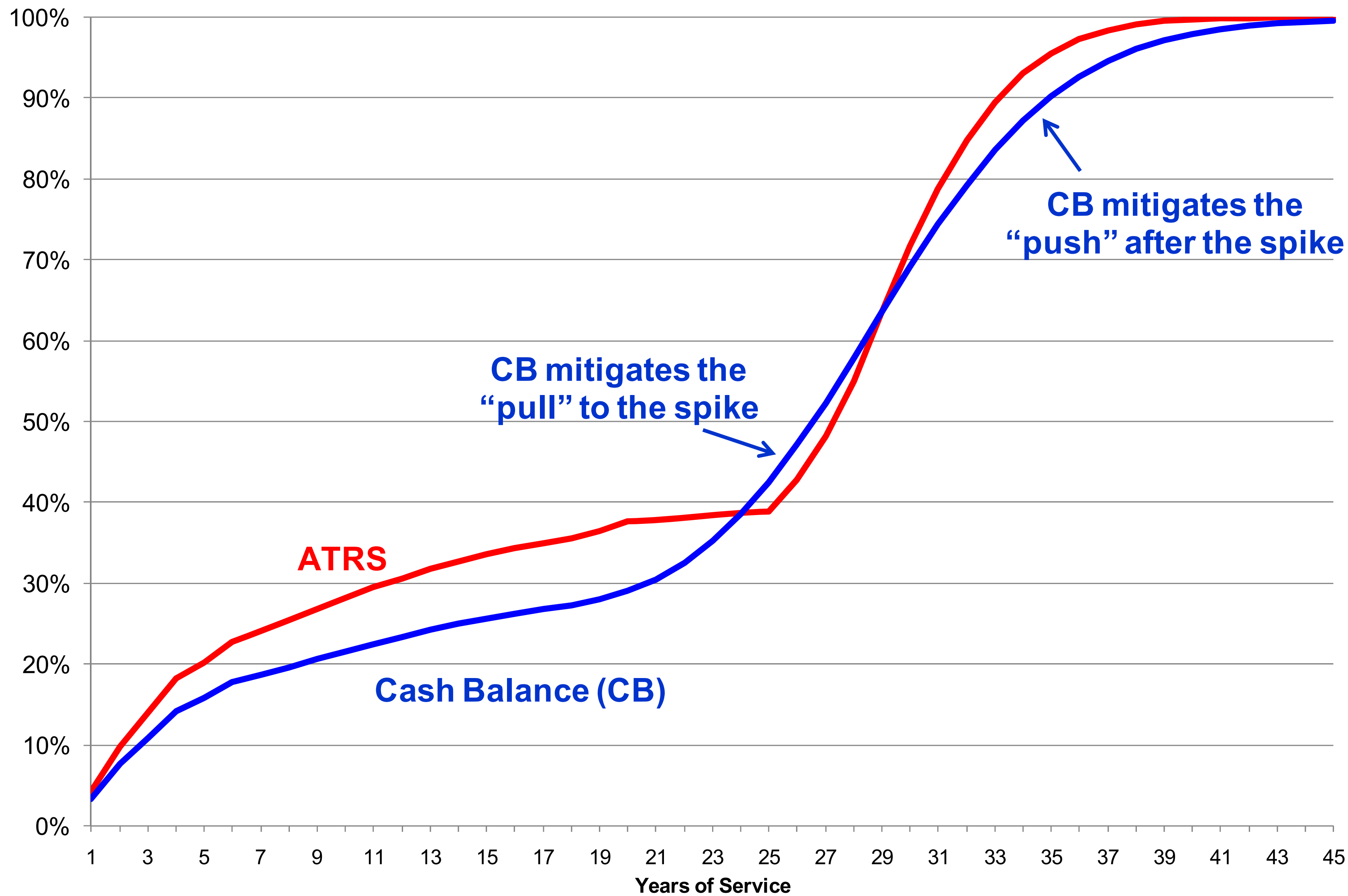


Figure 15: Predicted 5-year Separation Probabilities, Constant Accrual

(25 year old entrant. Estimated from equation corresponding to Column 2, Table 2)

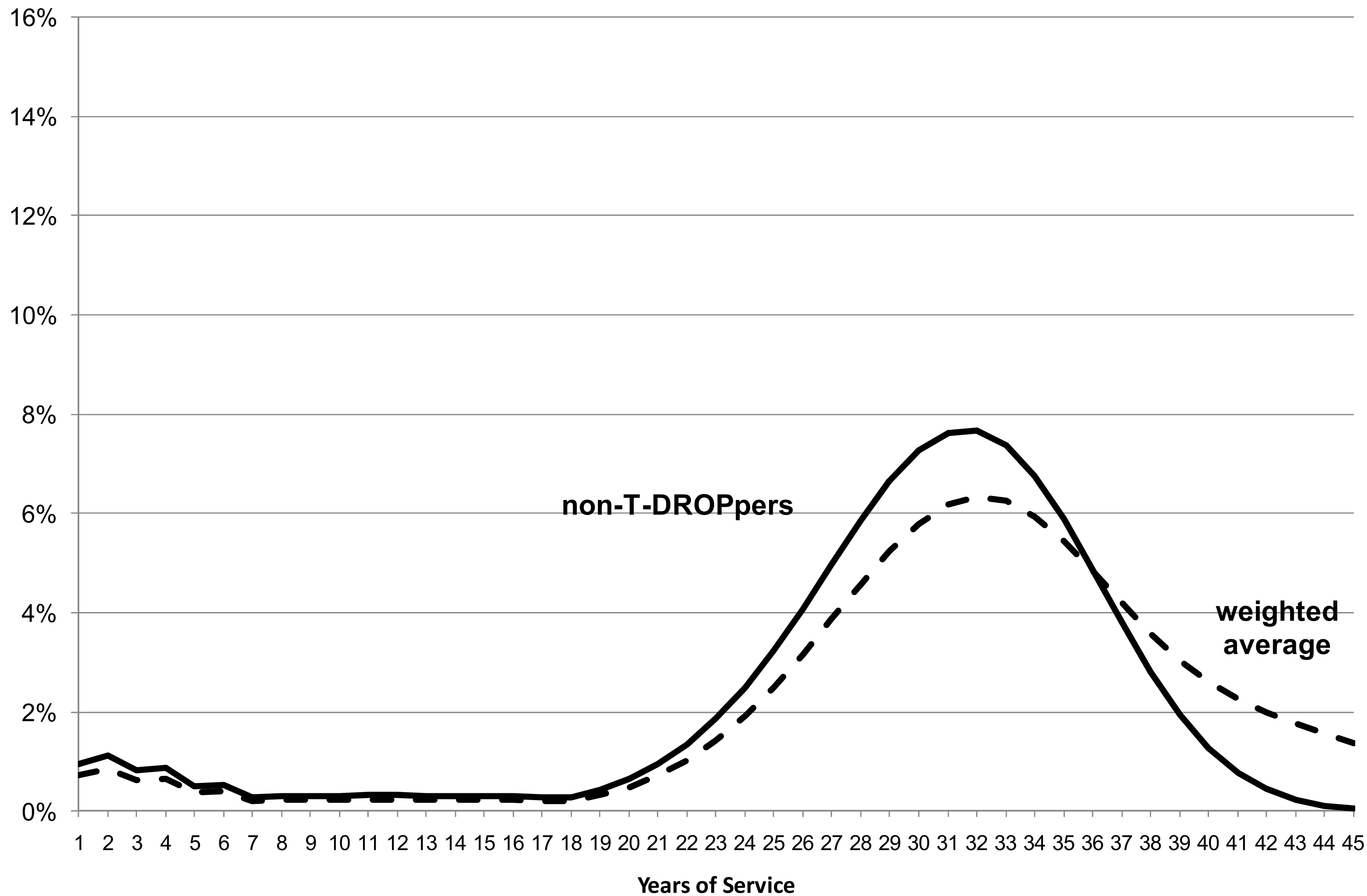
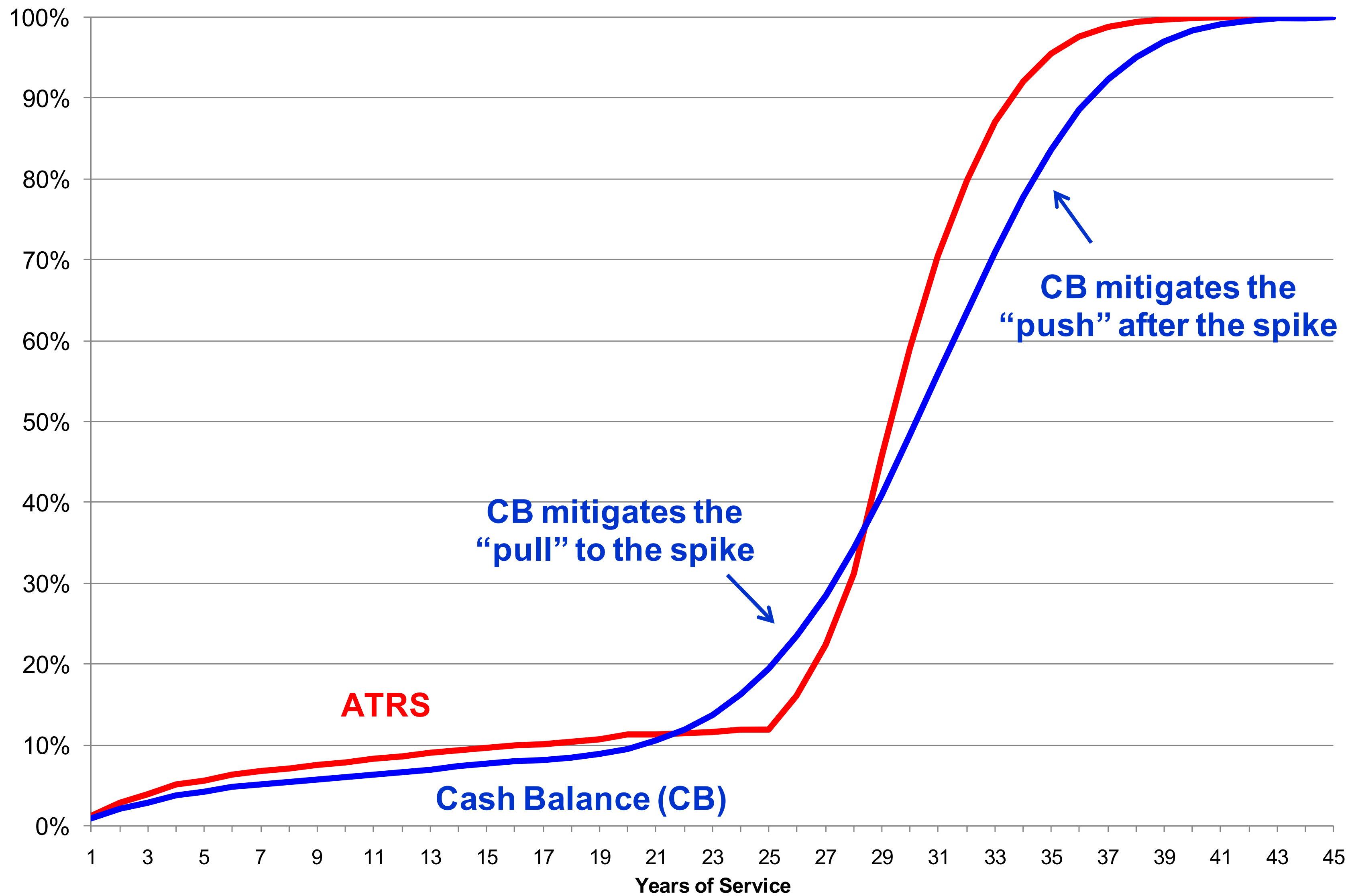


Figure 16: Predicted 5-year Cumulative Separation Probabilities, non-TDROP



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