

# Teacher Pension Incentives and Labor Market Behavior: Evidence from Missouri Administrative Teacher Data

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# Teacher Pension Incentives and Labor Market Behavior: Evidence from Missouri Administrative Teacher Data

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## **ABSTRACT**

Policy discussions about teacher quality and teacher “shortages” often focus on recruitment and retention of young teachers. However, attention has begun to focus on the incentive effects of teacher retirement benefit systems, particularly given their rising costs and the large unfunded liabilities. In this paper we analyze accrual of pension wealth for teachers in a representative defined benefit teacher pension system. Missouri substantially enhanced retirement benefits during the 1990s in response to a booming stock market. We estimate the current costs of those enhancements, and provide evidence of their effects on teacher retention and retirement. We construct forward-looking measures of teacher pension wealth and show that the actual distribution of teacher retirements can be approximated by simple models which assume that teachers retire when pension wealth is maximized. While retirement age is rising in other sectors of the economy, these pension enhancements appear to have lowered the average experience and age of retiring public school teachers in Missouri.

## 1. Introduction

Teacher pension funds and retiree health insurance represent a large and growing cost for public school districts. Many teacher pension funds have large unfunded liabilities. Undoubtedly these will rise as the recent stock market decline works its way into pension fund annual reports. However, even before the recent stock market meltdown, employer (and teacher) contribution rates were rising. Figure 1 reports BLS time-series data on employer contributions for retirement as a percent of earnings for public school teachers and private sector managers and professionals. Benefit levels are higher for public school teachers and the gap is widening.

(Figure 1)

Aside from their fiscal impacts, teacher pensions potentially have important labor market effects. A substantial literature in labor economics has identified the effect of incentives in pension systems on the timing of retirement decisions, labor turnover, and workforce quality (Friedburg and Webb, 2005; Asch, Haider, and Aissimopoulos, 2005; Ippolito, 1997; Stock and Wise, 1990). Unfortunately, little of this literature pertains to teachers. While there have been many studies of the effect of current compensation on teacher turnover and mobility (e.g., Murnane and Olsen, 1990; Stinebrickner, 2001; Hanushek, Kain, and Rivkin, 2004; Podgursky, Monroe, and Watson, 2004), the econometric literature on teacher pensions and their labor market effects is slender. The only published econometric study to date is Ferguson, et. al. (2006), who find that Pennsylvania teachers' retirement decisions are responsive to changes in pension wealth, earnings, and other school level variables.<sup>1</sup>

This paper contributes to the literature on teacher pensions and retirement behavior by developing a unique longitudinal state data set linking longitudinal SEA teacher records to state

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<sup>1</sup> See also Brown (2006), who examines the effect of an early retirement incentive program in California.

pension records to analyze the accrual of pension wealth in the teaching workforce. For each teacher in the workforce, we calculate current and maximum pension wealth. From the latter we derive a predicted age of separation assuming that teachers time retirement to maximize pension wealth. We also incorporate into our calculations of pension wealth the effect of numerous pension enhancements that have occurred over the period since 1992. We find evidence that these enhancements have lowered the average experience and age of retirement for teachers.

This type of analysis has utility for education policy analysis for several reasons. First, there is a surprising lack of descriptive data on teacher retirements. Even simple data on the average age and experience of retiring teachers by teaching field or demographics are not generally available. Second, there has been very little systematic analysis of the costs of the teacher benefits and their labor market consequences. Like Missouri, other states seem to have enhanced their retirement benefit rules during the bull stock market during the 1990's up to 2001. In the next section we describe the basic features of the teacher pension system and develop the concepts of current and maximum pension wealth. We then examine the pattern of enhancements in the rules of the teacher pension system and estimate their short and long run effects on teacher pension wealth. We then examine the pattern of actual teacher retirements and the relationship between the pension rules, retirement, and turnover.

## 2. Institutional Background: Basic Features of Missouri (and other) Defined Benefit Teacher Pension Systems

Missouri teachers, like nearly all public school employees, are covered by a defined benefit (DB) pension system.<sup>2</sup> The BLS reports that 72 percent of public school teachers

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<sup>2</sup> We say "traditional" because these are the types of plans that were the norm in both the public and private sector until recent decades. However, this is no longer the case in the private sector, which has largely shifted to defined contribution (DC) systems. Data collected by the U.S. Department of Labor show that DC plans now predominate in the private sector (EBRI, 2006).

nationally are covered by Social Security (BLS, 2008). In most cases this is a statewide decision. For example, California public school teachers are not in Social Security whereas Pennsylvania teachers are. Missouri is an exception to this general pattern. Teachers in the Kansas City and St. Louis school districts are covered by the Social Security system, and consequently they each have their own pension system. Teachers and other professionals in the 522 remaining school districts, which account for over 90 percent of public school teacher employment, are not in Social Security and are part of the Public School Retirement System (PSRS). Contribution rates in PSRS are substantial – currently 13 percent for teachers and districts, for a combined total of 26 percent. This percentage has risen sharply over the last decade. Nonetheless the system remains underfunded.<sup>3</sup>

In Missouri teachers become eligible for a full (undiscounted) pension if they meet one of three conditions: a) sixty years of age and at least five years of experience, b) thirty years of experience (and any age), or c) the sum of age and years of service equals or exceeds 80. The last condition is called the “rule of 80.”

Benefits at retirement are determined by the following formula (some variant of which is nearly universal in teacher DB systems):

$$\text{Annual Benefit} = S \times \text{FAS} \times R \quad (1)$$

where S is service years (essentially years of experience in the system), FAS is final average salary calculated as the average of the highest three years of salary, and R is the replacement factor. In Missouri teachers earn 2.5 percent for each year of teaching service up to 30 years.

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<sup>3</sup> The most recent annual report (FY2008) estimates the funding ratio (assets / liabilities) at 83 percent. This does not include the effect of the recent stock market decline.

Thus, a teacher with 30 years experience and a final average salary (average of last three years) of \$60,000 would receive:

$$\text{Annual Benefit} = 30 \times \$60,000 \times 0.025 = \$45,000$$

There are several other minor adjustments to the formula in equation (1). First, in order to provide teachers with assistance in purchasing health insurance, the average district contribution to individual teacher health insurance is included in FAS. Thus if the average of the highest three salary years was \$60,000 and the average contribution to health insurance was \$3,000 annually, then FAS would equal \$63,000. We use an estimate of health insurance benefit costs as a percent of earnings from the Columbia Public School system in estimating state-wide pension wealth accrual. Second, there is a “25 and out” option that permits retirement at a reduced rate if teachers have 25 or more years of experience. Finally, the value of R used in formula (1) is 2.5 for experience up to 30 years and 2.55 for experience of 31 or more years.<sup>4</sup>

### 3. Evolution of Rule Changes.

The rules of the pension system changed numerous times between 1992 and 2001. These rule changes made the system more generous for teachers and are widely acknowledged to have passed in response to the booming stock market returns earned by the fund during the 1990’s. The more uneven stock market performance since 2001 has tempered enthusiasm by the legislature for further generosity and no further significant enhancements have been implemented.

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<sup>4</sup> For years up to 30 the replacement factor is 2.5 percent. For 31 or more years the replacement factor is 2.55 percent, where the additional .05 percent is applied to the 30 inframarginal years. Thus the bump in the annual annuity for the 31<sup>st</sup> year of teaching is  $2.55 + .05(30) = 4.05$  percent. The return to the 32<sup>nd</sup> and subsequent years is 2.55 percent.

Table 1 chronicles eight significant rule changes over this period. At the beginning of the period, 1991-92, regular retirement occurred at 30 years, the replacement rate (R) in equation (1) was .021, final average salary was computed as the average of the five highest years of earnings, and cost of living allowance (COLA) increases were capped at 56 percent of the initial retirement annuity. Over the next decade all of these rules were liberalized. The most important change for regular retirement was the introduction of “rule of 80” in 1999. This permitted teachers to retire with regular benefits if experience was 30 years or greater or if the sum of age and experience was 80. A 1995 change (“25 and out”) permitted teachers to retire at reduced benefits at any age with 25 or more years of experience. The replacement rate rose to .025 by 1998 and .0255 for years above 30 in 2001. Another remunerative enhancement occurred in 1999, when calculation of final average salary was changed from the highest five years to the highest three years. Finally, the COLA cap increased from 56 to 80 percent in steps over the period. We will show below that these enhancements produced large increases in pension wealth for incumbent teachers.

#### 4. Incentives for Work Versus Retirement

Data on the parameters of teacher pension plans can be used to generate estimates of the magnitude of pension benefits using the concept of present value. When an individual retires under a DB plan he or she is entitled to a stream of payments that has a lump sum value that can be readily determined using standard actuarial methods. Indeed such methods form the basis for the pricing of annuities that are regularly bought and sold in the marketplace.

Figure 2 shows the increment in pension wealth as a percent of salary from an additional year of work for an educator who begins teaching at age 25 and works continuously until retirement. We assume the salary schedule of Jefferson City, Missouri (the state capitol) public



school teachers, although choice of a different salary schedule has little visible effect on the shape of the graph (since we normalize accrual by earnings in every year). The horizontal axis is the age at which the teacher separates. For the decade or so after vesting (5 years) a teacher's pension wealth grows slowly, as the accumulation of years of service raises the annual payment that one will eventually (at age 60) be eligible to receive. By our estimate, annual pension wealth accrual during this period is worth about 15-35% of the annual salary (or 5-15%, net of the employee contribution). By her mid-40s, however, the eligibility formulas kick in to gradually reduce the age at which she is eligible for a full pension, from 60 to 53. This has a dramatic effect on the teacher's pension wealth, and that wealth accrues annually at rates that actually exceed the salary for several years. Clearly, this teacher would have a powerful incentive to stay on the job during this period. The "25 and out" formula produces a very sharp spike at age 50 (since it permits roughly six extra years of pension eligibility which is not offset by the modest reduction in the annuity). Beyond age 56 the present value of pension benefits actually declines.<sup>5</sup>

(Figure 2)

## 5. Data

The data in Figure 2 describe incentives in terms of pension wealth accrual for each additional year of teaching for a representative teacher. We have seen that there are strong incentives to continue teaching, up to a point, but beyond that there are strong incentives to retire. However, it is an open question whether, and to what extent, teachers actually respond to these incentives. In our introduction we cited an empirical literature outside of teaching suggesting that workers in general are responsive to these retirement incentives. There are also

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<sup>5</sup> Costrell and Podgursky (2007) provide an extensive discussion of the "peaks and cliffs" in wealth accrual in teacher pension plans in Missouri and several other states. See also Kotlikoff and Wise (1984).

two studies which find that these retirement incentives matter for teachers as well (Brown, 2006; Ferguson, Strauss, and Vogt, 2007). In addition, not all teachers fit the simple example of our representative teacher (female, age 25 entrant, continuous work history). In fact, the teaching workforce has a wide range of experience, age, and earnings profiles, which interact in complex ways to produce considerable variation in workforce incentives. In order to further investigate the magnitude and structure of these incentives and their workforce effects, we turn to administrative data on teachers for Missouri.

We constructed from state administrative records a file of all full time teachers employed in Missouri public schools between 1991-92 and 2007-08. As noted above, the teacher pension system in Missouri is not uniform statewide. Teachers in the two largest school districts -- St. Louis and Kansas City -- are covered by the federal Social Security system and each district has its own pension system. Teachers in the remaining 522 school districts, comprising roughly 90 percent of the public school teachers, are in a state teacher pension plan (the Public School Retirement System, PSRS). In a cooperative agreement with the Missouri Department of Elementary and Secondary Education (DESE), we arranged a match between the records in the teacher file described above and PSRS retirement records. Along with data from the state department of education concerning teacher demographics, pay, experience, teaching assignments and related staffing information, we also used data on the month and year of retirement provided to DESE by PSRS. Thus, our study focuses only on retirement behavior of the teachers employed in the 522 districts under PSRS.

Figure 3 plots the distribution of years of experience at retirement for teachers who retired in 1993, 2002 and 2007. The first year, 1993, is before the major pension enhancements and the latter two years are after. Simple visual inspection of these data shows little difference

between the 1993 and 2002 distributions. The distributions show an increase in retirement rates at 25 years of experience, associated with the “25 and out” option and other early retirement options in the PSRS rules. For the 1993 and 2002 distributions there is a very sharp spike at 30 years experience, again, reflecting the fact that (as we will see below) most teachers maximize pension wealth at 30 years experience. The 2001 rule providing a replacement rate of 2.55 for 31 or more years took effect for teachers who retired after July 2001. The 2002 retirements still spike at 30 years, however, by 2007, the spike became a plateau, with slightly more teachers retiring at 31 years. While the mode has increased, the mean and median years of experience have declined. The average years of experience of 1993 retirees was 27.4 years. This fell to 26.2 years for 2002 retirees and 25.6 for 2007 retirees. The median fell from 29 in 1993 to 28 in 2002 and 27 in 2008. Mean and median retirement age fell over this period as well. Median retirement age fell from 58 in 1993 to 56 in 2007.

(Figure 3 and Table 2)

Figure 4 shows the patterns of retirement by age at retirement, for all retirees from 2002-2008 (i.e., after the wave of enhancements). We report these for all teachers, and, given policy interest in STEM teacher shortages, math and science teachers. The median retirement age for all teachers over this period is 56. For math teachers the median is 55. By age 60, 88 percent of math and 85 percent of science teachers have retired. The rate for all teachers is 83 percent. These rates are much lower than conventional retirement ages in the rest of the work force. By comparison, the minimum age for regular retirement under Social Security is 66 and rising.

(Figure 4)

## 6. Pension Wealth

As noted above, it is possible to estimate the implicit pension wealth of a teacher by summing the expected value of the flow of their annuity payments after retirement and discounting the total back to any year in her career. We make these calculations on the assumption that for any given year of separation, a teacher will only begin collecting her pension at an age when pension wealth is maximized. Figure 2 shows the increment in pension wealth from an additional year of work for a representative teacher operating under this rule. We made similar calculations for all of the teachers in the workforce.

In fact matters are a bit more complicated. In our data set we developed several measures of pension wealth, based on two important ideas in the retirement literature. The first is current pension wealth. This amount is the discounted present value of the retirement annuity to which a teacher is entitled given her salary and work history to date, and given the current pension rules.<sup>6</sup> Of course when the pension rules change, current pension wealth changes, and we can compute the change in pension wealth given any rule change. As we saw in Table 1, there were many rule changes that increased pension wealth during the 1990's. In fact, for nearly every year from 1994 to 2001, favorable rule changes enhanced teacher pension wealth.

Our measures of current pension wealth are shown in Figures 5-7. Figure 5 reports the distribution of our estimate of pension wealth for the 2301 teachers who retired in 2007 under current pension rules. The mean pension wealth (in current dollars) is \$684,635. Figures 6 and 7 show how the per-retiree and aggregate pension wealth for this group increased as a result of the various enhancements enacted between 1994 and 2001. If the pension rules of 1992 had prevailed in 2007, the average pension wealth of a retiree would have been \$193,000 lower.

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<sup>6</sup> Annuity values were constructed using standard life tables for males and females. We assumed a discount rate of 5 percent and an inflation rate of 3 percent. For each teacher we computed pension wealth in all future years (to 101 years of age) under all pension rules and selected the maximal value for that year. For details, see Appendix A.

Aggregated over all retirees this amounted to roughly \$390 million. However, the wealth gain for a single cohort of retirees is simply the tip of the iceberg. Figure 8 shows that the gain in pension wealth for the entire 2007 workforce is \$ 4.1 billion. Finally, Figure 9 reports the gains in maximum pension wealth as a result of these rule changes. We explain below in more detail how this is computed, however, to round out this discussion, we simply note that if all of the 2007 teachers timed their retirement so as to maximize pension wealth, then the present value of the gain in wealth due to these pension enhancements is \$9.8 billion.

(Figures 5-9)

This latter pension wealth measure is useful for predicting retirement. This we call maximum pension wealth, and we compute not only the level of maximum pension wealth, but also the year of experience in which this maximum is realized. A teacher who works beyond this point has negative accrual of pension wealth. Several studies have found that calculation of “peak value” of pension wealth can predict retirement behavior (e.g., Friedberg and Webb, 2005; Coile and Gruber, 2007).

Each of these enhancements produced an immediate increase in pension wealth for all active (and separated but not retired) teachers. For all teachers in our file we have actual salaries paid in each year and work history to date. However, to compute maximum pension wealth we had to forecast future salaries. Ideally we might have used salary schedules for all of the 522 school districts in the pension plan. Even these data would have been inadequate since teachers move across different columns based on education levels and teachers earn additional salaries for additional duties (e.g., coaching). In addition, the earnings in each cell grow over time. Thus we approximated a life-cycle earning profile by tracking earnings for an entry cohort of teachers from 1991-92 through 2006-07 as a cubic equation in experience. The regression also included

year dummies to pick up general cost of living increases. We used this cubic in experience to estimate the return to an additional year of experience, net of cost of living or overall increases. Thus, forecasts of future earnings for a teacher take current salary and add expected inflation (3 percent per year) plus the earnings growth from additional experience from the earnings regression. Using these forecast earnings, we estimated future values of pension wealth under all rules in place in all future years. We identified the year at which pension wealth is maximized. We define that year of experience as the “optimal separation year.”<sup>7</sup> Again, we emphasize that this is “optimal” only in the sense that pension wealth is maximized given our assumed five percent discount rate. This does not necessarily mean that this is the utility-maximizing choice for a teacher. That would depend on teacher preferences concerning work and leisure, individual health and family factors, and, of course, individual discount rates – data to which we do not have access. In addition, we are ignoring uncertainty in these calculations.<sup>8</sup>

In spite of these rather strong assumptions, it is clear that many teachers retire at or near the year in which pension wealth is maximized. Figure 10 reports the results of an exercise in which we forecast retirements through 2007-08 for all active teachers aged 50 or older in the fall 2004 teaching workforce. On the horizontal axis we report years of teaching experience. For each active teacher in fall 2004 we estimated the optimal separation year. Those data are plotted, along with the actual distribution of retirement. Both distributions have a peak at 31 years, although the forecast is much more concentrated on this value. In fact, the fit of the forecast model is better than indicated by this chart – 65 percent of teachers who retired during this three year window, were predicted to retire based on a forecast of maximum pension wealth.

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<sup>7</sup> Details concerning calculation of current and maximum pension wealth are presented in Appendix A.

<sup>8</sup> For example we assume a 3 percent inflation rate which is constant and known to the worker. Stock and Wise (1990) and others have estimated structural decision models, which identify some of these parameters in teacher utility functions. This will be a direction for future research.

(Figure 10)

We have seen that the distribution of retirements in 2003 and 2007 is similar to retirements in 1993, before the retirement enhancements. The only obvious difference is a shift in the mode from 30 to 31 years, which is predicted by our assumption of pension wealth maximization. Thus, an initial conclusion is that these enhancements were, for the most part, simply a wealth transfer to incumbent teachers. However, it is possible that the higher rewards for long term stability lowered teacher turnover in years leading up to retirement years. In Figure 11 we present data on teacher turnover by years of experience from 1992-94 and from 2004-06.<sup>9</sup> Both curves display the familiar U-shape in years up to retirement. As with the retirement distribution, the peak year for retirement related attrition moves from 30 to 31 between the two groups. What is interesting, however, is the significantly higher attrition rate between 15 and 28 years. The result of the various rules that effectively lowered the age at which a teacher can collect a full or reduced pension (e.g., from 30 years to “rule of 80”, “25 and out”) is that there is greater rather than less mid-career attrition of teachers.

(Figure 11)

The introduction of “25-and-out” and “age-reduced” rules during 1994 to 1996 substantially raised the number of teachers who are eligible for retirement. Among the 1648 retirees in 2007, 582 (or about 35 percent) of them would be ineligible under the 1992 rules and 337 (20 percent) would be ineligible before “25-and-out” was introduced. These rules appear to have induced early retirement of experienced teachers.

## 7. Conclusion

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<sup>9</sup> A teacher is defined as exiting if she left the PSRS workforce for at least one year.

Policy discussions about teacher recruitment, retention, and quality often focus on young teachers. However, public concern with large unfunded liabilities associated with teacher retirement benefits is focusing growing attention on late career employment decisions as well. In this paper we present descriptive data from a new state teacher administrative data file that links teacher administrative records to data from the teacher pension fund.

We showed that the pension rule changes enacted from the mid-90's through 2001 in response to the stock market boom produced large short-run and even larger long run increases in teacher pension wealth. Ironically, nearly all of the policy discussions of falling relative teacher pay during the 1990's failed to take note of the short and long run wealth effects of retirement benefit enhancements taking place at the time (e.g., Allegreto, Corcoran, and Mishel, 2004). As a consequence of those changes, Missouri educators now have \$4.1 billion more in pension wealth than they would have had under the 1992 rules – a gain of roughly \$67,000 per active teacher and \$193,000 per retiring teacher.

Do these pension incentives affect turnover and retirement? Simple visual inspection of experience data for retirees suggests that pension plan rules have an effect. Spikes are easily visible at certain key levels of experience (25 and 30 years). Second, forward-looking measures of maximum pension wealth can predict these peak values. The pension enhancements that occurred during the 1990's did little to change the existing structure of retirement incentives. However, a small bonus for 31 or more years of experience did move modal retirement experience from 30 to 31 years. The introduction of "25 and out" and other early retirement options allowed teachers to retire earlier and we find that a substantial number of teachers are taking advantage of that option. The net result is that Missouri teachers are retiring with fewer years of experience – an average of 27.1 years in 1993 and 26.4 years in 2007, and at younger



ages – 58.7 in 1993 and 56.5 in 2007. Thus while average retirement ages are rising in the rest of the U.S. economy as well as other industrial economies (Gendell, 2008; Muldoon and Kopcke, 2008; Burtless, 2008), they were falling for Missouri teachers.

Since few states have longitudinal teacher data linked to retirement records, we do not know if the findings in this paper generalize. With respect to Missouri, it is not clear that this enhanced retirement benefit system is sustainable in the long run. Teachers and districts both currently contribute 13 percent of earnings, for a combined contribution rate of 26 percent. This rate will increase to 14 percent for both groups next academic year. The recent sharp decline in the value of the pension portfolio greatly exacerbates these funding problems. We believe that a useful next step in teacher pension research is to estimate structural models of retirement that will permit better forecasts of retirement timing. These econometric models will, in turn, permit simulation of labor force and fiscal effects of alternatives to the current retirement benefit rules.

## Appendix A Calculation of Current and Maximum Pension Wealth

The key parameters are the discount rate ( $r$ ), the inflation ( $g$ ), and salary growth. Pension wealth is calculated under the assumption that  $r=4\%$ ,  $g=3\%$ . The growth of real teacher salaries over a life-cycle is assumed to follow a nonlinear schedule estimated using teacher level longitudinal data tracking the 1991-92 teacher cohort forward. We find that that real salaries peak at roughly 30 years of experience. The assumed inflation rate is 3 percent. Male and female survival probabilities are taken from U.S. Department of Health and Human Services National Vital Statistics Reports.

The survival rate used to compute the annuity value of the pension is gender dependent and is calculated from the mortality rate of the general population in the U.S.<sup>10</sup> We denote the survival rate at age  $A$  for one more year as  $G(A,A+1)$ , and denote  $G(A,A+i)$  as the survival probability from age  $A$  to age  $A+i$ . It follows that  $G(A,A+i)=G(A,A+1)\times G(A+1,A+2)\times\dots\times G(A+i-1,A+i)$ .

The current state of a teacher in teaching force is characterized by her age ( $a$ ), experience ( $e$ ), and salary ( $y$ ). The forward-looking pension-related choice variables are planned year of separation from the current year,  $s$  ( $s \geq 1$ ) and the year in which she starts collecting pension,  $c$  ( $c \geq s$ ). The final average salary  $FAS=f(y,s)$  is projected from the current salary ( $y$ ) and the number of years before separation ( $s$ ). The pension depends on FAS, the experience at retirement ( $S=e+s$ ) and the age ( $A=a+c$ ) when the teacher starts to collect pension.

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<sup>10</sup> National Vital Statistics Reports Dec 28, 2007, Vol 56, No. 9. United States Life Tables, 2004, Table 2 and Table 3.

The pension annuity in the first year is  $F(S,A,FAS)$ . We assume a COLA adjustment on the pension up to a COLA limit (currently 80 percent of  $F(S,A, FAS)$ ). After the nominal payment hits the COLA cap, we assume the nominal payment is constant so the real payment declines over time. The present value in terms of the first year of collection is  $F(S,A,FAS)=S \times FAS \times$  pension rate. The present value of  $i$ -th year after the starting the pension in terms of the first year of collection is  $C(A+i)=F(S,A,FAS)G(A,A+i)[(1+g)/(1+r)]^i$  if  $(1+g)^i \leq 1+COLA$  limit; or  $C(A+i)=F(S,A,FAS)G(A,A+i)(1+COLA)/(1+r)^i$  if  $(1+g)^i > 1+COLA$  limit.

The sum of the present value collected until age 101 is  $P(a,e,s,c,y)= C(A)+ C(A+1) + \dots + C(101)$ . The present value of pension wealth under choice  $(s,c)$  discounted to the current year with state  $(a,e,y)$  is  $PV(a,e,s,c,y) = 1/(1+r)^c \times G(a,A) \times P(a,e,s,c,y)$ .

For given separation year  $s=1,2,\dots$  the optimal collection year (assume it is no later than 80) is  $P(a,e,s,y)= \max_{\{s \leq c, a+c < 80\}} PV(a,e,s,c,y)$ .

The current pension wealth is defined as  $P(a,e,1,y)$ , i.e., pension wealth with next year as the separation year and optimal collection year. The maximum pension wealth under optimal choice  $(s,c)$  is  $PW(a,e,y)=\max_{\{s\}} P(a,e,s,y)$ .

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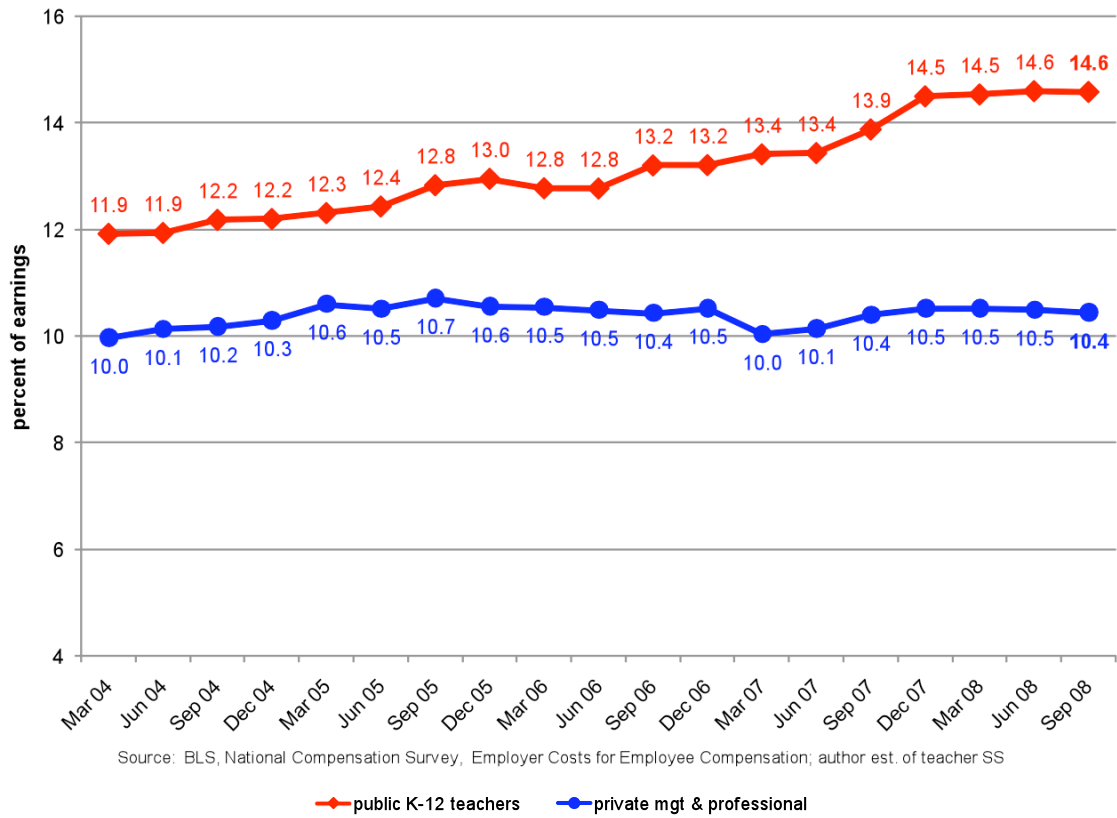
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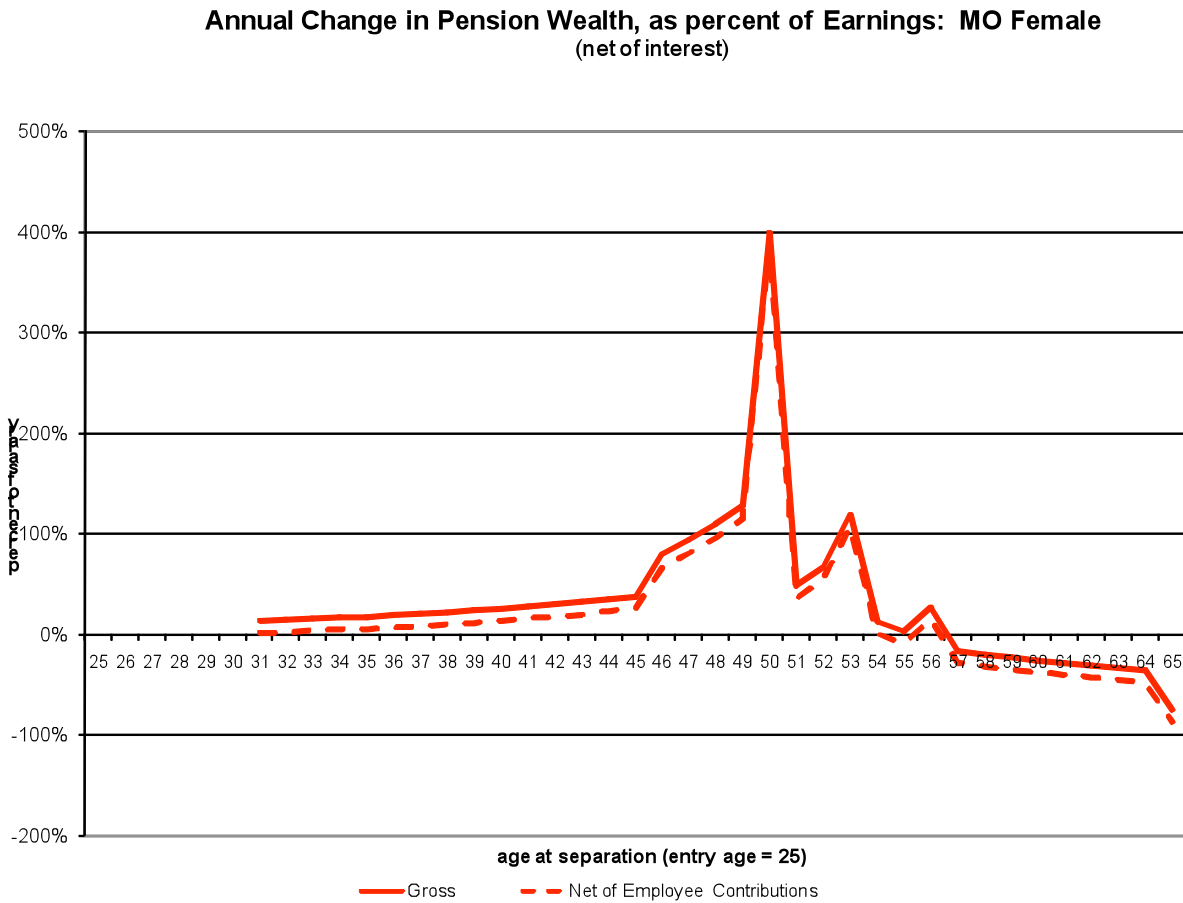
Figure 1

Employer Contributions for Retirement:  
Public School Teachers and Private-Sector Professionals and Managers



Source: Costrell and Podgursky (2009b)

Figure 2



Female teacher, age 25 entry, works continually, Jefferson City, Missouri salary schedule, inflation = 2.5 percent, discount rate = 5 percent. For further details see Costrell and Podgursky (2009a)

Figure 3

Years of Teaching Experience for Retiring Teachers:

1993, 2002, and 2007

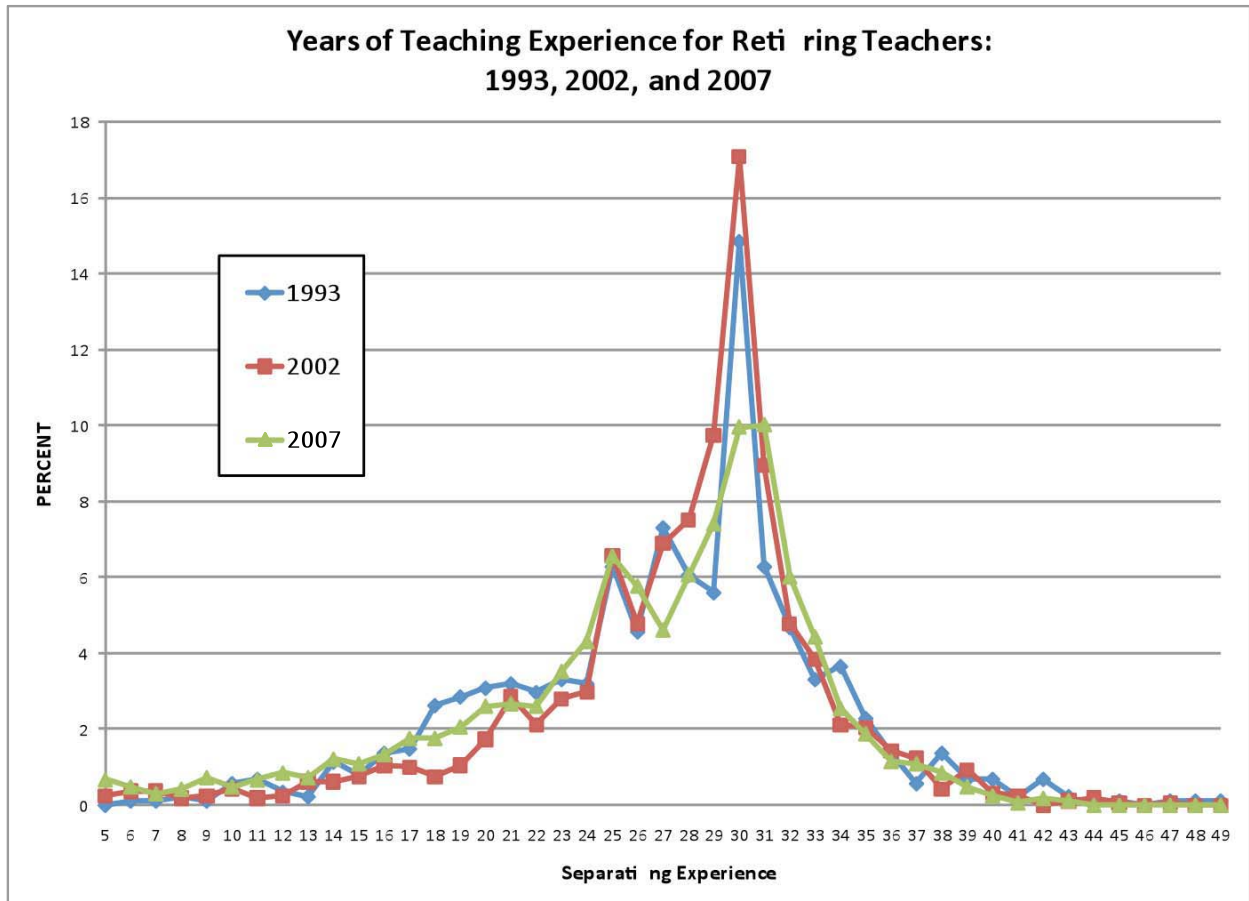




Figure 4

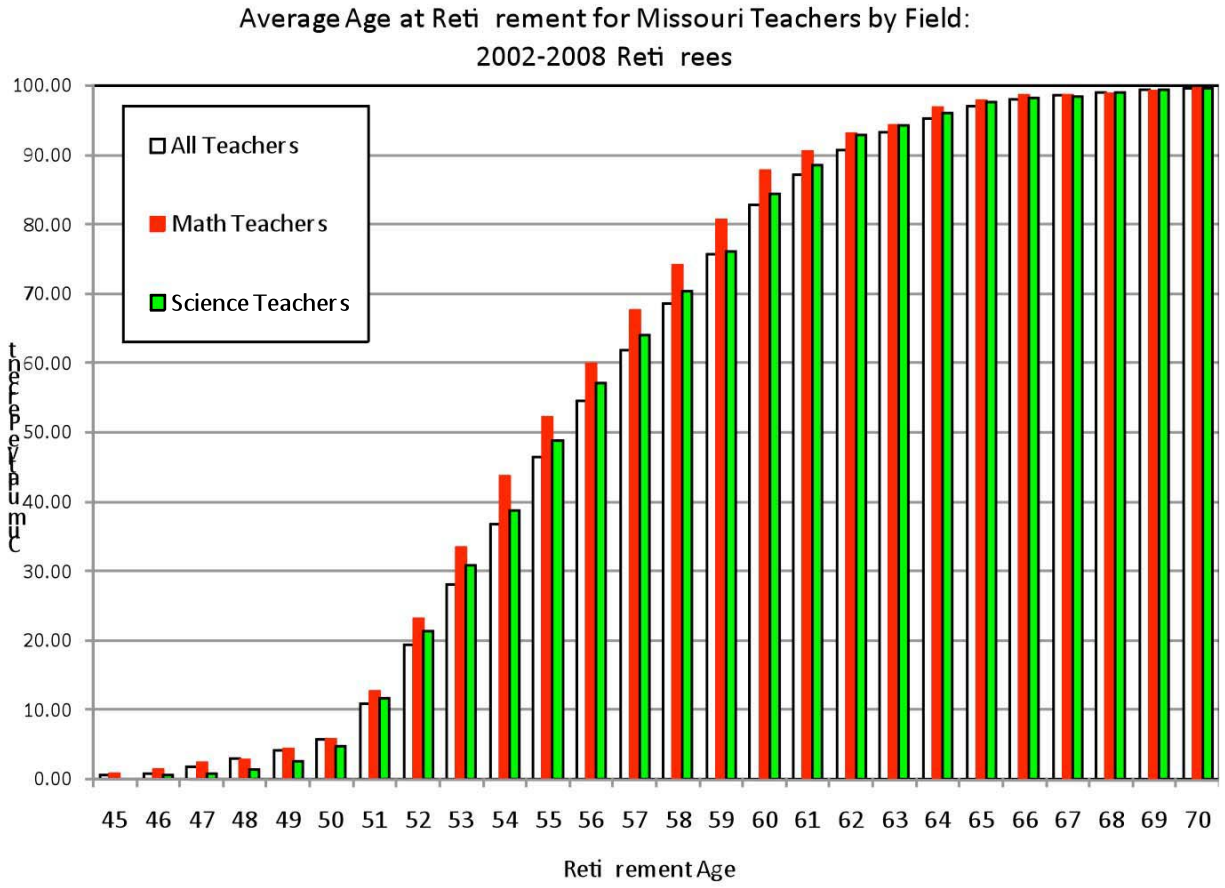
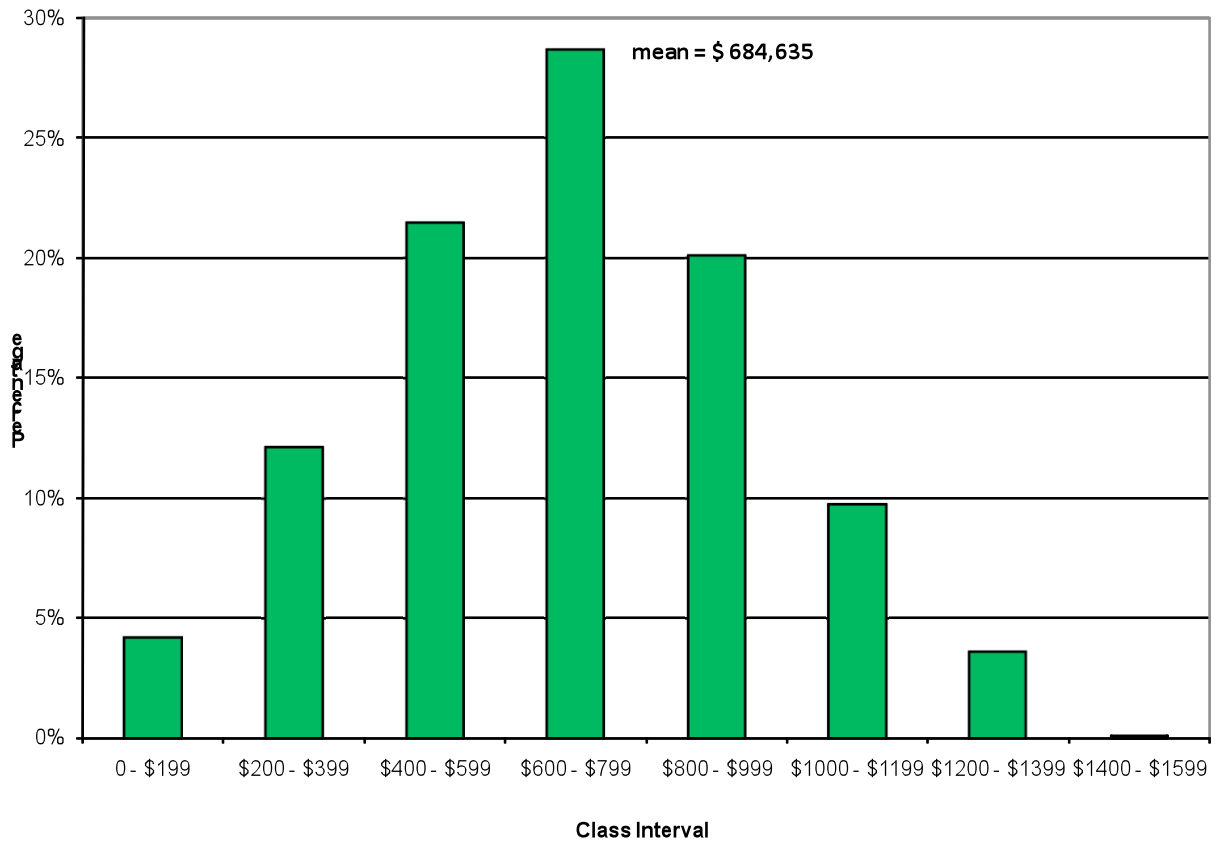


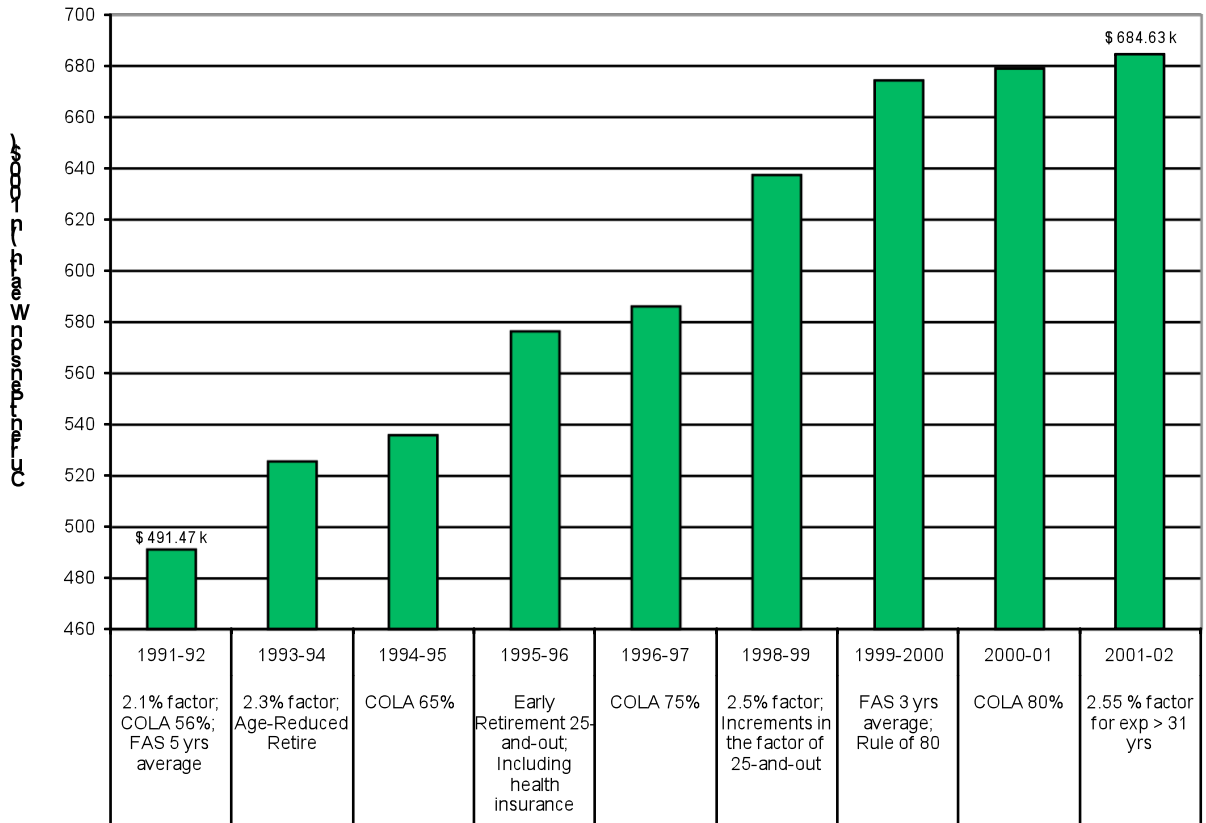
Figure 5

Distribution of Pension Wealth for 2007 Teacher Retirees

(\$ 000)

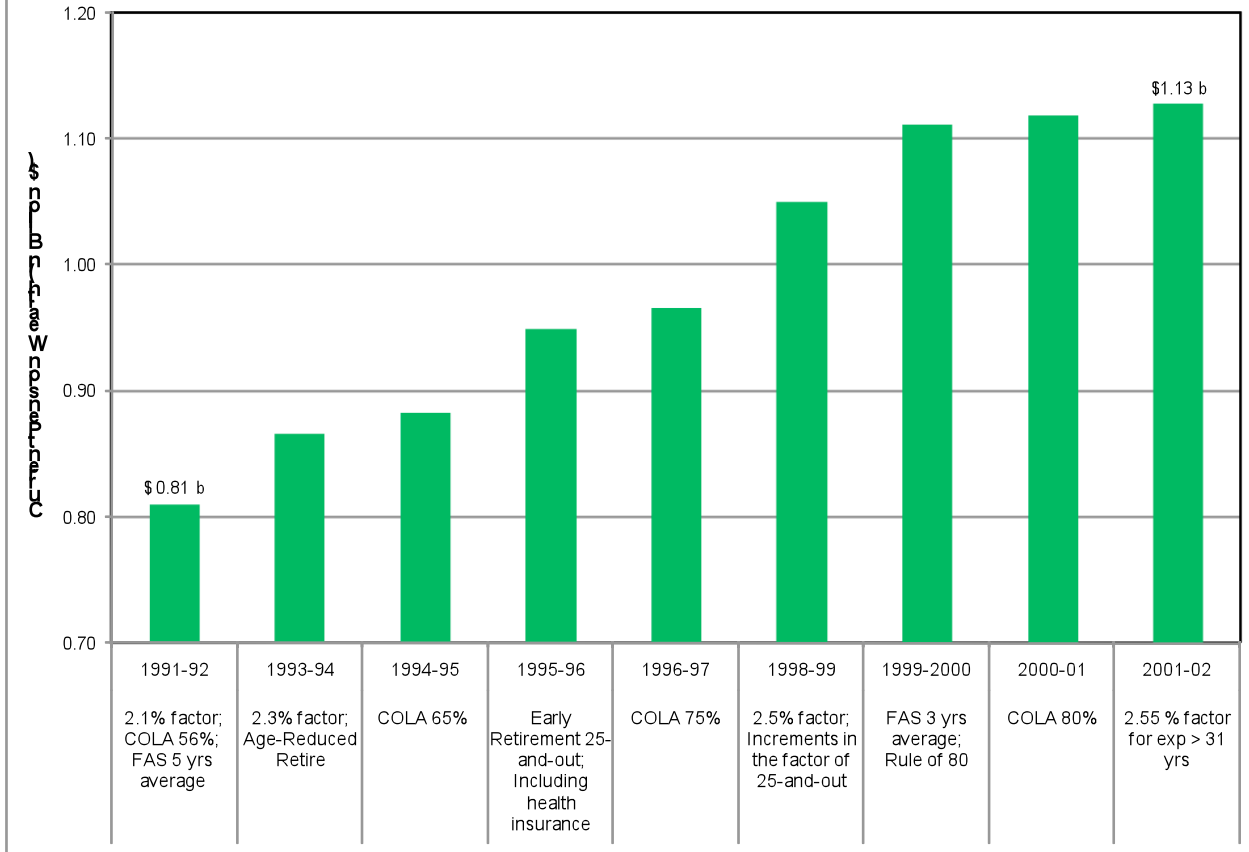


**Figure 6: Impact of Different Retirement Rules on Current Per Teacher Pension Wealth: 2007 Retirees, who were Full-Time Teachers in 2005-06 <sup>a</sup>**

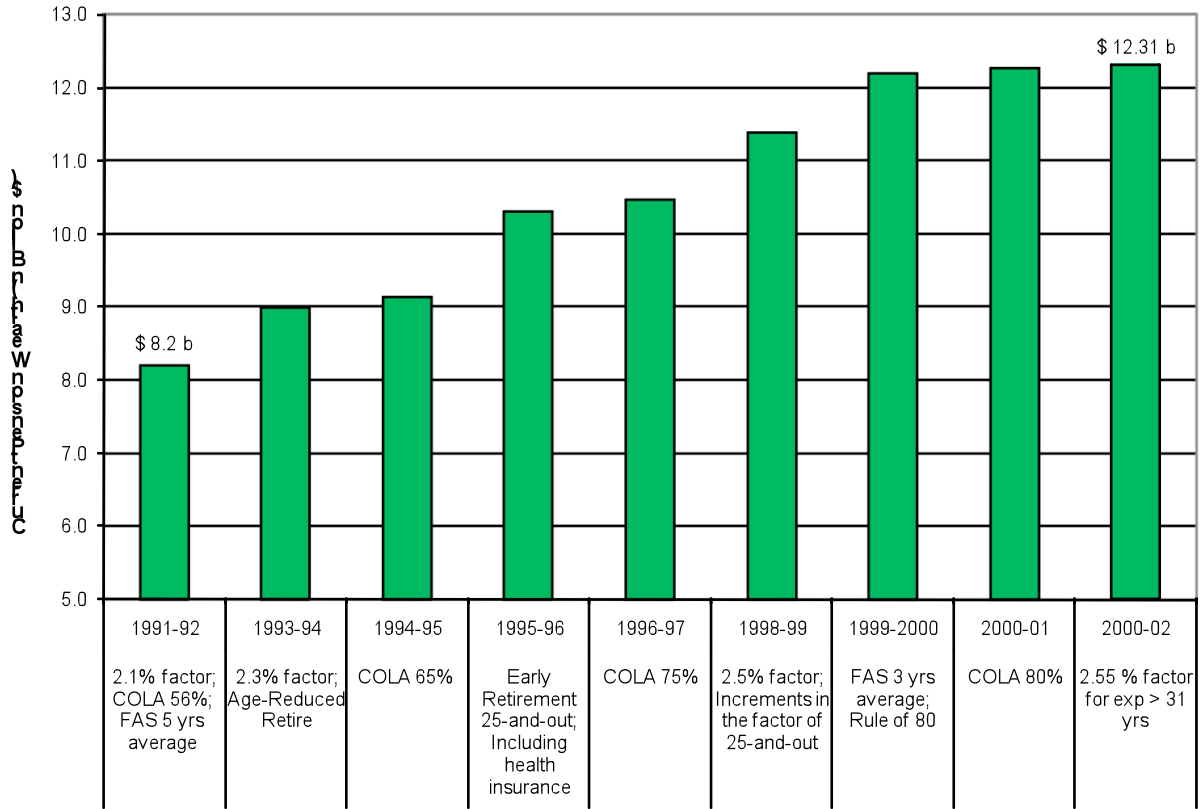


a. Except for 1991-92, the school year indicated refers to the first year that the enhancement became effective. Thus, changes from one bar to the next indicate the effect of the enhancement in question relative to the prior year and the rules in the starting year 1991-92. See Table 1 for details.

**Figure 7: Impact of Different Retirement Rules on Current Pension Wealth: 2007 Retirees who were Full-Time Teachers in 2006-07**



**Figure 8: Impact of Pension Enhancements on Current Pension Wealth for the 2007 Teaching Workforce**



**Figure 9: Impact of Pension Enhancements on Maximum Pension Wealth for the 2007 Teaching Workforce**

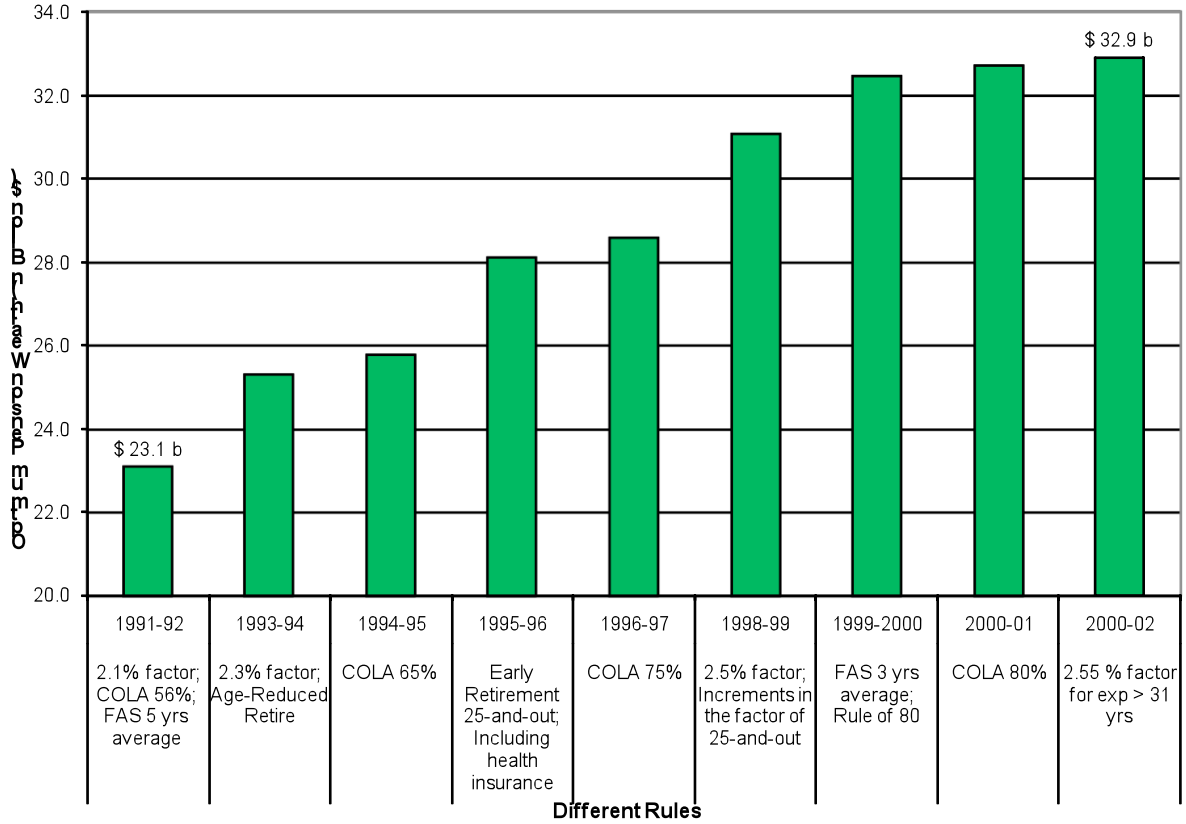


Figure 10

Forecast and Actual Retirements: 2006-2008

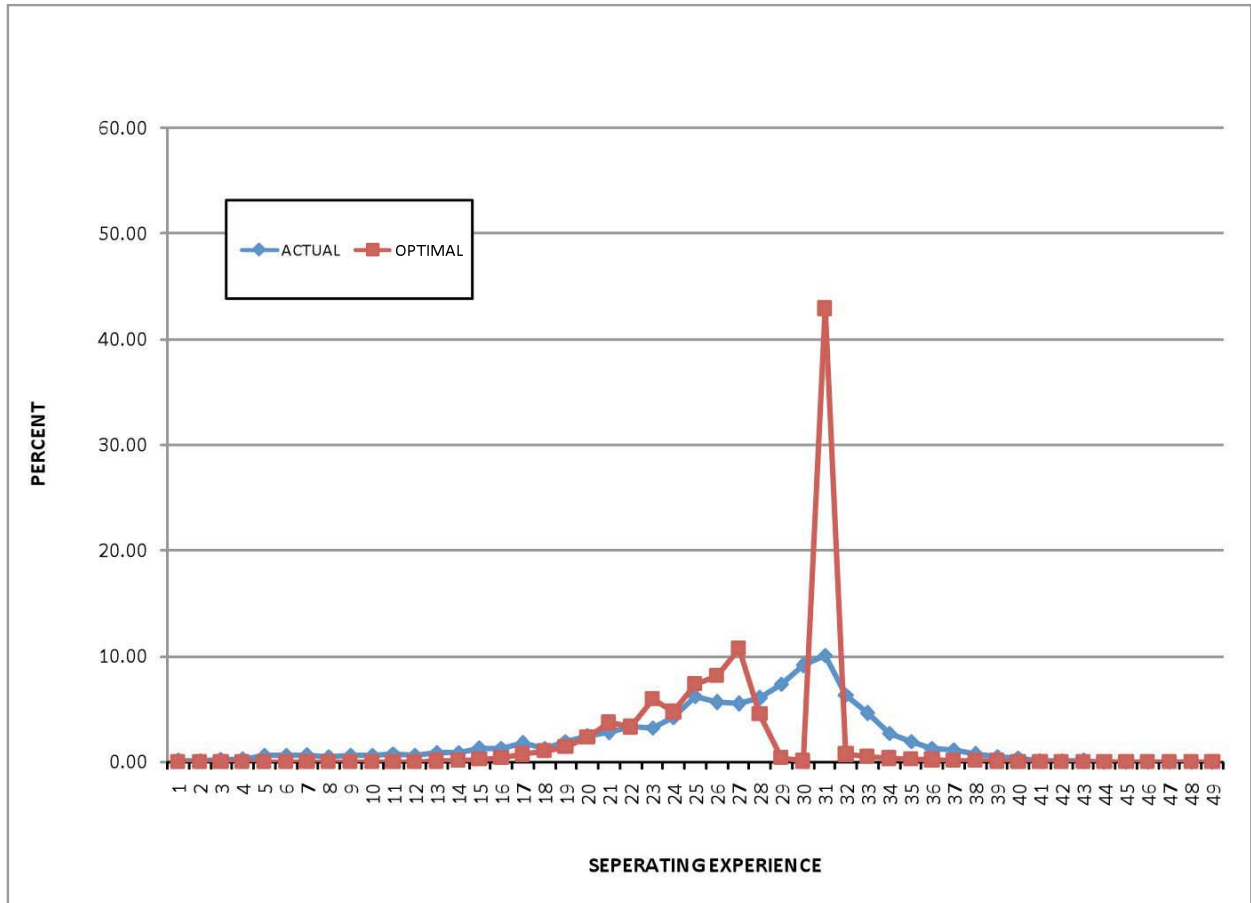


Figure 11

Teacher Attrition: 1992-94 and 2004-06

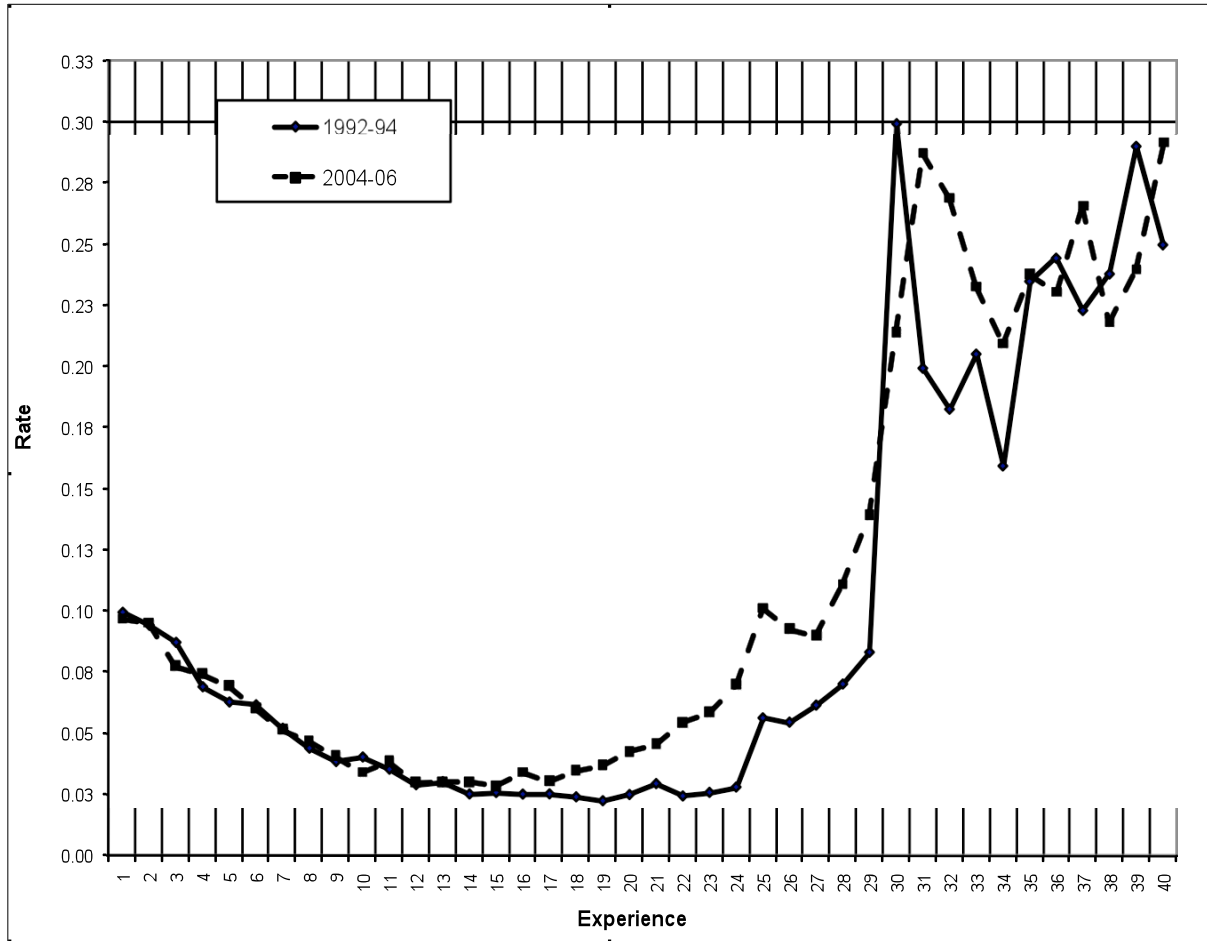




Table 1: Selected Recent Rule Changes in Missouri PSRS Teacher Pension System  
(by school year, change in bold)

1991-1992	2.1%, 30yrs experience, 56% COLA, FAS 5yrs average
1993-1994	<b>2.3%</b> , 30yrs experience, 56% COLA, Age-Reduced Criteria Introduced
1994-1995	2.3%, 30 yrs experience, <b>65% COLA</b>
1995-1996	2.3%, 30yrs experience, <b>early retirement “25 and out”, addition of district average health insurance contribution to calculation of FAS</b>
1996-1997	2.3%, 30yrs experience, <b>75% COLA</b>
1998-1999	<b>2.5%, 75% COLA, Increments in the factor of “25-and-out” criteria</b>
1999-2000	2.5%, Rule of 80, <b>3 yrs average FAS</b> , 75% COLA
2000-2001	2.5%, Rule of 80, 3 yrs average FAS, <b>80% COLA</b>
2001-2002	<b>2.55% for over 30 yrs experience</b> , Rule of 80, highest 3yrs FAS, 80% COLA
No Significant Enhancements <b>after</b> July 2001	

Table 2

Experience and Age of Teacher Retirees: 1993, 2002, and 2007

	1993	2002	2007
Mean Experience	27.1	27.6	26.4
Median Experience	28	29	28
Mean Age	58.7	55.7	56.5
Median Age	59	55	56
N	875	1612	1648

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