THE EFFECTS OF DEFINED BENEFIT PENSION INCENTIVES AND WORKING CONDITIONS ON TEACHER RETIREMENT DECISIONS

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Abstract

The retirement behavior of Pennsylvania public school teachers in 1997–98 and 1998–99, a period when state early retirement incentives were temporarily increased, is modeled using a choice framework that emphasizes both pecuniary and nonpecuniary factors of the retirement decision under a defined benefit retirement plan. We find each to have large and statistically significant effects on the decision to retire.

The present value of inflation-adjusted pension benefits of a public defined benefit plan is found to be an important and sizable determinant of retirement. A $1,000 (or .4 percent) increase in the real present value of pension benefits is estimated to increase the probability of retirement for female teachers by .02 to .08 percentage points; this implies an elasticity of retirement for female teachers with respect to the present value of real pensions of between 2.0 to 3.5. These estimated defined benefit pension elasticities for female teachers *are higher* than for male teachers, whose comparable retirement elasticity was 1.9 to 2.5.

A $1,000 increase in current salary is found to reduce the mean probability of retirement by .1 percentage points, implying an elasticity of −1.4. Thus, substantial salary increases systematically *reduce* the probability of older teachers retiring.

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Student achievement, but not student poverty, is also significantly related to teacher retirement; a one-standard-deviation increase in achievement scores reduces the mean probability of retirement by .38 to .64 percentage points, implying an elasticity of between −.24 and −.41. Measures of school crime were positively associated with male, but not female, retirement and were modest in size.

The estimated logistic model of the retirement decision under a public, defined benefit plan makes more accurate in-sample predictions than a simple model based on age-specific retirement rates; however, the logistic model, while relatively more accurate than other approaches, is less accurate in predicting the effect of *previous* early retirement incentive plans.

INTRODUCTION

Increasingly, public interest in school reform is focusing on improving classroom teacher quality. Indeed, the recent federal legislation No Child Left Behind obligates school districts throughout the United States to have in place a "highly qualified" teacher force as part of a federal effort to improve student achievement that also includes a federal system of monitoring (federally approved state-implemented standardized testing), incentives via increased flexibility in the expenditure of federal funds, and penalties through the threatened withdrawal of funds if various targets surrounding student achievement and teacher quality are not met.

Efforts to improve quickly the quality of the teacher profession are ambitious, since the K–12 teaching profession is one of the largest professional occupations in any developed country. In the United States, the U.S. Bureau of Labor Statistics reports that America had 4.187 million primary, secondary, and special education teachers in 2002. There were more such teachers in 2002 than professionals in accounting and auditing (1.06 million), computer and mathematical occupations of all kinds (3.018 million), architects and engineers (2.587 million), lawyers (1.168 million), registered nurses (2.284 million), and the entirety of protective services, including fire, police, correctional officers, and private protection services and agencies (3.116 million).[1]

As a consequence of increased public interest in primary and secondary school teachers, there has been increased research on many aspects of the market for them; however, there is virtually no literature dealing with older teachers' decision whether or not to retire, and the effect that unforeseen

1. See Bureau of Labor Statistics 2005.

changes in financial incentives to retire may have on that decision.[2] Hiring practices have been explored by Ballou (1996), Ballou and Podgursky (1997), and Strauss et al. (2000), among others, while teacher attrition, mobility, and retention have been explored by Dolton and van der Klaaw (1999), Grissmer and Kirby (1992, 1997), Hanushek, Kain, and Rivkin (2001), and Manski (1987). The decision to become a teacher and issues of early retention and turnover have been examined by Brewer (1996), Dolton (1990), Hanushek and Pace (1995), and Stinebrickner (1998), while questions of initial matching and geography have been importantly explored by Boyd et al. (2002, 2003), Lankford, Loeb, and Wyckoff (2002), Murnane et al. (1991), and Strauss et al. (1998).

It is generally understood that the probability of a teacher not voluntarily remaining in the same district next year is U-shaped; attrition or quit rates are quite high during the first several years of teaching, and then quite low for a long period of time until the possibility of retirement emerges under the terms of state personnel retirement laws. National Education Association (NEA 2003) notes that 27 percent of teachers had been in their current position for more than twenty years, compared to 8 percent in 1976. The lack of mobility for much of a teacher's career reflects not only likely personal circumstances that discourage moving while raising their own children, but also the general practice among school districts when hiring to not recognize *all* years of experience vis-à-vis the salary offer to experienced teachers in other districts seeking to change employment.

In the short run, improving teacher quality may entail professional development and training of the existing teacher force, as well as recruitment of new teachers. Unfortunately, local school staffing levels are relatively fixed in the short run as a consequence of the practice of granting tenure after two or three years. Teacher retirement, then, becomes an important event that creates an opportunity to improve the quality of a school or district's teacher force. The economic and job environments facing an older teacher, who is eligible to retire, are the foci of this article.[3]

Scholarly research on the general retirement decision is vast, and no attempt here will be made to summarize the literally hundreds of studies of

2. See Cochran-Smith and Zeichner 2005 for a far-ranging review of the literature on teacher preparation and teacher careers. They indicate that the primary reason older teachers leave teaching is to retire, but they find no theoretical or empirical models that address how pecuniary and nonpecuniary incentives impact this decision. Also see Whitener et al. 1997.
3. As we shall show below, financial prospects materially affect the decision of older teachers to retire or continue working. Thus, an important implication of our findings below is that salary *policy* or salary *structure*, which is revisited through the collective bargaining process, may have indirect and perhaps unintended effects on the willingness of older teachers to stay or retire and, in turn, has significant effects on the budgetary position of school districts.

factors affecting the decision to retire in the United States and elsewhere.[4] Because better than 85 percent of primary and secondary school teachers are public employees, they face distinctive incentives that are created by defined benefit plans whose retirement benefit is typically a function of the last three years of salary *and* the number of years of service as a teacher. This contrasts with other defined benefit plans, such as Social Security, whose benefit is a function of a very long period of historical earnings.[5] Further, while teachers in most states will enjoy both their teacher pension benefit and Social Security, the former is by far the more important financial consideration.

A typical defined benefit formula facing a teacher (or public employee) will be a percentage times years of service times an average of the last three years of salary. A teacher who began working at age 22 and retired at age 65 would have 43 years of service. At 2.0 percent, the pension benefit would thus be 86 percent of the average of the last three years of salary. Social Security typically provides a much lower replacement rate. For a teacher earning $89,000 today with the same years of experience, Social Security would likely replace only about 27 percent of current salary, and the combination of both retirement income streams would thus make the teacher 13 percent better off by retiring than by continuing to teach.

Of interest below is whether or not factors found to affect teacher voluntary attrition early in a teacher's career may also affect the teacher's retirement at the end of a teacher's career. Factors influencing attrition or teacher quits among beginning teachers such as working conditions, salary, and teacher characteristics, have been documented by Murnane and Olsen (1989, 1990), Mont and Rees (1996), and Stinebrickner (1998, 2002), among others (see also Theobold 1990 and Grissmer and Kirby 1992 for a combined analysis of the attrition of new and experienced teachers). However, some factors, such as childbirth and a desire for occupational change, that cause younger teachers to leave education are unlikely to influence the retirement decisions of older teachers. Additionally, if teachers who are most sensitive to working conditions leave teaching early in their career, it is possible that those who

4. In terms of benefits and financing, retirement policy attracts attention around the world not only from scholars but also from major international lending and economic development agencies, such as the World Bank. See Gruber and Wise 2004 for recent country-by-country studies of aspects of retirement policy and Wise 2004 for articles focusing on behavioral aspects of aging such as health and home ownership, and private retirement accounts, which in turn impact on the decision to retire and the pressures on general public and private retirement systems.
5. Responses to defined contribution programs, which increasingly characterize private retirement plans, are accordingly different, since such decisions are influenced by expectations of the future course of the stock market. In defined benefit plans, financing is largely irrelevant to the individual retirement decision unless the plan is badly underfunded.

remain will be much less sensitive to working conditions.[6] Strauss (1993) and Hanushek, Kain, and Rivkin (2001) found that higher student test scores reduced the probability of retiring for older teachers.[7] Hanushek, Kain, and Rivkin (2001) estimated that student poverty, measured by the percentage of students receiving a free lunch, had no systematic effect on experienced teacher attrition. Hanushek, Kain, and Rivkin (2001) and Strauss (1993) also examined the effect of demographic characteristics, working conditions, and salary on teacher retirement, but neither article used pension variables. To our knowledge, there has been no examination of the effect of workplace crime on teacher retirement.[8]

Typical projections of teacher retirement rates performed by local school districts or state pension actuaries do not take into account behavioral reactions to pension benefits. Usually, projections of retirement are calculated by observing retirement rates from observed age-experience profiles and do not take into account expected replacement rates[9] for recent salaries, other financial variables, or working conditions on the behavioral decision to retire.[10] On the one hand, previous general research on the retirement decision has found that pension benefits or the present value of pension benefits strongly influence the retirement decision. Samwick (1998), Stock and Wise (1995), Fields and Mitchell (1984), and Burkhauser (1979) all found a strong relationship between pensions and the decision to retire. There is also a general consensus that Social Security provides incentives to retire once individuals reach the age of sixty-five.[11]

The general retirement literature on the effects of temporary retirement incentives indicates that such temporary incentives increase retirement rates. Kotlikoff and Wise (1985) provided evidence that variation in retirement rates corresponded to pension incentives. Work by Hogarth (1988) and Kotlikoff and Wise (1985) found that temporary pension bonuses strongly induced workers to take early retirement. Lumsdaine, Stock, and Wise (1990) used the option value model to predict the effects of an early retirement incentive plan.

6. The effect of working conditions on retirement in occupations other than teaching has received little attention in the recent labor economics literature. Filer and Petri (1988) found that occupations with more difficult working conditions had earlier average retirement ages.
7. Additionally, there is some national survey evidence indicating that teachers may quit due to lack of administrative support as well as being generally dissatisfied with a teaching career. See Zumwalt and Craig 2005: 130–31.
8. See Hamermesh 1999 for the effect of crime on job preferences in the general labor market, and McLean 1978 on compensating wage differentials for hazardous work.
9. A replacement rate is the ratio of retirement income to most recent earned income and is usually viewed as a measure of adequacy.
10. See, for example, Barro 1992.
11. Kahn (1988) found that there may also be incentives to retire at age sixty-two if individuals have high discount rates due to liquidity constraints.

In this article we shall examine the effects of monetary and nonmonetary incentives on the decision of older teachers to retire; to do this we exploit a natural experiment in Pennsylvania that occurred in the late 1990s, when the Pennsylvania General Assembly dramatically increased the incentive to retire by 25 percent by increasing temporarily the amount of the retirement income available through an temporary increase in the retirement formula. We shall examine how the retirement decision is impacted by: (1) defined pension benefits that are typical among the states, early retirement incentives, and salary, and (2) working conditions. We shall do so with the administrative records on individual classroom teachers throughout Pennsylvania that were obtained and utilized under signed nondisclosure agreement with the Pennsylvania Department of Education. The plan of the article is as follows. In the next section we propose a theoretical framework for analyzing the retirement decision. Then we explain the provisions of Pennsylvania's defined benefit pension plan, examine actual and potential incentives, and describe the data. Then we present the results from the logistic estimation and evaluate the predictive capability of the estimated model in comparison to typical, purely demographic models of retirement. The final section presents conclusions and policy implications.

A MODEL OF THE RETIREMENT DECISION

We construct a simple model[12] of the retirement decision that builds on prior work in this area. A worker contemplating retirement considers the present value of the flow of utility if he were to retire *today* and compares that with the present value of the flow of utility arising from retirement at the best future date. These two flows are affected by a number of factors, both pecuniary and nonpecuniary.

Pecuniary factors include pension and wage wealth, for example, the present value of pension benefits and earnings flows. Note that we define pension wealth to include retirement benefits derived from a state retirement plan, denoted as PEN, and Social Security, denoted as SS. Current pension wealth should raise the probability of retirement, while the prospect of future

12. We should note there is a largely theoretical literature that views the retirement decision as a dynamic programming problem that is addressed by profit-maximizing employers, defined contribution pension plans, and nonunionized utility-maximizing employees. See, for example, Stern 1987. Our context and research interests are of course different, since public employee retirement plans are a universally defined benefit in nature, public employers are not profit maximizers, and public school teachers in most states, especially in Pennsylvania, are highly unionized. Since pension benefits examined here are defined in terms of historical salary, there is no need to model expectations about the stock market. Further, the progress of future salary increases are much more predictable in the case of public employers than in the private case, since state or school district bankruptcy is far more remote.

pension wealth should reduce the probability of retiring today, since working longer rather than retiring will increase it.

The effect of salary in such a model of the decision to retire, when the pension benefit depends on recent and projected salary, is ambiguous. Holding pension wealth constant, higher *future* salary should reduce the odds of retirement, since higher salary increases the wealth obtained by continuing to work. However, increasing salary also increases both current and future pension wealth, so that there is an indirect income effect that we would expect to operate in the opposite direction.

Nonpecuniary factors are also likely to affect retirement behavior. Factors tending to increase the disutility of work will favor earlier retirement. The disutility of work is based on work-related factors such as the quality of the working environment as well as leisure preferences. The theory of compensating differentials implies that if unpleasant work environments do not have higher wages or benefits, those workplaces will generally suffer higher worker attrition. We think age is a reasonable proxy for leisure preferences. Younger teachers have a higher disutility of work due to a desire to have children. Disutility decreases as middle-aged individuals have fewer family reasons for leaving. The disutility of nonleisure is then assumed to be small, either positive or negative, and relatively constant until a teacher reaches early retirement age. At that point, declining health (Reimers and Honig 1996), a desire to be with a retired spouse (Blau 1998), and increasing preferences for leisure cause the disutility of work to increase.

We pursue a reduced-form approach to statistical estimation. For our purposes, the most interesting dynamic aspects of the retirement decision surround pension wealth. One dimension of the worker's trade-off in making his retirement decision is balancing his current pension wealth against the future pension wealth he could accumulate by remaining employed. We enter current pension wealth in our empirical model below through the net present value of the expected flow of pension benefits, given retirement at the current age, R_1. To capture the pension-wealth incentive to remain employed, we should, in principle, include the value of pension wealth at every future possible retirement date. Concerns of multicollinearity obviously militate against doing this. Instead, we capture the pension value of continuing to work by entering the highest possible net present value (NPV) of pension flows the worker could possibly achieve by continuing to work. These two calculations are made explicit in equations below. Each takes into account the probability of surviving and the financial aspects of retiring or the financial aspects of continuing to work. Equation 1 describes the incentives to retire now, composed of the present value of teacher retirement benefits and the present value of Social Security, and equation 2 describes the incentives to work rather than retire now, composed of the present value of wages from continuing to work this year, and the present value of teacher retirement benefits and Social Security benefits that reflect the *indirect* effect of continuing to work this year and retiring next year:

$$\sum_{i=0}^{100-age} pr_{age+i}\frac{PEN_i(R_1, W_{fin})}{(1+r)^i} + \sum_{i=62-age}^{100-age} pr_{age+i}\frac{SS(R_1, W_p)}{(1+r)^i} \tag{1}$$

$$\sum_{i=0}^{x} pr_{age+i}\frac{W_i}{(1+r)^i} + \sum_{i=x}^{100-age+x} pr_{age+i}\frac{PEN_i(R_2, W_{fin})}{(1+r)^i} + \sum_{i=62-age}^{100-age} pr_{age+i}\frac{SS(R_2, W_p)}{(1+r)^i}. \tag{2}$$

The probability of surviving from the current age to (age + i) is given by Pr_{age+i}, with a maximum lifespan of 100 years. *PEN* is the annual pension benefit based on the retirement age (R) and the final average wage (W_{fin}). *SS* is the Social Security benefit, based on the retirement age (R), previous wages (W_P), and the assumption that the teacher begins collecting benefits at age 62. W is the teaching wage earned for x more years, where x equals $R_2 - R_1$. The nominal interest rate is r, assumed in our analysis to be 6 percent.

PENNSYLVANIA'S PUBLIC TEACHER RETIREMENT PLAN, DATA, AND STATISTICAL MODEL

Pennsylvania's State Employees' Retirement System

Public school teachers in Pennsylvania, like their counterparts in most other states, have a defined benefit pension plan operated by a state agency that is uniform across the state. The Pennsylvania State Employees' Retirement System (PSERS) receives state and local administrative unit contributions[13] annually and invests the proceeds in a pension trust that amounted to about $48.5 billion as of 2004. If a teacher leaves education with less than ten years of service, his contributions plus 4 percent interest are refunded. After ten years of service, the teacher can vest the pension and leave, or elect to receive monthly retirement benefits that are actuarially reduced to reflect early retirement. The

13. Currently each local school district contributes 5 percent of covered payroll to the state teachers retirement fund.

annual, defined pension benefit[14] is:

$$\textit{Annual Defined Benefit} = .02 \times \textit{Final Average Salary} \times \textit{Years of Service} \times (1 - \textit{Reduction Factor}). \quad (3)$$

Final average salary is the average of the teacher's three highest annual salaries. Until the teacher is eligible for "full" retirement, the reduction factor, which is the actuarial reduction factor, is greater than zero, and the factor declines to zero as age and years of service rise. This decline is nonlinear, with a large decrease once teachers become eligible for full retirement. To qualify for full retirement in Pennsylvania's teacher retirement plan, a teacher must have either (1) have thirty-five years of service, (2) have thirty years of service and be over age sixty, or (3) be sixty-two or older. For the years studied in this article, 1997–98 and 1998–99, the state enacted a temporary retirement incentive of "thirty and out," which allowed a teacher with thirty or more years of experience to retire with full benefits, regardless of age.

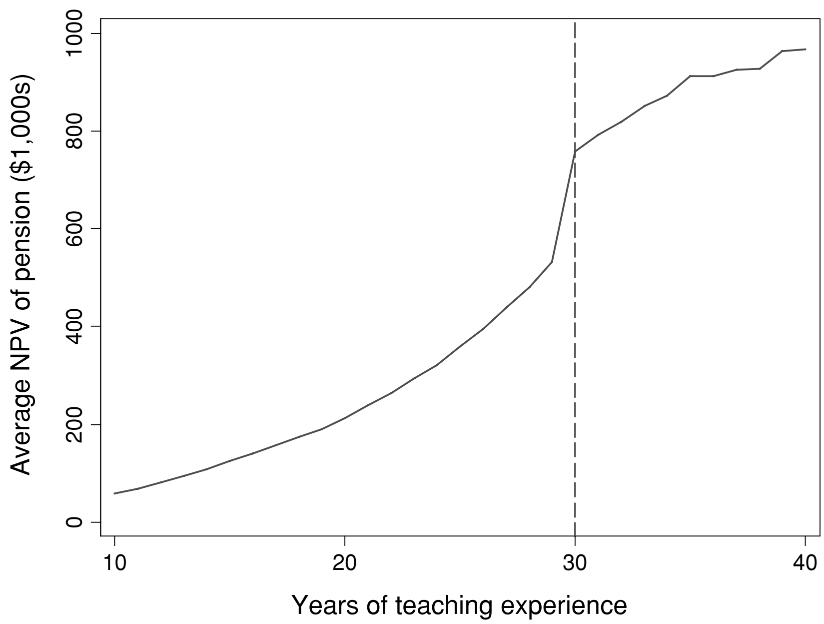
Figure 1 displays the observed relationship between the mean real present value of pension benefits by experience level for teachers in the 1997–98 school year. Note the substantial increase in mean pension benefits at thirty years of service, which is when most teachers become eligible for full benefits.

Although there is no automatic cost-of-living adjustment (COLA) for these pension benefits, the Pennsylvania legislature has typically increased pension benefits every five years. The last COLA was passed in 1998 and was equal to 1.86 percent per year, or roughly half the rate of inflation since the previous COLA. In order to qualify for the COLA, teachers must have reached full retirement status. While teachers who retired under the "thirty and out" rule or teachers who retired without full benefits are not initially eligible for the COLA, they become eligible for the COLA once they reach age sixty or would have reached the experience level necessary to qualify for full benefits.

The "thirty and out" early retirement window was periodically renewed by the Pennsylvania legislature throughout the 1990s, but it expired in 1999. The expiration in 1999 meant that a teacher with between thirty and thirty-three years of experience in 1999 was eligible for full benefits if he elected to retire in 1999 but would not be eligible for full benefits if he retired in 2000. Therefore, teachers in this experience range had a much stronger incentive to retire in 1999 than did similar teachers in 1998. During the 1990s the Pennsylvania Legislature adopted other early retirement incentive plans (ERIP) to encourage retirement. The first was a 10 percent experience bonus in 1992–93. If a teacher

14. Although there are various options that result in reduced benefits, most teachers elect to receive the maximum payment, therefore this formula will be used here.

Figure 1



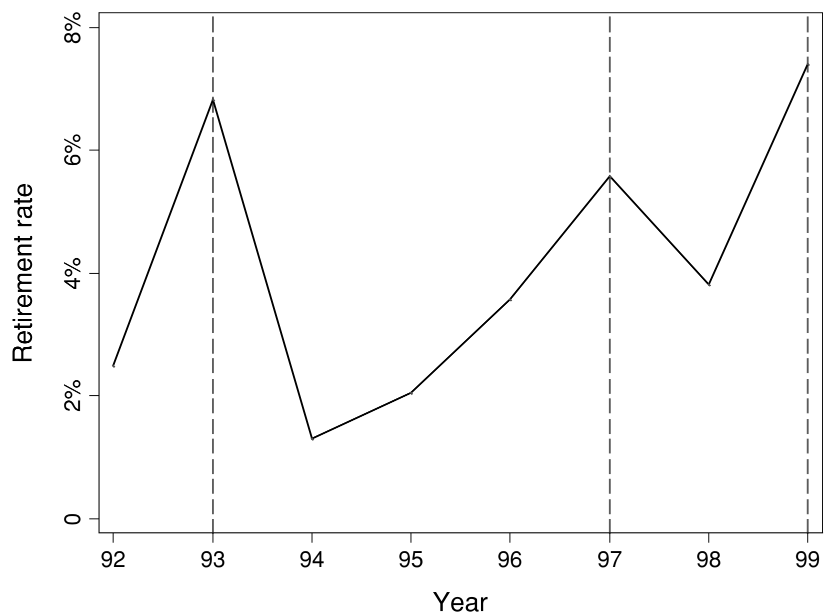
Calculated Average Net Present Value of Pension Benefits and Total Years of Teaching Experience, Pennsylvania Classroom Teachers, 1997–1998

retired in 1993, was older than fifty-five, and had at least ten years of experience, the years of service used to compute the pension benefit was adjusted upward by 10 percent. Since a teacher had to retire in 1993 to receive the bonus, there was a significant increase in the retirement rate that year (see figure 2). Also, although it was later renewed, the "thirty and out" rule expired at the end of the 1996–97 school year and renewal was uncertain, providing incentives for certain teachers to retire in 1997. Figure 2 displays the percentage of full-time teachers who elected to retire (the retirement rate) for each year. The large fluctuations in the retirement rate, almost certainly due to changes in the pension plan, imply that policy changes can significantly affect retirement choices.

Sources and Nature of Data

Each fall every local education administrative (LEA) unit in Pennsylvania is required under state law to provide a list of full-time professional personnel to the Pennsylvania Department of Education (PDE). The list contains the employee's Social Security number, birth date, years of professional experience, gender, race, salary, teaching specialty, building assignment, and reason for withdrawal if no longer working in the LEA. This list, the Elementary/

Figure 2



Aggregate Pennsylvania Classroom Teacher Retirement Rates, 1992–1999

Secondary Professional Personnel File (ESPPF), was obtained for several years under signed nondisclosure agreements. Each ESPPF contains the universe of Pennsylvania public school teachers for that year.[15] The 1997–98 and 1998–99 ESPPFs were used to estimate statistical retirement functions and forecasts, which were then compared to actual data using ESPPFs from previous years. School characteristics such as student achievement, percent low-income students, and violence/crime measures were also obtained from the PDE and were merged with the ESPPF by building number. Only classroom teachers who were eligible to receive pension benefits (i.e., teachers with more than nine years of experience or older than sixty-one) were included in the analysis. Individuals who stated that they were "retiring" and then left Pennsylvania public schools were classified as retired, even though their labor force status after leaving the school system is unknown.[16] Since the decision is assumed to be voluntary, classroom teachers who died, were fired, laid off, moved to work

15. Teachers from Philadelphia, 10.3 percent of all Pennsylvania teachers, were not included in the analysis, as the data were found to be unreliable. For example, in 1998–99 over two-thirds of ostensibly first-year Philadelphia teachers had previously taught in Pennsylvania public schools. Because accurate pension estimates depend on accurate experience levels, Philadelphia teachers were not included in the analysis.
16. Teachers who told the school district that they were leaving for other employment or "other" reasons were not included in the analysis.

in another district, or had their certification revoked were not included in the analysis. There were 55,861 full-time teachers in 1997–98 and 55,788 teachers in 1998–99 who had complete demographic and school-level information.[17]

Student academic achievement was measured using the Pennsylvania State School Association (PSSA) test, an annual test given to all fifth, eighth, and eleventh graders in Pennsylvania public schools. There are two sections, math and reading, with adjusted section scores ranging from a low of zero to a high of 600. A score of 300 represents the statewide section average in 1996, and scores can be compared across years. The score used in the analysis is the mean of the combined (math plus reading) test score for the school where the teacher worked. Student socioeconomic class is measured by the percentage of students eligible for the free or reduced-price lunch program at the school. The school crime measure was the number of weapons (firearms and knives) confiscated at the school.[18] In 1997–98 and 1998–99, respectively, 61 percent and 68 percent of schools had zero weapons violations, and the distribution was very right-skewed.

Table 1 displays variable definitions, means, and standard deviations in parentheses for all explanatory variables used to model the decision to retire.

In figure 3, we present information on the bivariate relationship between building-level weapons confiscation and retirement probabilities for the years 1997–98 and 1998–99. The bottom two graphs of that figure show the distribution of weapons confiscation experienced by teachers. For example, in 1997–98, 54 percent of teachers worked in buildings in which there were no weapons confiscations, while 3.5 percent worked in buildings with six or more. The upper panels of figure 3 show how retirement rates varied with weapons confiscation in 1997–98 and 1998–99. In 1997–98, teachers in buildings with

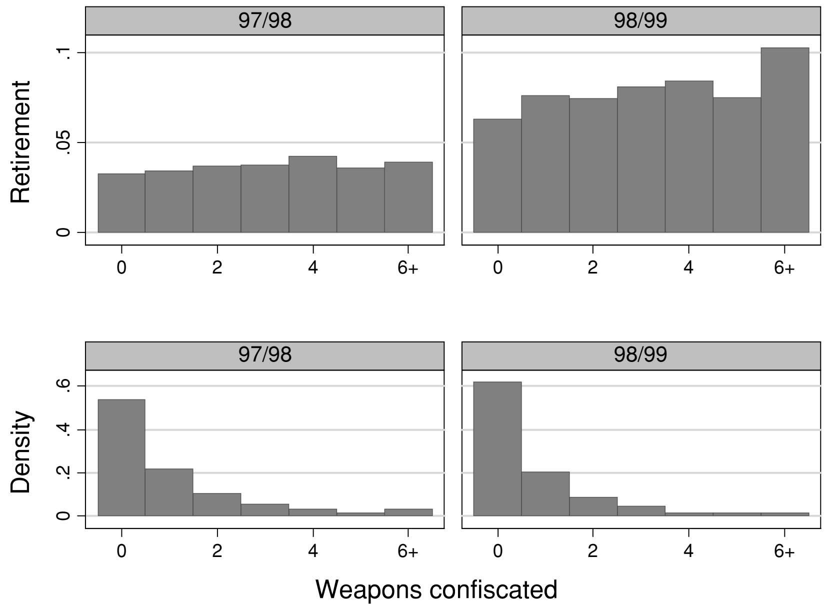
17. The 55,800 teachers analyzed in 1997–98 were from an initial universe of 132,187 persons with some form of Pennsylvania teacher certification who were reported to the Pennsylvania Department of Education as being employed by a local education agency in 1997–98. Of these, 13,647 were employed in Philadelphia School District and not included in the statistical analysis. Of the remaining 118,540, 34,551 had less than ten years of service and were dropped from the statistical analysis. Another 1,241 left teaching for reasons other than retirement and were dropped, as were 20,975 professional personnel who were not classroom teachers but administrators or coordinators. Also, 5,828 teachers in 1997–98 and 5,810 in 1998–99 did not have matching test scores; these teachers overwhelmingly taught at vocational or early childhood schools that do not administer the state test. Finally, 84 teachers who were not full-time were dropped from the analysis. The 1998–99 teachers analyzed followed a very similar pattern. Over 99.8 percent of the full-time, non-Philadelphia classroom teachers had matching crime and low-income student information.

18. In unreported robustness checks, other crime/violence measures such as expulsions of greater than one year, assaults on employees, and arrests at school were also used. However, because we believe that these variables are more subject to measurement error due to differences in reporting, definition of a violation, or discipline policy, we settled on the reported specification. The use of these alternative measures does not affect the results significantly.

Table 1. Data Definitions, Means, and Standard Deviations of Explanatory Variables in Logistic Equations

Acronym	Definition	Means 1997–98	Means 1998–99
P	retirement dummy	0.035	0.07
EXPERIENCE	years of service in school system	22.87 (6.96)	23.0 (7.17)
$EXPERIENCE^2$	experience squared		
AGE	age as of August following school year	48.34 (6.42)	48.71 (6.50)
AGE^2	age squared		
AGE^3	age cubed		
FEMALE	= 1 if female, = 0 if male	0.62	0.63
BLACK	= 1 if African American, = 0 if white, other	0.02	0.02
MASTERS	= 1 if highest degree is a master's degree, = 0 if no masters	0.52	0.52
SALARYK	salary (in thousands of 1997 dollars)	53.22 (10.27)	53.41 (10.32)
FEMSAL	interaction between *SALARYK* and *FEMALE*		
PVPENK	present value of current pension benefits (in thousands of 1997 dollars, r = 6%)	248.27 (167.51)	259.50 (175.71)
FEMPV	interaction between *PVPENK* and *FEMALE*		
PVMAXK	maximum present value of future benefits (in thousands of 1997 dollars, r = 6%)	377.54 (130.62)	366.22 (126.88)
FEMMAX	interaction between *PVMAXK* and *FEMALE*		
SS62	= 1 if age equals 62, = 0 if otherwise	0.006	0.006
SS65	= 1 if age equals 65, = 0 if otherwise	0.002	0.002
VOC	= 1 if teacher's major subject is vocational, = 0 if otherwise	0.08	0.08
LD	= 1 if teacher's major subject is learning disabled, = 0 if otherwise	0.1	0.1
SECNOLD	= 1 if teacher's major subject is secondary subject, (non–learning disabled), = 0 if otherwise	0.41	0.41
PSSA	sum of average math and reading PSSA score at the school (in hundreds)	6.30 (1.60)	6.36 (1.52)
LOWINC	percentage of low-income students at school	25.63 (19.66)	25.81 (20.20)
WEAPONS	number of guns and knives confiscated at the school	1.15 (2.07)	0.85 (1.66)
FEMWEAP	interaction between *WEAPONS* and *FEMALE*		

Figure 3



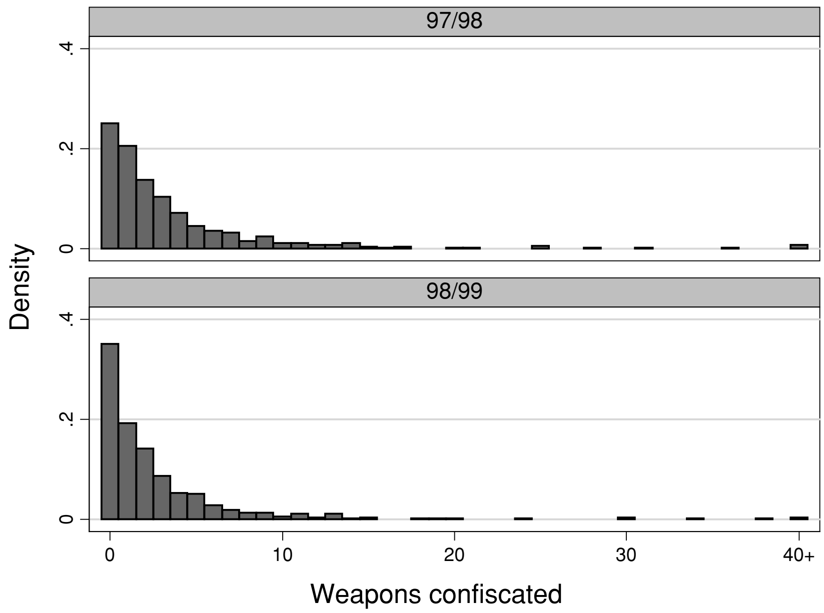
Bivariate Relationship between Retirement and Weapons

no weapons confiscated retired at a rate of 3.3 percent, while teachers in buildings with six or more weapons confiscations retired at a rate of 3.9 percent. The figure shows that a significant majority of teachers worked in buildings with few or no weapons confiscations and that there is perhaps a small positive effect of weapons confiscation on retirement.

Figure 4 shows the distribution of weapons confiscated and aggregated to the district level. In 1997–98 and 1998–99, respectively, 23 percent and 34 percent of districts had no weapons confiscated, and the average district had 4.0 and 2.9, respectively. The distribution of weapons confiscated by district has a long right tail: the maximial district in 1997–98 confiscated 159, and the maximal district in 1998–99 confiscated 133.

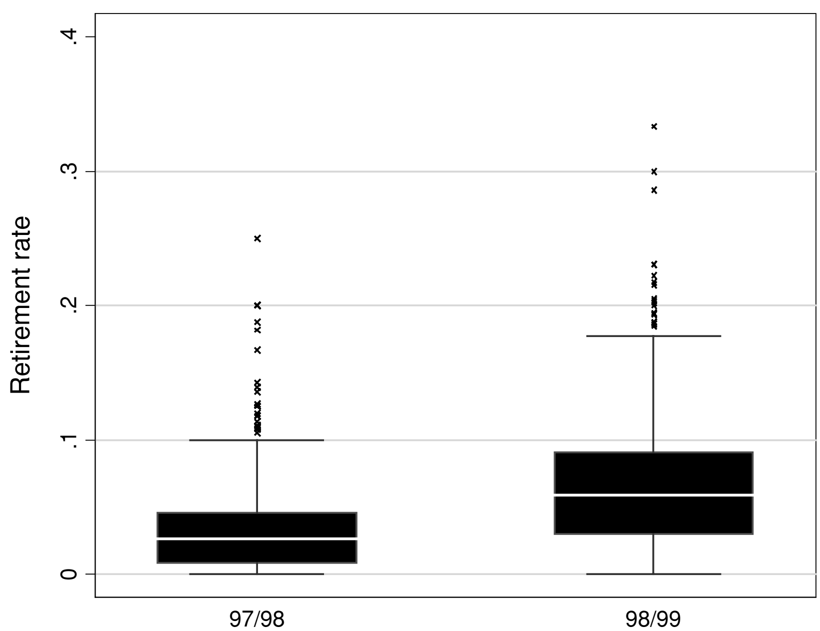
Figure 5 is a box-and-whiskers plot showing the distribution of retirement rates across districts in 1997–98 and 1998–99. In both years, there are some districts with zero retirements—as one would expect, given that retirement is a low-probability event and that some districts are relatively small. The mean retirement rate rose from 3.5 percent in 1997–98 to 7 percent in 1998–99, and the variation and number of outliers also rose. Presumably this was due to the expiration, in 1999, of the “thirty and out” rule, leading to increased retirement incentives for certain teachers that year.

Figure 4



Distribution of Weapons Confiscation by Pennsylvania School District, 1997–1998 and 1998–1999

Figure 5



Variation of Teacher Retirement Rates across Pennsylvania School Districts, 1997–1998 and 1998–1999

Statistical Model

We model the decision of each worker to retire in the current year as a binomial logit. As discussed above, we enter the NPV of current expected pension flows and the highest possible NPV of expected pension flows in the future.[19] Individuals almost certainly consider total retirement income (pension benefits plus Social Security) when making their retirement decision. Unfortunately, it was not possible to estimate Social Security benefits, since complete earnings histories were not available. However, individuals became eligible for reduced Social Security benefits at age sixty-two, and for full benefits (plus Medicare) at age sixty-five. To account for Social Security incentives, two age dummy variables were included in the model.

Because the relationship between age and the value of leisure is expected to be nonlinear, age-squared and age-cubed were included in the model. Previous work has found that the relationship between pension benefits and retirement was moderated by sex (Pozzebon and Mitchell 1989); therefore, each pension variable and salary was interacted with sex.

Since teachers in different classroom environments encounter different working conditions, dummy variables for secondary, vocational, and special education teaching positions were constructed; the omitted category was primary education position. Finally, the percentage of low-income students, student test scores, and weapons confiscations were used as measures of working conditions. It was hypothesized that fear of crime or crime victimization might differ by sex; therefore, an interaction between weapons confiscations and sex was included in the model.

LOGISTIC ESTIMATION RESULTS AND PREDICTIONS

Statistical Estimation Results

Table 2 displays logistic estimation results of the decision to retire, with standard errors in parentheses. Table 3 displays mean marginal effects and the associated standard errors. For each individual, the marginal effect is the predicted change in the probability of retiring, if the relevant independent variable is increased by 1. The reported marginal effect is the mean of the individual marginal effects, [20] and the standard errors are bootstrapped using 500

19. It is worth noting that, in all of these calculations, we assumed that the workers did not expect there to be another special pension retirement incentive, such as "thirty and out," in the future.
20. For continuous variables, the mean marginal effect is:

$$\frac{1}{N}\sum_{i=1}^{N} P(Y=1; X=X_i+1) - P(Y=1; X=X_i).$$

For dummy variables, the effect is:

$$\frac{1}{N}\sum_{i=1}^{N} P(Y=1; X_i=1) - P(Y=1; X_i=0).$$

Table 2. Estimated Logistic Parameters and Standard Errors[a]

	1997–98		1998–99	
Variable	β	**S.E.**	β	**S.E.**
INTERCEPT	34.2435	(7.7020)	20.5626**	(8.8851)
EXPERIENCE	0.0988**	(0.0317)	0.1277**	(.0267)
EXPERIENCE^2	−0.0025**	(0.0006)	−0.0021**	(0.0005)
AGE	−2.4575**	(0.4415)	−1.8077**	(0.494)
AGE^2	0.0486**	(0.0083)	0.0397**	(0.0091)
AGE^3	−0.0003**	(0.00005)	−0.0003**	(0.00006)
FEMALE (1 = Female)	−0.7630*	(0.3423)	−0.5681*	(0.2552)
BLACK (1 = Black)	−0.5872**	(0.2044)	−0.2911*	(0.1383)
MASTERS (1 if master's Present)	−0.1724**	(0.0528)	−0.1479*	(0.0386)
SALARY in $1,000s	−0.0480**	(0.0118)	0.0031	(0.0088)
FEMALE × SALARY	0.0271**	(0.0095)	0.0055	(0.0074)
PV PENSION Benefits in $1,000s	0.0112**	(0.0013)	0.0171**	(0.0008)
FEMPV	−0.0022	(0.0011)	−0.0029**	(0.0009)
PV MAX PENSION Benefits in $1,000s 1997 dollars	−0.0038	(0.0022)	−0.0166**	(0.0014)
FEMMAX	0.0001	(0.0016)	0.0038**	(0.0014)
Dummy if age = 62	0.8213**	(0.119)	0.5331**	(0.122)
Dummy if age = 65	0.7801**	(0.2148)	0.0484	(0.2324)
VOC = 1 if teaching vocational subject	0.0959	(0.1002)	0.1811*	(0.0746)
LD = 1 if teaching subject is learning disabled	0.1078	(0.1216)	0.0845	(0.0922)
SECONDARY TEACHER	0.0662	(0.066)	0.1484**	(0.0481)
PSSA Test SCORE	−0.0480**	(0.0216)	−0.0882**	(0.017)
% Low-Income Students in School	−0.0036	(0.0019)	0.0001	(0.0013)
Guns & Knives Confiscated	0.0182	(0.0177)	0.0462**	(0.014)
FEMALE × Guns & Knives Confiscated	−0.0105	(0.0247)	−0.0355	(0.0208)
LOG L	−5,906.00		−9,698.94	
LOG L—intercept	−8,394.72		−14,198.69	

[a] See Table 1 for variable definitions

*,**Coefficients significantly different from zero at the 5 and 1 percent levels are denoted with an * and ** respectively

replications. The size of the marginal effect is in terms of percentage points.[21] For example, in 1998–99 an increase of 1 in *PSSA* (which corresponds to a 100 point increase in PSSA test scores) is associated with a .45 percentage

21. This calculation can be turned into an elasticity by multiplying the marginal effect (in percent terms) by the ratio of the mean of the independent variable to the mean of the dependent variable.

Table 3. Marginal Effects on Mean Probability of Retirement and Standard Errors

	1997–98		1998–99	
Marginal Change	**Marginal Effect**[a]	**S.E.**	**Marginal Effect**	**S.E.**
Aging 34 to 35 & experience 11 to 12	−0.017	0.016	0.004	0.006
Aging 44 to 45 & experience 19 to 20	0.029**	0.005	0.067**	0.007
Aging 54 to 55 & experience 27 to 28	0.951**	0.093	1.487**	0.120
Aging 61 to 62 & experience 29 to 30	18.348**	2.449	12.892**	2.894
Aging 64 to 65 & experience 29 to 30	17.864**	5.655	0.548	5.087
Aging 69 to 70 & experience 30 to 31	−0.936	0.754	−2.972**	0.561
Female	−0.514	0.266	0.834*	0.366
Black	−1.368**	0.383	−1.412*	0.629
Master's	−0.491**	0.143	−0.778**	0.202
$1,000 increase in salary (females)	−0.049	0.026	0.035	0.035
$1,000 increase in salary (males)	−0.170**	0.042	0.022	0.063
$1,000 increase in present value of current pension benefits (females)	0.021**	0.003	0.059**	0.003
$1,000 increase in present value of current pension benefits (males)	0.040**	0.006	0.122**	0.005
$1,000 increase in present value of best future pension benefits (females)	−0.009	0.005	−0.053**	0.006
$1,000 increase in present value of best future pension benefits (males)	−0.014	0.009	−0.117**	0.010
Difference between vocational and primary teachers	0.279	0.290	0.986*	0.438
Difference between learning-disabled and primary teachers	0.315	0.362	0.451	0.521
Difference between secondary and primary teachers	0.187	0.179	0.779**	0.246
100-point increase in PSSA scores	−0.134*	0.061	−0.451**	0.082
1 percentage point increase in percent of low-income students	−0.010*	0.005	0.000	0.007
Increase of one weapon (females)	0.018	0.045	0.044	0.071
Increase of one weapon (males)	0.066	0.062	0.333**	0.106

[a] All marginal effects are in percentage points, so that a marginal effect of 1 means an increase probability of 0.01

* Effects significantly different from zero at the 5 and 1 percent levels are denoted with an * and ** respectively

point reduction in the predicted probability of retirement.[22] Statewide, a 1 percentage point increase in the retirement rate is equivalent to approximately 550 extra teachers retiring in a year.

22. From table 1 we note that for all classroom teachers, the mean PSSA score was 6.3 and the mean probability of retiring was .07 in 1998–99, implying an elasticity of $-.0045 \times (6.3/.07) = -.41$

There are several features to note about table 3. The first six rows of results report on the marginal effect of aging one year and, simultaneously, gaining one year of teaching experience. The years of experience we chose for each of the aging experiments in table 3 were the average years of experience for teachers of the relevant age. In a sense, these do not "add up": 54-year-olds have, on average, 27 years experience, whereas 64-year-olds have 29. This happens because teachers retire so frequently at 30 or 31 years of service. For each of the experiments in table 3, we averaged the marginal effects over a relevant subpopulation. For the experiment of aging from 34 to 35, we averaged marginal effects over the teachers in the data who were between 30 and 39 years of age. For the age 44–45, 54–55, 61–62, 64–65, and 69–70 experiments, we used teachers between 40–49, 50–59, 60–69, 60–69, and 60–69 years of age, respectively. The marginal effects of salary, pension, maximum pension, and weapons were taken only over men. For the other marginal effects, the averages were taken over the whole data set. Finally, the aging experiments for 61–62 and 64–65 do include an accounting for the effects of Social Security eligibility via the dummy variables for ages 62 and 65.

Consider the explanatory variables' effects on the retirement decision in table 2. Each age coefficient was statistically significant. The effect of age on the retirement probability was negative until age 40 in 1997–98 and age 36 in 1998–99. After these ages, the probability of retirement *increases* with age, and the relationship remains positive until leveling off and becoming slightly negative at age 70 in 1997–98 and age 64 in 1998–99.

The marginal effects indicate that females were significantly less likely to retire in 1997–98 and significantly more likely to retire in 1998–99. The results also indicate that older African American teachers were more likely to remain teaching.[23] One possible explanation for this second result is that African Americans may need to work longer because they have fewer sources of retirement income.[24] Note that in both years, classroom teachers with master's degrees were significantly less likely to retire than teachers with bachelor's degrees or PhDs.

As expected, the present value of current retirement benefits is positively and significantly associated with retirement. A $1,000 marginal increase in the present value of real pension benefits would represent, on average, a .4 percent increase in the present value of pension levels in 1997–98 and 1998–99. Overall, a marginal increase of $1,000 in the present value of pension benefits

23. The coefficient for *BLACK* must be interpreted cautiously, since the analysis does not include teachers from Philadelphia. Overall, 64 percent of African American teachers in Pennsylvania taught in Philadelphia.
24. Smith (1995) found that black households have roughly one-quarter of the wealth of white households.

would increase the probability of retiring in 1997–98 by .03 percentage points and by .08 points in 1998–99.[25]

These effects seem small, but when compared to respective means, they imply sizable elasticities. They suggest that a 1 percent increase in the present value of real pension benefits will lead to a 2.1 percent increase in the probability of retirement in 1997–98 and a 2.9 percent increase in the probability of retirement in 1998–99.

In both 1997–98 and 1998–99 the interaction between sex and pension benefits was negative and significant. Thus, ceteris paribus, women's retirement decisions were less responsive to pension benefits than were men's. However, since all else is not equal among the sexes, we shall see below that women are, in elasticity terms, a bit more sensitive to pension benefits than are men. The logit parameters on salary for men in 1997–98 and 1998–99 were 0.0112 and 0.0171, respectively. The corresponding parameters for women were 0.009 and 0.142—80 percent and 83 percent as large, respectively.

For female teachers, a $1,000 increase in the present value of pension benefits would, on average, increase the predicted probability of retirement by .02 percentage points in 1997–98 and .08 points in 1998–99. Since the retirement probabilities for women were 2.88 percent and 5.42 percent in the two years and the average pension wealth for females in the two years was $226,000 and $237,000, the pension elasticity of retirement for the two years were $0.02\frac{226}{2.88} = 2.0$ and $0.08\frac{237}{5.42} = 3.5$. For men, a $1,000 increase in the present value of pension benefits would increase the predicted probability of retirement by .03 percentage points in 1997–98 and by .08 percentage points in 1998–99, implying elasticities of $0.03\frac{281}{4.38} = 1.9$ and $0.08\frac{294}{9.50} = 2.5$. Thus, for both sexes the retirement decision was quite sensitive to the present value of real pension benefit levels.

The present value of future real pension benefits was negatively related to the retirement decision, although the coefficient in 1997–98 was relatively small and insignificant. The elimination of the "thirty and out" pension window provides an intuitive way to measure effect sizes for this variable. The ending of the "thirty and out" rule in 1999 caused a female teacher with thirty years of experience to have much lower inflation-adjusted potential pension benefits than she would have had if the window had been extended. This almost certainly would have increased retirement in 1998–99. The actual retirement rate for a female teacher with thirty years of experience in 1999 was 19.6 percent; if the "thirty and out" rule had been extended for another year,

25. These overall marginal effects are calculated from the sex-specific marginal effects in table 2 by weighting by the proportion of each sex in the teacher population. For example, in 1997–98, $0.03 = 0.638 \times 0.21 + 0.362 \times 0.40$.

the predicted retirement rate for the same teacher in 1998–99 would have been 13.3 percent.

Becoming eligible for Social Security and Medicare was associated with an increase in retirement, although teachers appeared to be less sensitive to Social Security and Medicare incentives in 1998–99. The coefficient for *SS62* was significant in both years, although the magnitude was much smaller in 1998–99. The coefficient for *SS65* was significant in 1997–98, but not in 1998–99, when the effect size was close to zero. The ending of the "thirty and out" rule in 1998–99 likely increased the importance of pension incentives in that school year, causing teachers to be less affected by Social Security and Medicare incentives.

The coefficient on current salary was negative and statistically significant in 1997–98 and positive but statistically insignificant in 1998–99. Focusing on the statistically significant result from 1997–98, we infer that an increase in salary, holding everything else (including pension wealth) constant, *reduces* the probability of retiring. Overall, a marginal increase in $1,000 of salary *reduces* the probability of retirement by .10 percentage points in 1997–98; this implies an elasticity of retirement with respect to salary of −1.4. Since increasing current salary also increases the present value of future pension benefits as well as the best future pension benefit, the total effect of such an increase is more complex. For a male teacher, the total effect of a salary increase on the probability of retiring is given by:

$$\beta_{sal} + \beta_{pvpen}\left[.0067 \times \exp \times \sum_{i=0}^{100-age} \frac{pr_{age+i}}{(1+r)^i}\right] + \beta_{pvmax}\left[.0067 \times \exp \times \sum_{i=x}^{100-age+x} \frac{pr_{age+i}}{(1+r)^i}\right] \times \left[(1.04)^x + (1.04)^{x-1} + (1.04)^{x-2}\right]$$

where *exp* is years of experience, pr_{age+i} is the probability of surviving from the current age to age + i,r is the discount rate set at 6 percent, 1.04 is the expected annual 4 percent increase in salary, and x is the number of years until retirement. The above equation should also be multiplied by: $(p) \times (1 - p)$, where p is the probability of retiring. For females, the effect of salary on the probability of retirement should include three more terms due to the sex-salary interaction and the sex-pension interaction variables. As an empirical proposition, for a sixty-year-old male teacher with thirty years of experience, the total effect of salary on probability of retirement was close to zero in both years.

The relationship between student test scores and retirement could be positive or negative. Teachers may enjoy teaching higher-achieving students, or they may enjoy the challenge of teaching less advanced students. The results indicate that teachers in both years were significantly less likely to retire if students at their school scored well on the PSSA test. A 100-point increase in school PSSA scores would reduce the probability of retiring by .13 in 1997–98 and .45 in 1998–99; this implies elasticities of retirement with respect to student achievement of −.24 in 1997–98, and −.41 in 1998–99.

The relationship between the retirement decision and percent low-income students was unexpectedly negative, but also extremely small and statistically insignificant in both years. This result is consistent with the observation that it is student achievement, rather than the socioeconomic status of a teacher's students, that affects teacher morale and, hence, the decision to retire.

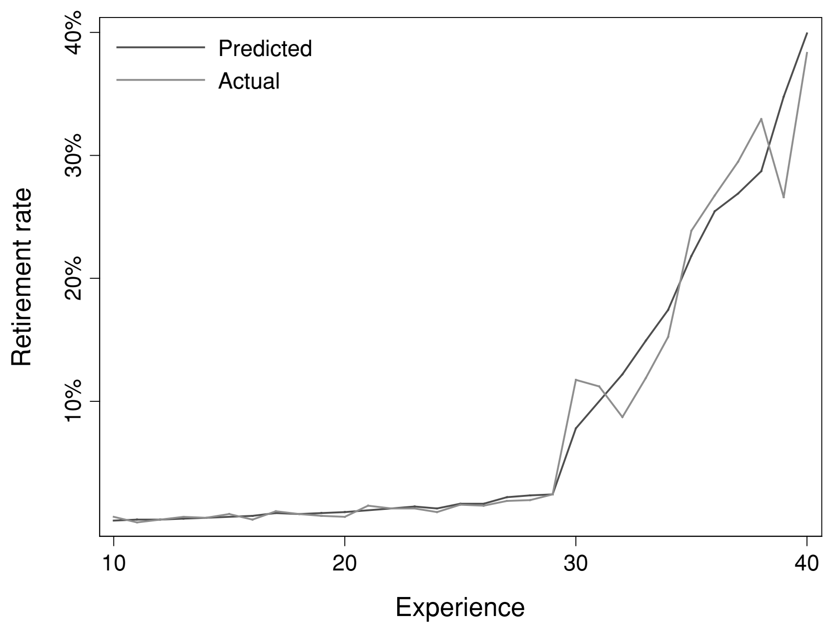
Weapons confiscation was positively related to the retirement choice for male classroom teachers, and this result was significant in 1998–99; however, the effect of weapons confiscation on the retirement decision for female classroom teachers was close to zero. Analyses conducted with other school crime measure,s such as expulsions, assaults on employees, and arrests, displayed smaller estimated effects for these crime proxy variables, but gender differences were still evident. A possible explanation for the gender differences could be that they reflect different male/female crime victimization rates. According to data from the National Crime Victimization Survey (NCVS), male teachers were more likely to be physically confronted with crime at work than female teachers in 1997 and 1998.[26] However, sampling variation casts some doubt on the precision and stability of these NCVS rates.[27]

One potential explanation for the relative weakness of the crime effects is a "rational expectations" explanation in which teachers know which buildings are high crime at the time they take their jobs and sort themselves accordingly. In this explanation, teachers more willing to accept high crime rates choose higher-crime schools. Although this effect is probably present, we do not think it is large. First, retirement decisions are made twenty or thirty years after teachers' choice of employer, and in that time both their preferences and the levels of crime may change substantially. Second, there is now and has been

26. Among high school teachers the male victimization rate was 18.3 per thousand in 1997 and 20.3 per thousand in 1998. The female victimization rate was 12.4 per thousand in 1997 and 6.2 per thousand in 1998.

27. Additionally, adding ethnicity measures of the school enrollments for 1997–98, which were obtained from the Pennsylvania Department of Education (percent black, percent Asian, percent Hispanic, percent Native American) did not result in any of these ethnicity measures being statistically significant and did not change the sign, significance level, or estimated effect of any of the factors in tables 2 and 3. Evidently, student poverty, the measures of weapons , and student achievement characterize student-level considerations for teachers when considering whether or not to retire.

Figure 6



Pennsylvania Teacher Retirement Model Performance, 1997–1998

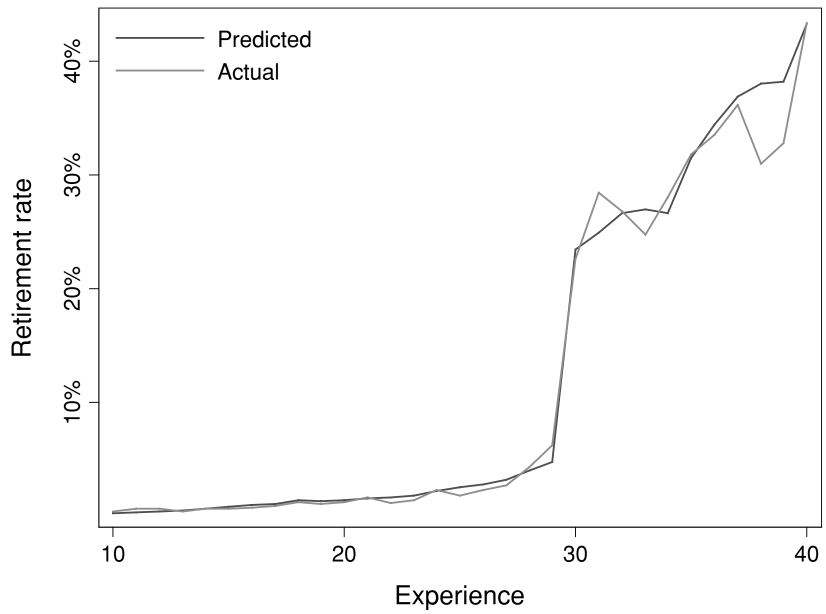
for some time a substantial excess supply of teachers in Pennsylvania, so it is likely that the choice being made was more by the district than by the teacher. Third, it is quite costly for teachers to switch districts, as they are typically not able to preserve their salary level for pension purposes. Finally, since crime is most relevant in high schools; since most districts have a single high school; and since, in the districts with many high schools, it is very difficult to move from a high crime to a low crime high school, the stickiness of the employment decision is exaggerated for the relevant population of high school teachers.

Predictive Accuracy of Estimated Models

Two types of forecasts were used to evaluate the empirical model: The model fit was assessed using predictions for 1997–98 and 1998–99, and the predictive ability of the model was examined by estimating retirement rates for previous years. These predictions were then compared to actual retirement behavior to evaluate model fit and predictive validity. Figures 6 and 7 display predicted and actual statewide retirement *rates* by experience level for 1997–98 and 1998–99.

Overall, the model appears to fit the data well. At low experience levels, the predicted rates closely approximate the actual rates. Many of the other empirical models have similar predictive validity for younger/less experienced

Figure 7

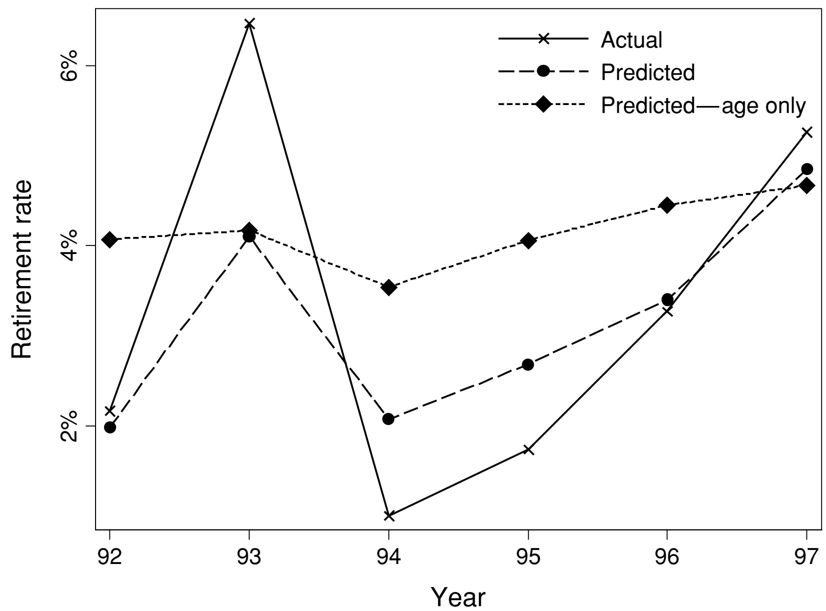


Pennsylvania Teacher Retirement Model Performance, 1998–1999

teachers; however, those predictive models often failed to "spike" when the actual retirement rates spiked (Lumsdaine, Stock, and Wise 1990; Samwick 1998). Most teachers qualify for full benefits when they attain thirty years of service, and the actual retirement rates increased significantly at that point. In 1997–98 the predicted retirement rate also increased considerably at thirty years of experience, although the predicted rate of increase was smaller than the actual rate. In 1998–99, the predicted increase for teachers with thirty years of service almost mirrors the actual increase. Figures 6 and 7 also show that the empirical model predicted well for older, more experienced teachers.

The predictive accuracy of the empirical model was examined by using the model to estimate retirement rates in previous years. Most teachers, roughly 95 to 98 percent, taught in the previous year. This means that predictions of teacher demand are very sensitive to the projected attrition rate. For example, assuming constant enrollment and class size, if the statewide attrition rate falls from 5 percent to 4 percent, the number of teachers needed would fall by 20 percent. Therefore, small changes in predicted retirement rates can have large effects on predicted shortages or surpluses. Current models of retirement and general attrition often use age-specific and subject-specific attrition rates to predict future attrition. A crucial and historically inaccurate assumption of the age-specific attrition models is that age-specific attrition rates are constant

Figure 8



Predictive Accuracy of Pennsylvania Teacher Retirement Model: Aggregate Model Performance vs. Simple Age Model, 1992–1997

(Barro 1992). Similarly, we find that there can also be substantial variation in subject specialty retirement rates, reducing the accuracy of those models.

To determine whether the empirical model proposed in this article can provide better predictions than the standard predictive model, new logistic coefficients were estimated using a data set that combined all observations from the 1997–98 and 1998–99 school years. This empirical model was then used to predict retirement rates for Pennsylvania teachers from 1991–92 to 1996–97.[28] This involved using the estimated coefficients to predict the probability of retiring for each individual and then aggregating those probabilities for each year. These predictions were then compared with the actual numbers of teachers who left, as well as predictions made using the current standard, age-specific retirement rates, with 1997–98 and 1998–99 as the combined base years.

Figure 8 shows that the age model (labeled *AGE*) predicted relatively smooth and constant retirement rates over time. Because it did not incorporate

28. Working conditions measures were not available for years prior to 1997–98, therefore the coefficients were estimated in a regression equation that did not include working conditions, and those coefficients were used to predict attrition in previous years. It is likely that the predictions would have been more accurate if working conditions had been included in the prediction model.

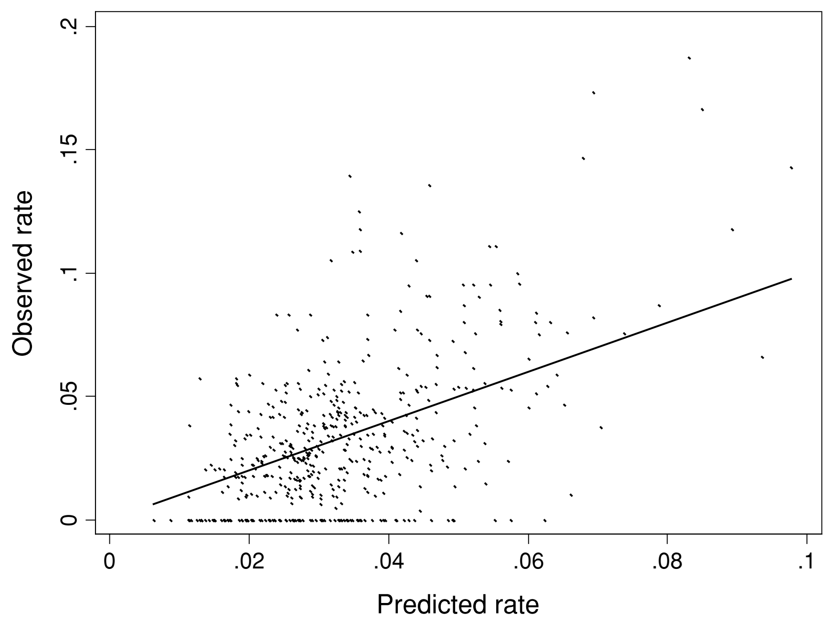
pension variables, this model did not predict significant increases in retirement during years with an ERIP. Our empirical model (labeled *PREDICT*) accurately predicted the effect of the pension rule change in 1996–97, but it was less accurate in predicting an increase in retirement in 1992–93. One possible reason the *PREDICT* model predicted better in 1996–97 than 1992–93 was that the pension changes that occurred in 1996–97 were the same as 1998–99, a base year, but differed from the ERIP that occurred in 1992–93. In 1996–97 (and 1998–99), the elimination of the "thirty and out" rule meant that teachers with between thirty and thirty-three years of experience had an incentive to retire in order to qualify for full benefits that they would not be eligible for in the following year(s). The 10 percent bonus in 1992–93 applied to all teachers over age fifty-five, a much broader group.

The *PREDICT* model made more accurate predictions for 1993–94 and 1994–95, but both models significantly overpredicted retirement rates in those years. Retirement rates in 1993–94 and 1994–95 were much lower than normal, most likely because teachers who were considering retiring at some point in the mid-1990s decided to retire in 1993 in order to receive the temporary retirement bonus. Teachers who were eligible for the bonus and did not retire in 1992–93 most likely enjoyed teaching and did not want to retire in the immediate years following the incentive. Since the *PREDICT* model's coefficients were based on a group of teachers who likely had a different distribution of teaching satisfaction, the model overestimated the probability of retiring in 1994 and 1995. It is unclear which of the models would predict best under a system without any changes in pension rules, although the accurate predictions of the *PREDICT* model in two years relatively unaffected by pension changes, 1991–92 and 1995–96, imply that regression models based on estimated parameters could be superior to current methods.

In five of the six years, the *PREDICT* model made more accurate predictions than the *AGE* model, although the differences were sometimes slight. It could be argued that the *AGE* model was inaccurate because the base years were 1997–98, which had no pension changes, and 1998–99, when the early retirement window ended. Because the model combined two dissimilar years with very different retirement rates, the *AGE* model did not predict well in previous years. To examine this possibility, new predictions were made using 1997–98 and 1998–99 as separate base years. Regardless of whether the base year was 1997–98 or 1998–99, the logistic models were more accurate than their respective age models in six of the seven possible years.

As an additional check on our model, we examined how well it predicted retirement across districts compared to a model containing only age. The results of this analysis are presented in figures 9 and 10. Those figures plot predicted (by the models) retirement rates for 1997–98 aggregated to the

Figure 9



Predicted versus Actual Teacher Retirement Rates by Pennsylvania School District, 1997–1998, Full Model

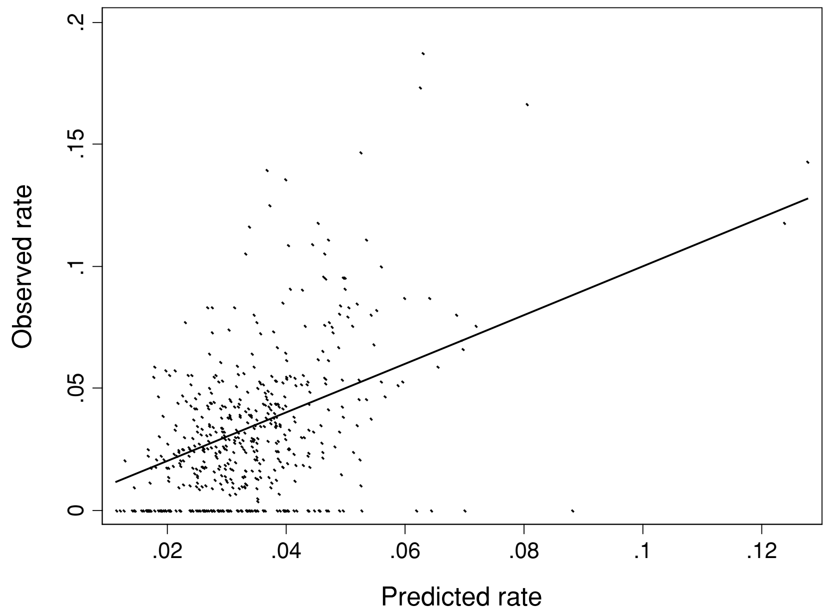
district levels against actual retirement rates in those districts in that year. Also shown is the 45-degree line. Each model fits the data quite well, with the full model achieving a correlation of 0.55 between predicted and actual retirements and the age model achieving a correlation of 0.48. The correlations for 1998–99 for the full and age models are 0.46 and 0.39, respectively, and the plots for that year look essentially the same as do the ones for 1997–98.

CONCLUSIONS AND POLICY IMPLICATIONS

The purpose of this article was to study if, and to what degree, pecuniary and nonpecuniary factors affect the retirement decisions of classroom teachers. We find that both have significant and large effects.

We expected that variables measuring current pension benefits and the maximum value of future defined retirement benefits would largely capture the pension incentives to retire. Some empirical support was found for these propositions. The present value of real pension benefits was strongly and significantly related to the retirement decision, holding constant a host of demographic and other factors. Potential future pension benefits were negatively associated with retirement, and this relationship was significant in 1998–99. Females' retirement decision was less sensitive to current and future pension

Figure 10



Predicted versus Actual Teacher Retirement Rates by Pennsylvania School District, 1997–1998, Age Model

benefit levels than was males'. Retirement also significantly increased at ages sixty-two and sixty-five, when teachers first become eligible to receive Social Security and Medicare benefits.

Current salary directly affects the work/retire choice by determining the value of future work, and also by indirectly influencing future pension benefits. In 1997–98, we found that, holding pension benefits constant, the effect of raising salaries for older classroom teachers was to encourage them *to continue* teaching. The calculated elasticity was −1.4. However, if salary changes are allowed to affect pension values (as they in fact do), changes in salary appear to have little effect on retirement.

For districts that wish to encourage older teachers to retire, this means that consideration should be given to providing one-time payments for early retirement. Simply extending raises across the board to younger and older teachers may have the unintended effect of keeping older classroom teachers in the schools.

Student characteristics and school environment were also related to the teacher retirement decision. Classroom teachers who taught at schools with higher student achievement scores were significantly less likely to retire. Holding student achievement constant, the percentage of low-income students at school did not affect retirement. Finally, school crime was positively associated with male, teacher retirement, but not female, and this result was significant in 1998–99. There is some evidence from the NCVS that male teachers are more likely to be victimized by violence at school, providing a possible explanation for this result.

These results indicate that schools with less appealing working conditions are likely to experience higher retirement rates. Since there is evidence that new teachers are not as effective as more experienced teachers (Hanushek, Kain, and Rivkin 1998), policy makers may want to consider providing salary or pension bonuses for teachers who teach in schools with less desirable working conditions in order to retain them. More generally, these results imply that cost-benefit analyses of crime should also consider the effect of crime on retirement and attrition in the workplace.

The forecasting accuracy of the statistically estimated models was also examined and compared to predictions derived from age-specific retirement rates. In years in which pension rules were constant, the logistic model's forecasting record was usually better than those forecasts derived from a model using age-specific retirement rates. The empirical model was able to accurately predict the effect of one pension change, although the model underestimated retirement by 35 percent with another type of ERIP. These results demonstrate that empirical models may be useful in estimating teacher demand, as well as designing future early retirement incentives that achieve desired retirement rates at minimum cost.

Due to data limitations, we were not able to account for whether school districts provided postretirement health insurance. Only 56 percent of Pennsylvania school districts provide teachers with full or partial postretirement health insurance (PSERS 1996), although all teachers are eligible for Medicare once they reach the age of sixty-five. Previous work has found that individuals with employer-provided postretirement health insurance retire earlier than those without health insurance (Madrian 1994). Providing postretirement health insurance until Medicare eligibility is another potential way for employers to encourage early retirement.

While this article provides some suggestions as to why teachers retire, a lack of data prevented comparisons of the quality of the teachers who retired with those who stayed. Often, the number of workers retiring could be less important than the quality of workers retiring. The one potential measure of quality available—whether the teacher has a master's degree—has not been found to correlate with student outcomes (Hanushek 1986). Another measure of teacher quality is the teacher's scores on the National Teacher Exam, now the PRAXIS exam. Previous work (Murnane and Olsen 1989; Schlechty and Vance 1981) has found that new teachers with higher subject-knowledge scores were more likely to leave education.[29] Also, there is evidence (Strauss and Sawyer 1986) that higher teacher test scores are associated with higher student test scores. Given that higher-quality teachers may be more likely to leave teaching, the use of ERIPs could be problematic if they encourage the retirement of more capable teachers, as opposed to more "burned-out" teachers. Further research should address this issue.

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