The Effect of Pension Incentives and Working Conditions on Retirement Decisions

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Abstract

The retirement behavior of Pennsylvania public school teachers is modeled using a choice framework that emphasizes both pecuniary and non-pecuniary factors. We find each to have large and statistically significant effects on the decision to retire.

The present value of inflation adjusted pension benefits is found to be an important determinant of retirement. A $1,000 (or .4 percent) increase in the value of pension benefits is estimated to increase the probability of retirement by .029 to .078 percentage points; this implies an elasticity of retirement with respect to the present value of real pensions of between 2.1 to 2.9. Estimated pension elasticities for female teachers are somewhat lower than for male teachers. 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.

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 are positively associated with male, but not female, retirement and were modest in size.

The estimated retirement model makes more accurate predictions than a simple model based on age-specific retirement rates; however, the model has a mixed record in predicting the effect of previous early retirement incentive plans.

1.0 Introduction

During the 1990's many school districts were unable to fill teaching vacancies that were created in part by growing teacher retirements. Nationally, between 25 and 33 percent of teachers leaving education said that retirement was their primary reason for leaving (Whitner et al., 1997). While fast growing states and regions report teacher shortages, others with stable or declining student populations have a surplus of qualified teachers. In these declining enrollment areas, school boards often encourage retirement to reduce short-term personnel costs or to bring new teachers into schools (PSERS, 1996).

Regardless of their goals, state and local policymakers can affect teacher retirement through decisions about pensions, salary, and working conditions. In the past, states and school districts facing teaching shortages have provided salary bonuses or other financial incentives in order to retain teachers. States seeking to reduce their salary costs or to remove "burned-out" teachers have also used temporary pension incentives to encourage early retirement.

Understanding why older teachers retire is essential to constructing accurate models of teacher demand. Current projections of teacher retirement do not incorporate pension benefits, other financial variables, or working conditions, but instead are usually based on age or experience specific attrition rates (Barro, 1992). As the teaching population and American labor force age, a better understanding of how salaries, pensions, and working conditions affect the retirement decision can improve policy decisions.

There is a relatively large academic literature examining the retirement decision, and a much smaller literature that examines teacher retirement and teacher attrition. Previous research on the retirement decision has found that pension benefits strongly influence the retirement decision. Samwick (1998), Stock and Wise (1990), Fields and Mitchell (1984), and Burkhauser (1979) all found a strong relationship between pensions and retirement. There is also a general consensus that Social Security provides incentives to retire once individuals reach the age of 65.[1]

[1] Kahn (1988) found that there may also be incentives to retire at age 62 if individuals have high discount rates due to liquidity constraints.

Temporary retirement incentives have also been found to 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.

Factors influencing attrition among beginning teachers, such as working conditions, salary, and teacher characteristics, have been documented by Murnane and Olsen (1989 and 1990) and Stinebrickner (1998 and 2002) among others (see also Theobold, 1990 and Grissmer and Kirby, 1992 for a combined analysis of new and experienced teachers). However, the applicability of this research to the retirement decision is limited; factors such as childbirth and occupational change that cause younger teachers to leave education are unlikely to influence the retirement decisions of older teachers. Hanushek, Kain, and Rivkin (2001) and Strauss (1993) examined the effect of demographic characteristics, working conditions, and salary on teacher retirement, but neither paper used pension variables.

The effect of working conditions on retirement in occupations other than teaching has received little attention in the recent labor economics literature. Within the education research literature, Strauss (1993) and Hanushek, Kain, and Rivkin (2001) found that higher student test scores reduced the probability of retiring for older teachers. 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. Mont and Rees (1995) and Theobold (1990) examined class size and found that larger class size was often associated with higher attrition, while Hanushek, Kain and Rivkin (2001) reported that class size did not systematically affect attrition. Conflicting findings in previous work may have also resulted from the use of imprecise school district, rather than school building, measures of working conditions. Much of the recent teacher attrition literature relates to new teachers, and does not address the retirement decision of older teachers. If teachers who are most sensitive to working conditions leave teaching early in their career, it is possible that those who remain will be much less sensitive to working conditions. To our knowledge, there has been no examination of the effect of workplace crime on teacher attrition or worker retirement.[2]

In this paper we examine the effect of 1) pension benefits, early retirement incentives, and salary, and 2) working conditions on the teacher retirement decision, *per se*, in Pennsylvania. The plan of the paper is as follows. Section 2 proposes a theoretical framework for analyzing the retirement decision. Section 3 explains the provisions of the pension plan, examines potential pension incentives, and describes the data. Section 4 presents the results from the logistic estimation, and evaluates the predictive capability of the model in comparison to the current standard model. Section 5 presents conclusions and policy implications.

2.0 A Model of the Classroom Teacher Retirement Decision

We construct a simple model of the retirement decision; one that is largely consistent with prior work in this area. A worker contemplating retirement considers the future flow of utility if he were to retire today, and compares that with the flow arising from retirement at the best future date. These two flows are affected by a number of factors, both pecuniary and non-pecuniary.

Pecuniary factors include pension and wage wealth. Pension wealth given current retirement (at age R_1) is given in equation (1). Pension and wage wealth given retirement at the best future date, (at age R_2), is given in equation (2).

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

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

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 that is based on the retirement age (*R*), previous wages (W_P) and assuming the teacher begins

[2]See Hamermesh (1999) for the effect of crime on job preferences.

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 to be 6 percent in our analysis.

It is hypothesized that a worker desires a certain level of retirement income before he will leave the labor force. This means the individual will be reluctant to retire until his current benefits and savings provide a desired retirement income. The higher the level of current benefits, the more likely he will reach his preferred level, and consequently the more likely he is to retire. Because the desired retirement income level is based on household income, the effect of current pension benefits on retirement should be smaller for females, who are more likely to have a working spouse and whose spouses, on average, are likely to earn more money (see Pozzebon and Mitchell, 1989). Increasing future pension wealth (relative to current) should decrease the likelihood of retirement.

Salary's effect is ambiguous. Holding pension wealth constant, higher future salary should reduce retirement, since it 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.

Non-pecuniary factors are also likely to affect retirement behavior. Factors tending to increase the disutility of work relative to leisure will raise the utility of choosing retirement in this period. 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 suffer higher worker attrition. Age is hypothesized to be a relatively accurate 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 non-leisure 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, 1995), a desire to be with a retired spouse (Blau, 1998), and increasing preferences for leisure cause the disutility of work to increase.

3.0 Pennsylvania's Public Teacher Retirement Plan, Data, and Statistical Model

3.1 Pennsylvania's State Employees' Retirement System

Public school teachers in Pennsylvania, like their counterparts in other states, have a defined benefit pension plan operated by a state agency. The Pennsylvania State Employees' Retirement System (PSERS) receives state and local administrative unit (LEA) contributions[3] annually and invests the proceeds in a $28 billion pension trust. If a teacher leaves education with less than ten years service, his contributions plus four percent interest are refunded. After ten years of service the teacher can vest the pension and leave, or elect to receive monthly retirement benefits. The annual pension benefit[4] is:

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

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 is greater than zero and declines to zero as age and years of service rise. This decline is non-linear with a large decrease with eligibility for full retirement. To qualify for full retirement, a teacher must have either 1) 35 years of service, 2) 30 years of service and be over age 60, or 3) be 62 or older. For the years studied in this paper, 1997-8 and 1998-9, the state enacted a temporary retirement incentive of "30 and out" that allowed a teacher with 30 or more years of experience to retire with full benefits, regardless of age. Figure 1 displays the relationship between the mean real present value of pension benefits by experience level for teachers in the 1997-8 school year. Note the substantial increase in mean pension benefits at 30 years of service which is when most teachers become eligible for full benefits.

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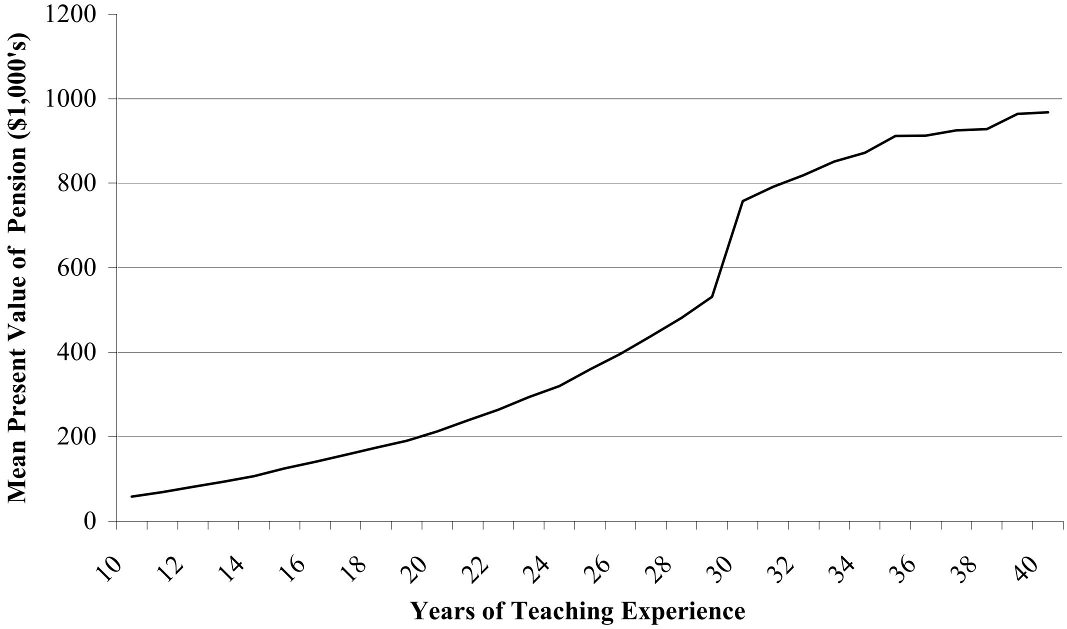
[3] Currently each body contributes 5% of covered payroll.

[4] Although there are various options that result in reduced benefits, most teachers elect to receive the maximum payment, and therefore this formula will be used in this paper.

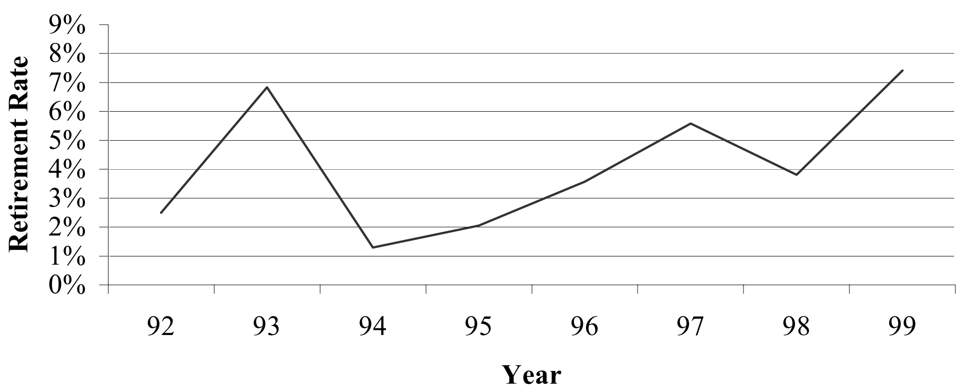
Figure 1
Mean Present Value of Real Pension Benefits by Years of Teaching Experience



Although there is no automatic cost-of-living adjustment (COLA) for 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 "30 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 60, or would have reached the experience level necessary to qualify for full benefits.

The "30 and out" early retirement window was periodically renewed by the Pennsylvania legislature throughout the 1990's, but expired in 1999. The expiration in 1999 meant that a teacher with between 30 and 33 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 similar teachers in 1998. In the past, the Pennsylvania Legislature adopted other early retirement incentive plans (ERIP). The first was a 10% experience bonus in 1992-93. If a teacher retired in 1993, was older than 55, and had at least 10 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 in that year (see Figure 2). Also, although it was later renewed, the "30 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.

Figure 2
Pennsylvania Teacher
Retirement Rate by Year



3.2 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/Secondary Professional Personnel File (ESPPF), was obtained for several years under signed non-disclosure agreements. Each ESPPF contains the universe of Pennsylvania public school teachers for that year.[5] The 1997-8 and 1998-9 ESPPF's were used to estimate statistical retirement functions and forecasts that were then compared to actual data using ESPPF's 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 61) 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.[6] Since the decision is assumed to be voluntary, classroom teachers who died, were fired, laid off, or had their certification revoked were not included in the analysis. There were 55,861 full-time teachers in 1997-8 and 55,788 teachers in 1998-9 that had complete demographic and school level information.[7]

Student academic achievement was measured using the Pennsylvania State School Association (PSSA) test, which is an annual test given to all 5th, 8th, and 11th 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 combined (math + reading) test score for the school. Student socioeconomic class is measured by the percentage of students eligible for the free or reduced lunch program at the school. The school crime measure was the number of weapons (firearms + knives) confiscated at the school.[8] Sixty-one and 68 percent of

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[5] Teachers from Philadelphia, 10.5 percent of all Pennsylvania teachers, were not included in the analysis, as the data were found to be unreliable. For example, in 1998-9 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.
[6] Teachers who told the school district that they were leaving for other employment or "other" reasons were not included in the analysis.
[7] 5,828 teachers in 1997-8 and 5,810 in 1998-9 did not have matching test scores. These teachers overwhelmingly taught at vocational or early childhood schools that do not administer the state test. Over 99.8% of teachers had matching crime and low-income student information.
[8] Other crime/violence measures such as expulsions of greater than one year, assaults on employees, and arrests at school were also used. However, it was believed that these variables were more subject to measurement error due to differences in reporting, definition of a violation, or discipline policy.

schools had zero weapons violations in 1997-8 and 1998-9 respectively, and the distribution was very right-skewed.

3.3 Statistical Model

To ascertain how responsive the retirement decision is to pecuniary and non-pecuniary incentives, we estimate a binary logit model of the decision to retire:

$$\ln\left(\frac{p}{(1-p)}\right) = X\beta + \varepsilon \qquad (3)$$

where p is the probability of retiring, β is a vector of estimated parameters, X is a vector of demographic, pecuniary and non-work environment variables and ε is an error term.

Because the relationship between age and retirement is expected to be non-linear, age-squared and age-cubed were included in the estimated model. Ideally, variables measuring future pension benefits at various ages would be included in the regression equation; however, since the variables would be highly correlated, multicollinearity problems would likely result. Instead, in this paper we assume that individuals consider retiring in the next 25 years, and then choose the retirement age that would maximize the present value of the future benefits. 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. Individuals almost certainly consider total retirement income (pension benefits + 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 become eligible for reduced Social Security benefits at age 62, and full benefits (plus Medicare) at age 65. To account for Social Security incentives, two age dummy variables were included in the model. 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 confiscation and sex was included in the model. Finally, since teachers in different classroom environments encounter different working conditions, dummy variables identifying teaching specialty were used.

4. Logistic Estimation Results and Predictions

4.1 Statistical Estimation Results

Table 1 displays variable definitions, means, and standard deviations in parentheses.

Table 1: Data Definitions, Means (Standard Deviations) of Data

Acronym	Definition	Means 1997-8	Means 1998-9
P	probability of retiring	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	48.34 (6.42)	48.71 (6.50)
AGE^2	age squared		
AGE^3	age cubed		
FEMALE	=1 if female	0.62	0.63
BLACK	=1 if African-American	0.02	0.02
MASTERS	=1 if highest degree is a 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)	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)	377.54 (130.62)	366.22 (126.88)
FEMMAX	interaction between *PVMAXK* and *FEMALE*		
SS62	=1 if age equals 62	0.006	0.006
SS65	=1 if age equals 65	0.002	0.002
VOC	=1 if teacher's major subject is vocational,	0.08	0.08
LD	=1 if teacher's major subject is learning disabled	0.1	0.1
SECNOLD	=1 if teacher's major subject is secondary (non LD)	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*		

Table 3 displays estimation results, with standard errors in parentheses. Table 4 displays marginal effects computed using the Delta method, 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. For continuous variables[9], the marginal effect equals:

$$\frac{1}{N}\sum_{i=1}^{N} P(Y=1; X=X_i+1) - P(Y=1; X=X_i)\,. \qquad (4)$$

The size of the marginal effect is in terms of percentage points.[10] For example, in 1998-9 an increase of 1 in *PSSA* (which corresponds to a 100 point increase in PSSA test scores) is associated with a .45 percentage point reduction in the predicted probability of retirement.[11] Statewide, a one percentage point increase in the retirement rate is equivalent to approximately 550 extra teachers retiring in a year. .

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[9] For dummy variables, the effect is: $\frac{1}{N}\sum_{i=1}^{N} P(Y=1; X_i=1) - P(Y=1; X_i=0)$

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

[11] 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 1998-9, thus the elasticity is:-.0045× (6.3/.07) =-.41

Table 2: Estimated Parameters and (Standard Errors)

VARIABLE	1997-8		1998-9	
	β	S.E.	β	S.E.
INTERCEPT	35.2035	(7.7249)	22.3271**	(8.9007)
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	-0.7630*	(0.3423)	-0.5681*	(0.2552)
BLACK	-0.5872**	(0.2044)	-0.2911*	(0.1383)
MASTERS	-0.1724**	(0.0528)	-0.1479*	(0.0386)
SALARYK	-0.0480**	(0.0118)	0.0031	(0.0088)
FEMSAL	0.0271**	(0.0095)	0.0055	(0.0074)
PVPENK	0.0112**	(0.0013)	0.0171**	(0.0008)
FEMPV	-0.0022	(0.0011)	-0.0029**	(0.0009)
PVMAXK	-0.0038	(0.0022)	-0.0166**	(0.0014)
FEMMAX	0.0001	(0.0016)	0.0038**	(0.0014)
SS62	0.8213**	(0.119)	0.5331**	(0.122)
SS65	0.7801**	(0.2148)	0.0484	(0.2324)
VOC	0.0959	(0.1002)	0.1811*	(0.0746)
LD	0.1078	(0.1216)	0.0845	(0.0922)
SECNOLD	0.0662	(0.066)	0.1484**	(0.0481)
PSSA	-0.0480**	(0.0216)	-0.0882**	(0.017)
LOWINC	-0.0036	(0.0019)	0.0001	(0.0013)
WEAPONS	0.0182	(0.0177)	0.0462**	(0.014)
FEMWEAP	-0.0105	(0.0247)	-0.0355	(0.0208)
LOG L	-5906.00		-9698.94	
LOG L-intercept	-8394.72		-14198.69	
Coefficients significantly different from zero at the 5 and 1 percent levels are denoted with an * and ** respectively				

Table 3: Marginal Effects on Mean Probability of Retirement and (Standard Errors)

Marginal Change	1997-8 Marginal Effect	1997-8 S.E.	1998-9 Marginal Effect	1998-9 S.E.
Going from experience 14 to 15	.080	(.055)	.265**	(.038)
Going from experience 24 to 25	-.095	(.054)	.131*	(.065)
Going from age 34 to age35	-.104	(.074)	-.026	(.083)
Going from age 44 to age 45	.069 **	(.008)	.259**	(.025)
Going from age 54 to age 55	.633**	(.066)	.781**	(.054)
Going from age 61 to age 62	1.395**	(.291)	.313*	(.129)
Going from age 64 to age 65	1.325**	(.390)	-.221	(.176)
Female	-.514**	(.252)	.834*	(.376)
Black	-1.368**	(.383)	-1.412*	(.618)
Masters	-.491**	(.152)	-.778**	(.204)
$1,000 increase in salary (males and females)	-.095**	(.028)	.030	(.042)
$1,000 increase in salary (females)	-.055*	(.027)	.046	(.043)
$1,000 increase in salary (males)	-.140**	(.037)	.015	(.043)
$1,000 increase in present value of current pension benefits (male and females)	.029**	(.003)	.083**	(.003)
$1,000 increase in present value of current pension benefits (females)	.024**	(.004)	.078**	(.004)
$1,000 increase in present value of current pension benefits (males)	.033**	(.003)	.085**	(.005)
$1,000 increase in present value of best future pension benefits (males and females)	-.011*	(.005)	-.076**	(.006)
$1,000 increase in present value of best future pension benefits (females)	-.010*	(.005)	-.069**	(.009)
$1,000 increase in present value of best future pension benefits (males)	-.011	(.007)	-.081**	(.006)
Difference between vocational and primary teachers	.272	(.289)	.948*	(.401)
Difference between learning disabled and primary teachers	.307	(.355)	.431	(.479)
Difference between secondary and primary teachers	.186	(.184)	.771**	(.249)
100 point increase in PSSA scores	-.134*	(.059)	-.451**	(.085)
1 percentage point increase in percent of low income students	-.010*	(.005)	.000	(.000)
Increase of one weapon (males and females)	.036	(.037)	.150**	(.058)
Increase of one weapon (females)	.021	(.049)	-.058	(-.090)
Increase of one weapon (males)	.054	(.053)	.230**	(.069)
Effects significantly different from zero at the 5 and 1 percent levels are denoted with an * and ** respectively				

Consider the explanatory variables' effect on the retirement decision in Table 3. Each age coefficient was statistically significant. The effect of age on the retirement probability was negative until age 40 in 1997-8 and age 36 in 1998-9. 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 1997-8 and age 64 in 1998-9.

The marginal effects indicate that females were significantly less likely to retire in 1997-8 and significantly more likely to retire in 1998-9. The results indicate that older African-American teachers were more likely to stay.[12] One possible explanation is that African-Americans may need to work longer because they have fewer sources of retirement income.[13] Note that in both years, classroom teachers with masters degrees were significantly less likely to leave than teachers with bachelor degrees or PhD's.

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 1997-8 and 1998-9. Overall, a marginal increase of $1,000 in the present value of pension benefits would increase the probability of retiring in 1997-8 by .029 percentage points and by .083 points in 1998-9.[14] While these effects seem small, when compared to respective means they imply sizeable elasticities. They suggest that a 1% increase in the present value of real pension benefits will lead to 2.1% increase in the probability of retirement in 1997-8 and 2.9% increase in the probability of retirement in 1998-9.

For female teachers, a marginal $1,000 increase in the present value of pension benefits would increase on average the predicted probability of retirement by .024 percentage points in 1997-8 and .083 points in 1998-9, which imply elasticities of 1.7 in 1997-8 and 3.1 in 1998-9. For male teachers, a marginal $1,000 increase in the present value of pension benefits would increase the predicted probability of retirement by .033 percentage points in 1997-8, and by .085 percentage point in 1998/9, and imply elasticities of 2.34 in 1997-8 and 3.13 in 1998-9. Thus, the retirement decision was sensitive to the present value of real pension benefit levels. In both 1997-8 and 1998-9 the interaction between sex and *PVPENK* was negative and significant. This result is consistent with the hypothesis that females are less sensitive to pension incentives.

The present value of future real pension benefits was negatively related to the retirement, although the coefficient in 1997-8 was relatively small and insignificant. The

[12] 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.

[13] Smith (1995) found that black households have roughly a quarter of the wealth of white households.

elimination of the "30 and out" pension window provides an intuitive way to measure effect sizes for this variable. The ending of the "30 and out" rule in 1999 caused a female teacher with 30 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 increase retirement in 1998-9. The actual retirement rate for a female teacher with 30 years of experience in 1999 was 19.6 percent; if the "30 and out" rule had been extended for another year, the predicted retirement rate for the same teacher in 1998-9 was 13.3 percent. The coefficient on the interaction between sex and future benefits was positive and significant in 1998-9, again implying that females are less sensitive to pension incentives.

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 1998-9. The coefficient for *SS62* was significant in both years, although the magnitude was much smaller in 1998-9. The coefficient for *SS65* was significant in 1997-8, but not 1998-9 when the effect size was close to zero. The ending of the "30 and out" rule in 1998-9 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 1997-8 and positive but statistically insignificant in 1998-9. Focusing on the statistically significant result from 1997-8, we infer that an increase in salary, holding everything else constant, *reduces* the probability of retiring. Overall, a marginal increase in $1,000 of salary *reduces* the probability of retirement by .095 percentage points in 1997-8; 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:

[14] See Table 4.

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

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, and 1.04 is the expected annual 4 percent increase in salary. The above equation should also be multiplied by: (p)×(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 60-year old male teacher with 30 years of experience, the total effect of salary on probability of retirement was close to zero in both years.

Theoretically, the relationship between student test scores and retirement is ambiguous. 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 .134 in 1997-8 and .451 in 1998-9; this implies elasticities of retirement with respect to student achievement of –.24 in 1997-8, and –.41 in 1998-9.

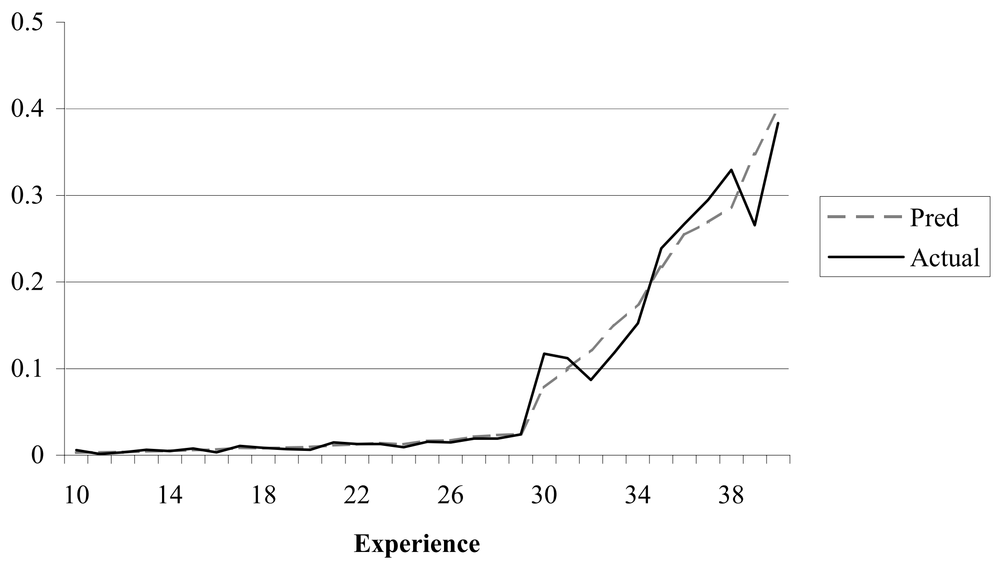
The relationship between the retirement decision and percent low-income students was unexpectedly negative, but also extremely small and statistically insignificant in both years. This result is consistent with the observation that it is student achievement, *per se*, rather than the socio-economic status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

Weapons confiscation was positively related to the retirement choice for male classroom teachers, and this result was significant in 1998-9; however, the effect of weapons confiscation on the retirement decision for female classroom teachers was close to zero. Analyses conducted with other school crime measures 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.[15] However, sampling variation casts some doubt on the precision and stability of these NCVS rates.

4.2 Predictive Accuracy of Estimated Models

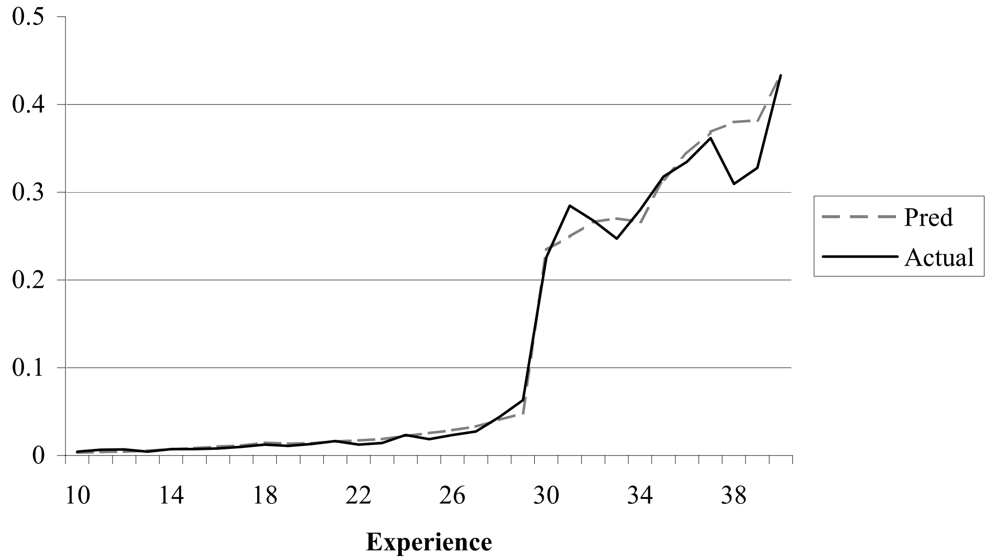
Two types of forecasts were used to evaluate the empirical model: the model fit was assessed using predictions for 1997-8 and 1998-9, and the predictive ability of the model was examined by estimating retirement rates for previous years. These predictions were then compared to actual retirement behavior to evaluate model fit and predictive validity. Figures 3 and 4 display predicted and actual statewide retirement *rates* by experience level for 1997-8 and 1998-9.

Figure 3
Actual vs. Predicted Retirement Rates: 1997-98



[15] 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.

Figure 4
Actual vs. Predicted Retirement Rates: 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 teachers, however, those predictive model often failed to "spike" when the actual retirement rates spiked (Lumsdaine, Stock, and Wise, 1990 and Samwick, 1998). Most teachers qualify for full benefits when they attain 30 years of service, and the actual retirement rates increased significantly at that point. In 1997-8 the predicted retirement rate also increased considerably at 30 years of experience, although the predicted rate of increase was smaller than the actual rate. In 1998-9, the predicted increase for teachers with 30 years of service almost mirrors the actual increase. The difference in predictive accuracy between the two years may derive from the small *PVMAXK* (future benefits) coefficient in 1997-8. Figures 3 and 4 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 in previous years. Most teachers, roughly 95 to 98 percent in Pennsylvania, 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 fell 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 (Barro, 1992). Similarly, we find there can also be substantial variation in subject specialty retirement rates, reducing the accuracy of those models.

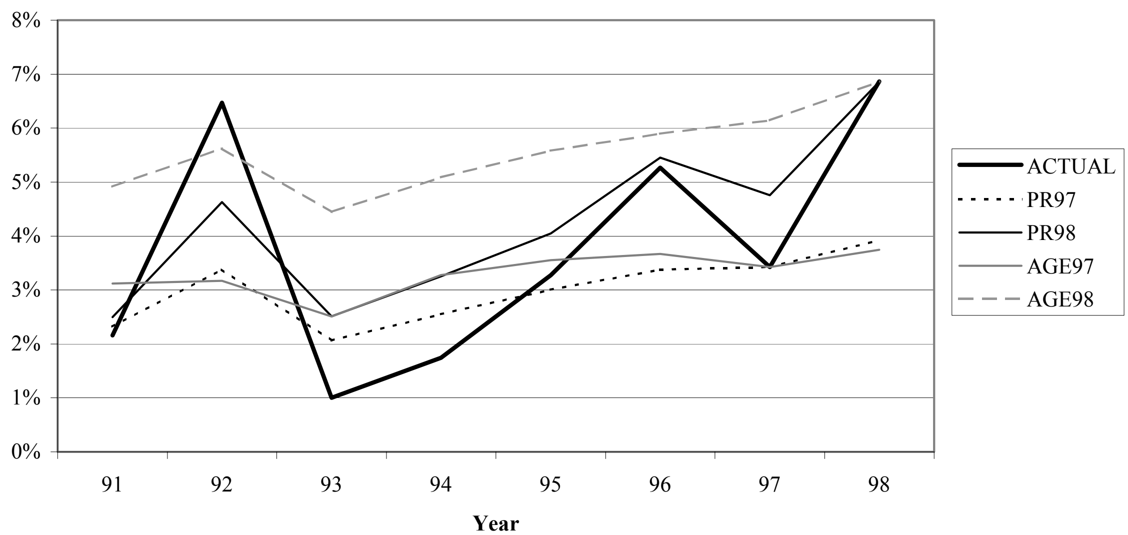
To determine whether the empirical model proposed in this paper can provide better predictions than the standard predictive model, the logistic coefficients previously estimated, both 1997-8 and 1998-9, were used to predict retirement rates for Pennsylvania teachers from 1991-92 to 1998-9.[16] This involved using the estimated coefficients to predict the probability of retiring for each individual, and then aggregating those probabilities. These aggregations, respectively known as PR97 and PR98, 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 1997-8 and 1998-9 as the base years. As shown in Figure 5, there were three years when the pension system provided incentives to retire: 1992-3, 1996-7, and 1998-9, and Figure 5 shows that temporary pension incentives may also lower retirement in future years, such as 1993-4, by reducing the pool of teachers who are inclined to retire.

Figure 5 shows that both age models predicted relatively smooth and constant retirement rates over time. Because they did not incorporate pension variables, neither of the models predicted significant increases in retirement during years with an early retirement incentive plan (ERIP). Although PR97 did predict an increase in retirement in 1992-3, the predicted increase was far less than the actual increase, and the model also did not capture the effect of the pension changes in 1996-7 and 1998-9. In terms of accuracy, the PR98 model made a very accurate prediction of retirement rates in 1996-7, but was less accurate in 1992-3. One possible reason why the PR98 model predicted well

[16] Working conditions measures were not available for years prior to 1997-8. Therefore the coefficients were reestimated 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.

in 1996-7 but not 1992-3 was that the pension incentives that occurred in 1996-7 and 1998-9 differed from the ERIP that occurred in 1992-3. In 1996-7 and 1998-9, the elimination of the “30 and out” rule meant that teachers with between 30 and 33 years of experience had an incentive to retire in order to qualify for full benefits that they would not be eligible for the following year(s). The ten percent bonus in 1992-3 applied to all teachers over age 55, a much broader group. The AGE98 model made relatively accurate predictions for both pension incentive years, because the model always estimated high retirement rates.

Figure 5
Predicted Retirement Rates



The PR97 model made the most accurate predictions for 1993-4 and 1994-5, but all of the models significantly over-predicted retirement rates in those years. Retirement rates in 1993-4 and 1994-5 were much lower than normal, most likely because teachers who were considering retiring at some point in the mid-1990’s decided to retire in 1993 in order to receive the temporary retirement bonus. One possible explanation for the models’ over-prediction is that teachers who did not retire in 1992-3, when there was a substantial pension bonus, enjoyed teaching more than teachers who did retire. Therefore, the older teachers who remained in 1993-4 and 1994-5 were likely the teachers who enjoyed teaching the most. Since the PR97 and PR98 models’ coefficients were based on a group of teachers who likely had a different distribution of teaching satisfaction, the models overestimated the probability of retiring in 1994 and 1995.

In six of the seven years, the PR97 and PR98 models made more accurate predictions than their respective age models, although the differences were sometimes slight. Overall, PR97 was the most accurate model in predicting yearly retirement, followed by PR98, AGE97, and AGE98. When predicting total retirement over the eight year period, PR98 and AGE97 predicted moderately well, PR97 predicted slightly worse, and AGE98 massively overpredicted total retirement. It is unclear which of the models would predict best under a steady-state pension system, although the accurate predictions of the PR97 model in 1991-2 and 1995-6 imply that regression models based on estimated parameters could be superior to current methods.

5.0 Conclusions and Policy Implications

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

It was hypothesized that variables measuring current pension benefits and the maximum value of future benefits would largely capture pension incentives to retire. Additionally, factors measuring the disutility of work, such as age and work environment were also hypothesized to affect the retirement decision. 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 real future pension benefits were not significantly associated with retirement in 1997-8 a year when pension rules were constant. However, in 1998-9, the last year of a pension "window," the level of real future benefits was significant and strongly related to the retirement decision. The female retirement decision was found to be less sensitive to current and future pension benefit levels than that of males. Retirement also significantly increased at ages 62 and 65, when teachers first become eligible to receive Social Security and Medicare benefits.

Conceptually, current salary directly affects the work/retire choice by determining the value of future work, and also by indirectly influencing future pension benefits. In 1997-8, we found that the effect of raising salaries for older classroom teachers was to encourage them to continue teaching. The calculated elasticity was –1.4. For districts that wish to encourage their older teachers to retire, this means that consideration should be given to both capping maximum salaries, *and* providing one time payments for early retirement. Simply extending raises across the board to younger and older teachers could have the perhaps 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. School crime was positively associated with male, but not female teacher retirement, and this result were significant in 1998-9. 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), policymakers 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 somewhat better than those forecasts derived from a model using age-specific retirement rates. A model using estimated parameters from 1998-9, a year with an early retirement incentive plan (ERIP), was able to very accurately predict retirement in a previous year with the same ERIP. However, the logistic model erred by roughly 30 percent when predicting retirement in a year with a different type of ERIP. These results demonstrate that empirical models may be useful in designing future ERIP's that achieve desired retirement rates at minimum cost.

Due to data limitations, we were not able to account for locally provided health insurance for teachers who are not yet eligible for Medicare. Only 56 percent of Pennsylvania school districts provide full or partial postretirement health insurance to teachers (PSERS, 1996), although all teachers are eligible for Medicare once they reach the age of 65. Previous work has found that individuals with employer provided postretirement health insurance retire earlier than those without health insurance (Madrian, 1994). Providing post-retirement health insurance until Medicare eligibility is another potential way for states or school districts to encourage early retirement. Undoubtedly this is an important factor in the retirement decision and is a subject for future research.

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