School Finance Redesign Project

center on reinventing public education

RETURNS TO SKILL AND TEACHER WAGE PREMIUMS

What Can We Learn by Comparing the Teacher and Private Sector Labor Markets?

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The School Finance Redesign Project

The School Finance Redesign Project (SFRP) encompasses research, policy analysis, and public engagement activities that examine how K-12 finance can be redesigned to better support student performance. The project addresses the basic question, "How can resources help schools achieve the higher levels of student performance that state and national education standards now demand?"

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Jacob Adams, Principal Investigator

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Introduction

Analysts have long argued that salary schedules in public education have pernicious effects on who ends up teaching. By ignoring differences in people's backgrounds and abilities that are rewarded elsewhere in the labor market, salary schedules are thought to make teaching a relatively costly choice for people with stronger academic or technical skills. This incentive structure may help to explain the fact that the 'brightest' college graduates tend to avoid teaching and are more likely to leave if they become teachers (Corcoran, Evans, and Schwab 2004; Gitomer and Latham 1999; Podgursky Monroe, and Watson 2004; Ballou 1996; Boyd et al. 2002; Murnane et al. 1991; Henke, Chen, and Geis 2000). Likewise, it may explain why science and math teachers are more likely to leave teaching than teachers in other subject areas (Ingersoll 2001; Kirby, Naftem, and Berends 1999; Henke and Zahn 2001; Murnane et al. 1991).

Some analysts and policymakers see these trends as cause for concern, especially given that teachers with high academic aptitude and technical expertise may be more effective at raising student achievement (e.g., Clotfelter, Ladd, and Vigdor 2005; Goldhaber, Choi, and Cramer 2007; Goldhaber and Brewer 2000; Greenwald, Hedges, and Laine 1996). In response, states and districts have experimented with targeted bonuses and wage differentials for teachers, hoping to make teaching more attractive to high-quality candidates and candidates with technical expertise. In 1998, for example, Massachusetts famously launched an alternative certification and incentive program called the Massachusetts Signing Program for New Teachers (MSPNT), which offered "high-quality candidates" a remarkable $20,000 signing bonus (Archer 2000). Although the program was later discontinued, states and districts across the country continue to experiment with incentives in hopes of attracting the best college graduates and people with math and science expertise to teaching.[1]

Making teaching relatively more attractive to such people may be a straightforward goal, but it is far from clear how much higher the pay would need to be to draw them into the classroom. The specific differentials offered by various states and localities span a wide range—sometimes thousands of dollars. These amounts are, in all likelihood, the result of political bargains, resource constraints, and anecdotal assessments of supply and demand conditions. Although these things are likely to continue to shape state and district experiments with salary incentives, policymakers also need a way to compare incentive proposals to estimates of the actual disincentive problem in public education. With that in mind, this paper examines the returns to skill in the teacher and nonteacher labor market to estimate a range of wage differentials that might equilibrate what individuals with particular skills could make in and outside of the teacher labor market.

[1] In 2006 more incentive proposals were being floated in Massachusetts, this time by local superintendents hoping to attract math and science teachers (Sachetti 2006). Massachusetts is not alone. In Washington State, governor Chris Gregoire recently proposed a $5,000 bonus for math or science teachers with national certification (from the National Board of Professional Teaching Standards) if they agree to teach in a high-needs school (Ammons 2006). In Florida, Lake City Community College is using a National Science Foundation grant to offer $7,000 bonuses as part of an alternative certification program for math and science teachers (Voyles 2006). According to a review of state legislation, 31 states now offer incentives for teachers in specific subject areas (Johnson 2005).

A number of studies have estimated the teacher/nonteacher wage difference (e.g., Allegretto, Corcoran, and Mishel 2008; Allegretto, Corcoran, and Mishel 2004; Hanushek and Rivkin 2007; Podgursky 2003; Podgursky and Tongrut 2006; Temin 2002). We advance this line of research by estimating how wage differences change over the course of a teacher's early career. On balance, it appears that differences in pay between teachers and nonteachers, especially for women, are not that great immediately upon their graduation from college. But the "salary gap" quickly grows as people progress through their early careers. The gap is particularly large for people with technical training who attended more selective colleges. A hypothetical female graduate from a top university with a technical degree, for example, may actually earn *more* as a public school teacher upon graduation (by about $3,500), but by the time she has about 10 years of labor market experience, she is estimated to be making over $10,000 *less* than she would in the nonteacher labor market (about 25% of her simulated teaching salary). Of course, given the observational nature of the data and the potential for selection bias, we should interpret these results with caution. They may reflect returns to unobservable characteristics associated with a person's career choice, not just returns to skills. We try to assess the selection problem by comparing our OLS results to propensity score match estimates. The results suggest our findings *underestimate* the disincentives associated with teaching.

The next section provides some background on the importance of teachers and teacher pay. Then, we present our methods and data for estimating a range of wage premiums. The last three sections present results, simulations, and conclusions.

Background

Among all of the school-related factors that affect student achievement in K-12 education, teacher quality is among the most important (Ferguson 1998; Goldhaber 2002; Rivkin, Hanushek, and Kain 2005; Rockoff 2004). When teachers are effective, they can achieve dramatic results (Hanushek 1992; Sanders and Rivers 1996). For example, Hanushek (1992) finds that, all else equal, the difference between having a highly effective teacher versus a highly ineffective teacher can be the equivalent of roughly a full year's learning growth. Using the Tennessee Value-Added Assessment System (TVAAS), Sanders and Rivers (1996) find that, on average, high-achieving students with the *most*-effective teachers made gains on achievement tests that were nearly 12 times higher (in percentage points) than those made by similar students with the *least*-effective teachers. These and other studies suggest that teacher quality effects are even more dramatic for low-achieving students.

Although it is clear that teachers matter, finding good proxies for teacher quality has proven difficult (the usefulness of proxies, such as experience or degree level, for example, appear to be highly context specific).[2] Nevertheless, there is some evidence that teachers who have demonstrated academic aptitude and technical expertise are more effective at raising student achievement. For example, using disaggregated student-level data from Alabama, Ferguson and Ladd (1996) find that teacher scores on the ACT college entrance exam have a positive and

[2] Paper credentials, such as teacher certification or education level, turn out to be weakly related to a teacher's ability to increase student achievement on standardized tests (Hanushek 1986; 1997). Experience appears to matter, but mainly at the beginning of one's teaching career (Rivkin, Hanushek, and Kain 2005; Rockoff 2004; Boyd et al. 2006; Clotfelter, Ladd, and Vigdor 2007; Goldhaber 2007; Kane, Rockoff, and Staiger 2006).

statistically significant effect on students' reading and math achievement. Clotfelter, Ladd, and Vigdor (2007) and Goldhaber (2007) both find that teacher performance on licensure exams predicts student achievement. And Goldhaber and Brewer's (2000) analysis of data from the *National Educational Longitudinal Study of 1988* (NELS:88) suggests that teachers with bachelors or masters degrees in mathematics are more effective at raising student test scores in math than teachers without them (they find a *negative* effect in mathematics associated with teachers who have BA degrees in education).[3] Such findings are reflected, albeit loosely, in the federal *No Child Left Behind* Act (NCLB) of 2001, which defines a "highly qualified teacher" in terms of academic proficiency (as measured by degree and licensure test scores) and subject matter competency (as measured by having a degree in the subject taught or a state-designed evaluation).

All of this makes the labor market trends identified in the introduction—that is, the difficulty attracting people with high academic ability and technical expertise into teaching—cause for concern. Much of the blame for these trends has fallen on the single salary schedule, the step-wise pay tables typically used in public education (e.g., Odden and Kelly 1997). Because district pay tables generally reward only experience and degree level, they make teaching relatively unattractive for people with demonstrated aptitude or technical skills, both of which garner premiums in the nonteacher labor market (Ehrenberg and Brewer 1996; Hoxby and Leigh 2004; Murnane, Willett, and Levy 1995; Stasz and Brewer 1999; Weisbrod and Karpoff 1968).[4] It should come as no surprise that differential attrition has been found among teachers with strong academic backgrounds (Corcoran, Evans, and Schwab 2004; Gitomer and Latham 1999; Podgursky, Monroe, and Watson 2004; Ballou 1996; Boyd et al. 2002; Murnane et al. 1991; Henke, Chen, and Geis 2000) and those teaching technical subject areas (Ingersoll 2001; Kirby, Naftel, and Berends 1999; Henke and Zahn 2001; Murnane et al. 1991). Although this means that experiments with incentives in education may be a logical part of increasing the attractiveness of teaching, there is little empirical guidance for policymakers on which incentives individuals with particular skills currently face in and outside of the teaching profession, especially as they progress through their careers. In the sections that follow we examine returns to skill in the teacher and nonteacher labor market in order to develop estimates of the financial incentives individuals with varying academic characteristics face if they become teachers.

Data and Methods

Data

The primary dataset we rely on is the U.S. Department of Education's *Baccalaureate and Beyond Longitudinal Study* (B&B:93/03). B&B tracks the experiences of a group of college graduates who received baccalaureate degrees in academic year 1992-1993. It provides

[3] These results suggest that a proxy's utility can vary depending on what grades or subjects are taught—it is reasonable, for example, to argue that technical skills in mathematics and science are more important at the secondary level and in technical subjects than they are at other grade levels and in other subjects.

[4] Evidence also shows that teacher pay puts all teachers, not just those with technical skills or academic aptitude, at a disadvantage. Allegreto, Corcoran, and Mishel (2008) find that even after considering non-wage benefits, teachers faced a weekly compensation disadvantage of 12% in 2006 contrasted with workers in "comparable" jobs.

information on individuals' undergraduate enrollment, early labor market experience, family background, and other demographic characteristics at three points in time: 1994, one year after graduation; 1997, four years after graduation; and 2003, ten years after graduation. To compare public school teachers only to nonteachers, we exclude private school teachers (who on average earn less than public school teachers) and individuals who worked as teachers, but whose sector (i.e., public or private) could not be identified. We also restrict our analysis to full-time employees working at least 35 hours per week who were employed in the first year of data collection. As a final exclusion, we drop nonteachers who reported salaries below what a full-time minimum wage worker would have earned in each year and drop teachers who reported salaries below the minimum beginning teacher salary for that year from our sample.[5] Likewise, individuals who reported salaries beyond five standard deviations above the mean within each group (teachers and nonteachers) are also excluded. Based on these exclusions, our final sample contains: 5,493 observations for 1994, 346 of whom are public school teachers; 4162 observations for 1997, 322 of whom are teachers; and 2930 observations for 2003, 232 of whom are teachers. Again, these samples are restricted to people who were employed in 1994, and follow them in a pseudo cohort fashion through the three years of data collection, regardless of their subsequent employment status. We do not include people who entered the workforce for the first time in 1997 or in 2003.[6]

The advantages of using B&B for this analysis are three-fold: the data allow us to look at public school teachers and nonteachers; they allow us to look at individuals at three points in time during their early careers (not, unfortunately, every year); and they include information on salary as well as several measures of each individual's academic proficiency and training that are of interest: college major, individual SAT score, and alma mater.[7] We collapse people's undergraduate major into three categories: technical major (including engineering, biological sciences, and mathematics and science); education major; and other major.[8] In some cases, individual SAT scores were missing; for those cases we imputed the average SAT score from their college. We rank people's alma maters by selectivity. Our college selectivity measures come from Barron's Profiles of American College's rankings for the year 1990 (when the B&B respondents would have been entering freshmen).[9] We collapse Barron's six rankings—most

[5] The federal minimum wage in 1994 was $4.25. In 1997 and 2003 it was $5.15 (http://www.dol.gov/esa/minwage/chart.htm). According to the American Federation of Teachers (AFT) annual Survey and Analysis of Teacher Salaries, the minimum teacher salary in 1994 was $17,453 (North Dakota). In 1997 it was $18,889 (North Dakota) and in 2003 it was $24,032 (Montana) (Muir, Nelson, and Baldaro 2005; Nelson and Schneider 1997).

[6] The results do not substantively change with other sample specifications, for example, if we include the full range of reported salaries, or include teachers whose sector we cannot identify, use less-restrictive measures of full-time work, or restrict our sample only to individuals who were employed during all three data collection periods.

[7] For respondents' 1994 salary we use APRANSAL, an annual salary measure calculated based on respondents' employment in April 1994. For 1997 we use B2SALARY, an annual salary measure that relies on April salary data for nonteachers but substitutes academic-year salary for teachers (B2SALTEA). For 2003, we use B3CRSAL, the current/most-recent salary for all respondents, including teachers. In 2003, respondents who reported salaries greater than $500,000 were recoded to $500,000.

[8] Prior research suggests that people with engineering, business, and science majors have the highest levels of initial earnings and early earning growth (Berger 1988). Our "other major" category includes the following majors: business and management; health professions; public affairs/social services; social science; history; humanities; psychology; and other.

[9] Hoxby (1998) finds high returns to attending a selective college (including differences in tuition costs). For example, even after controlling for ability, she finds that the return to career earnings from moving from a rank 3

competitive; highly competitive; very competitive; competitive; less competitive; and non-competitive—into three categories: selective, competitive, and less competitive (our "selective" category collapses Barron's top three rankings because of the small number of teachers graduating from these schools).[10]

Table 1 presents weighted mean descriptive statistics for our sample, which includes men and women, in each of the three years. Before we turn our attention to what the B&B sample suggests about an individual's earnings potential in and outside of the teaching profession, it worth noting that our findings reflect the general consensus about the qualifications of the teacher workforce. Specifically, mean comparisons suggest that nonteachers tend to have higher individual SAT scores than teachers and that, over time, individuals with higher SAT scores tend to leave teaching. For example, in 1994, the mean nonteacher SAT score was 29 points higher than the mean teacher SAT. By 2003, the mean nonteacher SAT score was 53 points higher. The proportion of teachers who attended a selective college does not decline over time (23.2% in 1994 to 23.3% in 2003), but individuals attending competitive colleges appear slightly less likely to be teachers over time (49.8% in 1994 and 45.9% in 2003). Unlike SAT scores, teacher GPAs start out and remain slightly higher than nonteacher GPAs across all three years. As we might expect, the proportion of individuals with a technical degree is higher among nonteachers than it is among teachers, with the gap between the two groups growing over time.

Table 1 suggests that the mean salary for nonteachers is higher than it is for teachers in all three years, and the gap between the two groups grows considerably during people's first decade in the workforce (the salaries reported in table 1 are adjusted for inflation and reported in 2003 dollars). In 1994 the nonteacher mean is $3,334 higher, but by 1997 the gap jumps to $11,847, and by 2003, nonteachers are making an average of $21,731 more than teachers. These comparisons do not account for the fact that teachers generally have a 10-month work year (versus a 12-month work year), a matter of some debate among researchers.[11] However, as long as work year differences are relatively stable over time (i.e., most teachers work a 10-month contract and most nonteachers work a 12-month contract), we are not overly concerned about the controversy for this analysis.

private college to a rank 1 private college (based on 8 selectivity rank groups) is 123.7%. Brewer, Eide, and Ehrenberg (1999) find similar results when accounting for self-selection into type of college as well as the likelihood of admittance into a higher-ranked college. In other specifications, we include measures for individual GPA and the average SAT of freshman at each individual's college. Including these measures does not substantively change the basic results.

[10] Barron's rankings also list some schools as highly competitive (+) and very competitive (+) if they are on the border of the next category. We include them in the category listed, not the next-highest category. There are very few schools in the (+) categories, so we collapsed them into the six main categories.

[11] Using hourly wage data to capture differences in work-year, for example, Podgursky (2003) and Vedder (2003) conclude that teachers are actually paid more than similar professions. By contrast, analyses of household surveys reporting weekly earnings by Allegreto, Corcoran, and Mishel (2004; 2008) find that teachers earn less than other professionals.

Table 1. Weighted* Descriptive Statistics for Public School Teachers and Nonteachers Employed in 1994 and Followed in 1997 and 2003

	1994		1997		2003	
	Public school teachers	Nonteachers	Public School Teachers	Nonteachers	Public School Teachers	Nonteachers
Salary**	$27,884	$31,218	$30,341	$42,188	$41,127	$62,858
	(3432.54)	(13523.25)	(3,814.80)	(16830.11)	(9,899.54)	(30,331.82)
Individual SAT	967	996	961	995	945	998
	(169)	(169)	(157)	(168)	(151)	(163)
Individual GPA	3.3	3.1	3.3	3.1	3.2	3.1
	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)
% Selective College	23.2	34.0	24.3	32.4	23.3	32.2
% Competitive College	49.8	46.0	49.7	46.8	45.9	37.7
% Technical Degree	8.7	16.2	7.6	16.2	8.1	17.9
% Education Degree	72.3	5.6	67.8	4.3	52.4	4.0
% Other Degree	19.0	78.2	24.6	79.5	39.5	78.1
% Married	50.1	30.7	68.9	49.9	84.0	68.1
% African American	4.1	5.6	5.5	6.0	7.8	6.1
% Asian/Pac. Islander	0.3	4.3	0.4	4.3	0.4	4.6
% Hispanic	10.0	3.9	8.3	4.4	9.0	4.7
% White	84.8	82.1	84.6	84.4	81.2	83.7
Weighted N	29692	581053	27896	452928	23899	362362
Sample N	346	5147	322	3840	232	2698

* Using sampling weights to provide an estimate of the number of persons in the population represented by each respondent in the sample.
**Salaries adjusted using the average CPI for 2003.

More of a concern is the fact that we only compare salaries and ignore non-salary benefits. Most teachers are covered by Defined Benefit (DB) retirement plans that provide guaranteed monthly benefits upon retirement. Most nonteachers are covered by Defined Contribution (DC) plans that provide benefits that depend on one's contributions and the performance of one's investments (for example, a 401(k)). Some evidence suggests that the accrual rate for DB plans is back-loaded (Podgursky and Ehlert 2007), and so, as pension wealth increases near the end of a teachers' career, the accumulation of deferred pay may make teaching relatively more attractive. Others, however, argue that the non-wage benefit bias for teachers is actually relatively small when the analysis considers several complicating factors for example, the fact that teachers' health benefits are year round, but their salaries are based on10months' work, or the fact that some teachers are not part of the Social Security system (Allegretto, Corcoran, and Mishel 2008). In any event, to the degree that people value the non-wage benefits associated with teaching, our models will underestimate the relative attractiveness of teaching, especially in the out years.

With those caveats in mind, table 2, which shows average salary and measured academic proficiency across years by undergraduate major (in 2003 dollars), suggests why college graduates with particular skills may be disinclined to teach. Specifically, the earnings gaps between teachers and nonteachers are significantly more pronounced for those with technical degrees. A nonteacher with a technical degree earns $5,029 more than a teacher in 1994 upon entering the workforce, $17,264 more in 1997 when they have been in the labor market for three years, and $28,177 more in 2003, when they have been in the labor market for almost 10 years. Taken together, these descriptive statistics echo a long line of evidence about differences between teachers and nonteachers and suggest that today's interest in wage differentials for teachers addresses a real-world problem. While we do not report descriptive statistics broken out by college selectivity or individual SAT score, the overall picture is the same: college graduates with greater demonstrated academic proficiency tend to earn more outside of teaching than in the teaching profession, and the differential tends to grow as individuals progress in their careers.

While striking, these types of broad comparisons confound the relationships between academic and technical skills and salary, and omit other important information that may account for some of the differences. For cleaner estimates of returns to skill, we need to make more controlled comparisons.

Table 2. Weighted Mean Salary by Degree Type for Public School Teachers and Nonteachers Employed in 1994 and Followed in 1997 and 2003

	1994		1997		2003	
	Public School Teachers	Nonteachers	Public School Teachers	Nonteachers	Public School Teachers	Nonteachers
Technical Degree	$28,883	$33,912	$30,481	$47,745	$40,760	$68,937
	(3982.11)	(10777.27)	(3433.78)	(15810.67)	(6177.78)	(25904.37)
Education Degree	$28,110	$24,235	$29,981	$33,628	$39,855	$53,386
	(3291.62)	(11507.16)	(3886.01)	(17085.92)	(9442.66)	(30651.55)
Other Degree	$28,406	$29,844	$31,012	$39,915	$42,153	$59,500
	(3302.03)	(12403.01)	(3868.51)	(15899.78)	(11911.85)	(30332.26)
N	346	5147	322	3840	232	2698

*Salaries adjusted using average CPI for 2003.

Methods

The basic framework we use to determine the returns to skill in the teacher and nonteacher labor market is a Mincer-type equation of the form,

$$SAL_{ij} = \alpha_j + \beta_{1j}A_i + \beta_{2j}E_i + \beta_{3j}C_i$$

where *SAL* is a measure of the natural log of salary; *A* is a vector of the individual's academic characteristics, including major, college selectivity, and individual SAT score; *E* is a vector of a quadratic form of experience; and *C* is a vector of other background controls, including gender, whether or not the individual has a master's degree or higher, race, marital status, and number of children. These vectors vary by individual, as noted in the subscript i. To obtain results for the general labor market we combine teachers and nonteachers. To compare the returns to skill in the non-teaching and teaching labor market, we estimate coefficients separately for teachers and nonteachers, indicated by the subscript j. If, as the descriptive statistics in table 2 suggest, the returns to skill are higher in the non-teaching labor markets, we expect the coefficients in β_{1j} to be greater for the non-teaching labor market. It is worth noting, however, that strict adherence to the single salary schedule does not preclude returns to skill in the teacher labor market, even though it does not explicitly reward technical or academic skills. This is because teachers' districts could place them on different places on the salary schedule based on their training (probably informally) and also because teachers may sort *between* districts with different levels of pay. If graduates of more-selective colleges tend to be employed in school districts with relatively higher salaries, then the teacher labor market as a whole would show a positive differential for college selectivity. Finally, as already suggested, we estimate returns at three points in time as people gain experience in the labor market, under the assumption that people consider lifetime earning when they make occupational decisions (Boskin 1974; Polacheck and Horvath 1977; Siow 1984; Willis and Rosen 1979; Zarkin 1985) and choose their college major (Berger 1988).

Results

General Labor Market Findings

We begin in table 3 by presenting coefficient estimates from OLS log salary equations for models that include both teachers and nonteachers and that are pooled across the three waves (1994, 1997, 2003) of the dataset. Column 1 reports the results for men and women; column 2 shows the results for men only; and column 3 shows results for a sample that only includes women. Robust standard errors are in parentheses. Since the dependent variable in these models is the log of earnings, the estimated coefficients represent percentage changes in salary.

Prior to focusing on the coefficients of interest, it is worth noting a few of the other findings. Upon graduation, public school teachers actually earn more than nonteachers, although when the sample is split by gender it appears that the difference is mainly driven by differences for women. The picture changes as we follow individuals progressing through their early careers. Three years after graduation, the variable identifying public school teachers is statistically significant and negative. In 1997, public school teachers earn an average of 5% less than nonteachers with similar characteristics. This differential grows over time so that by 2003, when most individuals are about 10 years out from having attained their baccalaureate degrees, public school teachers are found to be earning about 20% less than other college graduates employed outside of public schools. (For men the differential is about 29%.)[12]

In general, our findings closely reflect the broader labor economics literature. For example, we find across samples that, all else equal: earnings increase with experience (by about 2% per year) but at a decreasing rate (Topel 1991), and those individuals with advanced (MA or higher) degrees earn around 7% more than individuals who have only attained a baccalaureate degree (Becker 1964). Furthermore, women earn in the neighborhood of 15% less than men, and a Chow test confirms that there are structural differences between the male and female labor markets (Oaxaca 1973).

Turning our attention to the returns to skills variables, we find strong evidence supporting the notion that technical and cognitive skills are rewarded in the labor market (Grogger and Eide 1995; Murnane, Willett, and Levy 1995). Relative to those with education or other majors (the omitted group), individuals with technical majors start their careers (in 1994) with earnings premiums of just under 10% that persist later into their careers. This holds for both men (column 2) and, after 1994, for women (column 3). College graduates with education majors, by contrast, earn considerably less—roughly 10 to 15%—than college graduates with technical or other majors. Men with education degrees in particular appear to fall behind as they progress through early and mid-career.

We find similar results for college quality. Individuals who graduate from more-competitive or the most-selective colleges start out in 1994 earning about what those who graduated from less-competitive institutions (the omitted reference group), but by 2003 those in competitive colleges are estimated to be earning 6% more than those graduating from less-competitive institutions, and those in the most-selective college category are estimated to be earning as much as 14% more than those who graduated from less-competitive colleges. Individual SAT scores follow a similar pattern: higher scores are rewarded, and rewards to scores increase over time. By 2003, a 100-point gain in an individual's SAT score is rewarded by about 1.2% greater earnings.

[12] Allegreto, Corcoran, and Mishel (2008) analysis of weekly wage trends in the 1990s suggests that the deficit between teachers and nonteachers was relatively stable for younger teachers (ages 25-35—similar to the group in our analysis), while it grew for mid-career (35-55) and senior (45-54) teachers.

Table 3. OLS Results for Teachers and Nonteachers Employed in 1994 and Then Followed in 1997 and 2003 (with robust standard errors in parentheses)

	Men & Women	Men	Women
Year 2003	0.654***	0.667***	0.658***
	(0.044)	(0.063)	(0.062)
Year 1997	0.259***	0.255***	0.282***
	(0.037)	(0.057)	(0.049)
Selective College 2003	0.137***	0.161***	0.113***
	(0.017)	(0.026)	(0.024)
Selective College 1997	0.079***	0.109***	0.050**
	(0.015)	(0.024)	(0.019)
Selective College 1994	0.014	0.027	0.000
	(0.016)	(0.024)	(0.021)
Competitive College 2003	0.056***	0.073**	0.044*
	(0.016)	(0.024)	(0.020)
Competitive College 1997	0.043**	0.050**	0.040*
	(0.014)	(0.022)	(0.017)
Competitive College 1994	-0.008	-0.010	-0.005
	(0.015)	(0.022)	(0.019)
Individual SAT*100 2003	0.012**	0.005	0.021***
	(0.004)	(0.006)	(0.005)
Individual SAT*100 1997	0.007**	0.001	0.015**
	(0.003)	(0.005)	(0.004)
Individual SAT*100 1994	0.007**	-0.002	0.018***
	(0.003)	(0.005)	(0.005)
Technical Major 2003	0.090***	0.069***	0.108***
	(0.016)	(0.019)	(0.028)
Technical Major 1997	0.136***	0.151***	0.101***
	(0.015)	(0.019)	(0.024)
Technical Major 1994	0.098***	0.141***	0.042
	(0.015)	(0.018)	(0.025)
Education Major 2003	-0.112***	-0.171***	-0.081***
	(0.019)	(0.033)	(0.023)
Education Major 1997	-0.166***	-0.139***	-0.177***
	(0.018)	(0.039)	(0.020)
Education Major 1994	-0.155***	-0.113**	-0.181***
	(0.019)	(0.039)	(0.021)
Public School Teacher 2003	-0.204***	-0.291***	-0.157
	(0.017)	(0.029)	(0.021)
Public School Teacher 1997	-0.050**	-0.224***	0.016
	(0.015)	(0.028)	(0.017)
Public School Teacher 1994	0.160***	0.059	0.198***
	(0.017)	(0.035)	(0.019)
Experience	0.017***	0.017***	0.016***
	(0.003)	(0.005)	(0.004)
Experience squared	-0.001***	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)

Table 3 Cont. OLS Results for Teachers and Nonteachers Employed in 1994 and Then Followed in 1997 and 2003 (with robust standard errors in parentheses)

Female	-0.150***	(dropped)	(dropped)
	(0.009)		
Black	-0.014	-0.021	-0.005
	(0.017)	(0.030)	(0.021)
Hispanic	0.032	0.011	0.047*
	(0.019)	(0.031)	(0.024)
Has degree above BA	0.066***	0.065***	0.066***
	(0.011)	(0.018)	(0.013)
Married	0.067***	0.098***	0.039***
	(0.008)	(0.013)	(0.011)
Number of Children	0.026***	0.031***	0.018**
	(0.004)	(0.006)	(0.005)
Constant	9.952	10.005	9.734
	(0.034)	(0.048)	(0.046)
N	15452	7492	7960

Returns to Technical and Academic Skills Inside and Outside of The Teacher Labor Market

The results discussed above support the notion that the labor market as a whole strongly rewards measures of technical and academic skills, and that, if anything, these rewards grow as individuals progress through their careers. To more closely examine how reward structures differ in the teaching and non-teaching labor market, we divide our above sample into the teacher and nonteacher labor markets.

Table 4 presents selected coefficient estimates for models that are pooled across years and estimated separately for teachers (column 1) and nonteachers (column 2). The results reported in this table are pooled across men and women, but we have also estimated results for women only (since women make up the overwhelming majority, about 75%, of the teacher labor force) and find them to be broadly consistent with the findings discussed below.[13]

Casual observation of the differences in the magnitudes and statistical significance of the coefficient estimates suggests that the salary structure in and outside of the teacher labor market is quite different, and this is confirmed by a Chow test that rejects the null hypothesis of equal coefficients at the 1% level. In particular, table 4 shows that various measures of technical and academic skills tend to be significant in predicting the earnings of nonteachers. The point estimates are not too different from those presented above, which is not surprising given that nonteachers represent the majority of the pooled sample in table 3.

Our findings on the teacher labor market reflect those of Ballou (1996), who examines new hires and finds that the teacher labor market does not reward quantifiable measures of job candidate quality (his measure of quality is college selectivity) to the same degree as the private

[13] These results are available from the authors upon request.

sector. Teachers who graduate from more-selective colleges receive higher salaries than teachers from less competitive colleges, but these returns appear to plateau; by contrast, the rewards for college selectivity in the non-teaching labor market increase over time.[14] More telling is the fact that, controlling for college selectivity, teachers see no financial rewards for having a technical major (the one statistically significant coefficient on technical major for teachers—1997—is negative); the coefficient on SAT scores is either negative or not statistically significant.

Table 4. OLS Selected Results for Teachers and Nonteachers Employed in 1994 and Followed in 1997 and 2003 (with robust standard errors in parentheses)

	Teachers	Nonteachers
Selective College 2003	0.098***	0.141***
	(0.026)	(0.020)
Selective College 1997	0.098***	0.079***
	(0.017)	(0.017)
Selective College 1994	0.075***	0.012
	(0.021)	(0.017)
Competitive College 2003	0.075***	0.054**
	(0.020)	(0.018)
Competitive College 1997	0.065***	0.043**
	(0.013)	(0.016)
Competitive College 1994	0.037*	-0.010
	(0.018)	(0.016)
Individual SAT*100 2003	-0.013*	0.016***
	(0.006)	(0.004)
Individual SAT*100 1997	-0.008*	0.010**
	(0.004)	(0.004)
Individual SAT*100 1994	-0.004	0.008*
	(0.005)	(0.004)
Technical Major 2003	0.010	0.089***
	(0.034)	(0.016)
Technical Major 1997	-0.058**	0.144***
	(0.022)	(0.015)
Technical Major 1994	-0.001	0.102***
	(0.036)	(0.015)
Education Major 2003	-0.024	-0.168***
	(0.022)	(0.027)
Education Major 1997	-0.032*	-0.226***
	(0.015)	(0.024)
Education Major 1994	0.000	-0.186***
	(0.021)	(0.022)
Experience	0.013	0.016***
	(0.007)	(0.003)
N	1570	13882

[14] It may be that although the rewards to teachers who graduate from more-selective colleges tend to plateau over time, they may be rewarded later in their career in other, non-pecuniary ways, such as improved working conditions (Hanushek, Kain, and Rivkin 2004).

Tests of Robustness

While the results in table 4 suggest that individuals with different attributes face different financial opportunity costs to enter the teacher labor market, there are reasons to be cautious about drawing strong inferences from them. In particular, although we control for a number of observable individual characteristics, our models do not otherwise explicitly account for the fact that individuals self-select into both the labor market and their occupation. If individuals who love to teach are both better at teaching and obtain a degree in education, this means that our estimates will be upwardly biased. The same argument holds for people with technical majors in the nonteacher labor market. In short, there is reason to worry that rather than reflecting the structure of rewards in the teacher and nonteacher labor markets, the estimated coefficients in table 4 may reflect the returns to unobservable skills.

There is a small literature showing that the problem of self-selection into occupation can lead to biased estimates of the returns to college degrees. Berger (1988), for instance, in a study of the relationship between occupational earnings and choice of major, finds evidence of an upward bias for those with an education major, implying that the predicted earnings of teachers with degrees in education are higher than those of an individual with the same characteristics chosen at random. Dolton et al. (1989) write of the timing of occupational choices and suggest that predicted earnings impact occupational choices primarily through choice of major.[15] Finally, Gyourko and Tracy (1988) find selection effects in the wages of private sector non-union workers (positive) and public sector union workers (negative), but not among private sector union workers or public sector, non-union workers.

We cannot directly account for the selection bias problem given that individuals are only observed in occupations that they have selected, but we attempt to indirectly assess its potential impact. We do so by comparing OLS estimates of the earnings effect of being a teacher, separated by college major, with propensity score match (PSM) estimates of the same. The idea behind the PSM procedure is to re-estimate teacher earnings effects by comparing individuals who, based on observable characteristics, have similar probabilities of entering teaching (i.e., propensity scores) (Caliendo and Kopeinig 2005). If the OLS estimates are biased because of self-selection into occupation, we would expect that they would overstate the education majors' returns to teaching.

For our OLS baseline, we separately estimate the earnings effect of being a teacher for three different groups of people: those with technical majors, those with education majors, and those with "other" majors.[16] These OLS results suggest that, right out of college, an individual with a technical major earns about 6% less if he decides to teach, an opportunity cost that grows to 36% in 1997, and to 38% in 2003, though only the results for 1997 and 2003 are statistically significant. Education majors, by contrast, earn a premium as teachers when the graduate from college (26%) and three years later (16%), but they appear to earn less as teachers nine years out of college (-7%); only the 1994 results are statistically significant. Our third group, those with "other" majors, start out of college 6% ahead if they choose to teach, but they soon fall behind, facing opportunity costs of -13% in 1997 and -25% in 2003, all of which are statistically

[15] Specifically, in models of occupational choice that do not control for college major, they find an expected positive relationship between predicted earnings and people's occupational choices, but in models that do control for college major, they find that predicted earnings do not impact occupational choices.

[16] We use the same model used to produce the results in table 3.

significant. Next we briefly describe the two-stage PSM procedure and how its results compare with these OLS results.

In the first stage, we estimate the propensity score using a probit model where the dependent variable is the probability of being a teacher and the predictors are variables that influence simultaneously the participation decision (to teach) and outcome (salary). Given research on gender and race as predictors of entry into teaching (see Guarino, Santibanez, and Daley 2006 for a summary), our first-stage predictors include a dummy variable for being female, a dummy variable for being black, and a dummy variable for being Hispanic. We also include SAT scores and college selectivity given research on measured ability and entry into teaching (e.g., Murnane et al. 1991).

Once propensity scores are estimated, observations are sorted by their score and divided into blocks with similar scores; t-tests are then used to assess how balanced the covariates are in the two groups. Once the blocks are arranged so that there are no unbalanced covariates, the second stage of the procedure matches each teacher with “control” observations based on similar propensity scores to estimate the earnings difference due to being a teacher. We assess the quality of our matches by comparing the standardized bias (the difference of sample means in the treated and matched control sub-samples as a percentage of the square root of the average of sample variances in both groups) before and after matching. The resulting bias reductions in the various years are all well below 5%, indicating relatively successful matching.[17]

Table 5 shows the results using radial matching, and sets our PSM estimates alongside comparable OLS estimates by college major and year (we experimented with both radial matching (a radius of .1) and kernal-based matching, with similar results). On balance, the coefficients suggest that our OLS results underestimate the disincentives associated with teaching. In 1994, the PSM results for people with technical majors suggest an 8% penalty (versus 6% for OLS); the PSM results are also “higher” in 1997 and 2003. The results for education majors are close for 1994, but not for 1997 and 2003, where there are differences in both magnitude and statistical significance. An examination of the area of common support for these two years suggests that the matching procedure suffers from having very few available ‘matches,’ possibly accounting for these puzzling results.[18] Finally, the PSM results for ‘other’ majors suggest few differences from our original OLS results. Of course it is also important to recall that the PSM approach only accounts for individual differences that are observable, thus there is still a concern that teachers and nonteachers differ along unobserved dimensions and that these differences may bias our coefficient estimates. That said, some research suggests that the amount of selection on observed variables can serve as an informative guide for the amount of selection on unobserved variables; indeed, in order for the unobservables to explain away the entire effect, the selection on them would have to be much stronger□to an unlikely degree□than the selection on observables (Altonji, Elder, and Taber 2005).

[17] We also compared mean logged salaries in the treatment at matched control groups with negligible results.

[18] For several blocks in both of these years the number of individuals in the "control" group was the same or smaller than the number in the "treatment" group. For example, in two of the 1997 blocks there were 2 or fewer "controls" available as matches for 7 "treated" individuals. Similarly, a block in 2003 produced only 1 "control" as a match for 5 "treated" individuals." Even though the mean propensity score is not different for treated and controls in each block, the small number of potential matches may have lead to less-precise matches in these years.

Table 5. Comparison of OLS and PSM Estimates for Public School Teacher Coefficient by College Major Type for Individuals Employed in 1994, 1997, and 2003 (with robust standard errors in parentheses for OLS estimates)

	1994		1997		2003	
	OLS	PSM	OLS	PSM	OLS	PSM
Returns to teaching for people with *technical majors*	-0.060	-0.075*	-0.361***	-0.393***	-0.378***	-0.424***
	(0.039)	(0.035)	(0.035)	(0.028)	(0.046)	(0.040)
N	967	848	736	607	586	478
Returns to teaching for people with *education majors*	0.258***	0.274***	0.016	0.021	-0.068	-0.150**
	(0.024)	(0.025)	(0.035)	(0.038)	(0.064)	(0.052)
N	588	580	409	402	256	248
Returns to teaching for people with *"other" majors*	0.060**	0.040*	-0.133***	-0.175***	-0.252***	-0.278***
	(0.025)	(0.020)	(0.023)	(0.020)	(0.033)	(0.033)
N	3576	3441	2778	2268	1894	1767

Given recent skepticism about the PSM procedure (Wilde and Hollister 2007), we conduct an additional check on potential selection bias. As in table 3, we estimate OLS log salary equations separately for teacher and nonteachers, but this time we allow the returns to skill to vary by whether or not people in either group had at some point switched into their respective labor market. We do this to see if people who move into the teacher labor market earn different returns to skill than those who start and remain in the teacher labor market for all three years. Likewise, for nonteachers, we compare people who leave teaching and switch to the nonteacher labor market with those who start and remain in the nonteacher labor market for all three years. We do this by including interaction terms between the variables of interest (college selectivity, SAT, and college major variables) with an indicator of whether an individual had switched into the labor market in question (either the teacher or nonteacher labor market). In both teacher and nonteacher models, none of these interaction terms proved statistically significant, thus appearing to reinforce the PSM procedure results and our original comparisons.[19]

Policy Simulations

In this section we extend our results through statistical simulations for more practical interpretation. Based on the models in Section 4A (the full set of variables is listed in table 3), we

[19] These results are available from the authors upon request. Including people who jump in and then out of a labor market as "switchers," along with people who switched in and stayed, does not substantively change the results.

simulate the salaries that B&B college graduates with various attributes (e.g., a technical major from a selective college) would earn in and outside of the teaching profession separately for each of our three years. The predicted value of salaries, as well as the 95% confidence intervals for these expected values, is estimated based on 1,000 simulations of the parameter estimates from the model specifications that generate the results reported in table 4. In doing this simulation, we assume that the parameters are distributed multivariate normal with means equal to our estimated coefficients.[20] We only include women in our simulation, as they represent the overwhelming majority of the teacher workforce in our sample, however, the results are qualitatively similar if we do not make this restriction.[21]

We begin by focusing on the average woman in our sample: an individual who attended a competitive college—the middle of our three selectivity rankings—who was neither an education major nor a technical major. We assume that she is single, white, and has no children. Figure 1 shows simulated salaries across SAT scores for 2003 (the x-axis shows SAT deciles). The line on the top shows earnings in the nonteacher labor market; the marked line (●) on the bottom shows earnings in the teacher labor market. To include an estimate of the uncertainty of our simulation, the thin lines show 90% confidence intervals. Across the distribution of SAT scores it is clear that a teacher consistently earns between \$8,400 and \$9,500 less; there are small increases in the teacher/nonteacher gap near the top of the SAT distribution (this is consistent with the coefficients on individual SAT described earlier).

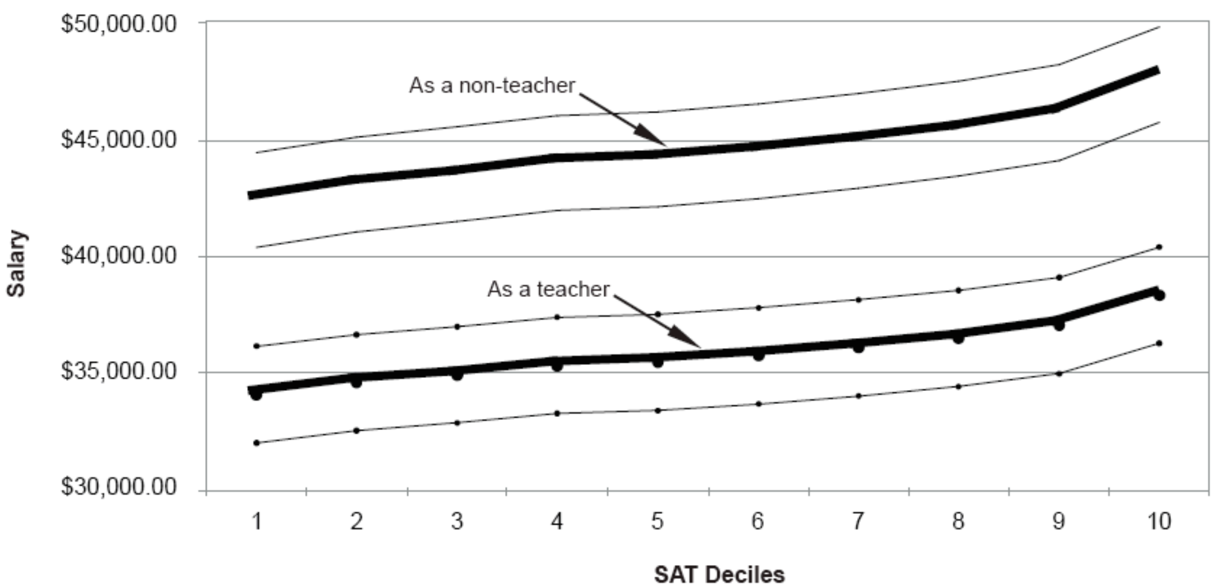


Figure 1. Simulated Salaries for the Mean Woman in the Sample—a Single White Female, Non-Education, Non-Technical Major, from a Competitive College—in the Nonteacher and Teacher Labor Market Across the Distribution of SAT Scores

[20] We use the Clarify program in STATA for this simulation. For more information on this procedure, see Tomz, Wittenberg, and King (2003) and King, Tomz, and Wittenberg (2000).

[21] Around 77% of our teacher sample for each year is made up of women, 83% of whom are white.

In figure 2 we focus on women who graduate with a degree in education. Graph A shows the simulated nonteacher salary and teacher salary for a single white woman with an education degree from a less-competitive college who has the mean SAT for women with education degrees from less-competitive colleges and the mean experience in each sample year. Graph B shows the same woman, but assumes she earned her degree from a selective college. On each graph the box plots show six groups of data. Starting from the left, the first two "boxes" represent what our hypothetical woman would earn as a nonteacher and as a teacher in 1994. The middle two boxes show her as a nonteacher and teacher in 1997. On the far right she is shown as a nonteacher and teacher in 2003. The dot in the middle of the box represents the predicted salary; the "whiskers" represent 90% confidence intervals.

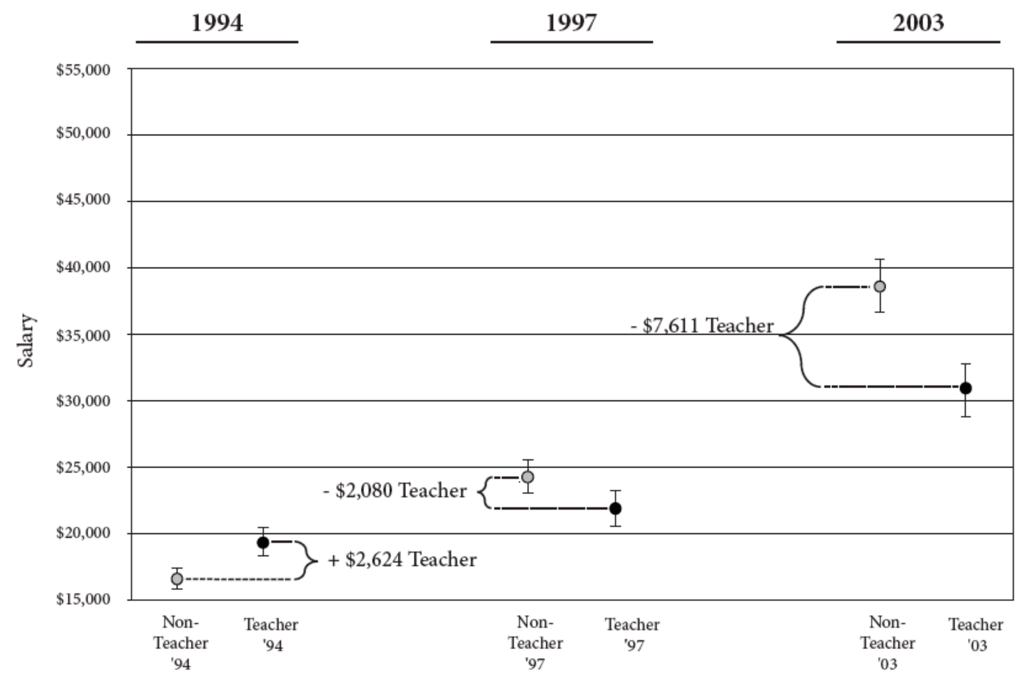
As suggested by our empirical results, teaching initially appears to be an attractive financial choice (the 1994 teaching box lies above the 1994 non-teaching box), but as our hypothetical education major progresses through her mid-career, it becomes less so. By 2003, the financial gap favors non-teaching over teaching, by $7,611 for the education major from the less-competitive college and by $8,644 for the education major from a selective college.

When we turn our attention to women with technical degrees, we see a similar pattern, but the gap in salary between teachers and nonteachers grows even more as people gain experience in the labor market. The box-plots arrangement in figure 3 is the same as the one in figure 2. Graph A shows the simulated salary for a single white woman with a technical degree from a less-competitive college who has the mean SAT for women with technical degrees from less-competitive colleges and mean experience in each sample year. Graph B shows the same woman, but assumes she earned her degree from a selective college. The six boxes should be read in pairs—nonteacher and teacher—for each of the three years.

In both cases, the teacher labor market offers a college graduate with a technical major a higher initial salary, but after a few years of labor market experience the differential shifts in favor of nonteachers, and the gap continues to grow over time, particularly for graduates from more-selective colleges. In other words, teaching appears as a relatively attractive initial choice for women with technical majors—even those from selective colleges.[22] If, however, we assume that our hypothetical woman's interests are not shortsighted, and that instead she makes her career path and migration decisions based on the relative costs and benefits that will occur in the future (Becker 1964; Friedman and Kuznets 1945; Schultz 1960; Siow 1984), teaching becomes less attractive. If we assume that teachers and potential teachers consider the discounted value of various benefit streams attainable to them over their working lives, and not—as a single-point measure assumes – this month's paycheck alone (Lankford and Wyckoff 1997), teaching looks like an unattractive choice for technical majors 10 years out. For a woman with technical expertise who graduated from a selective college, the gap is about $10,000—roughly 25% of her simulated salary as a teacher.

[22] One might speculate, however, that this initial gap in favor of teaching could be because women with technical undergraduate majors from selective colleges might be more likely to attend graduate school directly, where they earn a pittance as graduate research assistants.

Graph A



Graph B

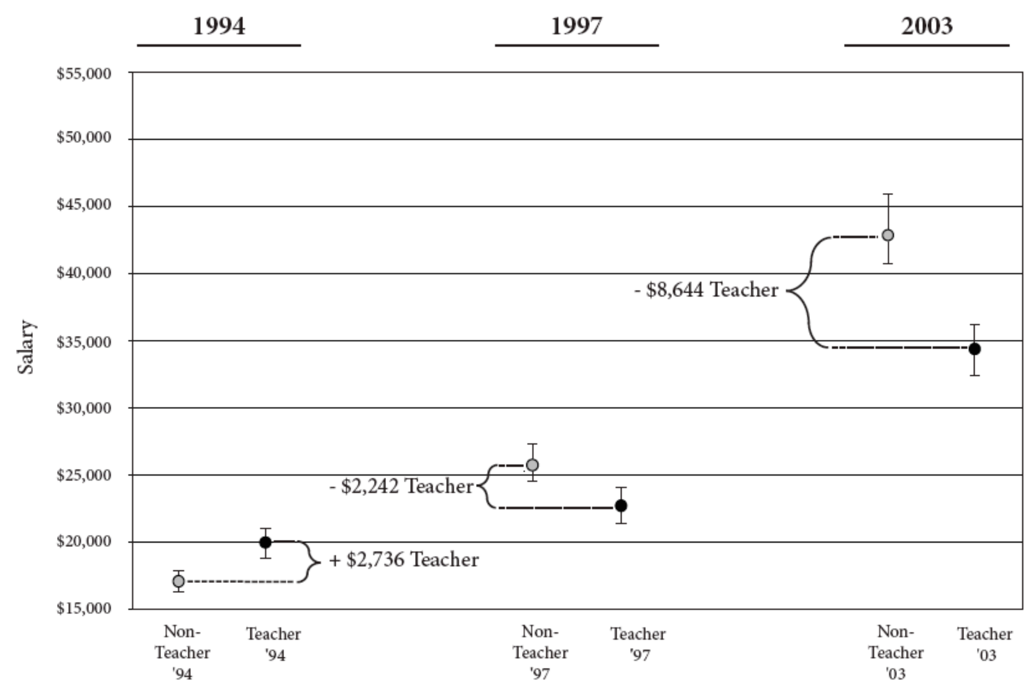
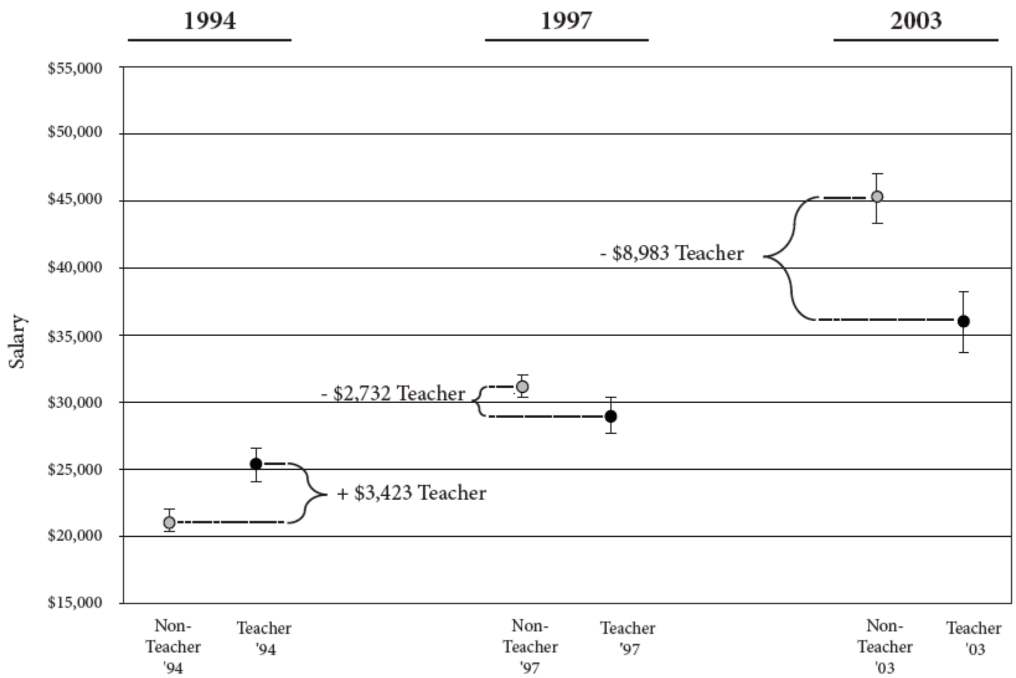


Figure 2. Women With Education Degrees, Regardless of Whether They Attended a Non-Competitive College, Lose Ground as Their Career Progresses

Graph A



Graph B

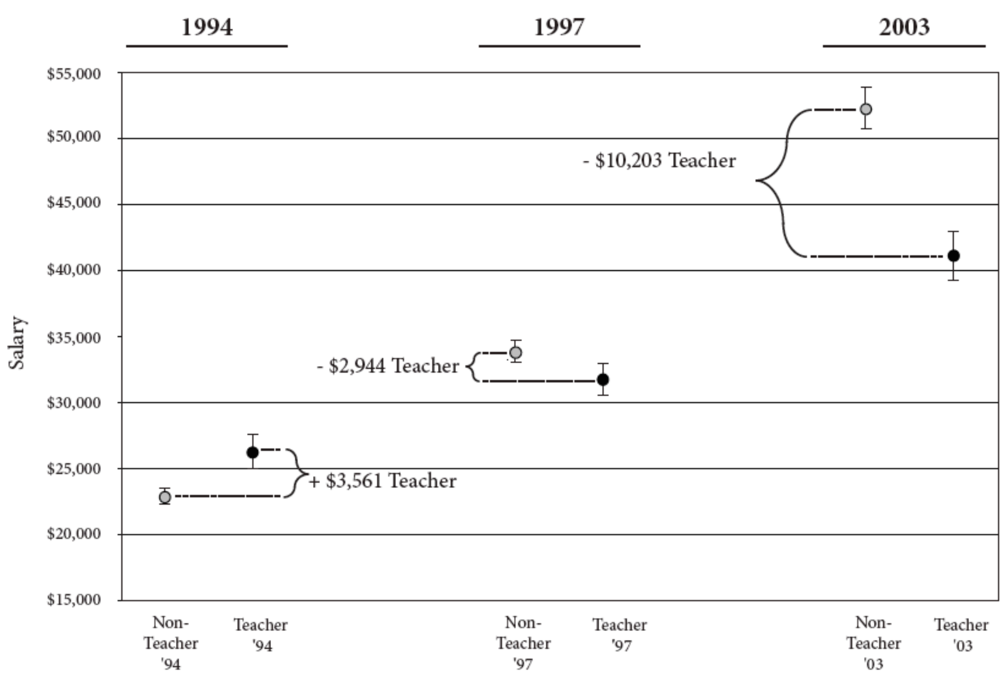


Figure 3. Women with Technical Degrees, Regardless of Whether They Attended a Non-Competitive College or a Selective College, Start Their Careers on Par, If Not Behind Teachers, But 10 Years Out They Earn Much More Outside of Teaching

Conclusion

The evidence presented here suggests that initial salaries may provide misleading impressions about what is needed to attract graduates with technical and strong academic skills. Starting salaries in teaching may be comparable to those outside of teaching, but after 10 years of labor market experience teaching becomes far less financially attractive. Our results also reinforce the idea that policymakers should not think about teachers generically when considering pay. Different incentives exist in the broader labor market for different types of people, whether or not those differences are recognized in public education.

Although our results suggest that incentives designed to attract teachers with technical skills from selective universities may need to be considerable, especially for individuals with labor market experience, we cannot conclude how increases in salaries would influence the decisions of college graduates with these characteristics. It is possible that people with technical degrees have different preferences for working conditions than people with non-technical degrees (for example, technical graduates might prefer socially isolated work), and so what we present here would vastly underestimate the premium needed to attract them to teaching. Others may argue that making teaching a more attractive profession should also include differentials for working conditions (so-called “combat pay”), and not just returns to skill (Hanushek, Kain, and Rivkin 2004a; 2004b). Nevertheless, our findings strongly suggest that salary structure is an important explanation for the observed pattern of occupational decisions made by various individuals, and that experimentation with salary differentials in education is warranted.

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