

THE ECONOMICS OF TEACHER QUALITY*

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ABSTRACT

Concern is often voiced about the quality of American schoolteachers. This paper suggests that, while the relative quality of teachers is declining, this decline may be the result of technological changes that have raised the price of skilled workers outside teaching without affecting the productivity of skilled teachers. Growth in the price of skilled workers can cause schools to lower the relative quality of teachers and raise teacher quantity instead. Evidence from the National Longitudinal Survey of Youth demonstrates that wage and schooling are good measures of teacher quality. Analysis of U.S. census microdata then reveals that the relative schooling and experience-adjusted relative wages of U.S. schoolteachers have fallen significantly from 1940 to 1990. Moreover, class sizes have also fallen substantially. The declines in class size and in relative quality seem correlated over time and space with growth in the relative price of skilled workers.

I. INTRODUCTION

THE importance of schooling in an advanced economy makes it hard to understand why the relative wages of teachers are falling. Figure 1 depicts the log change in the relative wages of primary school teachers for several Organisation for Economic Co-operation and Development member countries, from 1965 to 1994,¹ where teacher wage growth is deflated by growth

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¹ The log change in the teacher wage is constructed as the log of 1994 educational expenditures per teacher minus the log of 1965 educational expenditures per teacher (Organisation for Economic Co-operation and Development [OECD] 1981, 1989, 1990, 1993; United Nations Educational, Scientific and Cultural Organization [UNESCO] 1976, 1989, 1993). This estimate assumes that the proportion of expenditures on teacher salaries is constant. Where OECD or UNESCO data on this proportion are available for the countries in the figure, this assumption seems to hold. However, if this proportion rises, as seems likely in the United States (Nelson and Drown 2003), the figure understates the relative decline in wages.

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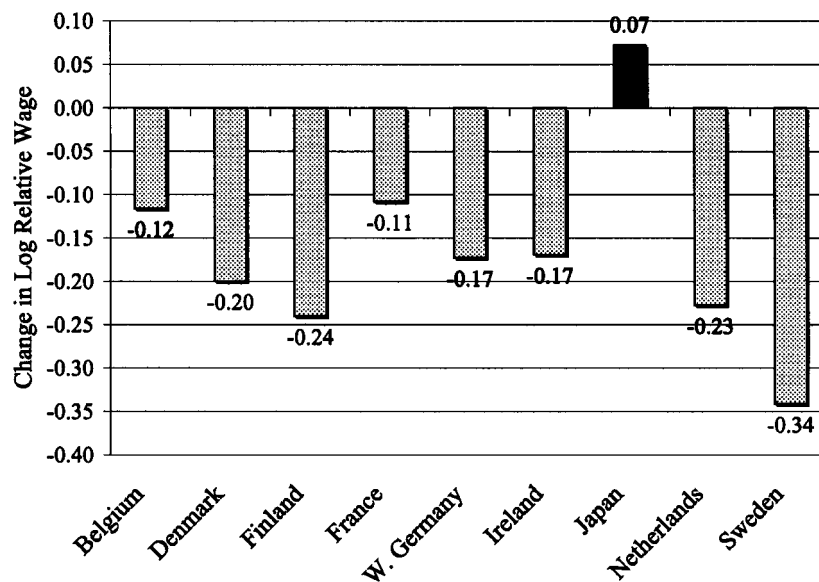


FIGURE 1.—Change in log relative wages of primary school teachers in developed countries, 1965–94.

in the wage of the average employee.² The figure suggests that the relative wages of primary school teachers have fallen in many advanced economies over the last half of the twentieth century.

The only 10-year increase for any country took place in Japan, from 1965 to 1975.³ Various researchers report results consistent with Figure 1. Bee and Dolton (1995) find that, after a brief upward swing during the post–World War II baby boom years, the relative wages of British schoolteachers have fallen 20 percent since 1965.⁴ Across the Atlantic, Hanushek and Rivkin (1997) find that since 1940 the wages of U.S. schoolteachers have declined relative to college graduates by 10–20 percent. Correspondingly, U.S. schoolteachers have skidded nearly 20 percentage points down the earnings dis-

² Wage growth of the average employee is calculated using total employee compensation from national accounts data and dividing this by the number of employees in the labor force. National accounts data are taken from OECD (1983, 1996), while labor force data are taken from OECD (1986, 1997).

³ The reasons for the Japanese increase are not entirely clear, but it may be related to the entrance of large baby boom cohorts into Japanese primary schools. Japanese fertility peaked during the mid- to late 1960s (OECD 1998).

⁴ Their results control for schooling, experience, union bargaining power, and demographic characteristics such as marital status and family composition.

TABLE 1
PRIMARY AND SECONDARY STUDENT/TEACHER RATIOS IN
SELECTED INDUSTRIALIZED COUNTRIES

	1950	1960	1970	1980	1990
Austria	21.07 ^a	21.08	20.83	13.05	9.19
Canada	28.57	24.99	20.92	15.73 ^b	14.63
Finland	24.67	23.35 ^a	20.13	15.61	. . .
France	27.98 ^a	26.14	20.00	20.69	13.70
Ireland	33.58	29.70	24.62	20.53	20.26
Italy	23.54	18.16	16.47	13.19	10.06
Japan ^b	31.15	27.78	21.81	20.75	18.35
Netherlands	30.83	29.12	23.31	19.28	15.98 ^c
Norway	24.30 ^d	19.07	15.60	14.02	11.07
United States	25.94	24.71 ^e	20.77	16.90	15.40 ^f

SOURCE.—UNESCO (1966, 1985, 1994).

^aData point is from 1955.

^bEstimates include students and teachers in vocational education.

^cData point is from 1985.

^dEstimates include students and teachers in public vocational education.

^eData point is from 1963.

^fData are from Hanushek and Rivkin (1997).

tribution for all workers and almost 15 percentage points down the earnings distribution for college graduates.⁵

Surprisingly, this deterioration has occurred while the demand for education and educational attainment has been rising rapidly in the advanced economies. Moreover, educational systems have been utilizing an increasing quantity of teachers. Table 1 demonstrates that the student/teacher ratio in primary and secondary schools has been falling steadily over the same period of time. In other words, the relative wages of schoolteachers in advanced economies have fallen just as the demand for schooling has risen and as more teachers have been hired per student.

This puzzling set of facts raises three important questions. First, what forces can drive down teachers' relative wages in the presence of a rising student/teacher ratio and growing demand for schooling? Second, do declining relative wages signal declines in relative teacher quality? Third, do these declines put at risk the future of today's students or the quality of their schooling? This paper attempts to answer these questions. First, it proposes an explanation for how economic development can result in declining relative wages and quality for schoolteachers and falling class sizes. Second, using U.S. census data, it argues that declining relative wages have historically been driven by declines in relative quality and that these seem to be related

⁵ These numbers include the effects of changes in schooling, experience, and the price of similarly skilled workers. Other researchers who have reported declining relative teacher quality in the United States include Weaver (1983), Kershaw and McKean (1962), and Thorndike and Hagen (1960).

to increases in the student/teacher ratio. Finally, the theoretical and empirical results are used to assess the outlook for today's students.

This paper suggests that the trends in Figure 1 and Table 1 are caused by growth in the price of skill for nonteaching workers, coupled with stagnant relative productivity for skilled teachers. To understand how this might work, suppose that the price of skilled workers outside teaching is rising as a result of advances in knowledge or breakthroughs in technology that raise their productivity relative to less skilled workers. For example, doctors might have access to more effective treatments, and engineers might develop more efficient production techniques. However, suppose that the general knowledge transmitted by schoolteachers, such as reading or arithmetic, remains largely unchanged and that schoolteacher productivity remains constant as a result.⁶ In this case, the price of all skilled workers would rise because the demand for skilled workers outside teaching rises, but the productivity of skilled teachers would remain constant. Schools would respond by substituting away from teacher skill and toward teacher quantity. The increase in the relative price of skilled workers is also predicted to raise educational costs if education is skill intensive. This may have contributed to the growth in real costs per student, which have nearly doubled over the past 30 years, even though educational output probably did not rise over the same period.⁷

An empirical investigation of this theory must start by grappling with the problem of measuring the quality of workers. Section III builds the case that wage- and schooling-based measures of quality for teachers have important practical advantages over alternatives like measured ability or IQ. Moreover, it also demonstrates a high degree of correlation among all these measures of relative teacher quality. Accordingly, Section IV uses U.S. census data on wages and schooling to investigate trends in relative teacher quality from the 1900 birth cohort to the 1955 birth cohort. Across these cohorts, the wages of male schoolteachers—adjusted for experience and weeks worked—declined by about 21 percentage points relative to those of college-educated workers. The declines were even steeper—50 percentage points—for females. In contrast, men and women in occupations that began the period equal in skill to teachers actually gained ground on college-educated workers. Teachers' relative wage declines were driven both by widespread declines in their relative educational attainment and by declines in their experience-adjusted relative wage residuals.

Section IV goes on to develop evidence for the rising relative price of

⁶ It is important to note that the focus here is on grade school teachers, not college professors, who teach specialized knowledge that may evolve over time with technological progress.

⁷ See Hanushek and Rivkin (1997) for the data on educational costs. Betts (1996) summarizes literature demonstrating that SAT scores have stagnated or fallen from 1970 to the early 1990s. Bishop (1989) finds that achievement scores in high school and middle school fell during the 1970s and rebounded during the 1980s; overall, there was no increase from 1970 to 1990, except perhaps for seventh and eighth graders.

skill as an explanation of declining relative quality and class sizes. Higher prices for skilled workers, across time and across U.S. states, appear to be correlated with smaller class sizes and with declines in relative teacher quality. Moreover, the breadth of the decline in relative quality may be explained better by skill-biased technological change than by several important alternatives: growing opportunities for skilled women outside teaching, the rise of teachers' unions, and public-sector involvement in education.

II. TECHNOLOGICAL CHANGE AND EDUCATION PRODUCTION

For the wider economy, there exists a considerable literature that finds evidence of growth in the price of skilled workers in twentieth-century United States. Murphy and Welch (1989) argues that the demand for skilled workers in the United States has risen quite consistently since 1960 and that the supply of skilled workers managed to keep pace only during the 1970s, which witnessed the labor force entrance of college-educated baby boomers. Further evidence for the period since 1960 is provided by Katz and Murphy (1992), who argue that growth in the monetary returns to schooling seems to occur across all cohorts and experience groups. This suggests growth in the relative demand for skilled workers rather than changes in their relative quality.

It is possible that growth in the skill price goes back even further in the twentieth century. According to Goldin and Margo (1992), the only post-World War II decade that witnessed growth in the relative demand for unskilled labor was the 1940s. In addition, Goldin and Katz (1996) provide some suggestive evidence that the period from 1910 to 1940 witnessed substantial growth in the relative demand for skilled workers.⁸ Skill-biased technological change is the most often cited explanation for the rising price of skill (see, for instance, Katz and Murphy 1992; Bartel and Lichtenberg 1987): new technologies are presumed to benefit the most skilled workers disproportionately.⁹

Baumol and Bowen (1965) and Baumol (1967) were perhaps the first papers to argue that productivity growth is slower in education than in the rest of the economy and that this contributes to ongoing growth in educational

⁸ However, Goldin and Katz (1996) also suggest that a fairly elastic supply of skilled workers during this period helped limit the growth in the equilibrium return to skill.

⁹ Some authors have given greater emphasis to institutional factors such as the decline of labor unions, the falling real value of the minimum wage, and industry-specific shocks to supply and demand, particularly for the period beginning in the 1970s (DiNardo, Fortin, and Lemieux 1996; Card and DiNardo 2002). For our purposes, the underlying mechanism behind the rising price of skill is not crucial. A rising price of skill—no matter the cause—coupled with stagnant productivity for skilled teachers leads to falling relative teacher quality and rising quantity.

costs.¹⁰ Several pieces of evidence seem to support this view. Strauss and Vogt (2001) find that the productivity of teachers is influenced primarily by their knowledge of subject matter rather than of pedagogical techniques. If correct, this suggests that productivity growth involves advancement in knowledge taught rather than in teaching techniques. Some advancement may be possible for older students; for example, high school biology students may learn more genetics than students in the past. However, the nature of educating young children makes advancement difficult in the early grades. All children must learn to read, write, and do arithmetic, yet every generation is born with the same amount of baseline knowledge. There is also evidence that technological change in physical capital has little effect on output. Angrist and Lavy (2002) provide evidence from Israel that the introduction of computers in the classroom did little to enhance student learning. Finally, it appears unlikely that children are learning more before they enter school: Bishop (1989) finds that the IQ scores of American 5-year-olds have remained fairly level over the post-World War II period. By this logic, the assumption of constant productivity (or at least slow productivity growth) in education is most easily justified for primary school teachers. It may also apply to a significant number of secondary school teachers, particularly those outside the hard sciences. While similar in spirit, this contrasts somewhat with Baumol's (1967) view that teachers at all levels and in all disciplines suffer equally from a lack of technological progress.

A. *Teacher Quality*

Suppose an economy contains skilled workers with human capital \bar{H} and unskilled workers with no human capital. Skilled workers, who acquired their human capital in school, earn the wage w_s . Unskilled workers, who did not attend school, earn $w_u < w_s$. Suppose further that people differ in their ability to acquire skill. This makes the supply of skilled workers upward sloping. In order to increase the total quantity of skilled workers, it is necessary to dig deeper into the ability distribution, where the price of acquiring skill is higher. An increase in the relative demand for skilled workers in the goods (noneducation) sector raises the relative quantity of skilled workers and—since supply slopes upward—also raises their relative wage w_s/w_u .

The education sector, which produces these skilled workers, faces an increase in the relative price of skilled teachers, but it does not enjoy any technological progress. This will affect its allocation of resources across

¹⁰ This paper differs from the earlier work in its focus on the productivity of human capital in particular. This leads to the additional implication that the rising price of skill causes schools to substitute away from teacher quality and toward teacher quantity. It also suggests that the predicted trends should be most apparent in primary schools, where productivity (in the form of the knowledge transmitted) may change the least.

skilled and unskilled teachers.¹¹ The education sector's output of human capital per student depends on the number of skilled teachers per student, T_s , and the number of unskilled teachers per student, T_u , according to the function $E(T_s, T_u)$, which is increasing and jointly concave.¹² Skilled teachers are more productive than unskilled teachers, so $E_s > E_u$, and education is skilled-teacher intensive, which is implied by $(E_s T_s)/E > (E_u T_u)/E$ (skilled teachers exhibit a larger output elasticity than unskilled teachers).¹³

Faced with equilibrium wages w_s and w_u , schools will produce skilled workers with human capital \bar{H} at minimum cost,¹⁴ according to

$$c(\bar{H}; w_s, w_u) = \min_{T_s, T_u} w_s T_s + w_u T_u, \quad (1)$$

subject to

$$\bar{H} = E(T_s, T_u). \quad (2)$$

This problem has the familiar first-order condition

$$\frac{w_s}{w_u} = \frac{E_s}{E_u}. \quad (3)$$

Figure 2 helps illustrate how the change in the relative wages of skilled workers affects teacher quality and educational costs. The curve represents the production isoquant for the level of skill \bar{H} . It is tangent to the solid isocost line along which cost is \bar{C} . When w_s/w_u rises to w_s^*/w_u^* , the isocost line rotates. The dotted line represents the rotated line that results when wages change but costs are held constant at \bar{C} . The point of tangency to the new family of isocost curves will involve less T_s and more T_u . This means that the quality of teachers relative to other skilled workers ($T_s \bar{H}/\bar{H}$, which is equal to T_s) declines. The quality of teachers relative to the average worker also declines: by definition, this relative quality measure is equal to

¹¹ The use of "unskilled teachers" is a theoretical device designed to capture the quantity/quality trade-off for schools. It should not be interpreted literally, that is, that schools are hiring completely uneducated teachers.

¹² There exists much controversy over whether teacher quantity or quality matter at all in educational outcomes. See, for example, Card and Krueger (1992), Mosteller (1995), and Hanushek (1996) for contrasting views. However, teaching inputs obviously matter at some level: no one could teach a class filled with 1,000 7-year-olds (with or without videoconferencing), and no graduate of the sixth grade could teach high school. The dispute in the empirical literature concerns the impact of input variation within the observed range of input usage. Therefore, it seems reasonable to assume that these inputs are productive over some, possibly unobserved, range.

¹³ Tamura (2001) provides some evidence for this assumption with his finding that educational output is more elastic to teacher quality than to reductions in class size.

¹⁴ While schools may not be efficient, the implications hold as long as their degree of inefficiency does not change over time. Section IVD considers several forces that may have led to changes in efficiency over time. Moreover, research by Hoxby (1994, 2000) suggests that schools do respond to competitive pressure from other districts and from private schools.

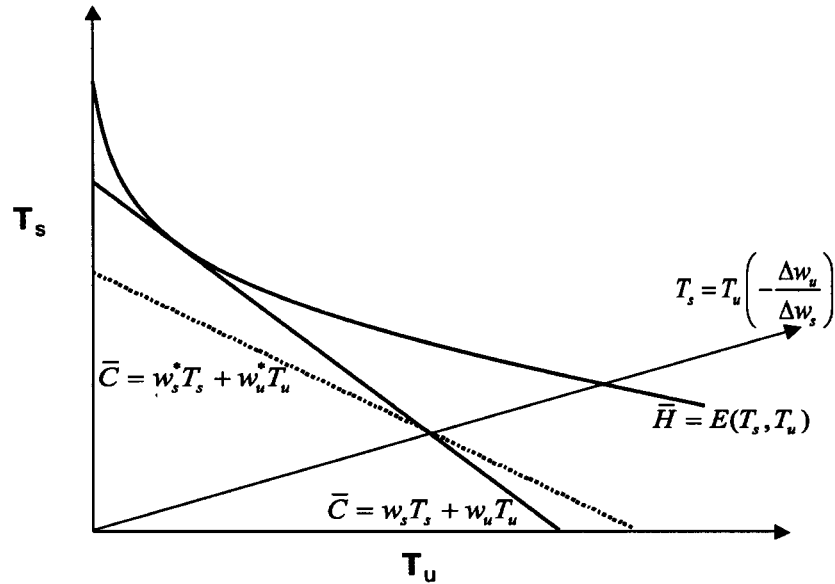


FIGURE 2.—Teaching inputs and the relative wages of skilled workers

$T_s \bar{H} / N_s \bar{H}$, where N_s is the number of skilled goods workers; this is clearly equal to T_s / N_s , which declines because T_s falls and N_s rises. These results for teacher quality obtain regardless of what eventually happens to equilibrium costs or the equilibrium quantity of skill, \bar{H} .¹⁵

B. The Cost of Schooling

No matter the precise nature of the growth in the relative price of skill, the cost of schooling will tend to rise overall. The easiest case is that in which the relative wage of skilled workers rises but the absolute price (and productivity) of unskilled workers does not. In this case, w_s will rise and w_u will not fall. The dotted isocost line in Figure 2 would lie strictly below the old one, and equilibrium costs will rise.

Now consider the more complex case in which the wage of unskilled workers actually falls, perhaps because new technologies pose difficulties that make them worse off. This is pictured in Figure 2, where the new isocost line lies partially above the old one. Even in this case, the costs of schooling will rise, as long as our assumption of skill intensity continues to hold and if the percentage growth in skilled wages is at least as large as the percentage reduction in unskilled wages. The ray in Figure 2 is defined by $T_s = T_u (-\Delta w_u / \Delta w_s)$,

¹⁵ The fact that the price of time is rising for skilled parents will tend to reinforce the substitution toward teacher quantity, as in the framework of Flyer and Rosen (1997).

where $\Delta w_u \equiv w_u^* - w_u$ and $\Delta w_s \equiv w_s^* - w_s$. Along this ray, the wage changes have no effect on costs. Above it, however, costs always rise, because the rotated isocost line is strictly below the original isocost line. Since education is skill intensive, $T_s > (E_u/E_s)T_u$. Therefore, as long as $(w_u/w_s) \geq \Delta w_u/\Delta w_s$, we have the result that $T_s > T_u(\Delta w_u/\Delta w_s)$ and that equilibrium input allocations will always be strictly above the ray. As a result, costs rise with the change in relative wages under the specified conditions.

C. The Student/Teacher Ratio

The rising price of skill lowers T_s and raises T_u . The resulting movement along the isoquant in Figure 2 raises $T_s + T_u$ because each skilled teacher must be replaced by more than one unskilled teacher. However, the isoquant itself—and thus \bar{H} —could also move. This can either reinforce or offset the effect of movement along the isoquant. For example, skill-biased technological change will raise the demand for worker quality, but it will also raise the cost of schooling. These effects offset and make it impossible to predict a priori what will happen to \bar{H} or the direction in which the isoquant moves. While changes in \bar{H} have no impact on our predictions for relative teacher quality and the cost of schooling, they can play a role in the determination of the student/teacher ratio.

The student/teacher ratio will always increase if \bar{H} remains at least constant, but its path is ambiguous if \bar{H} falls. Theory cannot provide guidance about the path of \bar{H} , but a review of the empirical evidence can help us draw some conclusions. From 1940 to 1960, there was essentially unbroken growth in U.S. student achievement for primary, middle, and secondary school students. From 1960 to 1970, achievement was roughly level, with slight declines among middle schoolers. The 1970s saw some growth in primary achievement but declines in middle and high school achievement. The 1980s saw growth at all levels that almost exactly offset the declines of the 1970s (Bishop 1989). The 1970s was the one decade of significant decline in achievement.

Given the observed patterns in achievement, it seems safe to assume stable or rising achievement throughout the period 1940–90, except during the 1970s, which represent an interesting anomaly. Class sizes did in fact fall during the 1970s. According to the theory, this would imply that the decline in achievement was not large enough to offset the growth in the relative price of teacher quality. Of course, it is also possible that different forces altogether were at work during this decade, such as the rise of teachers' unions discussed in Section IVD. At the very least, however, the assumption of stable or rising achievement seems to match the longer-run (1940–90) trends in test scores. If the production isoquant does not shift inward over the long run, the student/teacher ratio will tend to rise with the price of skill.

III. MEASURING QUALITY

A. *The Empirical Implications of the Theory*

The model implies a relative decline in the human capital of teachers compared with other skilled workers.¹⁶ In this context, human capital is best understood as a set of general, as opposed to occupation-specific, skills valued throughout the labor force. Implicitly, this assumes that a subset of human skills leading to teacher productivity also leads to productivity in other professions.

The empirical literature on teacher productivity provides support for the assumption that general human capital affects teacher productivity. Ehrenberg and Brewer (1994, p. 14) find that a teacher's undergraduate college selectivity, which they interpret as a "proxy for the verbal ability, or the intelligence, of teachers," is a significant and important determinant of student achievement gains. Strauss and Vogt (2001) find that a teacher's subject matter expertise is a more important determinant of productivity than pedagogical knowledge. Ferguson and Ladd (1996) find a relationship between the ACT composite scores of Alabama teachers and student reading score gains between the third and fourth grades.

B. *Measurement Choices*

Conceptually, it is necessary to measure the quality of teachers and other workers by identifying an index of skill that is valued throughout the labor force. A conventional approach to this problem is to use schooling, experience-adjusted wages, or wage residuals as measures of human capital. Schooling attainment can be regarded as a direct measure of intelligence or general skill. Wage-based measures are designed to capture the way the market values those skills. While these approaches are easy to implement and justified by theory, their weakness is the indirectness with which they measure general ability. An alternative is to construct a direct measure of intelligence, such as an IQ or achievement test score. The weakness of this approach, on the other hand, lies in the scarcity of data sources that collect this information, particularly for earlier time periods.

This weakness is well demonstrated by the teacher quality literature, where the paucity of data has precluded an inference that allows us to differentiate among competing theories about the decline in teacher quality. Bacolod (2001) and Corcoran, Evans, and Schwab (2002) have documented relative declines in the intelligence of female teachers using achievement score data. These trends are certainly consistent with the predictions of the model here,

¹⁶ It should be emphasized that teachers are predicted to lose ground to other workers, not necessarily nonworkers. Entrance by women into the labor force plays a large role in determining trends in the quality of teachers relative to all people, as opposed to all workers.

but they are also consistent with other theories that the achievement time series is not long enough to discern. Corcoran, Evans, and Schwab (2002) go back as far as the 1936 birth cohort, but they are left with very small samples, of around 2,000 nationally representative people, for these early birth cohorts. This is enough to measure the relative quality of female teachers because so many women entered teaching at that time, but it is far too small to study male teachers, as the authors recognize. This makes it impossible to separate the impact of changes in female labor force participation from alternative theories.

The wider availability of schooling and wage data makes them uniquely suited for an exploration of the theory presented here. I build the case for these measures in three pieces: (1) analysis of National Longitudinal Survey of Youth (NLSY) data shows that trends in teacher IQ are well measured by trends in relative schooling and relative earnings, (2) theory supports a correlation between these measures and intelligence or general ability, and (3) the existing empirical literature, although disparate and complex, provides consistent support for the relationships among teacher earnings, schooling, and intelligence.

C. Schooling, Wages, and the Ability of Teachers

The NLSY 1979 cohort administers to respondents the Armed Forces Qualification Test (AFQT), which is a type of intelligence test. In addition, the survey asks respondents about schooling attainment, earnings over time, and occupation. This provides a unique picture of how well trends in relative earnings, relative schooling, and relative ability track each other.

Labor economists commonly assume that schooling and wages are fairly well correlated overall with IQ and ability. The NLSY data bear that out in the aggregate. By itself, variation in schooling attainment explains about 30 percent of the variation in AFQT scores, while variation in earnings explains about 25 percent. I now show that these relationships hold as well for teachers.

Figure 3 compares trends over time in the relative schooling, earnings, and IQ of NLSY teachers. It tracks the position of the average teacher¹⁷ in the year- and sex-specific earnings, schooling, and IQ distributions for workers. For example, an NLSY female teacher in 1988 is assigned her percentile in the 1988 earnings distribution for all NLSY female workers, and so on.

The curves in the figure depict the percentile of the average teacher in each distribution, while the bars report the number of teachers in each year's sample. There is a close correspondence between trends in schooling, measured achievement, and earnings. Over this 14-year period, all three measures of human capital show a downward trend, but the most striking feature of

¹⁷ "Teacher" here is defined as someone who reports his or her primary occupation as teaching in the relevant sample year.

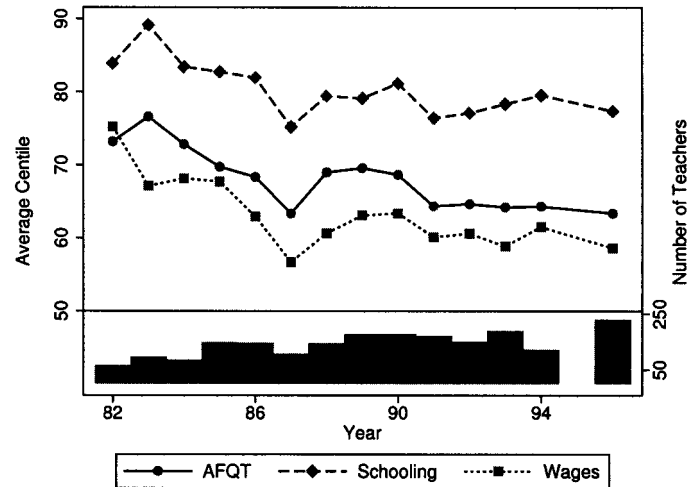


FIGURE 3.—Relative position of National Longitudinal Survey of Youth teachers in the earnings, schooling, and ability distributions.

this graph is how well even short-run year-to-year fluctuations track each other. With very few exceptions, major upticks and downticks coincide exactly in each series. Regardless of whether we measure it using AFQT percentile, schooling percentile, or earnings percentile, we would draw the same conclusions about trends in general human capital for teachers.

Table 2 presents a more formal analysis of the relationships among IQ, schooling, and earnings for teachers and for social workers and engineers, which are the occupations most similar to teaching.¹⁸ The between-year regressions formalize the degree to which trends in schooling and earnings percentiles predict trends in AFQT scores; all contain a linear age term. They cluster standard errors by year of observation, and the within-year regressions cluster them by individual. Schooling and earnings percentiles are strong and sensitive predictors of AFQT percentile for both male and female teachers. This is true both in isolation and compared with the analogous correlations within engineering and social work. For tracking trends in IQ over time, earnings seems the better measure for males, while schooling seems better for females.

Among female teachers, trends in schooling percentile explain, in the sense

¹⁸ Similarity was judged as follows. All three-digit 1970 census occupations reported in the 1987–91 National Longitudinal Survey of Youth waves were ranked according to their average level of educational attainment. This ranking was transformed into a percentile distribution using the share of the 1987–91 sample in each occupation. All occupations within 2 percentile points of teaching were deemed “similar,” but small (fewer than 50 total pooled observations) occupations were excluded. This narrowed the field down to engineering and social work.

TABLE 2
SCHOOLING, WAGES, AND IQ, FOR TEACHERS AND OTHERS IN THE NATIONAL
LONGITUDINAL SURVEY OF YOUTH, 1985-98

	BETWEEN-YEAR REGRESSION ON AFQT				WITHIN-YEAR REGRESSION ON AFQT			
	Schooling Percentile	Earnings Percentile	<i>N</i>	<i>R</i> ²	Schooling Percentile	Earnings Percentile	<i>N</i>	<i>R</i> ²
Females:								
Teachers	.95** (.09)		1,629	.9	.46** (.06)		1,575	.28
Social workers	.58** (.15)		361	.57	.48** (.07)		344	.28
Engineers	.74** (.16)		55	.65	.37 ⁺ (.18)		53	.51
Teachers		.74** (.123)	1,490	.75		.22** (.04)	1,442	.15
Social workers		.56* (.200)	339	.40		.20 ⁺ (.10)	324	.07
Engineers		.57 ⁺ (.285)	54	.27		.36 ⁺ (.20)	52	.42
Teachers	.70** (.20)	.31 ⁺ (.151)	1,478	.89	.43** (.06)	.04 (.04)	1,430	.26
Social workers	.47** (.12)	.12 (.170)	331	.75	.47** (.08)	.02 (.10)	316	.28
Engineers	.68** (.19)	.20 (.240)	52	.69	.31 ⁺ (.18)	.18 (.15)	50	.54
Males:								
Teachers	.96* (.40)		288	.33	.41* (.21)		278	.14
Social workers	.63** (.19)		181	.48	.42** (.11)		176	.25
Engineers	.48* (.18)		374	.38	.36** (.06)		370	.20
Teachers		.50* (.181)	277	.39		.09 (.10)	267	.07
Social workers		-.27 (.348)	173	.05		-.01 (.12)	170	.11
Engineers		.20 (.199)	359	.08		.15 ⁺ (.09)	355	.05
Teachers	.376 (.586)	.36 (.256)	275	.41	.40 ⁺ (.21)	.04 (.10)	265	.15
Social workers	.278 (.324)	-.15 (.384)	170	.11	.48 (.13)**	-.18 ⁺ (.10)	167	.22
Engineers	.476* (.199)	-.03 (.195)	355	.40	.36** (.07)	-.04 (.06)	351	.19

NOTE.—Between-year regressions use data that are averaged by year. Within-year regressions include year fixed effects. The National Longitudinal Survey of Youth contains no female engineers in 1994. An engineer is an aerospace, civil, electrical, industrial, or sales engineer, as defined by the 1970 census occupational classification. AFQT = Armed Forces Qualification Test.

⁺ Significant at the 10% level.

* Significant at the 5% level.

** Significant at the 1% level.

of R^2 values, 90 percent of the variation in AFQT trends for teachers, and movements in the schooling percentile have a roughly one-for-one relationship to movements in AFQT percentile. The estimated relationship between schooling and AFQT score is larger in magnitude for female teachers than for other female workers, although not statistically different: schooling is thus at least as sensitive a predictor of AFQT scores for female teachers.

Trends in earnings percentiles explain about 70 percent of the trend in AFQT scores for females. A 1-percentile-point movement in the earnings distribution is associated with a highly significant .74-percentile-point movement in the AFQT distribution. Even though teacher pay is heavily influenced by politics and union rules, earnings percentile is a more responsive and less noisy (in the R^2 sense) measure of AFQT percentile for teachers than for their predominantly private-sector colleagues in engineering and the similar occupation of social workers.

For male teachers, there is also a nearly one-for-one relationship between schooling and AFQT percentiles. In the case of male teachers, schooling is a noisier measure in the R^2 sense for teachers than for the other occupations. However, earnings percentile is a much better measure of IQ for male teachers than for other male workers. In fact, earnings percentile trends are uncorrelated with IQ trends for social workers and engineers, but they explain 39 percent of trends in IQ for male teachers. This is a rather striking result and suggests the importance of evaluating trends both in schooling attainment and in wages.

It is also interesting to note that, for all occupations, earnings percentile adds little information above and beyond schooling percentile. This suggests that the wage residual might have less to do with ability and more to do with other factors like the pure price of workers in a given occupation.

The object of the within-year correlations in Table 2 is to quantify the cross-sectional variation rather than the time-series variation. The cross-sectional variation indicates that more educated or more highly paid female teachers are more likely to have higher IQs. These relationships are quite similar for all three occupations. However, almost across the board, the cross-sectional relationships are weaker than the aggregate time-series relationships, and they are also noisier in an R^2 sense, presumably because averaging across years removes noise. Since the cross-sectional coefficients are about half the size of the between-year coefficients, it would take about twice as much variation in schooling or earnings to identify a given amount of variation in teacher intelligence (holding statistical power constant).

Indeed, cross-sectional variation in earnings is not significantly associated with intelligence for male teachers or social workers and only weakly associated for male engineers. There is a significant relationship between schooling and intelligence for male teachers, but it is about half the size of the between-year relationship and seemingly noisier. In general, these results suggest that schooling and earnings might be better suited for aggregated comparisons across time rather than for cross-sectional comparisons at the individual level.

D. Human Capital Theory and Quality Measurement

In addition to the empirical performance of schooling and earnings trends in predicting IQ trends, there are theoretical reasons to believe in a link between teacher pay and general human capital. If the labor market is functioning, the more highly paid workers will tend to be those with the best opportunities elsewhere and with the most general human capital. This is true regardless of how inefficient schools are. Even if schools hire teachers randomly, offering lower pay will attract a poorer quality applicant pool.

The theoretical link between schooling and general human capital is somewhat different. There may be an intrinsic link, if schooling represents the

individual's primary source of general human capital. There is some evidence for this: Card (1995) has argued that schooling (at least for male workers) is a much more important determinant of wages than innate ability, which he argues accounts for relatively little wage variation.¹⁹ This would argue for the use of schooling as a direct measure of general human capital.²⁰ Alternatively, there may be an induced link between schooling and general human capital if more able individuals can acquire schooling at lower cost than the less able.²¹

E. The Empirical Literature on Quality Measurement

The NLSY results and the theoretical discussion presented above relate to a substantial existing literature on teacher characteristics and their impact. Although the literature is complex, there is a fair degree of consensus on two points. First, higher relative pay within teaching is associated with more general human capital, in the sense of higher alternative rates of pay in nonteaching occupations. This is the way in which this paper defines "quality." Second, general human capital—as opposed to pedagogical skill—is linked to student achievement and teacher output. This result suggests that the decline in general human capital has an impact on educational production.

The NLSY evidence presented above suggests correlations among pay, schooling, and ability for teachers; this evidence is consistent with the existing literature. Ehrenberg and Brewer (1994) find that school districts offering higher starting salaries attract teachers from more selective undergraduate institutions and that districts offering greater financial rewards for postgraduate degrees attract more teachers with these degrees. Figlio (1997) corroborates the link between teacher pay and the general human capital of teachers. Within a metropolitan area, districts that pay more are more likely to attract teachers who are from selective undergraduate institutions and who have relevant subject matter expertise. Reservation wages also appear to affect entrance and duration in the expected way. Murnane and Olsen (1989, 1990) have found that teachers in higher-paying fields and with higher intelligence test scores are more likely to leave teaching.

¹⁹ Even though the theoretical model relied on ability variation to generate an upward-sloping supply of skill, it is not inconsistent with Card's (1995) finding. Ability can affect the costs of acquiring schooling, and schooling itself can produce additional skill. It is theoretically possible that the ability acquired through schooling is quantitatively more important than the innate ability that affects the cost of schooling.

²⁰ This view would interpret the Armed Forces Qualification Test score as a measure of both acquired and innate intelligence. It is hard to test this particular assumption or its converse.

²¹ The situation is more complex if we consider nonworkers and changing incentives to participate in the labor force. If, for example, skilled women faced poor incentives for labor force participation, they may have chosen not to acquire schooling, even though they were more skilled than other female workers who chose to acquire some schooling for the purposes of labor force participation. As a result, relative teacher quality is best understood to be declining in comparison to all workers, rather than all people.

With some attention to detail, these results can be reconciled with findings that appear at first to threaten them. Hanushek, Klein, and Rivkin (1999) show that within-district shifts in salary schedules have no appreciable impact on the quality of teachers as measured by the certification test scores of entering teachers. Certification scores measure occupation-specific pedagogic skill rather than general human capital. Empirically, this is not inconsistent with the other findings above that stress the link between pay and general human capital, which is the key concept of “quality” used in this paper. Moreover, the theoretical link from teacher pay to occupation-specific skill depends on the efficiency of the school system, while the link to general human capital depends only on the efficiency of the overall labor market.

Second, Hanushek, Klein, and Rivkin (1999) have also pointed out that higher-paying districts provide better working conditions that may be the real reason why teachers choose them. This makes the important point that an equilibrium correlation between teacher ability and pay (or schooling) does not imply a causal link between shifts in district-level salary schedules and teacher quality. For example, higher pay can promote the retention of poor teachers (Ballou and Podgursky 1995), and in the long run, its effects may be dampened if a district fails to recognize and reward able teachers (Ballou 1996). Nonetheless, the empirical strategy here relies not on any causal relationship between salary shifts and quality but on the equilibrium correlations among salaries, schooling, and ability. I rely on salary and schooling as proxy measures of ability, not as policy instruments.

IV. AN EMPIRICAL ANALYSIS OF TEACHER QUALITY

The rising price of skilled workers is predicted to contribute to growth in real per-student educational costs and to encourage substitution of class size reductions for relative teacher quality. Figure 4 documents class size reductions for U.S. public schools in terms of the total student/teacher ratio and the ratio of students to full-time-equivalent (FTE) teachers.²²

Class size did not begin to decline significantly until 1935, but this incipient decline was cut off in 1945. The decline then resumed from 1955 onward. The periods from 1935 to 1945 and 1955 to the present witnessed significant and fairly rapid reductions in class size. The pace of decline was fairly similar across the two periods. During the earlier period, class size fell by about .9 percent per year, while in the latter, it has fallen by about 1.1 percent per year. In Section IVB, I show that relative teacher quality declined, and in

²² The total student/teacher ratio is from the U.S. Bureau of the Census (1975). The series in full-time-equivalent teachers is from U.S. Department of Education (2001). Both series measure the number of classroom teachers to enrolled students, but the total ratio figures make no adjustment for the presence of part-time teachers. Finally, note that over the 1900–1940 period, there were considerable declines in class size for black students, particularly in the southern states, even though aggregate class size did not change much (Hanushek and Rivkin 1997; Card and Krueger 1992).



FIGURE 4.—Historical trends in class size for U.S. public schools

Section IVC, I investigate the linkages among class size reductions, declining relative quality, and the relative wages of skilled workers. Finally, Section IVD assesses the extent to which alternative theories can account for the trends in quantity and quality, as measured by schooling and experience-adjusted wages.

A. Summary of the Data

The data are from the U.S. census Integrated Public Use Microdata Samples from 1940 to 1990 (Ruggles and Sobek 1997). With the exception of the 1950 census, which is a weighted sample, these are all flat 1 percent samples of the U.S. population in the census year. The census contains detailed data on earnings, education, age, sex, occupation, and labor force status. These data are summarized in Table 3.

Construction of the various data series is detailed in Appendix A. The table reports the characteristics of 5-year birth cohorts from 1900 to 1955. Since the model predicted changes in relative quality across generations of teachers, I analyze the evolution of schooling and wages across birth cohorts rather than time periods.

In the table, a teacher is defined as someone who reports his or her previous year's occupation as primary or secondary schoolteaching. Since the theory applies with the most force to primary school teachers and to secondary school teachers in the humanities, the cleanest test of it would be to restrict the analysis to these teachers. Unfortunately, the census does not report a

TABLE 3
SUMMARY OF CENSUS DATA, 1940-90

BIRTH COHORT	MALES				FEMALES			
	Proportion of Workers	Proportion with 14+ Years of Education	Proportion of Teachers	Average Schooling	Proportion of Workers	Proportion with 14+ Years of Education	Proportion of Teachers	Average Schooling
All adults, 18+:								
1900	.65	.10	.01	8.65	.20	.09	.02	8.82
1905	.68	.12	.01	9.27	.22	.11	.03	9.45
1910	.72	.13	.01	9.72	.25	.12	.02	9.91
1915	.74	.15	.01	10.31	.23	.11	.01	10.32
1920	.66	.19	.01	10.83	.22	.12	.02	10.75
1925	.72	.21	.01	11.06	.21	.13	.03	10.99
1930	.74	.26	.02	11.72	.30	.16	.05	11.38
1935	.80	.27	.02	11.99	.29	.17	.06	11.61
1940	.83	.37	.03	12.81	.53	.26	.06	12.33
1945	.84	.44	.03	13.24	.51	.32	.07	12.70
1950	.80	.61	.02	13.70	.65	.57	.07	13.56
1955	.81	.55	.01	13.44	.63	.56	.05	13.44
Adult workers:								
1900		.11	.01	8.95		.15	.09	9.66
1905		.13	.01	9.62		.17	.11	10.29
1910		.13	.01	9.88		.16	.06	10.34
1915		.15	.01	10.49		.14	.05	10.66
1920		.22	.01	11.32		.17	.05	11.49
1925		.24	.01	11.50		.18	.06	11.63
1930		.29	.02	12.10		.21	.08	12.01
1935		.29	.02	12.29		.23	.08	12.21
1940		.39	.03	13.02		.29	.08	12.67
1945		.46	.03	13.43		.36	.09	13.10
1950		.63	.02	13.88		.62	.09	13.84
1955		.58	.01	13.62		.62	.05	13.76

Adult population with 14+ years of education:						
1900	.71	.08	15.73	.34	.20	15.27
1905	.74	.09	15.72	.36	.21	15.27
1910	.73	.06	15.76	.34	.16	15.46
1915	.74	.04	15.74	.30	.13	15.45
1920	.78	.05	15.92	.31	.18	15.40
1925	.81	.07	15.96	.29	.21	15.44
1930	.83	.08	16.12	.40	.26	15.55
1935	.85	.09	16.09	.38	.29	15.60
1940	.87	.07	16.16	.59	.20	15.78
1945	.87	.07	16.05	.59	.20	15.80
1950	.84	.03	15.38	.70	.12	15.25
1955	.85	.02	15.26	.70	.07	15.09
Working adult population with 14+ years of education:						
1900		.11	15.69		.52	15.53
1905		.11	15.67		.53	15.49
1910		.07	15.73		.35	15.69
1915		.05	15.71		.32	15.67
1920		.05	15.82		.26	15.58
1925		.06	15.88		.28	15.58
1930		.07	16.03		.33	15.69
1935		.08	16.03		.33	15.78
1940		.08	16.17		.26	15.89
1945		.07	16.04		.23	15.92
1950		.04	15.39		.13	15.29
1955		.02	15.26		.08	15.13

SOURCE.—Ruggles and Sobek (1997).

NOTE.—All statistics are measured for the single census year when the cohort is aged 30–39. Workers are defined as having worked at least 26 weeks and having received positive employment earnings in the prior year.

teacher's discipline, and it is not possible to separate primary and secondary schoolteachers prior to the 1960 census. If technological change improves the knowledge of some secondary school teachers, this strategy may in fact understate its effect on relative quality.

Schooling is measured at the census year during which the cohort was aged 30–39. Similar results were obtained when average schooling was constructed over ages 40–49, 30–49, and 30–59.²³ A worker is defined as someone who worked at least 26 weeks in the previous year and received positive employment earnings. The results for relative teacher quality do not seem sensitive to this definition: very similar results were obtained using a definition of “any weeks worked” and “at least 48 weeks worked.” The results for the middling definition of 26 weeks are presented here. A college-educated person is defined as one with at least 14 years of schooling. This definition is more appropriate to the labor market for teachers than one based on 16 years of schooling, because teachers' colleges, a dominant form of teacher training during the first half of the twentieth century, often required little more than 2 years of post-high-school training.

Several trends are apparent in the table. First, teaching in the United States has been dominated by women during this period, and this condition has persisted (see, for example, Perlmann and Margo 2001). Women are about two to three times as likely as men to be teachers. Among working college graduates, they were almost five times as likely in the early cohorts, and about four times as likely in the more recent cohorts. Second, there has been a dramatic expansion of female labor force participation (see, for example, Goldin 1990, 1995). In particular, there has been significant expansion of opportunities for skilled women outside teaching. In the 1900 birth cohort, over half of all college-educated working women were teachers. By the 1955 birth cohort, this fraction had plummeted to just 8 percent. Finally, the proportion of workers with at least 14 years of schooling roughly quintupled for both men and women over this period in history. Average years of schooling also grew significantly, both for the whole population and for the labor force. In the 1900 birth cohort, the average person had not even entered the ninth grade. For the 1955 cohort, on the other hand, the average person had spent 1 full year in college. These trends in schooling are fairly similar for men and women.

It also appears that—at least among 30- to 39-year-olds—less skilled women were entering the labor force more rapidly than skilled women, since average schooling grew by about .5 years more for the whole population of women than for working women. Among older age groups, however, this difference turns out to be much smaller. This may be related to Goldin's (1991) finding that as a cohort ages, more and more of its less educated

²³ As further detailed in Appendix A, schooling was uniformly top coded when year-to-year comparisons were made.

female members enter the labor force. Therefore, between-cohort increases in labor force participation by less skilled women may have been more marked at younger ages. In addition, there were particularly large increases in labor force participation by college-educated women from the 1925 cohort onward, or from the 1960 census onward. Finally, observe that among those with at least 14 years of schooling, average schooling actually fell slightly, particularly from the 1940 cohort onward. For this period, it is possible that the number of new entrants into the bottom of this group offset growth in average schooling among those already in it.

B. Trends in Relative Teacher Quality

The Comparison Occupations. To compare the quality of teachers to the quality of occupations that started out with the same human capital as teachers, I match teachers to occupations with similar amounts of schooling in the 1900 birth cohort. Average schooling (again measured between ages 30 and 39) is calculated for all occupations in the 1900 birth cohort. Each occupation is then ranked by its average schooling and assigned percentiles, where each occupation is weighted by its share of the labor force. The comparison occupations are taken to be those that are sufficiently close to teaching in this distribution. Male teachers—representing about 1.2 percent of the male labor force—occupy the 97.9th through 99.1st percentiles in this distribution. The comparison occupations are those that lie in part between the 97.2d and 97.9th percentiles and between the 99.1st and 99.8th percentiles. The male comparison occupations turned out to be architects, chemists, chiropractors, college professors, dentists, engineers (chemical, electrical, mechanical, and metallurgical), farm or home management advisors, lawyers and judges, librarians, optometrists, osteopaths, pharmacists, and physicians and surgeons. College professors are included simply because they meet the criterion set out above, but their inclusion is particularly interesting and significant. The theory suggests that college professors are more likely to benefit from innovation than grade school teachers because the knowledge they transmit is more likely to evolve over time. Female teachers occupy the 90th through 99.5th percentiles. Their comparison occupations, which lie between the 89.5th and 90th percentiles or between the 99.5th and 100th percentiles, turned out to be authors, college professors, dentists, draftsmen, lawyers and judges, librarians, physicians and surgeons, social workers, sports instructors, and farm managers.

Note that the comparison occupations are within equally sized bands above and below the teachers' position in the occupation distribution. The size of the bands was chosen to be the smallest size that included the topmost educated occupation (physicians and surgeons for male workers and college professors for female workers). The distributional position and mean schooling for all of the comparison occupations is given in Appendix B.

Trends in Relative Schooling. A simple way to measure relative changes in human capital is to measure relative changes in schooling, as in Figure 5.²⁴ In Figures 5A and 5B, the solid lines represent the schooling of teachers minus the schooling of nonteaching workers.²⁵ Similarly, the dashed lines represent the schooling of the comparison workers minus that of workers outside those occupations (including teachers). The schooling premium of teachers has not kept pace with that of the comparison workers. Male teachers have lost about .97 years compared with these occupations, and female teachers have lost about .41 years. In other words, the decline in schooling is not generated simply by less skilled occupations catching up over time to more skilled workers. Teachers are losing ground to occupations that were once their equals. This is also evident when I compute within-occupation changes in schooling: male teachers have lost about 2.58 years of schooling, holding the occupational composition of the labor force fixed at its 1900 birth cohort levels. These declines are made even more significant when we consider the expansion in teachers' attainment of master's degrees in education, which most research finds to have a modest or insignificant impact on productivity (see, for example, Ballou and Podgursky 1999).²⁶

There are two problems associated with the estimates in Figures 5A and 5B. The first is the observation by Goldin (1998) that older high school dropouts in the 1940 census were more likely than in other years to overstate their schooling (see also, for example, Margo 1986). This phenomenon would have biased down the schooling premium for teachers in 1940 and would lead the figure to understate the true decline in relative schooling. This is not so much of a problem for us as the second issue, top coding in the census schooling measures, which could have the opposite effect. Top coding will tend to understate schooling growth more among the more skilled occupations. Figures 5C and 5D are more robust to changes in top coding since they present the movement of teachers and skilled workers in the schooling distribution. Male and female teachers are being overtaken in the schooling distribution. Male teachers fell from the 94th percentile to the 84th; female teachers fell from the 90th percentile to the 78th. In contrast, the comparison workers fell by much less. Male comparison workers fell from just below the 94th percentile to the 89th. Female comparison workers fell from the 92d to the 83d percentile.

Trends in Experience-Adjusted Wages. Schooling is not the only respect in which teachers have lost ground. Their experience-adjusted relative

²⁴ As before, schooling for each cohort is measured between ages 30 and 39.

²⁵ The results of the figure are similar regardless of whether I use working women or all women as the baseline group. If one computes the decline in schooling relative to all women, the magnitude of the decline falls by about .3 years of schooling, roughly 8 percent of the total decline.

²⁶ This is consistent with the literature, discussed above, that finds little effect of general pedagogical skills on productivity and/or wages.

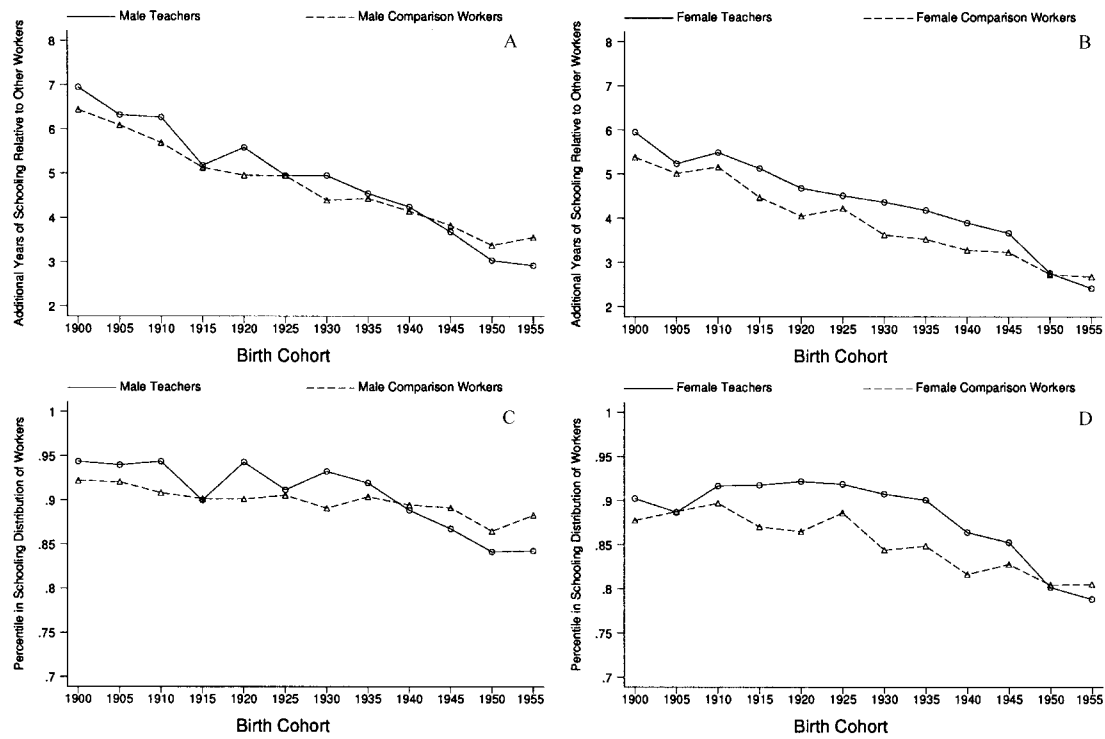


FIGURE 5.—Trends in the schooling of U.S. school teachers and comparison workers, relative to the average worker

wages—earnings controlling for experience, annual hours, and (for female teachers) number of children borne—have also declined relative to comparison workers as well as relative to college-educated workers. To construct the experience-adjusted wages, I estimate the following regression equation for individual i in occupation j , cohort c , and at time t :

$$\begin{aligned} \ln(\text{Earn}_{ijct}) = & \beta_0 + \beta_1 \text{AnnHrs}_{ijct} + \beta_1' \text{Tch} \times \text{AnnHrs}_{ijct} \\ & + \beta_2^c \text{School}_{ijct} + \beta_3^j \text{Exp}_{ijct} + u_{ijct}. \end{aligned} \quad (4)$$

Appendix A discusses the construction of each variable in detail, but it is worth discussing a few features of this regression equation here. The dependent variable is annual earnings, rather than weekly or hourly wages, and annual hours worked ($\text{AnnHrs} = \text{Weeks} \times \text{Hours}$) is on the right-hand side. This is because “weeks worked” might mean something different for teachers than for other workers. The coefficient on annual hours worked is constrained to be the same for all nonteachers but is allowed to vary from one census year to the next for teachers (Tch is an indicator variable for teachers), because of changes in the way teachers were asked about weeks worked across census years.²⁷ The variable School represents years of schooling; its coefficient is allowed to vary across the cohort to account for changes in the quality of schooling. Exp is a set of dummy variables denoting the experience category to which the worker belongs: 0–4, 5–9, 10–14, 15–19, 20–24, 25–30, or more than 30 years of experience. Its coefficient is allowed to differ for teachers because the log earnings profile of teachers seems approximately linear, while the log-earnings profile of other workers is more concave (Flyer and Rosen 1997). This may be because school districts set salary schedules that award fixed percentage increments to teachers, while other workers do not have such a rigid wage profile. As a result, teachers tend to have a U-shaped relative earnings profile.²⁸ Finally, the regression for females also includes a variable for the number of children that the woman has borne. This is a partial solution to the problem that potential experience may overstate actual experience for women who have taken time out of the labor force for child rearing. This variable is interacted with Tch , because the wage penalty for taking time out of the labor force has been found to be lower for teachers than for other skilled women (Flyer and Rosen 1997).

The residual u_{ijct} represents the standardized log wage for each individual.

²⁷ In 1940, teachers were instructed not to count their summer vacations as time spent teaching (although if they held a nonteaching job during the summer, they presumably counted weeks spent working at that). In 1950, they were instructed to count all paid time, including vacations. In later years, no specific instructions were given. Consistent with this fact, the coefficient on annual hours seems significantly higher for teachers in the 1940 census than for other workers and for teachers in other years.

²⁸ Evidence for this finding is presented in an earlier version of this paper, available upon request from the author.

The experience-adjusted wage is given by $\beta_2^c \text{School}_{ijct} + u_{ijct}$. From this, I construct the relative wage series and wage percentiles presented in Figure 6.²⁹ Here and elsewhere, each cohort's residual and percentile is calculated in the census year during which it was aged 30–39.

The figure shows that the experience-adjusted wages of male and female teachers have declined considerably relative to their comparison occupations. Figures 6A and 6B show male teachers losing a full 49 percentage points to male comparison workers, in the process of losing 80 percentage points to the average worker. Relative wages for female teachers and comparison workers declined dramatically as more women entered skilled occupations, but teachers' wages fell much more rapidly than those of their colleagues in the comparison group. Female teachers lost 45 percentage points relative to female comparison workers.

In terms of percentiles, shown in Figures 6C and 6D, male teachers slid from the 86th percentile to the 66th, but their comparison workers fell by much less, from the 87th to the 82d percentile. While they started out at essentially the same position, male teachers ended up 16 percentile points below their similarly skilled counterparts. Female teachers fell from the 86th to the 64th percentile. Female comparison workers, on the other hand, started out 5 points below teachers, at the 81st percentile, and ended up 3 points above them, at the 67th percentile.

Note that relative declines were observed in both components of the experience-adjusted wage: the wage residual, u_{ijct} , and the return to schooling, $\beta_2^c \text{School}_{ijct}$. There is no obvious dimension along which teachers are holding their own against the comparison occupations.

While the previous figures compare teachers and comparison workers to the average worker, it is also informative to compare them to the average college-educated worker, defined as the set of workers with at least 14 years of schooling. Experience-adjusted wages relative to this group are shown in Figure 7.

Figures 7A and 7B show that the relative experience-adjusted wage of teachers has declined significantly compared with college-educated workers, by 21 percentage points for men and 50 percentage points for women. In contrast, male comparison workers actually gained about 36 percentage points on other college-educated workers, while female skilled workers gained about

²⁹ Effectively, I am assuming that there are no period effects in the relative wage series and that changes in standardized wages are driven entirely by cohort effects. An earlier version of this paper—available upon request from the author—presents a more general framework for estimating cohort effects for teachers in the presence of possible period effects and reaches qualitatively similar conclusions about declining relative teacher quality.

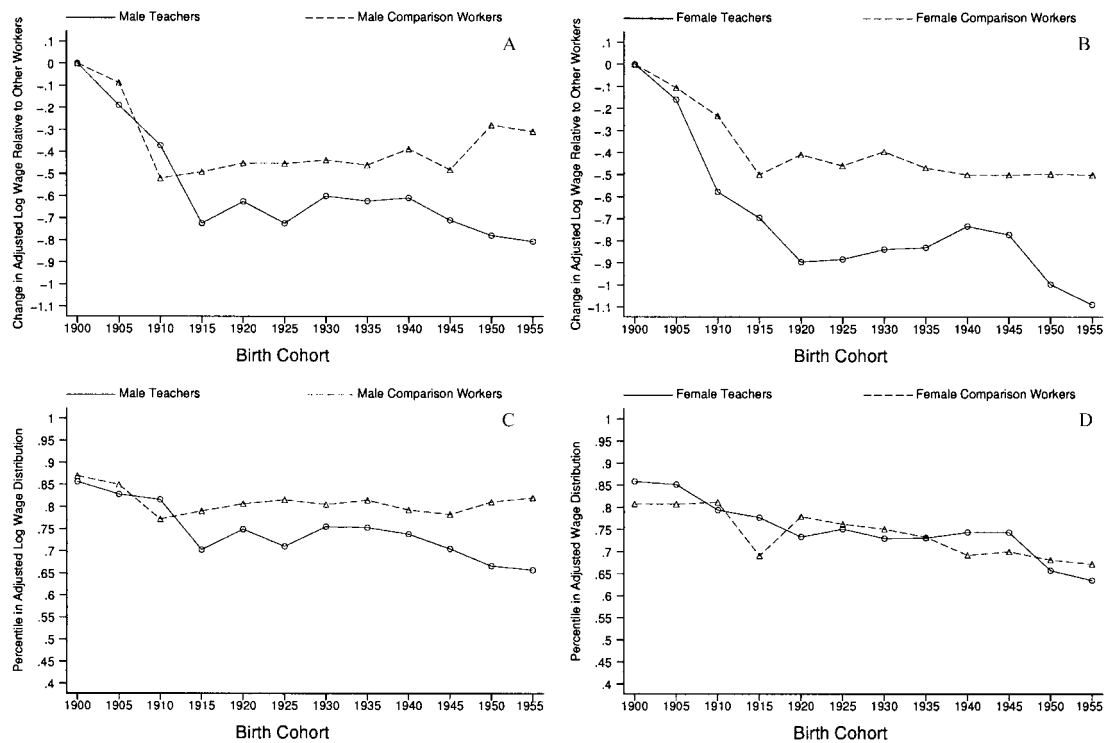


FIGURE 6.—Trends in the experience-adjusted wages of U.S. schoolteachers and nonteaching comparison workers, relative to the average worker

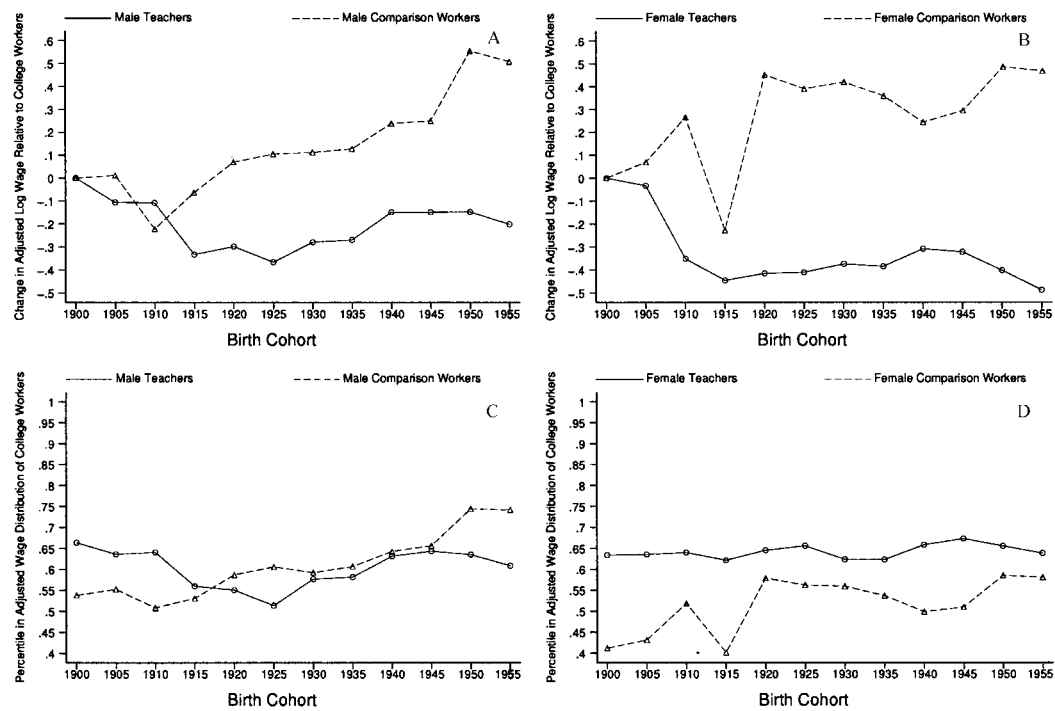


FIGURE 7.—Trends in the experience-adjusted wages of U.S. schoolteachers and nonteaching comparison workers, relative to the average college-educated worker.

45 percentage points.³⁰ The improving position of comparison workers with respect to college-educated workers is not that surprising since the expansion of college education would most likely have diluted the average ability of college graduates. However, for the same reason, the decline in teachers' wages relative to this group is striking.

Figure 7C shows that male teachers lost about 6 percentile points in the experience-adjusted wage distribution of college-educated workers, while male comparison workers gained about 15 percentile points. Female teachers gained about half a percentile point, while comparison workers gained about 17. It is interesting that female teachers held their position in the distribution, even though their average relative wages fell by about 50 percentage points. It is a virtual certainty that the pool of college-educated working women changed dramatically over this period of time as a result of expanding opportunities for skilled women. The results suggest a great deal of entrance at the lower end of the college-educated pool, as well as even larger increases in the quality of female workers at the top of the distribution. Female teachers lost ground to skilled women and to the average college-educated worker, although they managed to hold their ground in the distribution of college-educated workers. Male teachers, on the other hand, lost ground to college-educated and skilled workers along every measured dimension.

C. *Teacher Quality, Quantity, and the Price of Skill*

Exogenous changes in the price of skill have largely eluded the broader literature on technological change and the wage structure. This owes itself in large part to the difficulty of identifying changes that are exogenous in the context of a general equilibrium theory. This makes it difficult, if not impossible, to identify a smoking gun that conclusively demonstrates the linkages among quantity, quality, and the rising price of skill. Nonetheless, an empirical case can still be made.

I use two sources of variation in the price of skill to develop evidence linking these quantities. The first is the Great Compression of the 1940s, the only postwar decade to exhibit clear declines in the relative demand for skilled workers (Goldin and Margo 1992). The theory suggests that compression in the relative price of skill ought to interrupt the substitution of teacher quantity for quality. The second is geographic variation in the price of college graduates. If the theory is correct, there ought to be a positive correlation between the equilibrium price of skill and the equilibrium quantity

³⁰ The analysis presented here was exactly repeated on data from U.S. Department of Labor (1992–2001) to construct estimates of relative quality for the 1960 birth cohort. Over this period, there were continued declines in relative quality for women and men. If Figure 7B were extended in time, it would fall by about 6 percentage points for female teachers between the 1955 and 1960 cohorts and rise by 5 percentage points for female comparison workers. If Figure 7A were extended, it would remain flat for male teachers between 1955 and 1960 and rise by 5 percentage points for male comparison workers.

of teachers: schools faced with a higher skill price will choose to substitute toward quantity.

The Great Compression. A reversal of trend in the rising price of skill would provide us with an interesting case study, but the unbroken growth in wage inequality makes such a reversal difficult to find. There are three possible time periods during which an interruption may have occurred. One of them—the 1940s—survives close scrutiny to emerge as a largely undisputed interruption of the growth in wage inequality.

The first candidate period, from 1915 to 1940, may have witnessed a contraction in the price of skilled workers, but the data are too sparse to support definite conclusions. Soaring high school graduation rates during this period may have bid down the relative price of high school graduates, but these dramatic expansions in supply were accompanied by equally dramatic technological breakthroughs that may have raised the demand for educated workers (Goldin and Katz 1996). It is not clear what effect the race between technology and education had on the high school premium itself. In one of the few pieces of research on trends in the high school premium, Goldin and Katz (1999) find that the skill premium in Iowa declined from an unusually high level in 1915 to a lower level in 1940. It is hard to know if this result generalizes, since (as the authors note) Iowa may have been 20 years ahead of the rest of the country in schooling attainment (and perhaps also 20 years ahead in its declining returns to schooling). Data limitations make it hard to draw definite conclusions about the price of skilled workers in the pre-World War II U.S. economy because supply and demand were both likely to be expanding.

More complete evidence exists for the 1970s, but the interpretation is less clear. While differentials across education groups clearly contracted, residual wage inequality rose, possibly to an even greater extent (see, for example, Juhn, Murphy, and Pierce 1993; Katz and Murphy 1992), although this is a subject of great debate (for a summary of the literature, see Autor and Katz 1999). If residual wage inequality represents growth in the return to unobserved skill, the 1970s may have seen an increase in the price of unobserved skill.

Less ambiguous evidence suggests that the returns to schooling and skill contracted significantly during the 1940s but rebounded during the 1950s and 1960s (Goldin and Margo 1992). Indeed, the decline in the relative wages of skilled workers was so steep that it took at least 30 years to return to prewar levels (Goldin and Margo 1992). It is hard to time these various events exactly, but trends in teacher quantity and quality do show an interruption around the time of World War II. According to Figure 4, class size fell from 1935 to 1945 and again from 1955 onward. The experience-adjusted wages of male teachers relative to their comparison occupations, shown in Figure 6A, fell from the 1910 to 1925 birth cohorts and again from the 1940 birth cohort onward. Assuming that each cohort enters the labor force ap-

proximately 20 years after its midpoint, the relative quality of entering teachers declined from (approximately) 1932 to 1947 and again from 1962 onward. Both these series exhibit steady declines that begin in the 1930s, with a coincident period of interruption that begins around the end of World War II.³¹ Time trends are similar for the female workers in the figure, except that the early period of decline started earlier and lasted from 1900 to 1920. The feature common to the male and female series is the period of interruption that appeared for the cohorts entering the labor force during the 1940s.

The relative schooling trends in Figure 5 reveal rough parity between teachers and comparison workers until the 1930 birth cohort, when the relative schooling of teachers begins a steady decline against the comparison occupations' schooling. Both schooling and experience-adjusted wages entered a period of relative decline for teachers beginning with the cohorts entering the labor force during the 1950s.

Geographic Variation. The price of skilled workers varies significantly across U.S. states. Define the college premium as the average log wage residual, u_{ijct} , from regression equation (4), of college graduates minus the average log wage residual of high school graduates. In 1980, the residual college premium among male workers varied from $-.22$ (in Montana) to $.16$ (in North Dakota). To investigate whether states facing higher relative prices of skill assemble smaller classes, I present some correlations between the state-level college premium and state-level class size.

The residual college premium (constructed from a regression for all workers) is constructed separately for male and female workers. The student/teacher ratio is measured as the number of primary and secondary public school students enrolled in the fall of each census year divided by FTE teachers in those public schools (U.S. Department of Health, Education, and Welfare 1971; U.S. Department of Education 1982, 1992). The student/teacher data are available from 1970 onward; to my knowledge, there are no data on FTE teachers in 1960 or earlier. Figure 8 plots the resulting statewide college premia, for males and females, against the state-level student/teacher ratios, along with the associated regression lines. Each panel contains 153 observations: 50 states plus the District of Columbia in each of the 3 years, 1970, 1980, and 1990.

Since I wish to focus on geographic variation, the line is based on a within-year regression, where 1980 is taken to be the baseline year. For both males and females, the regression line has a significantly negative slope. As shown in Table 4, a within-year regression of the student/teacher ratio on the college premium suggests that a one-student increase in the student/teacher ratio is

³¹ While it is difficult to separate the effects of the early baby boom from the Great Compression, it is worth noting that the K–12 student population did not peak until 1971 (U.S. Department of Education 2001), 9 years after relative quality resumed its decline, and that class sizes resumed their decline before the largest baby boom cohorts entered elementary school.

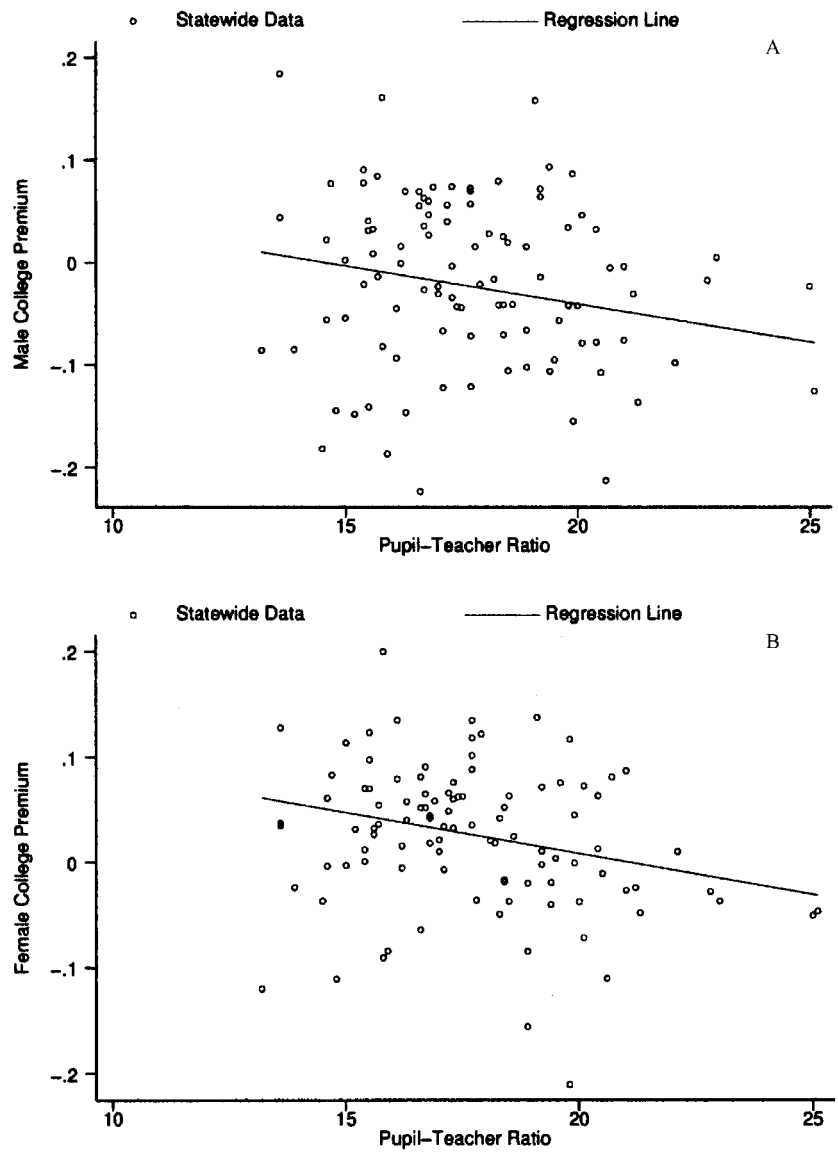


FIGURE 8.—The student/teacher ratio and the relative wages of college graduates in U.S. states, 1970–90.

TABLE 4
CORRELATION BETWEEN STATEWIDE SKILL PREMIUM AND
STUDENT/TEACHER RATIOS, 1970–90

	MALES			FEMALES		
	(1)	(2)	(3)	(1)	(2)	(3)
Student/teacher ratio ^a	-.743** (.210)	-.745** (.204)	-.666** (.208)	-.777** (.257)	-.824** (.198)	-.775** (.202)
Per capita personal income ^b		-.003 (.039)	-.024 (.041)		-.073** (.026)	-.087** (.027)
Population density ^c			.174** (.048)			.102** (.019)
R ²	.35	.35	.37	.27	.31	.33

SOURCE.—Ruggles and Sobek (1997).

NOTE.—All regressions include dummies for the census year. Robust standard errors clustered at the state level are in parentheses. The dependent variable is $100 \times$ (Statewide Sex-Specific College Premium). $N = 153$. Census year dummies are included for all regressions.

^aEnrolled students per full-time-equivalent teachers.

^bPercentage of nationwide average.

^cHundreds of people per square mile.

**Significant at the 1% level.

associated with a .74-percentage-point reduction in the male college premium and a .77-percentage-point reduction in the female college premium.

Both these coefficients are significant at the 1 percent level on the basis of robust standard errors clustered by state. This relationship persists even after one adjusts for economic characteristics of states, as the table also shows. I added controls for per capita personal income and population density. The income figures—for 1969, 1979, and 1989—were obtained from Bureau of Economic Analysis data on statewide per capita personal income as a percentage of nationwide per capita personal income.³² The population density figures are based on the 1970, 1980, and 1990 censuses.³³ Adding a control for per capita income slightly strengthens the relationship between class size and the college premium, while adding population density reduces it slightly but not significantly.³⁴

The data suggest that rich states have higher college premia (for women but not for men) and that they hire more teachers per student. The latter can be inferred because adding a control for per capita income strengthens the relationship between class size and the college premium. On the other hand,

³² U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Accounts: Annual State Personal Income (<http://www.bea.gov/bea/regional/spi/default.cfm?satable=summary>).

³³ These data are taken from U.S. Bureau of the Census (1994).

³⁴ For the sake of completeness, I also ran a specification including state fixed effects. These should be interpreted with caution, since I am estimating about 56 parameters (including the fixed effects) on the basis of, at best, 153 independent observations, possibly fewer in the presence of serial correlation. In any event, the within-state correlation is larger in absolute value for women, although much smaller for men.

it appears that sparsely populated states pay lower college premia (perhaps as a result of lower returns to specialization) and have smaller class sizes. This may result simply from the fixed costs of school building in rural areas. As a result, population density explains part of the negative correlation between class size and the college premium, but only a small part.

D. Evaluating Alternative Models

Declining relative quality and class size seem roughly to coincide across time and space with growth in the price of skilled workers, but perhaps the primary virtue of the skill price explanation is its ability to explain the breadth of the trends in quality and quantity. This becomes apparent when the explanation is compared to three alternatives. First, skilled women enjoyed a dramatic expansion in their labor force opportunities. Second, teachers' unions were born and have become entrenched, and school district mergers may have further reduced the competitiveness and efficiency of public education. Finally, policies in the public sector may have led to quality reduction or cost growth. On the one hand, the evidence certainly supports the existence of at least one of these alternatives because educational costs have been growing much more quickly than the real wages of college-educated workers since 1970.³⁵ However, relative quality declined for women and men, before and after the advent of unions, and even relative to skilled workers in the public sector. The alternative candidates cannot by themselves account for these patterns.

One of the most important forces affecting the labor market for teachers is the rise of labor market opportunities for skilled women outside teaching. According to Table 3, in the 1900 birth cohort, nearly half of all working women with 14 years of schooling were teachers. By the 1955 birth cohort, this proportion had fallen to 10 percent. The increasing availability of alternative skilled jobs would have bid up the price of skilled women. While this can explain falling class sizes and the declining relative quality of female teachers, it cannot explain why declines for female teachers were larger than for women in similarly skilled occupations. In addition, it cannot account for declines among male teachers. If the relative demand for (male plus female) skilled workers had not changed, increasing opportunities for women outside teaching would have come at the expense of skilled male workers. This would have lowered the price of skilled males and raised the relative quality of male teachers.

Even though female labor force participation cannot explain all the trends by itself, female teachers have lost more ground to college-educated workers and to skilled workers than their male counterparts have. In addition, it is

³⁵ If the rising price of skill were the only relevant force, costs would grow at most by the rate of real wage growth for similarly skilled workers.

likely that these factors are of continuing importance. As explained in footnote 30, between the 1955 and 1960 birth cohorts, female teachers lost 10 percentage points to other skilled workers, while men lost just 5.

The rise of teachers' unions represents another theory that could fit all the facts. Hoxby's (1996) model of a rent-seeking union is a good candidate. Suppose that teachers' unions value smaller classes, because they are more pleasant to work in, but that they do not value teachers of high relative quality. This could explain falling relative quality and class sizes and rising per student costs. The rise of unionization seems particularly well timed to explain the rapid acceleration in costs since 1970. However, declining class sizes and relative teacher quality predate unionization. Teachers' unions were largely powerless (if they existed at all) before 1960. The percentage of school districts engaged in collective bargaining started out at 1 percent in 1962. This rose to 8 percent in 1966, 28 percent in 1972, 45 percent in 1982, and 54 percent in 1992. Even as late as 1972, only 14 percent of school districts had a majority of unionized teachers with a collectively bargained wage agreement (Hoxby 1996). According to Figure 4, however, from 1955 to 1970, class sizes fell by about 18 percent. Moreover, declining relative quality also seems to predate unionization.

Figures 9A and 9B are analogous to Figures 7A and 7B, except that they are estimated using only the preunionized data from 1940–70. Before the advent of unions, the fitted wages of male teachers fell by about 9 percentage points relative to college-educated workers and by about 13 percentage points relative to other skilled workers. Female teachers lost about 25 percentage points to other college-educated workers and 48 percentage points relative to skilled workers.

A related trend, the consolidation of school districts, might also have lowered the efficiency of public schools by decreasing the extent to which districts compete among themselves (Hoxby 2000). The timing of this trend is not as clean or as recent as trends in unionization, but district mergers are less likely to have affected the relative quality of private-school teachers. Individual private schools are likely to have very little market power; this makes them function as competitive price takers, regardless of what happens to their larger competitors.³⁶ Figure 10 demonstrates that trends in the relative quality of male teachers in private schools (solid lines) are quite similar to trends for male teachers in public school (dashed lines).

The figure shows that relative schooling—in levels and percentiles—has declined for both public and private schoolteachers, as have experienced-adjusted relative wages. Relative wages and schooling have declined by slightly more for public schoolteachers. This is consistent with the idea that

³⁶ Private schools that do have market power may also have less incentive to remain efficient when their fellow oligopolists become more sluggish competitors.

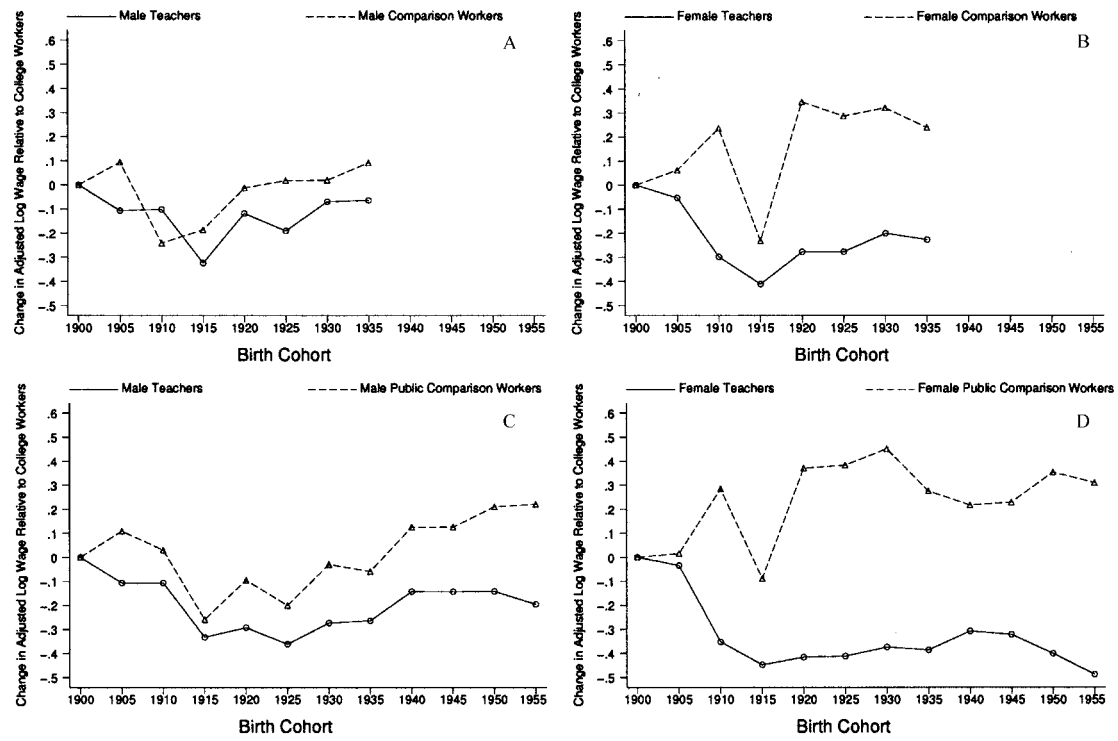


FIGURE 9.—Trends in the relative quality of teachers before unions and compared with skilled workers in the public sector

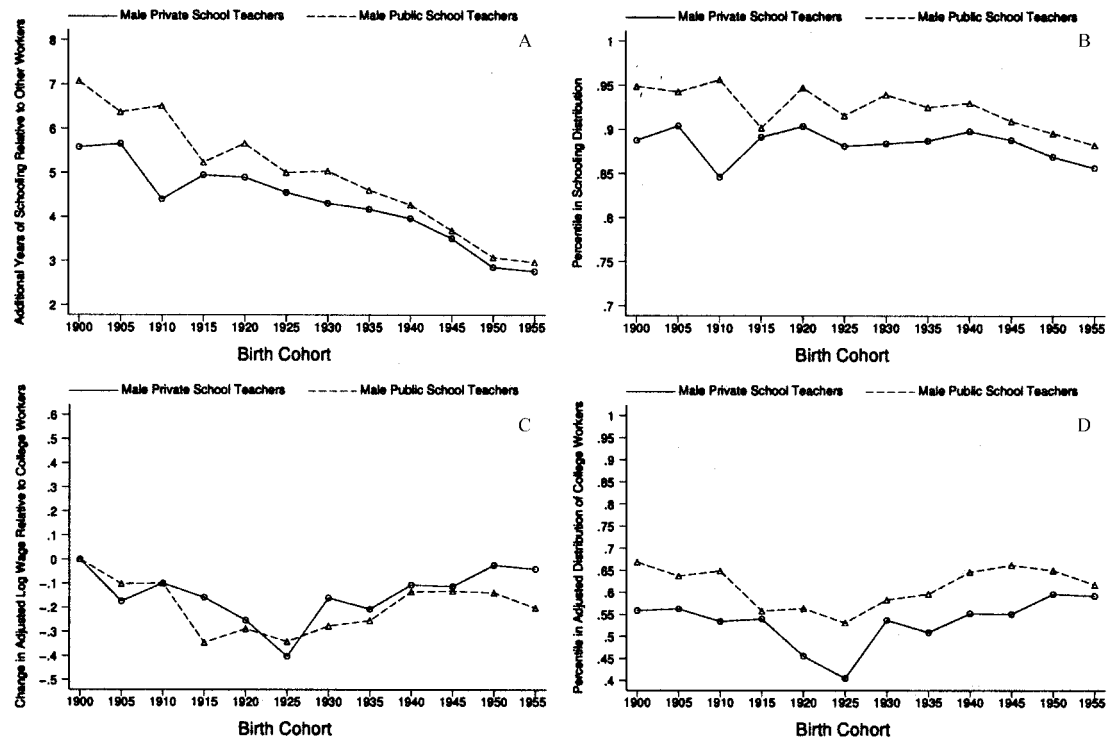


FIGURE 10.—Trends in the relative schooling and experience-adjusted wages of U.S. male private and public schoolteachers, relative to the average worker.

public schools have become less efficient over time, but the declines have not been unique to public-sector education.

A third class of alternatives emphasizes the effects of public policy. One possibility is the emergence of state laws limiting class sizes. These are too recent to explain the long-running trends. In 1984, Texas passed legislation limiting class sizes. Nevada followed in 1990, Virginia in 1995, and California in 1996 (Pritchard 1999). Another possible explanation is the rigidity of public-sector budgets or wage schedules that cause schools to mechanically hire teachers of lower relative quality when the price of skill rises. This may have contributed to the decline in relative quality, but it cannot be the sole explanation for it, because the quality of teachers has declined relative to other skilled workers in the public sector. Out of our skilled male worker comparison group, about 15–20 percent (depending on the birth cohort) worked in the public sector. Among females, about half to two-thirds worked in the public sector. Figures 9C and 9D compare the experience-adjusted relative wages of male teachers to the experience-adjusted relative wages of these public-sector skilled workers. In Figure 9C, public-sector skilled males gained about 17 percentage points relative to teachers and lost just 2 percentage points relative to college-educated male workers over this period. If I had restricted the comparison to public-school teachers versus public-sector skilled workers, this would have added about 4 additional percentage points to the gap between teachers and public-sector skilled workers. In Figure 9D, public-sector skilled females gained almost 78 percentage points relative to teachers and about 29 percentage points relative to college-educated females. To be sure, public-sector skilled workers have not kept pace with their colleagues in the private sector; this supports the idea that the public sector does not retain worker quality as well as the private sector.³⁷ Nevertheless, even after accounting for this effect, the relative quality of male and female teachers has declined compared with that of other skilled workers in the public sector.

Finally, one might argue that reductions in class size represent growth in the nonpecuniary compensation of teachers and thus that relative wage declines need not be accompanied by relative quality declines. However, in addition to declines in relative schooling, even nonwage measures of relative quality like teachers' achievement test scores have fallen in as robust fashion since at least the late 1960s (see the discussion in Section III).

V. CONCLUSIONS

Economywide growth in the price of skill can cause substitution from teacher quality to teacher quantity if the productivity of skilled teachers does

³⁷ Perhaps as a result, the skill premium in the public sector, unlike that in the private sector, never recovered from the Great Compression (Margo and Finegan 2002).

not grow with the skill price. A great deal of empirical evidence suggests that the relative quality of U.S. teachers has been declining, even as teacher quantity has been rising. The relative schooling of teachers has declined considerably compared with other workers of all stripes. In addition, the human capital of schoolteachers appears to have declined in value relative to that of highly skilled workers, college-educated workers, and the overall labor force.

While there is no single piece of evidence that conclusively links the historical trends in teacher quantity and quality to the rising price of skill, this explanation of the facts is appealing for several reasons. First, there appears to be a correlation between growth in the price of skilled workers and growth in class sizes, across U.S. states, and during an important episode of contraction in the skill premium. Second, while there are several other important forces at work in the labor market for teachers, it is difficult to explain the breadth of the decline in relative quality without including the rising price of skill as part of the explanation. Finally, the simplicity of the explanation—that schools are cutting their use of a more expensive input—also works in its favor.

Although the relative quality of schoolteachers appears to be falling, this does not necessarily compromise the position of today's students. The rising price of skill alters the relative efficiency of various educational inputs. This causes resources to flow away from schoolteacher quality and toward other, more productive uses within the educational system. Indeed, resources have not simply departed from the educational system. On the contrary, spending per pupil has grown substantially. The relative quality of schoolteachers has declined, but there has been simultaneous and dramatic growth in the student/teacher ratio. Since a decline in one set of educational inputs is likely to be accompanied by growth in another set, it may be misleading to focus exclusively on a single input.

One of the most controversial areas of education research concerns the impact of class sizes on student achievement. It has often been difficult to identify an effect of class size reduction on student achievement. Some researchers argue that there is no real effect.³⁸ The theory presented here suggests one reason why it has been so difficult to find an effect. Nonexperimental variation in class sizes may be correlated with the price of skill and the relative quality of teachers. Since teacher quality will never be measured perfectly, this correlation will bias down the estimated effect of class size reductions and possibly lead to an estimated effect of zero.

Finally, it seems important to understand in more detail the cross-country patterns summarized in Figure 1 and Table 1. The predictions of the theory should apply with more force to developed countries than to developing countries. Since the relative demand for skill may be lower in developing

³⁸ See note 12 for examples of the literature.

countries, school systems there may be investing more in relative school-teacher quality and less in schoolteacher quantity. It would be useful to investigate whether this prediction is consistent with observed cross-country patterns. At the very least, it seems that the patterns of relative wage decline are not consistently present in developing countries (Schultz 1987).

APPENDIX A

DEFINITIONS AND VARIABLE CONSTRUCTION

Worker. Throughout the analysis, a worker is defined as someone who reported working at least 26 weeks and receiving positive annual wage earnings in the prior year.

College Educated. Throughout the analysis, a college-educated person is one with at least 14 years of schooling.

Earn. This variable is defined as earnings from employment in the previous year. It is top coded at \$5001 in 1940, \$10,000 in 1950, \$25,000 in 1960, \$50,000 in 1970, and \$75,000 in 1980. In 1990, all values above \$140,000 are recoded to the state median for incomes above this level. Wage residuals and percentiles for a cohort are always calculated for the census year in which the cohort is between ages 30 and 39.

School. This variable is defined as years of schooling, where completion of the first grade corresponds to a value of one, and so on. In 1940 and 1950, this was top coded at 17 years of schooling. In 1960 and 1970, it was top coded at 18 years of schooling. In 1980, it was top coded at 20 years. In 1990, the census switched to a different scheme that records degree received or bracketed grade levels for those who did not complete high school. The 1990 values were recoded to represent years of schooling as follows. Grades 1–4 were recoded to 3 years of schooling. Grades 5–8 were recoded to 7 years of schooling. People who reported 12 years of schooling but no degree or a high school degree (including GED) were assigned 12 years of schooling. Associate degrees were assigned 14 years of schooling. Bachelor's degrees were assigned 16 years of schooling. Master's degrees or professional degrees were assigned 18 years of schooling. Doctoral degrees were assigned 20 years of schooling. I explored a variety of modifications to this recoding scheme—such as changing the recoded values by 1 year for one or more categories—and found the results to be robust. Throughout the paper, the average schooling of a cohort is always measured during the census year in which all members of the cohort were between the ages of 30 and 39. In addition, whenever comparisons in schooling are made across years—that is, for all calculations except those involving schooling percentiles and the identification of skilled occupations—top coding is made uniform across years: observations in 1980 and 1990 are top coded at 18 years of schooling; those top coded at 17 years in the 1940 and 1950 censuses are assigned the average schooling of same-sex workers with at least 17 years of schooling in the 1960 census.

Weeks. This variable represents weeks worked in the previous year. In 1960 and 1970, the census recorded bracketed weeks worked, rather than actual weeks. These were converted to actual weeks worked by computing average weeks worked for the 1940–50 and 1980–90 census years, within cells defined by the weeks bracket, years of schooling, sex, age category (≤ 20 , 20–29, 30–39, 40–49, 50–59, and 60+), and teaching status. The mean weeks worked within the relevant cell was then assigned to each respondent in the 1960 and 1970 census years.

Hours. This variable represents hours worked in the week preceding the census data collection. In 1960 and 1970, the census recorded bracketed hours worked,

rather than actual hours. These were converted to actual hours worked by computing average hours worked, for the 1940–50 and 1980–90 census years, within cells defined by the hours bracket, years of schooling, sex, age category (≤ 20 , 20–29, 30–39, 40–49, 50–59, and 60+), and teaching status. The mean hours worked within the relevant cell was then assigned to each respondent in the 1960 and 1970 census years.

AnnHrs. This variable represents annual hours worked and is equal to Weeks \times Hours.

Tch. This variable is one if the individual reported her primary occupation as being elementary or secondary schoolteaching in the previous year.

Exp. This variable represents potential experience and is defined as age minus years of schooling minus 6. Categorical dummies are used, where the categories are defined by 0–4, 5–9, 10–14, 15–19, 20–24, 25–29, and 30+ years.

APPENDIX B

COMPARISON OCCUPATIONS

The characteristics of male and female comparison occupations are given in Table B1. The upper percentile refers to the maximum percentile occupied by the occupation. For example, male teachers reside between the 97.87th and 99.14th percentile, so that their upper percentile is 99.14.

TABLE B1
EDUCATIONAL POSITION AND MEAN SCHOOLING OF MALE
AND FEMALE COMPARISON WORKERS

Occupation	Upper Percentile	Mean Schooling
Males:		
Chemists	97.21	14.13
Pharmacists	97.45	14.18
Optometrists	97.47	14.31
Electrical engineers	97.79	14.66
Architects	97.84	15.00
Librarians	97.85	15.40
Chiropractors	97.86	15.42
Osteopaths	97.86	15.50
Teachers	99.14	15.52
Chemical engineers	99.18	15.54
Metallurgical engineers	99.22	15.79
Dentists	99.28	15.88
Lawyers and judges	99.57	16.05
Farm and home management advisors	99.59	16.43
Physicians and surgeons	99.78	16.51
Females:		
Social and welfare workers	89.53	14.12
Dentists	89.56	14.25
Draftsmen	89.58	14.50
Authors	89.61	14.57
Librarians	89.96	14.86
Lawyers and judges	89.99	14.88
Teachers	99.48	14.93
Farm managers	99.50	15.00

TABLE B1 (Continued)

Occupation	Upper Percentile	Mean Schooling
Sports instructors and officials	99.58	15.11
Physicians and surgeons	99.63	15.18
Farm and home management advisors	99.69	15.83
College professors	100.00	16.36

NOTE.—Comparison occupations must be within X percentile points of teachers at their closest point; X is .6 for females and .7 for males.

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