The Influences of Salaries and "Opportunity Costs" on Teachers' Career Choices: Evidence from North Carolina

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Richard Murnane, Judith Singer, and John Willett analyze data from a larger study on the factors influencing career paths of teachers, focusing specifically on the career paths of White teachers in North Carolina who were first hired between 1976 and 1978. Using methodology known as "hazards modeling," the authors explore the relationship between the risk of leaving teaching, on the one hand, and teacher salary and opportunity cost, on the other hand. By employing hazards models, they are able to examine simultaneously various predictors of risk of leaving teaching—gender, National Teacher Examination (NTE) score, subject specialty, and the level of teaching (elementary or secondary)—and to determine whether the effects of these predictors remain constant or vary across teachers' careers. The authors conclude by discussing implications for policy and for teacher supply and demand models.

Over the next ten years, the number of new teachers needed to staff the nation's schools is expected to increase dramatically.[1] Two demographic trends underlie this prediction: the aging of the current teaching force, and the projected increase in public school enrollment. From 1976 to 1986, the proportion of the nation's teaching force over fifty years of age increased by 37 percent (from 15.5 percent to 21.2 percent).[2] And in 1985, after fifteen years of steady decline, the number

[1] National Research Council, *Precollege Science and Mathematics Teachers: Monitoring Supply, Demand and Quality*, Report of the Panel of Statistics on Supply and Demand for Precollege Science and Mathematics Teachers (Washington, DC: National Academy Press, in press).

[2] National Education Association, *Status of the American Public School Teacher 1985-86* (Washington, DC: Author, 1987), p. 73, Table 60.

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of students enrolled in U.S. public schools bottomed out at 39.5 million, and began to increase as the children of the post-World War II baby boom generation entered the schools. The National Center for Education Statistics (NCES) projects that by 1995, public school enrollments will increase to 43.4 million.[3]

The combination of increased student enrollments and the expected wave of teacher retirements raises the specter of a teacher shortage in the years ahead. The extent to which shortages do develop depends critically on the answers to at least two questions: How long will newly hired teachers remain in the classroom? Of those who leave, what proportion will eventually return? As noted in a 1987 National Research Council report, we have very little knowledge about how long teachers continue to teach, what personal factors affect teachers' decisions to leave or to return after an interruption, and how important economic factors, such as salary and opportunity cost (defined as the salary a teacher would have earned had she pursued her best career alternative outside of teaching) are in influencing these decisions.[4]

This paper reports results from the first research that explicitly examines these issues within the context of a single study, focusing specifically on the factors influencing career paths of teachers in three states—North Carolina, Michigan, and Colorado.[5] We use data on 5,100 White elementary and secondary school teachers who began teaching in North Carolina public schools between 1976 and 1978, to show that salaries are an important predictor of whether these teachers remain in the classroom, particularly during their first years on the job. We also find evidence that the number of years teachers in our sample stayed in teaching, and the probability that those who left would return after a career interruption, are related to measures of opportunity cost.

Economic Influences on Employment Duration

Unlike most other countries in the world, public school teacher salaries in the United States are determined locally in more than 15,000 school districts. The vast majority of local schedules specify a base salary for a teacher with a bachelor's degree and no experience, and salary increments for an advanced degree and for each year of experience up to a prespecified maximum.[6] Typically every teacher in a district is paid according to the same schedule, regardless of grade level or subject taught.

During the last twenty years, there have been dramatic changes in the compensation of public school teachers in the United States. Expressing all salaries in 1987

[3] National Center for Education Statistics, U. S. Department of Education, *Digest of Education Statistics 1988* (Washington, DC: GPO, 1988), pp. 9-10.

[4] National Research Council, *Toward Understanding Teacher Supply and Demand*, Interim Report of the Panel of Statistics on Supply and Demand for Precollege Science and Mathematics Teachers (Washington, DC: National Academy Press, 1987).

[5] We chose these states for three reasons. First, only a minority of state departments of education had the type of computerized information on teachers needed to build the longitudinal datasets. Second, we wanted geographically large states to minimize the preparation of teachers who were "lost" because they decided to teach in an adjacent state. Third, the chief state school officers in these states expressed a willingness to provide the requisite data.

[6] Stephen M. Barro, *International Comparisons of Teachers' Salaries: An Exploratory Study*, report prepared for the U.S. Department of Education (Washington, DC: 1987).

constant dollars to control for inflation, the average starting salary of public school teachers in the United States peaked in 1971 at $19,522. Over the next decade, teaching salaries failed to keep up with inflation, and by 1981, the constant dollar average starting salary had fallen to $14,922. Over the following six years, teaching salaries increased steadily. By 1987, the average constant dollar starting salary had reached $18,480, an increase of more than $3,500 since 1981, but still more than $1,000 lower than the average starting salary in 1971.[7]

Current concern about the quality of U.S. education and the significant tax burden created by increases in teacher salaries has led many legislators and policymakers to ask: What are the consequences of these salary increases for public school teachers? There is surprisingly little evidence available to answer this question, and to our knowledge, no research has asked specifically whether higher salaries are associated with longer teaching careers. Common sense may suggest that if teacher salaries were doubled, for example, teacher turnover would drop dramatically. At issue, however, is whether moderate changes of a few thousand dollars, such as those affecting average starting salaries in recent years, will influence the decisions of enough teachers to affect supply markedly. Our research addresses this issue.

Over twenty-five years ago, two economists, Joseph Kershaw and Roland McKean, argued that the *structure* of public school teacher salary schedules was a primary cause of many districts' inability to recruit and retain qualified teachers in certain subject areas such as chemistry and physics.[8] The logic underlying their argument is that college graduates trained in chemistry and physics command higher starting salaries in business and industry than do those trained in the humanities. For example, in 1987, average starting salaries paid by business and industry in the United States to college graduates trained in physics, chemistry, and the humanities were $27,444, $24,708, and $20,256 respectively.[9] As a result of these differences in *opportunity cost*, district salary schedules that do not differentiate by field of training may be less attractive to talented college graduates trained in chemistry or physics than to equally able college graduates trained in the humanities.

Although educational reform reports bemoan the quality of instruction in science and mathematics,[10] few researchers have examined Kershaw and McKean's hypothesis critically. Virtually all prior research has focused on the decision to enter teaching,[11] not on the length of time spent in teaching, and the probability of returning to teaching after a career interruption. We focus on these latter issues, using two measures of opportunity cost: subject specialty and standardized test

[7] The teacher salary figures come from publications of the National Education Association.

[8] Joseph A. Kershaw and Roland N. McKean, *Teacher Shortages and Salary Schedules* (New York: McGraw-Hill, 1962).

[9] College Placement Council Surveys, 1970–1987.

[10] See, for example, National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform*, a Report to the Nation and the Secretary of Education (Washington, DC: Author, 1983).

[11] See, for example, Charles F. Manski, "Academic Ability, Earnings, and the Decision to Become a Teacher: Evidence from the National Longitudinal Study of the High School Class of 1972," in *Public Sector Payrolls*, ed. David A. Wise (Chicago: University of Chicago Press, 1987); and Russell W. Rumberger, "The Impact of Salary Differentials on Teacher Shortages and Turnover: The Case of Mathematics and Science Teachers," *Economics of Education Review, 8* (1987), 389–399.

scores.[12]

Because college graduates trained in certain fields—especially chemistry, physics, and mathematics—earn higher salaries in business and industry than do college graduates trained in the humanities, subject specialty can serve as an indicator of opportunity cost. Scores on standardized tests of general knowledge and verbal ability can serve as proxies for opportunity cost, because such tests are often used to screen applicants for entry to relatively high-paying professions. As a result, graduates who score well on these exams may be more likely to have access to high-paying occupations than graduates with lower scores. In our research, teachers' scores on the general and professional knowledge subtest of the National Teacher Examination (NTE) (which are positively correlated with scores on other standardized tests such as the Graduate Record Examination) represent this aspect of opportunity cost.[13]

NTE scores should not, however, be interpreted as indicators of "teaching effectiveness," because available evidence does not support this interpretation. Since we make extensive use of NTE scores in our analysis, a brief explanation is appropriate. There is evidence that teachers' scores on standardized tests of verbal ability are correlated with students' scores and test score gains on standardized tests of reading.[14] The evidence therefore suggests that some dimensions of cognitive skills are positively associated with teaching effectiveness. Since scores on the NTE are reasonably highly correlated with scores on other standardized tests of cognitive skills,[15] one could argue that a teacher's NTE score is one predictor of teaching effectiveness. However, as Walt Haney, George Madaus, and Amelia Kreitzer explain in a review essay examining the history of the NTE, NTE scores are relatively uncorrelated with other measures of teaching effectiveness, such as supervisors' ratings.[16] It is this puzzle—that teachers' scores on some tests are positively asso-

[12] While we focus on the effects of salaries and opportunity costs on length of stay in teaching, we *do not mean to imply that these are the only* factors influencing teachers' career decisions, or even that they are the most important influences. Teachers leave teaching for a variety of reasons—to pursue another occupation, to follow a spouse whose job has been relocated, to engage in full-time child-rearing. In addition to these reasons for voluntary turnover, some teachers leave teaching because they have lost their positions as a result of staff layoffs, or because they face the denial of tenure.

[13] Another reason for including NTE scores in our analyses is that if they are correlated with teaching salaries—which would occur if districts with high salaries sought to attract teachers with high NTE scores—then it is necessary to control for the influence of NTE scores on duration to develop an unbiased estimate of the impact of salary on duration.

[14] James S. Coleman, Ernest Q. Campbell, Carol J. Hobson, James McPartland, Alexander M. Wood, Frederic Weinfeld, and Robert L. York, *Equality of Educational Opportunity*, Office of Education, National Center for Educational Statistics (Washington, DC: GPO, 1976); and Eric A. Hanushek, *Education and Race* (Lexington, MA: D.C. Heath, 1972).

[15] Jerry B. Ayers and Glenda S. Qualls, "Concurrent and Predictive Validity of the National Teacher Examinations," *Journal of Educational Research, 73* (November/December, 1979), 86–92; Linda K. Pratt, *Study of Predictors of National Teacher Examination Scores at a Predominantly Black Institution*, paper presented at the Annual Forum of the Association for Institutional Research, San Diego, May 1979 (ERIC ED 174-117); Norman Wexler, *Concurrent Validity of the National Teacher Exams* (Washington, DC: National Institute of Education, 1975).

[16] Walt Haney, George Madaus, and Amelia Kreitzer, "Charms Talismanic: Testing Teachers for the Improvement of American Education," in *Review of Research in Education*, ed. Ernst Rothkopf (Washington, DC: American Educational Research Association, 1987). This review paper describes the history of the NTE and the attempts to relate scores on the NTE to various measures of teaching effectiveness.

ciated with some measures of teaching effectiveness (student test score gains), but NTE scores, which are quite highly correlated with scores on other standardized tests, are not systematically related to measures of teacher effectiveness—that creates ambiguity in interpreting NTE scores.

At the same time, the NTE score can serve as a proxy measure for the set of skills sought after by private employers. Consequently, evidence that teachers with high NTE scores are especially likely to leave teaching after only a few years in the classroom suggests that schools tend to lose teachers with skills valued by business and industry.

Methodology

Data

The results presented in this paper are based on the career paths of a sample of White teachers in North Carolina. We provide a context for our work by describing briefly the state's residents, student population, and teachers. North Carolina is the tenth most populous state, with a population of 5.9 million in 1980. In this same year, the state had a per capita income of $7,782 (18 percent below the national average) and a per pupil expenditure of $1,965 (also 18 percent below the national average). Ninety-five percent of school-aged children in the state attend public institutions. Although 76 percent of the state's *residents* in 1980 were White, only 68 percent of the state's *public school students* were White. In 1981, 56,222 teachers taught in North Carolina public schools. Seventy-eight percent of these teachers were White, a proportion marginally higher than their proportion in the population, and 10 percent higher than the proportion of White students in the state's public schools.[17]

The state government in North Carolina specifies a minimum statewide teacher salary scale and provides the 140 school districts in the state with the funds to pay teachers according to this scale. Approximately half of the districts in the state provide local salary supplements. In 1980, starting salaries paid to teachers with a bachelor's degree and no prior teaching experience ranged from the state-specified minimum of $12,390 to a maximum of $13,340. The average starting salary of $12,616 was 17 percent above the average starting salary in the nation for public school teachers in that year.[18]

[17] With one exception, all of the descriptive statistics reported in this paragraph come from *SEIS Data Profiles* (Triangle Park, NC: Southeastern Regional Council for Educational Improvement, 1987). The one exception is the racial composition of the 1981 North Carolina teaching force. This information was provided by M. Engin Konanc, director of the information center, North Carolina Department of Education. He stated that 1981 is the earliest year for which racial composition of the North Carolina teaching force is available.

[18] We computed the information on starting salaries in North Carolina from a database that we constructed from paper copies of the salary schedules of North Carolina school districts for each year from 1976 to 1986. The estimate of the average starting salary in the nation came from a report of the National Education Association. The competitiveness of North Carolina teaching salaries vis-à-vis the rest of the country varies considerably from year to year. North Carolina salaries were particularly competitive in 1980 because the state legislature dramatically increased the state scale in the previous year. The average North Carolina salary for beginning teachers was 4 percent above the national average in 1978 and 3 percent above the national average in 1986.

There was somewhat more variation in the salaries paid in North Carolina to experienced teachers than in the salaries paid to beginning teachers. For example, the 1980 salary paid to a teacher with a master's degree and fourteen years of experience ranged from $16,230 to $18,573.

TABLE 1
Age and Gender Composition of the Sample, by Area of Certification

Subject	N	Percent of all teachers	Percent of teachers who are 30 or younger		Percent of teachers who are over 30	
			Female	Male	Female	Male
Elementary	3622	71.0	85.0	5.7	0.8	8.4
English	488	9.6	72.5	18.0	2.3	7.2
Social Studies	383	7.5	43.3	49.1	3.4	4.2
Mathematics	301	5.9	73.4	22.3	1.3	3.0
Biology	259	5.1	48.3	46.3	2.3	3.1
Chemistry/Physics	47	0.9	36.2	55.3	2.1	6.4
All Subjects	*5100*	*100.0*	*77.7*	*13.6*	*1.3*	*7.4*

We began our analyses by examining data for the 5,863 teachers who were first hired in North Carolina public schools between 1976 and 1978, who took the NTE, and who were certified to teach either elementary school or a core academic subject. Early in our exploratory work, we found that the employment duration patterns among the 711 Black teachers in our sample differed dramatically from the employment duration patterns among the 5,100 White teachers.[19] Black teachers were more likely to stay in teaching than were their White colleagues; additionally, the specific predictors of employment duration differed by race. Had we included both groups in a single analysis, the overall findings would have been overwhelmingly dominated by the career patterns of the White majority. To ensure accurate representation of the career patterns of *each* group, we conducted entirely separate analyses. This paper reports results for the 88 percent of the initial sample who were White. A companion paper by James Kemple reports results for the Black teachers.[20]

For each teacher in our dataset, we know the number of years she or he taught continuously in the state between year of hire and 1986 (which we refer to as length of "first spell"); for those who left, we also know whether they returned for a "second spell" before 1986. Moves between districts within North Carolina are not considered to be exits from the profession.

Table 1 presents the age and gender composition of the sample of teachers, by area of certification. We selected the age and gender categories shown because

[19] The group of fifty-two teachers whose racial/ethnic identity was other than Black or White was too small to analyze.

[20] James John Kemple, "The Career Paths of Black Teachers: Evidence from North Carolina," paper delivered at the American Educational Research Association Meeting, San Francisco, March 1989.

preliminary analyses indicated that employment duration differs dramatically among these groups. Across the full sample, the modal entering teacher is a woman under 31; in social studies and chemistry/physics, it is a man under 31. To simplify our discussion, we refer to area of certification as "subject specialty" and, because the vast majority of teachers of core academic subjects work in secondary schools, we refer to them as "secondary school teachers."

Analytic Approach

Most previous quantitative research on teacher career paths has suffered from serious methodological limitations which raise questions about the interpretation of the results.[21] The central dilemma has been the analytic treatment of teachers who were still employed when data collection ended, and for whom the outcome—eventual employment duration—is unknown (the so-called "censored" observations). For the 51 percent of teachers in our sample still teaching in 1986, all we know is that they taught for at least 10, 11, or 12 years (for teachers hired in 1976, 1975, and 1974, respectively); we do not know how many additional years they remained in the profession after 1986.

Researchers who set aside these censored observations, and who analyze data based only on those teachers no longer in the profession at the end of data collection, necessarily distort the complete distribution of employment duration. The very existence of continuing teachers indicates, for example, that the true median employment duration must be longer than that found among teachers who have already left. Data on continuing teachers tells us a great deal—especially about the probability that teachers stay in the profession longer than the length of data collection (in our study, ten to twelve years). Accurate analysis of teacher career path data must attend to these continuing teachers, even though their actual employment durations are ultimately unknown.

We include these continuing teachers in our work by using a relatively new analytic technique, hazards modeling, to explore the relationship between employment duration and selected predictors. Hazards models resemble the more familiar multiple regression models, but are especially designed to handle the censored observations that arise in studying how long it takes for any critical event to occur, including a teacher's exit from the profession. Using this approach, we do not examine employment duration directly, but rather we examine the *hazard function*, a mathematical transformation of duration that remains meaningful when censored data are included. Because the hazard function is a mathematical transformation of duration, analytic results from hazards models can be interpreted in terms of duration (years of employment).

Mathematical definitions of hazard are related to the probability that a teacher will stop teaching in a specific year *given that she or he has taught up to that year*.[22] Per-

[21] John B. Willett and Judith D. Singer, "Two Types of Question about Time: Methodological Issues in the Analysis of Teacher Career Path Data," *International Journal of Educational Research* (in press).

[22] Careful definitions of the hazard function distinguish duration measured *discretely*, for which hazard is a conditional probability, and duration measured continuously, for which hazard is a rate. John B. Willett and Judith D. Singer, "Doing Data Analysis with Proportional-Hazards Models: Model Building, Interpretation, and Diagnosis," paper presented at the American Educational Research Association Meeting, New Orleans, April 1988 (ERIC ED 293 899, TM 011-603).

haps the easiest way to conceptualize hazard is visually, as a plot, over time, of the *risk* of leaving teaching in each given year of a teacher's career (see Figures 1-5). The magnitude of the hazard indicates how r··y (or hazardous) each year of teaching is.

By comparing hazards for different years, we can determine whether the first year of teaching is particularly risky or whether, for example, the second year is less risky than the first, and so on. If many teachers leave at a specific point in time, as might happen after the first year of classroom teaching, the hazard function is high, reflecting the higher likelihood that a teacher will leave. If, at another point in time, say seven or eight years after entry, relatively few of the remaining teachers leave, the hazard function will stabilize near zero, and we can conclude that this time period is not very risky at all. By comparing hazards for teachers of different ages, gender, subject specialties, and so forth, we can determine whether the risk of leaving teaching is more or less associated with specific characteristics of teachers, such as their background, training, and environment. We do this by including predictors in the hazards models, in much the same way that they are included in the more familiar multiple regression models.

The major advantage of hazards models for researchers studying teacher career paths is that these models permit the appropriate inclusion of teachers with censored employment durations. In addition, these models allow us to: 1) include multiple predictors simultaneously; 2) examine the effects of predictors, such as salary, which themselves vary over time; and 3) determine whether the effects of predictors remain constant or vary across teachers' careers. This last feature allows us to determine, for example, whether salary is more strongly related to the risk of leaving among beginning teachers, who may have not yet made a long-term commitment to teaching and for whom occupational changes may be relatively easy, than among experienced teachers, who have already invested several years in the profession.

We estimated a series of hazards models to explore the relationship between the risk of leaving teaching, on the one hand, and teacher salary and opportunity costs, on the other. We conducted separate, but parallel, analyses for elementary and secondary school teachers because exploratory analysis showed that results for the two groups differed dramatically. We began by fitting a "baseline" model composed of "control" predictors peripheral to our research questions, but associated with employment duration.[23] Then, building on the baseline model, we examined the effects of salary, subject specialty, and test score by fitting a hierarchical series of models that examined not only the main effects of each predictor, but also interactions between predictors. This enabled us to determine, for example, not only whether NTE scores were associated with hazard (the main effect), but also whether this relationship differed by the teachers' subject specialty (the interaction effect)—a plausible hypothesis, because a high scoring graduate with a degree in

[23] The control predictors were gender, age, the interaction of gender and age, years of entry into the profession, and the following district characteristics (taken from the 1980 U.S. Census of Population): median family income; median educational attainment of head of household; percent population that is Black; percent owner-occupied houses; and percent of children living in poverty. These district characteristics were chosen, not because they might influence duration, but rather because, as a group, they serve as proxies for the unmeasured variables, such as stress, which may influence duration.

chemistry may well have more lucrative options outside of teaching than a high scoring graduate with a degree in history. At every stage of our analyses, we also examined whether the relationship between the predictors and hazard was constant or varied over the course of teachers' careers.

We summarize our results by displaying fitted hazard functions for subgroups of teachers with specific values of the different predictors. We also use median employment duration (which we refer to as "median lifetime") to summarize the cumulative effects depicted by the fitted hazard functions. Median lifetime estimates the number of years that pass before half of any given group of teachers leave teaching. The fitted hazard function and associated median lifetime are intimately linked—subgroups at greater risk of leaving teaching have shorter median lifetimes.

Secondary School Teachers

White teachers are most likely to leave teaching at early stages of their teaching careers. Seventeen percent of the secondary school teachers in our sample left after one year in the classroom; another 9 percent left after two years. By eight years after entry, less than half the secondary school teachers (46 percent) remained. As we show below, however, these patterns differ dramatically by teachers' subject specialty, salary, and NTE score.

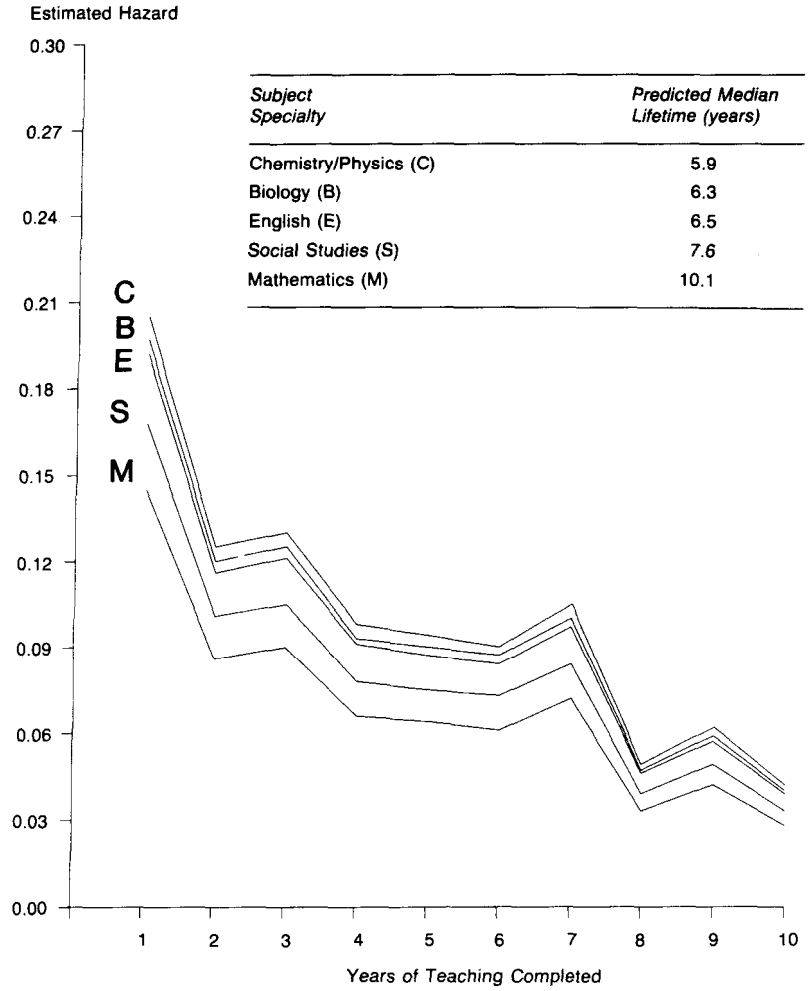
Subject Specialty

As illustrated in Figure 1, teachers' subject specialties are important predictors of turnover during the first years on the job. Compared to mathematics and social studies teachers, chemistry/physics, biology, and English teachers are particularly "at risk" of leaving teaching after only one or two years in the classroom. These differences in the likelihood of leaving teaching have a cumulative effect and eventually lead to large differences in median lifetime. Chemistry/physics teachers have the shortest median lifetimes (5.9 years), followed closely by biology teachers (6.3 years) and English teachers (6.5 years); social studies and mathematics teachers have the longest median lifetimes (7.6 and 10.1 years, respectively).[24]

Do the observed differences in median lifetimes by subject specialty support the notion that those teachers with the best job opportunities outside of teaching will be the most likely to leave the classroom? In one sense, the observed patterns do

[24] The model that underlies the predicted hazard plots and the median first-spell lengths in Figure 1 does not include NTE score. The reason for this omission is that it did not seem appropriate to "control for NTE score" in addressing the question of whether first-period patterns varied by subject specialty. If NTE score is included, the only change in the pattern is that the hazard for chemistry/physics teachers is slightly lower than the hazard for biology teachers. The model does include controls for age, gender, and their interaction, the salary each teacher was paid each year, and a set of variables describing the residents of each school district. These variables were included in the model in order to isolate the effects of subject specialty from other factors influencing length of stay that might be correlated with subject specialty. However, it is also important to know the answer to the simple "uncontrolled" question: Do teachers with some specialties stay in teaching longer than teachers with other specialties? To address this question, we calculated the median first-spell lengths by subject specialty for the teachers in our sample. The values (in years) were as follows: chemistry/physics, 5.9; English, 6.3; biology, 6.3; social studies, 7.8; mathematics, 9.6. Note that these values are very close to the predicted median first-spell lengths calculated from the hazard model estimates.

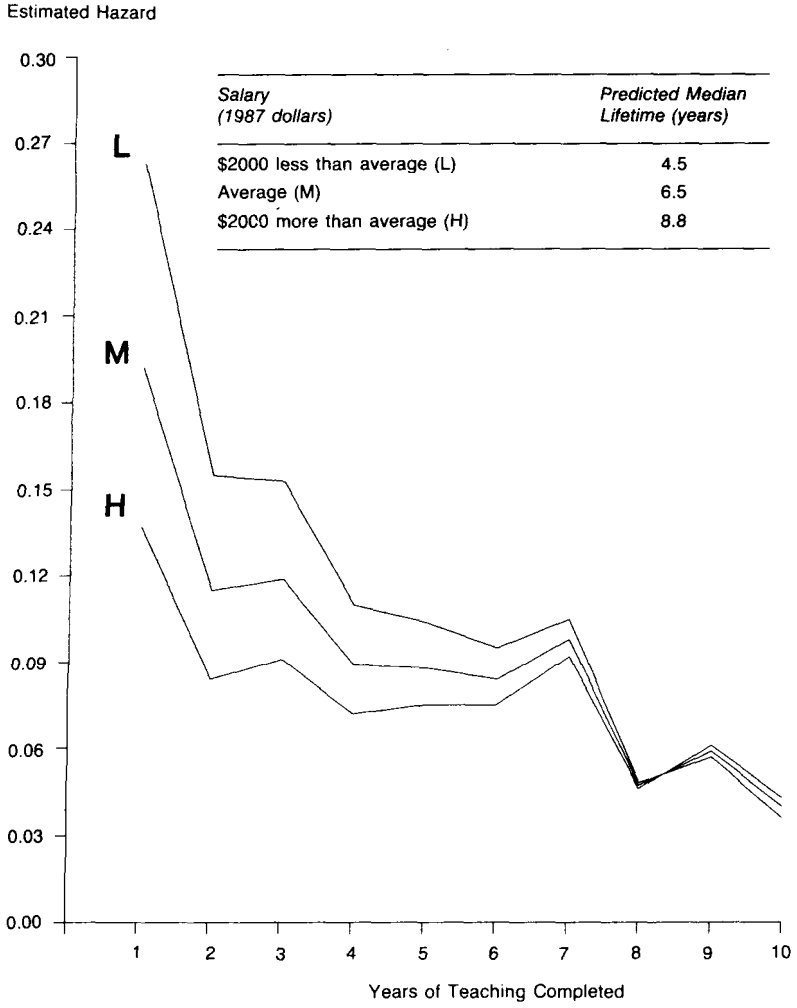
FIGURE 1
Risk of Leaving High School Teaching, by Subject Specialty



Subject Specialty	*Predicted Median Lifetime (years)*
Chemistry/Physics (C)	5.9
Biology (B)	6.3
English (E)	6.5
Social Studies (S)	7.6
Mathematics (M)	10.1

support this notion because the subject specialties with the shortest median lifetimes, chemistry and physics, are areas commanding particularly high starting salaries in business and industry. On the other hand, this logic would seemingly imply that mathematics teachers should also have relatively short median lifetimes, because the average starting salary for mathematics graduates employed by business and industry has been close to the average starting salary paid to chemistry majors in most years. We have no compelling explanation for why mathematics teachers have the longest median lifetimes among secondary school teachers of core academic subjects. One possibility may be that the high starting salaries paid to mathematics majors who work in business and industry may not be a good measure of the opportunity cost facing mathematics teachers because the skills de-

FIGURE 2
Risk of Leaving High School Teaching, by Salary



manded by business and industry (for example, computer skills) could differ from the skills possessed by most mathematics teachers. We cannot, however, test this hypothesis with these data. We want to note that the short median lifetime for chemistry/physics teachers, and the relatively long median lifetime for mathematics teachers, are not unique to North Carolina; our analyses of teacher career paths in Michigan also uncovered the same pattern.[25] Thus, short stays in teaching do contribute to the oft-reported shortage of chemistry and physics teachers,

[25] Richard J. Murnane, Judith D. Singer, and John B. Willett, "The Career Paths of Teachers: Implications for Teacher Supply and Methodological Lessons for Research," *Educational Researcher, 17* (August-September, 1988), 22-30.

but not to the shortage of mathematics teachers.

Salary

Our data indicate that the more a teacher earns, the more likely he or she is to stay in teaching. The median lifetimes displayed in the insert to Figure 2 summarize the cumulative effects of salary and show that secondary school teachers earning $2,000 more than average (in 1987 dollars) stay in the classroom, on average, an extra two years.[26]

As with subject specialty, the importance of salary in predicting the likelihood that a teacher will leave teaching diminishes over time. We illustrate this effect in Figure 2 by presenting predicted hazard functions for three prototypical English teachers: one in an average salary stream; one in a low salary stream ($2,000 less per year than average), and one in a high salary stream ($2,000 more per year than average).[27] Poorly paid teachers are twice as likely as highly paid teachers to leave teaching at the end of their first year. Over time, however, the importance of salary in predicting whether a teacher leaves teaching declines and, by year eight, disappears entirely.

We have two complementary conjectures that may explain the declining effect of salary on the risk of leaving teaching. First, switching occupations may become more difficult the longer one stays in teaching. Second, among teachers in relatively low-paying districts, those whose career choices are most sensitive to salary tend to leave after only a few years in the classroom. Consequently, teachers who continue to teach in low-paying districts may tend to be those whose career choices are relatively insensitive to salary.

NTE Score

Employment duration is strongly related to NTE scores, but unlike subject specialty and salary, NTE score is an important predictor of the risk of leaving teaching not only for beginning teachers, but for teachers with several years of experience as well. Figure 3 displays predicted hazard functions for three new prototypical English teachers, one with an average NTE score, one with a low NTE score, and one with a high NTE score.[28]

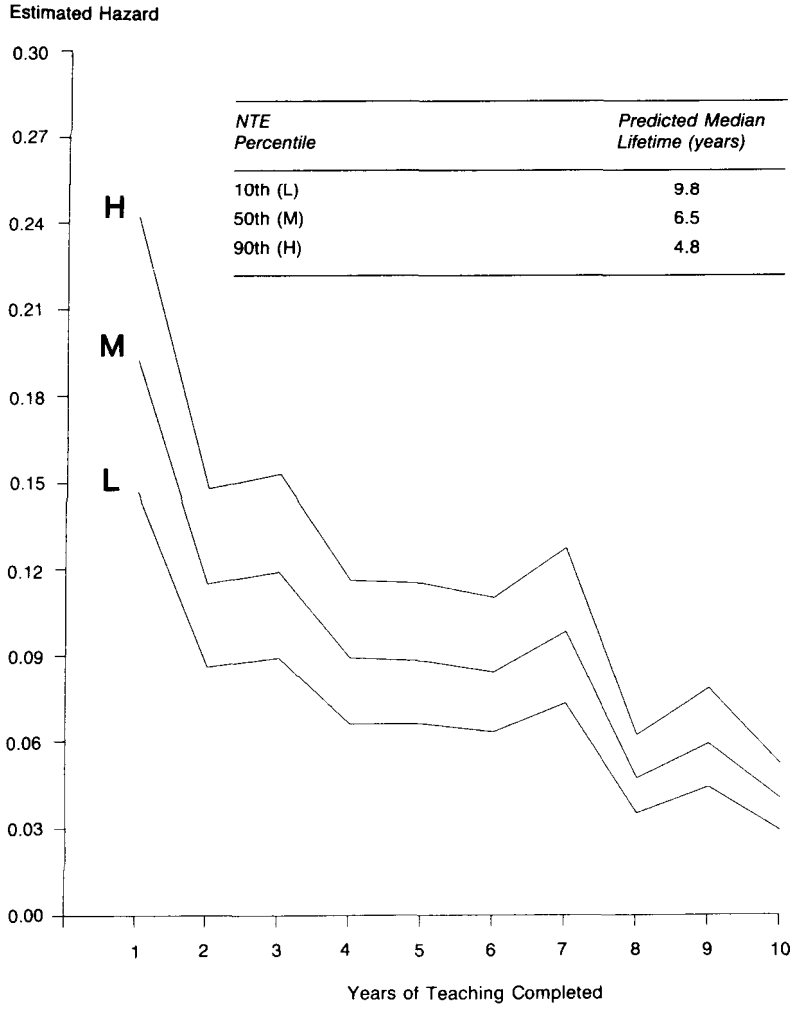
Those secondary school teachers with high NTE scores are almost twice as likely as those with low scores to leave teaching after one year. Although other researchers have documented the relationship between NTE scores and employment dura-

[26] The effect of salary on employment duration was estimated in a model that included NTE score. Because NTE score is negatively related to employment duration, but positively related to salary, the influence of salary is smaller when estimated in a model that does not include NTE score. Omission of the NTE score from the model biases the effect of salary on employment duration.

[27] We constructed the average salary profile as follows: The initial salary was calculated as the average first-year salary paid by North Carolina school districts in 1976 to teachers with a bachelor's degree and no prior teaching experience. The second-year salary was calculated as the average second-year salary paid by North Carolina school districts in 1977, and so on. Because salary and subject specialty did not interact, our plots, which present predicted hazard functions for teachers with modal characteristics in our sample of high school teachers—a female English teacher under the age of 31 when she started to teach—depict the *comparative* effects of salary on the risk of leaving teaching for all secondary school teachers.

[28] We have selected NTE scores for the three prototypical teachers as follows: one with an average NTE score (50th percentile, score of 637), one with a low NTE score (10th percentile, score of 541), and one with a high NTE score (90th percentile, score of 726).

FIGURE 3
Risk of Leaving High School Teaching, by NTE Score



tion,[29] we found that even among experienced secondary school teachers in our sample, those with high NTE scores continue to be more likely to leave than their lower scoring colleagues.

The insert to Figure 3, which displays the median lifetimes for the three prototypical White English teachers, shows the dramatic cumulative impact of these

[29] F. Howard Nelson, "New Perspectives on the Teacher Quality Debate: Empirical Evidence from the National Longitudinal Survey," *Journal of Educational Research, 78* (1985), 133-140, uses multivariate methods to analyze data from the U.S. Department of Education's database entitled "The National Longitudinal Survey of the High School Class of 1972." Philip C. Schlechty and Victor S. Vance, "Do Academically Able Teachers Leave Education? The North Carolina Case," *Phi Delta Kappan, 63* (1981), 106-112, use bivariate methods to analyze data on North Carolina teachers. Both studies report a negative association between NTE score and length of stay in teaching.

large differences in risk. The median lifetime of a high-scoring teacher is five years shorter than that of a low-scoring teacher. This differential provides compelling support for the opportunity cost hypothesis, because high-scoring teachers are likely to have greater access to high-paying occupations than other teachers have.[30]

In interpreting this evidence, it is instructive to compare the experiences of private schools and public schools. Analysis of longitudinal information in a nationwide sample of high school seniors in 1972, many of whom later became elementary or secondary school teachers, shows that private schools have been more successful than public schools in recruiting teachers with very high scores on the Scholastic Aptitude Test. Yet high-scoring teachers in private schools have been more likely than their high-scoring peers in public schools to leave after only a short spell in the classroom.[31] Consequently, the evidence does not support blaming the work environments in public schools (as compared to those in private schools) for the relatively short teaching careers of many high-scoring teachers. However, the public-private comparison does suggest that if the public sector wants to increase the number of high-scoring college graduates in public schools, an effective strategy may be to make entry into teaching easier for these graduates, recognizing that many of them will resign after a few years to pursue other careers.

Elementary School Teachers

The career paths of the elementary school teachers in our sample differ considerably from those of secondary school teachers. Not only are elementary school teachers less likely to leave in any given year, the risk of leaving teaching is not very high even in their early years in the classroom. Eight percent of the elementary school teachers in our sample left after one year of teaching; 6 percent left in each of the next four years. In the eighth year after entry, 60 percent of the teachers were still in the classroom.

Salary

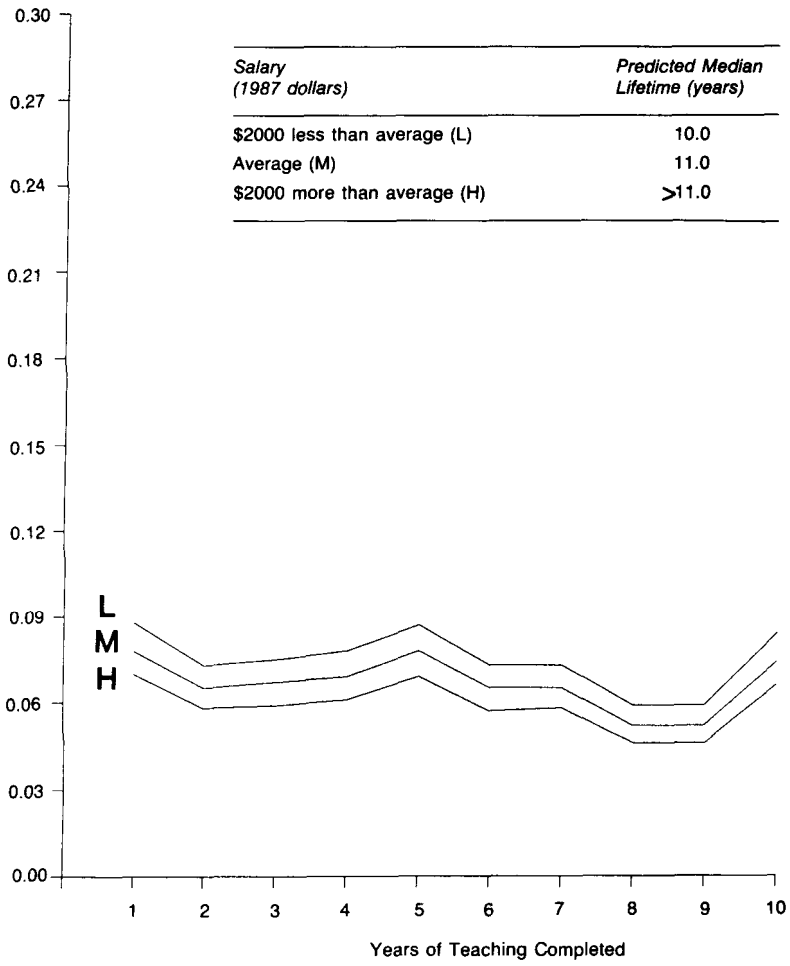
As at the secondary level, the more an elementary school teacher earns, the more likely she or he is to stay in teaching. But in comparison to secondary school teachers, the relationship between salary and the risk of leaving teaching is both modest and stable over time. This is illustrated in Figure 4, which presents predicted hazard functions for three prototypical White elementary school teachers: one in an average salary stream, one in a low salary stream ($2,000 less than average), and one in a high salary stream ($2,000 more than average). The close spacing of the predicted hazard functions indicates that salary is a modest predictor of the risk of leaving teaching for these elementary school teachers. But even small differences in risk do cumulate: those elementary school teachers paid $2,000 per year less than the average leave the classroom an average of one year earlier.

We believe there are two reasons why career decisions of the elementary school

[30] The relationship between NTE score and employment duration did not differ by subject specialty or salary.

[31] Nelson, "New Perspectives on the Teacher Quality Debate," 133–140.

FIGURE 4
Risk of Leaving Elementary School Teaching, by Salary



teachers in our sample may be less sensitive to financial incentives than those of their secondary school colleagues. First, elementary school teachers are generalists who instruct children across a broad range of subjects, yet business and industry often offer the highest salaries to specialists with detailed expertise in specific subject areas. Consequently, elementary school teachers may face lower opportunity costs than their colleagues in secondary schools.

Second, because of age and gender differences in the composition of the two teaching groups in our sample it may be that elementary school teachers may be more likely than their secondary school counterparts to interrupt their careers to raise children. Eighty-six percent of the elementary school teachers in our sample

were women aged thirty or younger when they started teaching compared to 60 percent of the female secondary school teachers. Salary may feature less in the timing of a teacher's decision to end a first teaching spell in order to engage in full-time child-rearing, than it would in a teacher's decision to leave teaching in order to pursue alternative types of work outside the home. If this is the case, then the relatively high percentage of these elementary school teachers who are women of prime childbearing age could explain the relatively small effect of salary on length of first teaching spell. We were not able to test this hypothesis, however, because we do not know why our sampled teachers left teaching.[32] It is important in interpreting our evidence to remember that it concerns only length of first spells. As we discuss below, women returning to the classroom after a career interruption are an important source of teacher supply. Our research does not explore the potentially critical role of salary in influencing the decision to return.

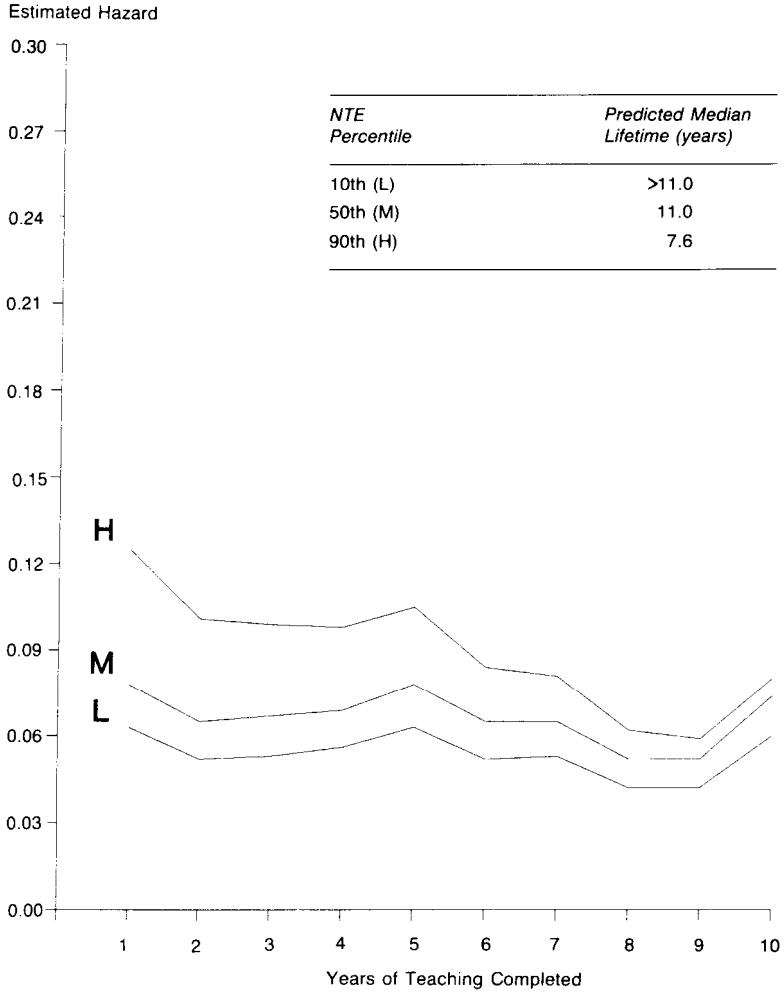
NTE Score

The relationship between NTE score and employment duration for elementary school teachers is similar to that found among the secondary school teachers in our sample: the effects are large, especially in the first years on the job. Figure 5 displays predicted hazard functions for three prototypical White elementary school teachers, young women with low, average, and high NTE scores identical to those for secondary school teachers shown in Figure 3. In any given year, high-scoring elementary school teachers are consistently more likely to leave than their low- and average-scoring colleagues. Although these differences in the risk of leaving teaching persist over time, their magnitudes diminish.

There is one respect in which the relationship between NTE score and the risk of leaving teaching differs between the elementary and secondary school teachers in our sample. For secondary school teachers, the relationship between NTE score and the risk of leaving teaching after one year in the classroom is linear; in other words, a 100 point difference in NTE score at the top of the test score scale corresponds to a difference in the risk of leaving teaching of the same size that a 100 point increase at the bottom of the scale does. This is not the case for elementary school teachers, for whom a 100 point difference at the top of the test score scale is associated with a larger difference in the risk of leaving than is a 100 point difference at the bottom of the scale. The insert to Figure 5 shows how important these risk differentials become when cumulated over time. Elementary school teachers with high scores have median lifetimes of only 7.6 years, whereas their colleagues with average and low scores have median lifetimes of 11 years or more. Nevertheless, elementary school teachers with high scores are still much more likely than secondary school teachers with high scores to remain in the classroom. For example, the median lifetime of English teachers with high scores is only 4.8 years (see Figure 3).

[32] We tested for interaction effect between salary and the three variables used to depict each teacher's gender and age. The values of the point estimates suggested that the effect of salary was largest for men aged $\leq$ thirty, and considerably smaller for women and for men aged $\geq$ thirty-one. However, we could not reject the null hypothesis at our prespecified .05 level that the interaction effects were zero.

FIGURE 5
Risk of Leaving Elementary School Teaching, by NTE Score



NTE Percentile	*Predicted Median Lifetime (years)*
10th (L)	>11.0
50th (M)	11.0
90th (H)	7.6

Who Returns to the Classroom?

Thirty percent of the White teachers in North Carolina hired between 1976 and 1978 who left teaching within five years after entry returned to teach in North Carolina by 1986.[33] The phenomenon of teachers returning to the classroom after a career interruption is not unique to these teachers in North Carolina; we found a similar pattern among White teachers in Michigan.[34] Moreover, our data are

[33] The 30 percent figure is a lower bound on the true return rate, because it does not include teachers who began a second spell after 1986, the last year for which we have information.
[34] Murnane, Singer, and Willett, "The Career Paths of Teachers."

consistent with a national trend whereby an increasing proportion of newly hired teachers come from the "reserve pool"—defined loosely as individuals certified to teach who had neither been teaching in the previous year nor been attending college. In 1966, 33 percent of new hires came from the reserve pool; in 1986, the percentage was 84.[35] Who are the returning teachers? After examining the probability of return for many different subgroups of teachers, we found major differences by certification level, subject specialty, length of first teaching spell, NTE score, and gender.[36]

First, the elementary school teachers in our sample were more likely to return than were their secondary school peers. Among the elementary school teachers who left in their first five years on the job, 34 percent returned by 1986, whereas only 23 percent of comparable secondary school teachers did so. And at the secondary level, the probability of return differed by subject specialty. Only 15 percent of the mathematics teachers who left returned by 1986 compared with 24 to 25 percent of other subject area secondary teachers.

Length of first teaching spell was also associated with the probability of returning. Those teachers who taught for only one year, or for more than three years, were more likely to return to teaching than were teachers who taught for two or three years (31 and 35 percent, respectively, versus 25 percent). Tenure prospects may help explain this differential. In most states, the tenure decision is made during the third year of teaching. Although formal denial of tenure is rare, we conjecture that some teachers may resign after two or three years rather than face an unfavorable tenure decision. Teachers who leave in anticipation of a negative tenure decision will generally do so in their second or third year, and may be less likely to return than teachers who leave for other reasons.

The higher a teacher's NTE score, the less likely she or he is to return after a career interruption. Among teachers who ended a first spell within five years, 38 percent of those with NTE scores in the bottom 10 percent of the score distribution returned to teaching by 1986, compared to 16 percent of teachers with scores in the top 10 percent of the score distribution. This finding further validates the use of NTE score as an indicator of the quality of a teacher's occupational alternatives outside of teaching. *White teachers with the best alternatives leave earlier, and do not return.*

The probability of return also differed dramatically by gender—women were almost twice as likely as men to return (32 versus 18 percent). One hypothesis that could explain this differential is that a high percentage of female teachers ended first spells to engage temporarily in full-time childrearing.

Implications for Policy

For White teachers hired in North Carolina between 1976 and 1978, salary differ-

[35] National Education Association, *Status of the American Public School Teacher: 1985–86* (Washington, DC: Author, 1987), as cited in Neil B. Carey, Brian S. Mittman, and Linda Darling-Hammond, *Recruiting Mathematics and Science Teachers through Nontraditional Programs: A Survey* (Santa Monica, CA: Rand Corporation, 1988), p. 10. The information is derived from surveys periodically administered by the National Education Association.

[36] We fitted a series of logistic regression models to test the hypotheses that there were interactions between the effects of first-spell length, gender, subject specialty, and NTE score on the probability of returning for a second spell. We found none.

ences are associated with differential turnover. For this group of teachers, at least, those earning more tend to stay in teaching longer than those earning less. This suggests that salary increases may help reduce the number of districts that find themselves on a treadmill, repeatedly hiring new, inexperienced teachers to replace teachers who leave after one or two years. Prior research indicates that teachers make marked gains in effectiveness during their first years in the classroom.[37] Consequently, reducing the frequency with which children are taught by a successive stream of novice teachers may be one step toward improving educational quality.

Salary increases that are not coupled with changes in certification requirements may not improve the academic ability of the teaching force—at least as measured by NTE scores.[38] In this research, we found that White teachers with high NTE scores are more likely to leave teaching after only a few years in the classroom, and are less likely to return, than are teachers with low NTE scores. If the high-scoring teachers are replaced by teachers whose NTE scores are randomly drawn from the distribution of applicants' scores, then over time the average academic ability (as measured by NTE scores) of teachers in the schools will decline.

This process may, however, be counteracted by two forces. First, higher salaries may increase the size of the applicant pool, thereby increasing the number of applicants from which school districts can choose. Second, by reducing turnover, higher salaries may reduce the number of new teachers school districts must hire, therefore allowing them to be more selective in choosing among applicants. A recent study of hiring strategies in six school districts indicates, however, that hiring academically talented applicants may not be a high priority in some school districts.[39]

Many state legislatures are at least implicitly aware of the potential consequences of stand-alone salary increases, and have coupled these with increasingly stringent entry requirements, including scoring above prespecified levels on stan-

[37] Richard J. Murnane and Barbara R. Phillips, "Learning by Doing, Vintage, and Selection: Three Pieces of the Puzzle Relating Teaching Experience and Teaching Performance," *Economics of Education Review, 2* (1981), 453–465. See also Richard J. Murnane, *The Impact of School Resources on the Learning of Inner City Children* (Cambridge, MA: Ballinger, 1975). This evidence pertains to both White and Black teachers.

[38] Whether this outcome is seen as a problem depends on one's interpretation of the ambiguous evidence relating teachers' scores on standardized tests to measures of their teaching performance. There are two databases in which analysts have found positive relationships between a teacher's score on a vocabulary test and the average score, or the average increase in score of the teacher's students on a test of reading or mathematics. See James Coleman et al., *Equality of Educational Opportunity*; and Eric A. Hanushek, *Education and Race*. The results of these, albeit nonexperimental, studies provide some evidence that academic ability is a desirable attribute of classroom teachers. See also Eric Hanushek, "The Economics of Schooling," *Journal of Economic Literature, 24* (1986), 1141–1177, for a statement of this conclusion. At the same time, as explained in the text, there is no solid evidence that a teacher's score on the NTE predicts the teacher's effectiveness in helping children to acquire cognitive skills.

[39] See Arthur E. Wise, Linda Darling-Hammond, and Barnett Berry, *Effective Teacher Selection: From Recruitment to Retention* (Santa Monica, CA: Rand Corporation, 1987). This study reports that the academic achievement of candidates for teaching positions is not highly valued by administrators in some school districts for two reasons: First, some administrators tend to believe that "the brighter teachers are, the more likely they are not to have patience to work with average students." Second, some administrators are reluctant to hire "bright candidates" because they believe that they leave teaching too quickly (p. 18).

dardized tests.[40] The success of this kind of a policy mix will depend in part on whether these tests predict teaching effectiveness more successfully than the NTE appears to.

Nevertheless, we believe that it is especially important, in districts with relatively low teacher salaries, to increase the salaries paid to teachers in their first years in the classroom. The reason is as follows. Except in periods of declining enrollments, a large part of the teaching in U.S. schools has always been done by women and men who teach for a few years, and then leave to follow other pursuits.[41] College graduates with this career pattern tend to be particularly academically able,[42] and consequently are an important source of talent for the schools. Our findings suggest that, for many such teachers, the decision to stay in teaching for one year, three years, or five years is highly sensitive to salary. Teachers who leave after one year may not have stayed long enough to learn to teach or to enjoy it. Teachers who stay for five years may have learned enough to be of real service. Consequently, adopting a policy of increasing beginning salaries in order to reduce turnover among beginning teachers may have a significant impact on the quality of education provided to children.

Although our results suggest the value of increasing salaries for beginning teachers in low-salary districts, it is important to make clear that our research does not consider all of the critical factors relevant to the design of salary policy. In particular, we have not examined the relationship between salary and the decisions of college students to enter the teaching profession. As a result, we cannot infer how changes in either the level or shape of salary schedules might influence the composition of the pool of new entrants to teaching.

Our results might also be interpreted as supporting higher salaries for secondary school teachers than for elementary school teachers, because the employment duration of secondary school teachers seems to be more sensitive to salary. Indeed, this interpretation would be correct if the country were satisfied with the current quality of elementary school education. There is evidence, however, that at least some of the roots of the inadequacies in American education, especially in the areas of mathematics and the sciences, lie in the elementary schools. For example, one comparative study of the mathematics achievements of American and Japanese children detected no large differences among first grade children, but found that by the fifth grade, the average achievement in the highest scoring American classroom was lower than the average achievement in the lowest scoring

[40] For example, the state of Connecticut has raised the minimum salary for a beginning teacher to $20,000, while simultaneously mandating that applicants for teacher certification in the state either have a combined score of 1000 on the verbal and math portions of the Scholastic Aptitude Test or score above a prespecified cutoff on a state-administered test of reading, writing, and mathematics skills. For the details of these certification requirements, see *CONNCEPT, Connecticut Competency Examination for Prospective Teachers Research Bulletin, 1988–89* (Amherst, MA: National Evaluation Systems, Inc., 1988).

[41] See, for example, Michael Sedlak and Steven Schlossman, *Who Will Teach? Historical Perspectives on the Changing Appeal of Teaching as a Profession* (Santa Monica, CA: Rand Corporation, 1986), and Willard S. Elsbree, *Teacher Turnover in the Cities and Villages of New York State* (New York: Teachers College Press, 1928).

[42] Nelson, "New Perspectives on the Teacher Quality Debate."

Japanese classroom.[43] Although higher salaries, by themselves, will not solve the problem of inadequate teaching of mathematics and science in U.S. elementary schools, we believe that serious attempts to improve instruction in elementary schools require higher salaries. Consequently, recommending lower salaries for elementary school teachers than for secondary school teachers at a time when there is a pressing need to upgrade the knowledge and skills of elementary school teachers seems ill advised.

Our findings indicate that White secondary school teachers in some subject fields, including the high opportunity cost fields of chemistry and physics, tend to have particularly short teaching spells. Kershaw and McKean's remedy was to pay salary premiums to teachers in shortage fields. This practice, while contrary to the spirit of the uniform salary schedule, is not unknown in practice. For example, a recent study of two school districts in the Northeast illustrates salary differentials in use. One medium-sized, ethnically diverse district, which has a reputation for educational excellence, convinces particularly strong applicants in math and science to accept teaching positions by placing them several steps higher on the salary scale than where they would otherwise belong. The second district, which has severe financial constraints and serves a high proportion of educationally disadvantaged students in an urban area, has a practice of hiring many new teachers as permanent substitutes rather than as regular teachers (at an annual savings of approximately $9,000 per teacher). However, the district does offer regular contracts to applicants trained in math, chemistry, and physics.[44]

In recent years, there have been increases in flexibility in formal hiring practices in many school districts. For example, the 1983–1986 Boston teachers' contract states: "For the purpose of recruiting teachers into areas where there may be a teacher shortage or for affirmative action purposes, the [School] Committee may place newly hired teachers on any step of the salary grid."[45] Contracts in many other districts, including Hartford, Connecticut, and Detroit, Michigan, have similar provisions.[46] That this practice may become more widespread is suggested by the following section from an educational reform report that was adopted by the American Federation of Teachers (AFT) in 1986: "As an incentive to attracting and hiring teachers in all areas of shortages, as they develop, the AFT recommends that locals and school districts consider placing entering teachers in areas of shortage on higher steps of the salary schedule."[47] These examples suggest that it is possible for teachers' unions and local school district managers to negotiate

[43] Harold S. Stevenson, Shin-Ying Lee, and James W. Stigler, "Mathematics Achievement of Chinese, Japanese, and American Children," *Science*, February 14, 1986, pp. 693–699.

[44] Joseph Shivers, "Hiring Shortage-Area and Non-Shortage-Area Teachers at the Secondary School Level," Diss., Harvard University Graduate School of Education, 1989.

[45] Contract between the Boston Teacher Union and the School Committee of the City of Boston 1983–1986. Boston, MA.

[46] Agreement between the Board of Education of the School District of the City of Detroit and the Detroit Federation of Teachers, Local 231, American Federation of Teachers, AFL-CIO, July 1, 1987–June 30, 1990; Agreement between the Hartford Federation of Teachers and the Hartford Board of Education, effective July 1, 1985–June 30, 1989.

[47] *The Revolution That Is Overdue*, A Report of the AFT Task Force on the Future of Education (Washington, DC: American Federation of Teachers, 1986).

contract provisions that increase flexibility in hiring practices.

Implications for Teacher Supply and Demand Models

A final set of implications of our work concerns the models that states and the federal government use to predict teacher demand and supply. As David Grissmer and Sheila Kirby have pointed out, predictions from these models are highly sensitive to assumptions that are made about the rate at which the current stock of teachers leave teaching.[48] Most models, including that used by the National Center for Education Statistics, assume a single attrition rate for teachers in all subject areas. Our evidence, though limited to White teachers in North Carolina, calls this assumption into question.

Another assumption implicit in demand and supply models is that the rate of teacher attrition is not sensitive to salaries. Our work indicates that, at least for one group of teachers, the median length of stay in teaching, and consequently, the overall attrition rate, are quite sensitive to salaries. Thus, we are extremely skeptical about predictions of teacher shortages or surpluses based on the current generation of models—models that falsely assume that teachers do not respond to financial incentives.

A third assumption in the national teacher supply and demand model, and in most state models, is that new college graduates represent the only source of teacher supply. Our finding that almost one in three White teachers in North Carolina who left did return to the classroom, coupled with the recent hiring experiences of many states,[49] indicates that this assumption is patently false. We believe that more realistic projections of the balance between teacher supply and demand require a better understanding of the size and composition of the so-called "reserve pool" of individuals certified to teach, but not currently teaching. Even more important is the need for a better understanding of the factors that influence former teachers' decisions to return to the classroom.

[48] David W. Grissmer and Sheila N. Kirby, *Teacher Attrition: The Uphill Climb to Staff the Nation's Schools* (Santa Monica, CA: Rand Corporation, 1987).

[49] Connecticut reported that 75 percent of the teachers newly hired in 1986 were returning teachers. (See Connecticut Department of Education, *A Second Look at Connecticut Teacher Supply and Demand*, unpublished report, 1987.) In a personal communication, John Stiglmeier, director of the information center in Education, New York Education Department, reported that the analogous figure for New York State was 70 percent.

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