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The Impact of Salary Differentials on Teacher Shortages and Turnover: The Case of Mathematics and Science Teachers

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Abstract — One of the major focuses of the recent reform movement in education concerns perceived and anticipated teacher shortages, especially in particular fields such as mathematics and science. It is widely believed that lower salaries relative to alternative occupations are responsible for teacher shortages and that higher salaries will therefore help reduce shortages. Yet there is little empirical research that examines the relationship between teacher shortages and teacher salary differentials. This paper examines this relationship for the case of mathematics and science teachers using data on a sample of medium and large school districts located within large metropolitan areas throughout the United States. The results support the general proposition that salary differentials between teachers and alternative occupations influence teacher shortages, although the relationship varies by gender and geographic area of the U.S.

INTRODUCTION

TEACHER shortages constitute a major concern of the current reform movement in education. There is a widespread belief that the United States currently suffers from shortages of teachers in particular fields, with mathematics and science as among the most acute areas (National Science Board, 1983; National Commission on Excellence, 1983). There is also a concern that in the future there will be a general shortage of teachers and more severe shortages in fields such as mathematics and science (Carnegie Forum, 1986).

Although there is little concrete information on the exact nature and severity of teacher shortages (U.S. General Accounting Office, 1984; Rumberger, 1985), a variety of proposals and policies have been instituted to address them. Many of the remedies have been aimed at raising teacher salaries, which historically have been lower than other occupations pursued by college graduates (Levin, 1985). Many states have already funded major increases in teacher salaries. As a result, the average teacher salary increased 15% between 1983 and 1985, while the average salary for beginning teachers increased 11% in just 1 year (Nelson *et al.*, 1986, Tables 1–2, and III — 1).

Recent efforts to raise teacher salaries are premised on the belief that raising salaries will make teaching more attractive relative to other occupations and help alleviate current or anticipated shortages. Yet to date there has been little analytic research on the role of salaries in attracting and retaining teachers in the profession. As a result, efforts to project teacher supply and demand are almost exclusively based on projections of past trends (Barro, 1986).

Any effort to analyze the influence of teacher salaries on the size of the teaching work force should consider several factors. First, it is important to properly compare the financial rewards of teaching with alternative occupations that are available to

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college graduates. It is widely reported that teachers receive much lower salaries than many other professions. The recent Carnegie report, *A Nation Prepared*, points out, for example, that in 1985 the average salaries of attorneys were $51,400, engineers were $39,500, accountants were $36,500, and teachers were $23,500 (Carnegie Forum, 1986, p. 37).

Yet another recent report on the status of teaching suggests that such figures are misleading because they ignore differences in employment opportunities and earnings between men and women across and within occupations. Using different sources of data, this study shows average teacher salaries quite similar to those reported by Carnegie — $23,620 in 1984 dollars — with male teachers reporting an average salary of $25,817 and female teachers reporting an average salary of $22,813 (Feistritzer, 1986, Table 1a).

In comparison, the average earnings of all male college graduates were $32,122 in 1984, while for all female college graduates they were $16,894. Even among full-time, year-round workers, male college graduates had average earnings of $36,104 and females only $22,072. These figures suggest that teaching is not as financially attractive for male college graduates as alternative occupations, but it is for females. These differences should be considered in examining the role of salaries in attracting and retaining teachers.

Second, consideration should be given to working conditions of teaching and alternative occupations. It is not clear whether working conditions are generally better in teaching than alternative occupations. Teachers report higher levels of job satisfaction than either the general public or other college graduates (Feistritzer, 1986, Table 5). At the same time, teachers report higher levels of job stress than either former teachers or American adults (Harris *et al.*, 1985, p. 25).

Third, it is important to consider individual tastes for the intrinsic and extrinsic rewards from work. In general, teachers report more interest in the intrinsic than the extrinsic rewards of their jobs compared to other workers (Feistritzer, 1986, Table 18). And again there appear to be gender differences in tastes for intrinsic and extrinsic rewards, with males reporting more preference for extrinsic and females reporting more preference for intrinsic rewards. Yet current and former teachers agree that both improvements in salaries and working conditions are necessary to attract and retain more teachers in the profession (Harris *et al.*, 1985).

Finally, it is important to consider changes over time in the actual rewards — both extrinsic and intrinsic — of teaching relative to other occupations and changes in the tastes of individuals for those rewards. The financial rewards of teaching appear to have risen substantially in the last few years, both in real terms and relative to other occupations (Nelson *et al.*, 1986). At the same time, it appears that younger teachers, those most likely to have recently entered the profession, are more likely to cite financial rewards of teaching as important compared to older teachers (Feistritzer, 1986, Table 18). This would suggest that recent efforts to raise teacher salaries could have more impact in attracting people into teaching than in times past. In fact, a recent report states that an increasing number of former teachers are reentering the profession (Nelson *et al.*, 1986).

These same considerations should be given to proposals to address teacher shortages within particular specialty areas. It has been suggested that some areas of teaching, such as mathematics and science, face severe shortages because, in part, alternative occupations for college students with mathematics and science interests, such as engineering and computer science, have become relatively more attractive financially over the last decade (Levin, 1985). One possible response is to provide differential salaries to teachers in those fields where shortages exist, as is done in higher education (National Science Board, 1983, Woo, 1985). But beyond the political issues surrounding such a proposal, it is important to consider the possible response of individual teachers and would-be teachers.

The purpose of this paper is to attempt to address at least some of these issues through an empirical analysis of the relationship between salary differentials and teacher shortages. The focus of this analysis is the shortage of mathematics and science teachers and the salary differentials that exist between teachers and workers who have academic backgrounds in mathematics and science and who are employed in alternative occupations.

METHODOLOGY

Model

The empirical analysis is based on a simplified model of teacher shortages, derived from more complex models of teacher supply and demand (e.g., Chambers, 1978; Boardman, *et al.*, 1982). The demand for teachers at a school district level is assumed to be a function of a district's budget (b), the characteristics of students in the district (D), and the costs of the resources required to provide educational services to those students (Chambers, 1978). Because salaries for instructional personnel constitute the major share of educational expenditures (U.S. Census, 1982, p. vii) and because in many districts budgets and teacher salaries are determined jointly, only the costs of teacher services are considered (w_t) here, leaving a teacher demand model:

$$Q^D = f(D, w_t). \qquad (1)$$

The supply of teachers to the district is assumed to be a function of the district's characteristics (D), which reflects it's desirability as a place to work, the wage rate for teachers in the district (w_t), the wage rate of alternative occupations (w_m) that teachers might consider, and the extent of employment opportunities in alternative occupations relative to teaching (e_{tm}). Only current wages and characteristics are considered in this model, even though some recent research suggests that occupational choice is influenced by expectations of future benefits as well as current conditions (Zabalza, 1979; Zarkin, 1985). Thus, the supply of teachers can be written:

$$Q^s = f(D, w_t, w_m, e_{tm}). \qquad (2)$$

Teacher shortage (S) is merely the shortfall between the number of teachers demanded (Q^D) and the number of teachers supplied (Q^s):

$$S = Q^D - Q^S = f(D, w_t, w_m, e_{tm}). \qquad (3)$$

This model can be used to study shortages of different types of teachers or teachers of different quality. In the present study they are used to study reported shortages of mathematics and science teachers.

One variable of particular interest in the present study is teacher turnover. Teacher shortages are likely to be higher in districts with high teacher turnover, yet turnover is itself likely to be influenced by many of the same factors that influence teacher shortages. Therefore, in the following analysis, teacher shortages are estimated as a two step, recursive model. The first step is simply to use the basic equation (3), with district characteristics (D) consisting of an array of variables related to the quality of the teaching environment in the district, such as class size or the kinds of students in the district:

$$S = f(D, w_t, w_m, e_{tm}). \qquad (3a)$$

The second step adds an intervening variable that measures total teacher turnover (t) in the district, not simply turnover related to mathematics and science teachers (which was not available in the data available for this study):

$$S = f(D, t, w_t, w_m, e_{tm}). \qquad (3b)$$

The purpose of this two step estimation is to ascertain the degree to which shortages of mathematics and science teachers result from supply and demand factors that influence turnover of all teachers and to what extent these factors influence shortages independent of their influence on turnover. That is, the first equation (3a) shows the total direct and indirect effects of the independent variables on teacher shortage, while the second step shows only the direct effects after controlling for teacher turnover.

Because the problem of teacher turnover is so important to understanding and addressing the problem of teacher shortages, an additional analysis is preformed to examine the influence of supply and demand factors on teacher turnover using the same model as above:

$$t = f(D, w_t, w_m, e_{tm}). \qquad (4)$$

Data and Variables

The data for this study came from a merged file of school district information that was constructed from four different sources. Information on teacher shortages comes from the 1983–1984 Survey of Teacher Demand and Shortage conducted by the Research Triangle Institute of North Carolina under contract to the National Center for Education Statistics. The survey was conducted on a stratified random sample of public and private high schools in the United States. In this study only public school districts were examined because data on teacher salaries were only available for public school

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districts. Survey results were obtained for about 2300 public school districts, which represents 89% of the original sample.

The survey asked school district officials to determine the primary teaching field of all secondary school teachers in the district and to indicate the number of teachers who had regular or standard State certification to teach in their primary teaching field and the number who did not hold such certification (they might hold emergency credentials, for example). Shortage of mathematics and science teachers was expressed as the percentage of mathematics and science (biology, chemistry, and physics) teachers who did not hold regular or standard State certification (PMSN).

This procedure is based on the premise that districts faced with an unfulfilled demand for mathematics and science teachers can hire teachers on an emergency basis to teach mathematics and science classes. This probably understates the true shortage since districts can also use current teachers in other fields to teach mathematics and science on a part-time basis (Robinson, 1985). This survey also provided information on the total number of teachers in the district and the proportion of teachers in the district who were new hires (NEWP), which can be used to measure turnover after controlling for district growth (since new hires result from turnover and district growth).

Information on district enrollment and teacher salaries comes from the 1982 Census of Governments conducted by the U.S. Census Bureau. This survey collected information on employment and finances from all public school districts in the United States enrolling 5,000 or more students. For this study, information was used on enrollment in October 1982 (ENROLL82), and the average October 1982 earnings of full-time, instructional employees, which was converted to an annual basis (×10) and used as a proxy for annual teacher salaries (DISTSAL).

The third source of data used in the study was the 1980 Decennial Census, which provided information on employment and salaries for males and females in all major occupation groups for Standard Metropolitan Statistical Areas (SMSAs) or 250,000 inhabitants or more in the United States. School district data was linked to Census data for the SMSA in which the district was located. This defined a somewhat arbitrary local labor market for mathematics and science teachers. Defining alternative boundaries to these local labor markets could lead to somewhat different results than those reported below (Luizer and Thorton, 1986).

In this study, where the focus is on shortages of mathematics and science teachers, engineers were used as the alternative occupation for males and females with mathematics and science backgrounds. Another occupation — computer specialists (computer scientists and systems analysts) — was also considered, but salaries for these occupations were highly correlated with those for engineers, so engineering occupations can be considered a proxy for a class of occupations requiring science and mathematics training.

Salary information from the two Census surveys was combined in two ways. In some cases, separate variables were entered into the equations for 1979 male (ENGSALM) and female (ENGSALF) engineering salaries and 1979 teacher salaries, which were converted from 1982 dollars based on average changes in teacher salaries between 1979 and 1982 (U.S. National Center for Education Statistics, 1985a, Table 3.11). In other cases a single variable was used that represented the average salary differential (SALDIF) between engineers, which was constructed from male and female engineering salaries weighted by relative shares of total employment, and teachers.[1] Census data was also used to construct a variable that measured the total number of engineers employed in the SMSA in which the district was located divided by the total number of mathematics and science teachers employed in the district (REMST).

The final source of data was the 1978–1979 Merged Federal File from the U.S. Department of Education. This file contains a comprehensive set of information on a variety of school district characteristics compiled from several U.S. government agencies. This compilation is undertaken on an irregular basis, so the 1978–1979 data file was the latest one available at the time of this study. Two variables were used from this source. One measured school district enrollment in the fall of 1978; the other measured the percentage of minority students enrolled in the district.

From these various sources, several variables were used or constructed to measure school district quality. One was the size of the district in 1982 (ENROLL82), expressed in logarithmic form (LOGEN). Larger districts, because they may be more bureaucratic or may have larger, more im-

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portant schools might be less desirable to work in than smaller districts.

Another variable that may influence teacher turnover and shortages is the student/teacher ratio (STEA). Teachers, in general, prefer smaller to larger classes as evidenced, in part, by the influence of class size provisions in their contracts on turnover rates (Eberts, 1987). Unfortunately, the student/teacher ratio can only serve as a proxy for class size since the former is also influenced by the number of teachers employed outside the classroom.

Finally, the percentage of minority students in the district (PMIN) could decrease not only the demand for mathematics and science teachers (Crane, 1982, Table 2) but also the supply, either because teachers might view minority students as more difficult to teach or because schools with high concentrations of minority students may be characterized by other conditions that teachers find undesirable. Finally, a variable (PCHANGE) was constructed to measure the percentage change in enrollment between 1978 and 1982 since districts with expanding enrollments will generally require more teachers than districts with declining enrollments.

Limitations on the universe of districts included in the various data sources used in this study restricted the final number of districts that were analyzed below. District salary information was only available for districts with 5000 or more students, so this limitation greatly reduced the number of usable responses from the original teacher demand and shortage survey, since the vast majority of districts in the U.S. have fewer than 5000 students (about 88% in 1977 according to Williams and Waff, 1978, Table 4). The sample was further restricted to districts within relatively large SMSAs since salary information on alternative occupations was restricted to those areas. These restrictions resulted in district file with 453 cases, although only 346 cases had usable data on all the variables of interest.[2]

This sample probably represents a fairly high proportion of large districts located in large urban areas in the United States. In fact, virtually all of the largest urban districts are included in the sample, together with larger suburban districts.[3] Nonetheless, the results of the following analysis at best can be used to generalize about the influence of salaries on the teacher shortages and turnover within this limited population of school districts.

A complete description of the dependent and independent variables used in the analyses together with the various surveys that provided the data is displayed in Table 1. Also displayed are the mean and standard deviation for each variable. The percent of math and science teachers who are not certified (MSNP) has a mean value of 2.4% (based on district means), which is similar to unpublished estimates for the entire population of public elementary and secondary schools from the complete sample of districts in the 1983–1984 Survey of Teacher Demand and Shortage. These estimates show that uncertified math teachers represent 2.4% of all mathematics teachers and uncertified science teachers represent 2.5% of all science teachers (U.S. National Center for Education Statistics, 1985b, Table 4B).

ESTIMATES OF TEACHER SHORTAGES

National Estimates

Estimates of teacher shortages in mathematics and science for the entire sample of school districts are shown in Table 2, column 1. The top half of the table shows estimates based on a single salary variable that measures the differential between engineering and teaching salaries. The estimated coefficient is positive and significant, which suggests that salary differentials between teachers and engineers are related to teacher shortages in mathematics and science areas. The point estimate suggests that each 1000 dollar increase in the salary differential is associated with a 0.19 percentage point increase in teacher shortages. In other words, to eliminate the reported shortage of mathematics and science teachers would require eliminating the existing salary differential of $10,000 (in 1979 dollars).

When the percent of newly appointed teachers is entered into the model (equation 1b), the salary variable becomes insignificant. This implies that higher salary differentials lead to increased teacher turnover which, in turn, lead to increased shortages of mathematics and science teachers. Unfortunately, newly appointed teachers were not identified by subject area in the teacher survey, so the turnover variable pertains to all newly hired teachers, not simply those in mathematics and science.

The other labor market variable, the ratio of the number of engineers in the district's surrounding area (SMSA) to the number of mathematics and science teachers in the district (REMST), also is

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Table 1. Variable descriptions and descriptive statistics for merged district file ($N = 346$)

Name	Mean	S.D.	Description	Source
PMSN (%)	2.314	4.611	Percentage of mathematics, biology, chemistry, and physics teachers who were uncertified in the 1983–1984 school year	(1)
DISTSAL ($1000)	14.220	3.199	Mean earnings for full-time instructional employees in October 1982, converted to an annual basis (×10) and 1979 dollars (×0.75)	(2)
ENGSALM ($1000)	24.679	2.064	Mean 1979 annual earnings for all male engineers employed in the SMSA in which the school district is located	(3)
ENGSALF ($1000)	15.254	2.105	Mean 1979 annual earnings for all female engineers employed in the SMSA in which the school district is located	(3)
SALDIF ($1000)	10.040	3.050	Mean 1979 salary differential between weighted average engineering salaries and teacher salaries	(3)
REMST (×100)	3.129	5.500	Number of engineers in the SMSA in which the school district is located divided by the number of mathematics and science teachers in the district	(1), (3)
PMIN (%)	26.591	25.446	Percentage of minority students in the 1978–1979 school year	(4)
STEA	19.058	2.765	Number of students enrolled in October 1982 divided by the number of teachers employed in the 1983–1984 school year	(1), (2)
LNENROLL	9.793	0.837	Natural logarithm of October 1982 student enrollment	(2)
PCHANGE (%)	−6.060	14.465	Percentage change in enrollment between the 1978–1979 school year and October 1982	(2), (4)
PNEW (%)	5.881	4.004	Percentage of teachers who were newly hired in the 1983–1984 school year.	(1)

Data sources: (1) The 1983–1984 Survey of Teacher Demand and Shortage, U.S. Department of Education. (2) The 1982 Census of Governments, U.S. Bureau of the Census. (3) The 1980 Census of the Population, U.S. Bureau of the Census. (4) The 1978–1979 Merged Federal Files, U.S. Department of Education.

positive and significant. This suggests that districts located in areas with high concentrations of engineers report higher shortages of mathematics and science teachers after controlling for the influence of other factors, including salary differentials. Moreover, the influence of this variable is not attenuated after controlling for teacher turnover, which further suggests that the variable measuring turnover for all teachers inadequately reflects turnover for mathematics and science teachers.

Other variables also show significant effects on teacher shortages. Districts with higher student/teacher ratios report higher proportions of uncertified math and science teachers, although further analyses reported below reveal that this is an artifact of other differences among districts. Districts with increasing enrollments report higher shortages of mathematics and science teachers probably because of increased demand. This factor, too, is attenuated once the proportion of newly appointed teachers is controlled for. Overall, the model yields the expected results although the model only explains from 12 to 15% of the variance in the dependent variable.

Table 2. Regression estimates of teacher shortages

	All states (1)		California (2)		Other states (3)	
	(a)	(b)	(a)	(b)	(a)	(b)
Selected means:						
PMSN (%)	2.314		6.249		1.857	
SALDIF ($1000)	10.039		6.924		10.402	
REMST	3.129		8.501		2.505	
STEA	19.058		24.001		18.484	
Regression coeff.:						
Panel A						
SALDIF ($1000)	0.194*	0.129	1.250*	0.820	0.196*	0.142
REMST (×100)	0.113*	0.126*	−0.060	−0.058	0.124*	0.147*
PMIN (%)	0.035*	0.029*	0.092	0.082	0.025*	0.020*
STEA	0.309*	0.301*	0.525	0.385	0.074	0.079
LNENROLL	0.273	0.214	1.111	1.659	0.445	0.401
PCHANGE (%)	0.032*	−0.002	−0.057	−0.168	0.028	0.001
PNEW (%)	—	0.254*	—	0.964*	—	0.201*
R^2 (adj)	0.118	0.148	0.133	0.216	0.088	0.116
Panel B						
DISTSAL ($1000)	0.194*	0.129	1.250*	0.820	0.196*	0.142
ENGSALM ($1000)	0.107	0.124	2.328	2.414	0.030	0.036
ENGSALF ($1000)	0.284*	0.245*	−0.771	−0.172	0.230*	0.203*
REMST (×100)	0.108*	0.111*	−0.093	−0.098	0.141*	0.152*
PMIN (%)	0.030*	0.025*	0.108	0.082	0.021*	0.017*
STEA	0.298*	0.284*	0.368	0.230	0.056	0.089
LNENROLL	0.315	0.231	0.648	1.813	0.503	0.437
PCHANGE (%)	0.029	−0.003	−0.016	−0.099	0.024	0.001
PNEW (%)	—	0.254*	—	1.149*	—	0.186*
R^2 (adj)	0.126	0.155	0.086	0.207	0.098	0.121
N	346		36		310	

*Significant at 0.05 level.

Estimates using separate salary variables, shown in the bottom half of Table 2, suggest a more complex relationship between salary differentials and shortages. Higher district salaries are associated with lower shortages of mathematics and science teachers, as expected, apparently by reducing teacher turnover. Yet only female engineering salaries show a strong and statistically significant effect on shortages of mathematics and science teachers, while male engineering salaries do not. Moreover, the influence of female engineering salaries is reduced only slightly after controlling for turnover and it remains significant.

Estimates for California and Other States

The model for teacher labor markets developed and tested above should apply reasonably well to all districts in the sample. There were enough districts in the sample to test this notion formally for several large states, notably California, New York, and Texas. Only one state — California — appeared to show any appreciable difference in the general

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findings reported above. In addition, one of the independent variables in the model — the student/teacher ratio in the district — had a much higher value in California districts than in other districts, which distorted the apparent influence of this factor in the earlier estimates.

These differences are shown in columns 2 and 3 of Table 2. In several respects, California districts appear quite different from other districts in the U.S. California districts report a much higher proportion of uncertified mathematics and science teachers (6.2%) than districts in other parts of the country (1.9%). Average district salaries are also higher in California than elsewhere, resulting in a smaller salary differential between teaching and engineering salaries. Districts in California are also located in areas with much higher concentrations of engineers than districts on other states. The number of students per teacher is much higher in California (24) than elsewhere in the country (18.5).

These figures suggest that the conditions of teaching are quite different in California than elsewhere in the United States. Teachers enjoy higher salaries, but they may also appear to have larger classes than teachers in other states.[4] Moreover, despite higher salaries, districts in California report much higher proportions of uncertified mathematics and science teachers.

Despite these differences, salary differentials show a similar effect on shortages of mathematics and science teachers. In both cases, an increase in the salary differential between teachers and engineers is significantly associated with a larger proportion of teachers who are uncertified. Moreover, in both cases the effect becomes insignificant when turnover is controlled for, implying that salary differentials increase turnover for all teachers which, in turn, leads to greater shortages of mathematics and science teachers.

Yet the salary differential between engineering and teaching shows a much larger effect on shortages in California than elsewhere, by a factor of almost 6 to 1. Differences in state certification requirements for mathematics and science teachers could account for some of this difference. California is one of the only states in the U.S. that does not grant an undergraduate degree in education. Hence, teachers must hold bachelor's degrees in other fields. It is possible, therefore, that mathematics and science teachers in California are more likely to hold regular degrees in mathematics and science areas and thus be more readily employable in mathematics and science occupations than teachers in other states. Unfortunately, the author is not aware of any data that would confirm this hypothesis.

Although the magnitude of the coefficient for the salary variable is different between California and other states, in both cases eliminating the salary differential would more than eliminate the reported shortages of mathematics and science teachers.

There are also differences in the estimated effects of some of the control variables between these two groups. The ratio of engineers to teachers has no influence on shortages in California, while it does elsewhere. Thus, this variable is unable to explain differences in teacher shortages *among* California districts who, on average, have much higher ratios than other districts. The percentage of minority students also shows no significant effect in California districts while it does elsewhere.

When the salary differential is decomposed into district and engineering salaries, the two groups of districts show somewhat different patterns. In both groups, higher district salaries are associated with lower shortages, apparently by leading to lower turnover rates. Female engineering salaries have a positive and significant effect on shortages of mathematics and science teachers outside of California, even while controlling for the influence of teacher turnover, whereas in California they do not.

These comparisons suggest that shortages of mathematics and science teachers in California are primarily a function of district salaries that influence teacher turnover, while in other states both district salaries and engineering salaries for females influence shortages. Why these differences exist is not clear.

ESTIMATES OF TEACHER TURNOVER

The preceding results suggest that teacher turnover is associated with teacher shortages in mathematics and science. The turnover measure used in this analysis, however, pertains to all teachers, not simply mathematics and science teachers. To better understand the influence of market factors on overall teacher turnover and its subsequent influence on shortages, the variable measuring the proportion of newly hired teachers was regressed on the same set of independent variables studied above. As in the case of teacher shortages, estimates are first derived for the total sample of districts and then for California and all remaining states.

National Estimates

National estimates appear in Table 3, column 1. The upper half of the table shows estimates based on the single salary variable measuring the difference between mean teacher salaries in the district and the mean salary of engineers in the district's surrounding area. The results suggest that larger salary differentials are significantly associated with larger incidences of teacher turnover. Eliminating the existing differential of approximately $10,000 (Table 1) would reduce the average proportion of newly appointed teachers by almost half. Considering that turnover in this case pertains to all teachers and not simply mathematics and science teachers, who generally make up a small fraction of the total teaching corp, then the effect might be considered quite large.

When the salary differential is disaggregated into its component parts, the estimates reveal that turnover of all teachers is significantly influenced by district salaries and not engineering salaries. This is to be expected since there is no reason that engineering salaries (or salaries in mathematics and science areas for which engineering salaries serve as a proxy) should influence turnover rates for all teachers. In addition, high concentrations of engineering jobs in the district's surrounding area shows no significant influence on overall teacher turnover, further substantiating the notion that the labor market for mathematics and science teachers operates differently from the labor market for teachers generally.

These estimates, in conjunction with those for

Table 3. Regression estimates of teacher turnover

	All states (1) (a)	All states (1) (b)	California (2) (a)	California (2) (b)	Other states (3) (a)	Other states (3) (b)
Selected means:						
PNEW (%)	5.881		5.927		5.876	
Regression coeff.:						
Panel A						
SALDIF ($1000)	0.255*		0.456*		0.256*	
REMST (×100)	−0.051		−0.030		−0.115	
PMIN (%)	0.025*		0.011		0.023*	
STEA	0.031		0.145		−0.026	
LNENROLL	0.232		−0.568		0.219	
PCHANGE (%)	0.134*		0.115*		0.133*	
R^2 (adj)	0.343		0.236		0.354	
Panel B						
DISTSAL ($1000)	−0.346*		−0.537*		−0.366*	
ENGSALM ($1000)	−0.065		−0.074		−0.034	
ENGSALF ($1000)	0.155		−0.521		0.148	
REMST (×100)	−0.013		0.045		−0.061	
PMIN (%)	0.020*		0.023		0.018*	
STEA	0.057		0.120		−0.018	
LNENROLL	0.332		−1.014		0.355	
PCHANGE (%)	0.125*		0.072		0.124*	
R^2 (adj)	0.370		0.261		0.379	
N	346		36		310	

*Significant at 0.05 level.

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shortages of mathematics and science teachers in Table 2, suggest that salaries influence shortages of mathematics and science teachers in two ways. First, district salaries influence overall teacher turnover which, in turn, leads to shortages of mathematics and science teachers. Second, engineering salaries, at least for females, also influences shortages directly, even controlling for teacher turnover.

Estimates for the remaining variables in the model suggest that the proportion of newly hired teachers is higher in districts with larger proportions of minority students and in districts with increasing enrollments. Overall, the model explains from 34 to 37% of the variance in turnover.

Estimates for California and Other States

In order to see whether the earlier differences between California and other states were evident with respect to turnover, separate estimates were derived for districts in California and those in other states. The results, shown in columns 2 and 3 of Table 3, suggest that California is no different than other states in terms of the influences on teacher turnover. In both groups, higher salary differentials and particularly lower district salaries increase turnover, although the impact is larger in California than elsewhere.

SUMMARY AND IMPLICATIONS

The purpose of this research was to examine the relationship between salary differentials and teacher shortages and turnover. The focus was on mathematics and science teachers since it is in this group that more acute shortages are thought to exist. And increased course requirements in mathematics and science areas could further exacerbate shortages in the future. Because of data restrictions, the analysis was limited to a sample of larger districts (5,000 students or more) located within larger metropolitan areas (SMSAs of 25,000 people or more).

Overall, the results of the analysis support the proposition that salary differentials between teachers and alternative occupations influence teacher shortages and turnover. In this study, engineering salaries were used as a proxy for salaries of other occupations requiring mathematics and science training that would compete with teaching. The analysis revealed that larger salary differentials are associated with larger shortages of mathematics and science teachers and that reported shortages would be eliminated by eliminating the existing salary differential between teaching and engineering.

When salary differentials are disaggregated into their component parts, a more complex picture emerges. First, district salaries alone appear to influence teacher turnover which, in turn, leads to shortages of mathematics and science teachers. Second, engineering salaries for females, but not males, further influence shortages in most states.

These results, though far from definitive, do suggest that salary policies will have an effect on teacher shortages and turnover. Thus recent actions in many states and localities to raise teacher salaries should reduce turnover among all teachers and help reduce shortages of mathematics and science teachers. Yet that action alone is unlikely to eliminate completely shortages for such highly competitive areas as mathematics and science without additional differentials paid to teachers in specific shortage areas, as some analysts have suggested (National Science Board, 1983; Levin, 1985). Finally, the results of this study confirm that estimates of teacher shortages based on static projections of teacher turnover and supply are likely to be inaccurate because they ignore the dynamic operation of the teacher labor market in response to salary changes.

NOTES

1. One of the problems with all the salary data is that observed salaries reflect differences in experience levels of the job incumbents as well as the salary structure of the occupation. This may be particularly problematic in making comparisons among districts who vary widely in enrollment changes and hence in the experience levels of the teaching force (since most districts tend to lay off teachers based on seniority). To some extent these differences are controlled for by including a variable for changes in district enrollment. This variable is described below.
2. Most of the cases with missing data were lacking information on the percentage of minority students, probably because that information was collected from the office of Civil Rights and not every district was required to supply the information. Additional analyses were performed to see if districts with

missing data were different than those with valid data and to see how their inclusion would influence the results. In general, the districts with missing data appeared quite similar to those districts with valid data, except that the former group were much smaller (mean enrollment of 12,000 students) than the latter group (mean enrollment of 31,000 students).

3. The Los Angeles School district was excluded from the sample because it appeared to skew the results due to its large size and reported large proportions of uncertified mathematics and science teachers. One district official reported to the author that during the year when teacher survey was conducted, 1983–1984, the district was faced with unusually large numbers of mathematics and science teachers who were issued emergency credentials.
4. As noted earlier, the student/teacher ratio is only a proxy for class size.

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