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AUTHOR	Stern, David
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ABSTRACT

Using data on mean achievement of third and sixth graders in individual California schools, coupled with salary data for those students' teachers, this study tested whether teacher salary variables are associated with student achievement, when socioeconomic characteristics are controlled. Differences among schools in the amount of teachers' pay per pupil are the result of differences in the level of district salary schedules, placement of each school's teachers on the local salary schedule, and the number of teachers per pupil. The study also introduced a novel procedure for using daily student class hours (instead of average daily attendance) as a more refined measure of student attendance. Several versions of the regression model were estimated for two different grade levels and three separate subjects in two different years. Results showed that achievement was positively and significantly associated with local salary schedule level, positively associated with placement of the school's teachers on the salary schedule, and negatively associated with the teacher-pupil ratio. Possible reasons for these associations are discussed. Results clearly imply that raising teacher salaries would be more cost-effective than reducing class size in California schools. Included are 15 references and 5 tables. (MLH)

TEACHERS' SALARIES, CLASS SIZE, AND STUDENT ACHIEVEMENT IN GRADES 3 AND 6: SOME NEW EVIDENCE

David Stern
School of Education
University of California, Berkeley

Requests for reprints should be addressed to David Stern, Graduate School of Education, 4625 Tolman Hall, University of California, Berkeley, CA 94720.

Teacher Salaries and Student Achievement

Teachers' Salaries, Class Size, and Student Performance:
Some New Evidence

Abstract

This study combines data on students in particular grade levels at individual schools with data on salaries of those students' teachers, to test whether teacher salary variables are associated with student achievement, when socioeconomic characteristics are statistically controlled. Several versions of the regression model were estimated, for two different grade levels, three separate subjects, in two different years. Results showed a consistently positive and significant association of achievement with level of the local salary schedule, and a generally positive association with placement of the school's teachers on the salary schedule, but no positive association with the teacher/pupil ratio.

Teachers' Salaries, Class Size, and Student Performance: Some New Evidence

Objectives

Using data on mean achievement of third and sixth grade students in individual schools, coupled with information on the salaries of those students' teachers, this study tests whether schools with higher teachers' pay per pupil also have higher student achievement. Differences among schools in the amount of teachers' pay per pupil are the result of differences in the level of district salary schedules, placement of each school's teachers on the local salary schedule, and the number of teachers per pupil. These three separate sources of variation are treated as separate predictors of student achievement. The paper also introduces a novel procedure for using daily student class-hours instead of ADA as a more refined measure of student attendance.

Economic efficiency in schools requires that no reallocation of school resources would raise student achievement without increasing cost. To take a simple example, schools would not be running efficiently now if it would be possible to raise achievement by adopting different textbooks at the same cost. Similarly, the issue in this paper is whether it would be possible to raise student achievement by reducing (or increasing) both class size and teachers' salaries, so that total cost remains the same. In short, this is another inquiry into schools' cost-effectiveness (see Levin, 1970, 19

Economists and other researchers have spent considerable effort trying to estimate cost and "production functions" in education (see Benson, 1978, Chapter 7; Cohn, 1979, Chapter 8; Lau, 1979; Kiesling, 1984 is a more recent example). Many of the efforts have failed to show strong, consistent relationships between school inputs and outputs (see Hanushek, 1986). It has been especially difficult to demonstrate a direct connection between achievement and the amount of money spent per pupil, when students' socioeconomic background is statistically controlled (Childs and Shakeshaft, 1987). The study reported here is another test of association between dollars and test scores, using some new methods.

Method

The analysis begins by defining attendance in terms of "daily student class-hours" (DSCH). One student supervised by a teacher for one hour a day is one DSCH. Thirty students in class for five hours a day are 5 x 30 = 150 DSCH.

We had to invent a concept like DSCH instead of using a conventional measure like ADA, because our procedure matches classroom-level data on number of students with salary information for the teacher in that classroom. Data on ADA are generally not available by classroom, though in theory they might be. DSCH does have the theoretical advantage of reflecting any differences among districts in length of the local school day; ADA does not reflect such differences.

The largest single component of instructional cost is the salary paid to teachers. Annual teachers' salary cost, divided by the number of DSCH for which the teachers are responsible, is a measure of instructional expenditure per student-hour. This is the product of three factors:

-- level of the local salary schedule (measured here by starting salary level in the school district);

-- placement of a school's teachers on the salary schedule (measured by the ratio of school mean salary to district starting salary); and

-- number of teachers per pupil (measured by full-time teachers per DSCH).

For example, suppose the starting salary on the local district salary schedule is $18,000 per year. This is a measure of how high the salary schedule is locally. Suppose, in a particular school, the mean salary for full-time teachers is $30,000. Then the ratio of $30,000 to $18,000, or 1.67, is a measure of how far up on the salary ladder these teachers are placed on account of experience and further education. Suppose further that teachers in this school are each responsible, on average, for 150 DSCH, so the number of teachers per DSCH is 1/150. Then the product of these three factors, ($18,000) x (1.67) x (1/150) = $200, is the annual cost of teachers' salaries per DSCH in this example.

We used the three components of teachers' salary per DSCH (level, placement, and number) as predictors of achievement by students in grades 3 and 6 in California public schools. We used weighted least-squares regression to estimate separate equations predicting school mean achievement in math, reading, and writing at each of the two grade levels. In addition to the three components of salary per DSCH, predictors in the regressions included the proportion of students in the school receiving AFDC, the proportion identified as Limited or Non-English Speaking, and an index of occupational status of students' parents as estimated by the teacher.

Data and Findings

The California State Department of Education annually conducts a testing program called the California Assessment Program (CAP). This produces data on school mean achievement in various subjects at several grade levels, along with the measures of students' socioeconomic background listed in the last paragraph. Since 1982 the Department has also conducted an annual census of students and teachers at the classroom level for the California Basic Educational Data System (CBEDS). The availability of data on students and teachers at the classroom level now makes it possible to measure the association between student achievement and instructional cost for specific grade levels in individual schools; previous studies correlating CAP achievement scores and cost data have had to be done at the level of school districts (e.g., Sebold and Dato, 1981).

The CBEDS data are collected in October; CAP testing for grades 3 and 6 takes place in the spring. We merged the CAP achievement and socioeconomic data from spring, 1984 with the

CBEDS enrollment and salary data from October, 1983. We also merged the spring, 1986 CAP data with the October, 1985 CBEDS. We thus performed the analysis for two separate years, 1983-84 and 1985-86.

Results are in Tables 1-4. Each table shows three different regressions for school mean achievement in each of three subjects: math, reading, and written language. The first regression uses only the socioeconomic variables as predictors. The second regression adds expenditure per DSCH on teachers' salaries. The third equation, instead of using teacher salary expenditure per DSCH, uses the three components of it: level of the salary schedule as indicated by minimum full-time salary paid in the district, the index of teachers' education and seniority (school mean salary at grade 3 or 6, divided by district minimum salary), and the number of full-time equivalent teachers per DSCH in the school at grade 3 or 6. The whole analyis was done by ordinary least-squares (unweighted), and then by generalized least-squares, with all data weighted by the square root of the number of students in the school. The weighted analysis is more efficient statistically, and gives more accurate estimates of the standard error and t-statistic for each coefficient (e.g., see Hanushek and Jackson, 1977, Chapter 6).

Tables 1-4 each show unweighted and weighted results for one grade level in one year.

[Insert Tables 1-4 about here.]

Students' socioeconomic characteristics, by themselves, account for approximately half the inter-school variance in mean achievement. They account for less of the variance in math scores than in reading and written language. In particular, the percentage of limited-English-speaking (LES) students is more strongly associated with (lower) reading and writing scores than with math achievement.

When expenditure per DSCH on teachers' salaries is added to the equation, the results are mixed. Considering only the weighted analysis, there were 12 equations using this predictor. In three equations, the coefficient on teachers' salary per DSCH actually had a negative sign, and one of those was statistically significant. In the other nine equations the coefficient was positive, but only four were significant at the 0.05 level. If these were the only results we had, we would conclude, like Hanushek (1986), that differences in per pupil spending for teachers' salaries are <u>not</u> associated in a consistently and significantly positive direction with students' achievement.

However, when teacher salary expenditure per DSCH is replaced by its three components, we get a different result. The level of the district salary schedule, as indexed by the minimum salary, is significantly and positively associated with student achievement in both grades 3 and 6, for all three subjects, and in both years. This is a remarkably consistent finding. The index of teachers' education and seniority also is positively associated with students' achievement in every equation, and is statistically significant in 1985-86, though not in 1983-84 (except in one equation). On the other hand, the number of full-time equivalent teachers per DSCH is not positively associated with student achievement. In fact, the coefficient is negative in 10 of 12 equations, and four of these 10 negative coefficients are significant; of the two positive coefficients, neither is significant.

The main new finding, then, is this: the amount of money spent on teachers' salaries per daily student contact-hour is not a consistent, positive predictor of student achievement -- but, when that amount is factored into its three components, the level of the salary schedule is always positively associated with student achievement, the index of teachers' education and seniority usually is, and the number of FTE teachers per student hour usually is not.

Alternative Versions of the Regression Model

To test further the robustness of these findings, several alternative versions of the model were estimated. One alternative used different lower bounds on the range of annual salaries considered to be valid. Since CBEDS salary data are self-reported by teachers rather than taken from district personnel records, there is some inaccuracy. In particular, some reported salaries are unrealistically low. Since the minimum full-time salary paid in a district plays such a key role in the analysis, it is important to make sure that the results do not depend on our decision about which numbers to consider valid. For the analysis in Table 4, the minimum valid full-time salary was assumed to be $10,000 in 1983-84 and $11,000 in 1985-86. In the alternative version, the minima were set at $13,000 and $14,000 for the two years, respectively.

A second alternative was to exclude Los Angeles County from the analysis. Los Angeles County includes Los Angeles Unified School District, the biggest district in the state. It is generally known by those who work with California school data that results can change when Los Angeles is left out. Excluding Los Angeles reduced the number of schools in the complete regression analysis from 1411 to 1232 at grade 3 and 1679 to 1098 at grade 6 in 1983-84; in 1985-86 the numbers went from 3538 to 2609 at grade 3 and 2789 to 2064 at grade 6.

A third alternative changed the analytical model itself, to test the influence of the maximum salary paid in the district, in addition to the minimum. Turner et al. (1986) found that Colorado districts where the difference between the maximum and minimum salary was greater also had higher student achievement. In theory, a steeper salary/experience gradient may have a positive effect on teachers' motivation and performance (Stern, 1986). Accordingly, in this alternative version of the model the amount of teachers' salary per DSCH was factored into the product of four, instead of three, components:

- minimum salary paid to a full-time teacher in the district;
- ratio of maximum full-time teacher salary in the district to minimum full-time teacher salary;
- ratio of mean full-time salary for teachers in each school at grade 3 or 6 to the district maximum full-time teacher salary; and
- number of full-time teachers per DSCH in the school at grade 3 or 6.

These four factors were entered in the regressions as predictors of mean achievement for students in each school at grades 3 and 6.

Finally, a measure of school size (more precisely, the square root of the number of students in grade 3 or 6 -- the same number that was used as a weight in the weighted regressions) was entered as a separate predictor in some of the regressions. There are two reasons for adding school size as a predictor. First, if it accounts for some otherwise unexplained variance in achievement, it produces more precise estimates of the coefficients on other predictors. In fact, school size was negatively and significantly correlated with achievement in every equation. The second reason is that small schools tend to be located in rural districts and large schools in urban districts. The level of the salary schedule for teachers also tends to be lower in rural districts than in urban districts. Therefore, school size serves in part as a proxy for rural versus urban location, and reduces any possible confounding of salary level variables with whether a school is in an urban or rural area.

The number of different regression equations generated by all these alternatives was too large to report them all in detail here. However, salient results are reported in Table 5. The top four rows

[Insert Table 5 about here.]

show results when Los Angeles County is included but the range of valid full-time salaries was assumed to have a higher minimum as stated above. The bottom four rows in Table 5 show results when the range of permissible salaries was the same as in Table 4, but Los Angeles County is excluded from the population. Each row then shows results with or without school size included as a predictor, and with or without the ratio of district maximum to minimum full-time salary.

Each of the predictors listed in the column headings in Table 5 was used in 12 different regressions in each row: for predicting achievement in three subject areas at two grade levels in two different years. Thus, for instance, the numbers in the first row and first three columns of Table 5 reveal that teacher salary per DSCH, when entered in regressions that included neither school size nor the ratio of district maximum to minimum salary, had a significant (at the 0.05 level) positive coefficient six times, a non-significant coefficient five times, and a significant negative coefficient once. The three socioeconomic control variables were included in all regressions reported in Table 5.

Overall, Table 5 displays several clear results. First, the minimum full-time salary paid to a teacher in the district still consistently shows a positive and significant association with school mean achievement, under all the alternatives tested here. Average experience and training of teachers in a given school and grade level, as indexed by the ratio of school mean salary to district minimum or maximum salary, is also positively associated with student achievement. The number of full-time teachers per DSCH in a particular school and grade level is not positively associated with achievement; when Los Angeles County is included in the analysis the association is significantly negative, and when Los Angeles County is excluded the association is usually not significant. The ratio of maximum to minimum salary in the district is often positively associated with achievement, but sometimes the association is negative or not significant. Finally, teacher salary per DSCH -- the product of these three (or four) other factors -- does show a positive association with achievement when Los Angeles County is excluded, but when Los Angeles is included the results are mixed, as in Table 4.

Discussion

One possible reason for the positive association between the level of the local salary schedule and test scores is that districts which maintain higher salary schedules attract better teachers (both new and experienced) away from other districts. Whether a statewide or nationwide across-the-board salary increase for teachers also would attract better teachers (i.e., would induce more talented people to choose teaching instead of other occupations) is a separate question, but Manski (1985) has estimated that it would. Another possible reason for the link between salary levels and achievement differences among California schools is that higher salaries may produce better morale and greater effectiveness on the part of teachers.

A third possible explanation of the tie between district salary levels and student achievement is that districts with higher salaries may have other characteristics, not fully measured by the socioeconomic background variables, which affect achievement. For example, there may be a local tradition of community support for schools which accounts for both higher salaries for teachers and higher achievement by students. Unless this third explanation is the only one that matters, our findings do suggest that raising teachers' salaries could have a positive effect on student achievement.

The generally positive association of student achievement with the index of teachers' education and seniority also may have a straightforward interpretation: i.e., that more highly educated and experienced teachers are in fact more effective. After all, that is the rationale for structuring teachers' salary schedules to pay more for experience and further education. Even Hanushek (1986), who is skeptical about the effect of school resources on students' learning, concludes that teachers' experience is fairly consistently associated with achievement. However, this association does not necessarily mean that more experienced or highly educated teachers are more effective. It could instead reflect the fact that teachers with more seniority sometimes prefer, and are able, to get themselves assigned to schools where the high-achieving students are.

The third component of teacher cost, namely the number of teachers per student hour, does not appear to be positively associated with student achievement in our California school data. Although many practitioners and policy makers strongly maintain that reducing class sizes would be beneficial, our result is consistent with most previous research, which finds that differences in class size, within the range of ordinary practice, are not significantly associated with students' achievement (see Hanushek, 1986; Robinson and Wittebols, 1986).

The fact that several of our estimated coefficients suggest a negative relationship between number of teachers and student achievement may be attributable to circumstances resulting from declining student enrollment. In California public elementary schools, enrollment fell nearly nine percent between 1974 and 1980, and as of 1984 enrollment had recovered only to 94 percent of its 1974 level (California State Department of Education, 1986). Since public school revenues are tied to enrollment, districts with declining enrollment face severe budget problems, which necessitate cutting back programs, closing schools, and reducing the number of teachers by attrition, early retirement, or layoffs. All this is bad for morale. Yet, because districts are usually reluctant to lay off teachers, the number of teachers usually does not decline as fast as the number of students. Consequently, when student enrollment declines, the teacher-pupil ratio typically increases. Therefore, districts where student enrollment has declined most sharply may have suffered more disruption of programs, deterioration of morale, and consequent negative effects on student achievement -- but at the same time, they have higher teacher-pupil ratios. This historical explanation may account for our sometimes finding a negative relationship between student achievement and the number of teachers per student hour.

Given these interpretations, our results clearly imply that it would be more cost-effective for California public school authorities to spend money on raising teachers' salaries than on reducing class sizes in grades 3 and 6. For instance, suppose a district with a starting salary of $18,000 were to raise that starting salary to $20,000. Suppose also that the whole salary schedule were to increase by the same percentage, so that the ratio of the average teacher's salary to starting salary remained constant. If the initial number of teachers per student hour were 0.0067 (which implies 1/0.0067 = 150 daily student class-hours per teacher), then that number would have to decrease to 0.0060 (implying 167 daily student class-hours per teacher), in order to hold constant the amount spent on teachers' salaries per student hour. That is,

teachers' salaries per DSCH =

$$\text{starting salary} \times \frac{\text{mean salary}}{\text{starting salary}} \times \text{no. of teachers per DSCH}$$

Initially, suppose the numbers are

$$\$200 = \$18{,}000 \times 1.67 \times 0.0067.$$

Then, after raising salaries and reducing the number of teachers per DSCH to keep constant the total salary cost per DSCH,

$$\$200 = \$20{,}000 \times 1.67 \times 0.0060.$$

Now, given the estimated coefficients in Tables 1-4, the increase in achievement resulting from the increase in starting salaries would be two to four points -- about one-tenth of the inter-school standard deviation in these scaled achievement test scores. But the reduction in teacher-pupil ratio would not cause any reduction in achievement, according to our estimates. Therefore, this reallocation of resources would yield a gain in predicted achievement without any increase in total instructional cost.

In closing, it is important to note that drawing dynamic inferences from static patterns is always risky. Whether changing teachers' salaries or class sizes would have the effects predicted by our static model depends on the dynamics of the labor market for teachers and how schools change over time. In theory, an explicitly dynamic model could be estimated, but the CBEDS data used here have not been collected for enough years to make this worth doing yet with these data. For now, our interpretation of changes over time, and the inferences for policy suggested here, must be treated as untested conjectures. Nevertheless, the static results are sufficiently striking and robust to warrant attention.

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Table 1

Regressions for grade 3 achievement, 1983-84
(t-statistics in parentheses)

Unweighted

Variable	Math			Reading			Writing		
AFDC	-0.683 (-17.60)	-0.739 (-14.08)	-0.708 (-13.17)	-0.723 (-18.75)	-0.749 (-14.47)	-0.688 (-13.14)	-0.578 (-17.46)	-0.609 (-14.08)	-0.549 (-12.55)
LES	-0.276 (-5.25)	-0.369 (-4.55)	-0.325 (-4.04)	-0.576 (-11.02)	-0.690 (-8.81)	-0.613 (-7.83)	-0.503 (-11.19)	-0.635 (-9.70)	-0.559 (-8.56)
Parent occup.	41.714 (27.52)	41.453 (18.00)	41.926 (18.26)	47.242 (31.37)	46.873 (20.62)	47.612 (21.30)	38.130 (29.47)	36.384 (19.15)	37.012 (19.84)
Teacher salary per student hour	–	0.0[illegible]7 (2.2[illegible])	–	–	0.021 (1.33)	–	–	0.021 (1.57)	–
Min. teach. sal.	–	–	0.001 (2.86)	–	–	0.001 (4.14)	–	–	0.001 (5.02)
Educ. and seniority index	–	–	3.325 (1.52)	–	–	0.857 (0.40)	–	–	2.287 (1.28)
Teacher FTE per student hour	–	–	540.771 (1.23)	–	–	419.988 (0.98)	–	–	-145.736 (-0.41)
Intercept	189.884 (52.14)	183.41[illegible] (29.9[illegible])	165.061 (14.91)	170.040 (47.01)	166.382 (27.49)	143.710 (13.33)	195.970 (63.04)	194.573 (38.45)	173.843 (19.32)
R^2	0.507	0.546	0.548	0.587	0.617	0.628	0.559	0.600	0.614
N	3034	1411	1411	3034	1411	1411	3034	1411	1411
F	1040.50	422.69	283.52	1432.92	565.06	394.94	1280.79	528.04	371.66

Table 1. cont'd.

Weighted

Variable	Math			Reading			Writing		
AFDC	-0.681 (-17.66)	-0.753 (-14.51)	-0.719 (-13.58)	-0.722 (-18.93)	-0.761 (-14.83)	-0.697 (-13.49)	-0.582 (-17.63)	-0.621 (-14.39)	-0.558 (-12 89)
LES	-0.273 (- 5.36)	-0.356 (- 4.67)	-0.316 (- 4.09)	-0.555 (-11.00)	-0.668 (-8.85)	-0.591 (-7.84)	-0.507 (-11.59)	-0 632 (-9.95)	-0 553 (-8.76)
Parent occup.	42.873 (28.76)	42.455 (18.64)	42.726 (18.84)	48.590 (32.92)	48.329 (21.45)	48.611 (21.98)	39.191 (30.69)	37.764 (19.92)	37.980 (20.50)
Teacher salary per student hour	–	0.039 (2.42)	–	–	0.026 (1.64)	–	–	0.022 (1.63)	–
Min. teach. sal.	–	–	0.001 (3.33)	–	–	0.002 (4.88)	–	–	0 002 (5 68)
Educ. and seniority index	–	–	3.632 (1.69)	–	–	1.947 (0.93)	–	–	2.514 (1.43)
Teacher FTE per student hour	–	–	570.206 (1.28)	–	–	464.448 (1.07)	–	–	-92.179 (-0.25)
Intercept	186.646 (52.05)	180.683 (29.63)	160.362 (14.70)	166.252 (46.84)	161.780 (26.82)	135.580 (12.74)	193.195 (62.90)	191.295 (37.69)	168.374 (18 89)
R^2	0.530	0.573	0.576	0.609	0.642	0.654	0.582	0.626	0.642
N	3034	1411	1411	3034	1411	1411	3034	1411	1411
F	1137.20	471.78	317.63	1574.63	629.10	441.97	1407.06	588 85	419 58

Table 2

Regressions for grade 6 achievement, 1983-84
(t-statistics in parentheses)

Unweighted

Variable	Math			Reading			Writing		
AFDC	-0.683 (-17.60)	-0.732 (-15.08)	-0 675 (-13.51)	-0.723 (-18.75)	-0.749 (-15.50)	-0.660 (-13.40)	-0.578 (-17.46)	-0.599 (-14.84)	-0 516 (-12 63)
LES	-0.276 (- 5.25)	-0.335 (- 4.77)	-0.309 (- 4.40)	-0.576 (-11.02)	-0.653 (-9.32)	-0.600 (-8.65)	-0.503 (-11.19)	-0.585 (-10.00)	-0 537 (-9 32)
Parent occup.	41.714 (27.52)	42.520 (20.72)	42.236 (20.68)	47.242 (31.37)	47.857 (23.41)	47.655 (23.65)	38.130 (29.47)	37.976 (22.26)	37.611 (22.49)
Teacher salary per student hour	–	0.004 (0.24)	–	–	-0.020 (-1.27)	–	–	-0.035 (-2.67)	–
Min. teach. sal.	–	–	0.001 (3.81)	–	–	0.002 (5.14)	–	–	0 001 (4 98)
Educ. and seniority index	–	–	5.040 (2.60)	–	–	3.195 (1.67)	–	–	2.420 (1.53)
Teacher FTE per student hour	–	–	-923.210 (-1.91)	–	–	-1166 904 (-2.44)	–	–	-1981 581 (-5.00)
Intercept	189.884 (52.14)	187.723 (33.94)	168.727 (17.30)	170.040 (47.01)	172.335 (31.27)	147.968 (15.38)	195.970 (63.04)	201.700 (43.85)	186.720 (23 37)
R^2	0.507	0.543	0.549	0.587	0.612	0.624	0.559	0.596	0 613
N	3034	1679	1679	3034	1679	1679	3034	1679	1679
F	1040.50	497.64	339.00	1432 92	658.81	462.86	1280.79	617.42	441 57

Table 2 cont'd.

Weighted

Variable	Math			Reading			Writing		
AFDC	-0.681 (-17.66)	-0.735 (-15.39)	-0.681 (-13.85)	-0.722 (-18.93)	-0.755 (-15.84)	-0.666 (-13.74)	-0.582 (-17.63)	-0.608 (-15.19)	-0.523 (-12.94)
LES	-0.273 (-5.36)	-0.322 (-4.79)	-0.298 (-4.43)	-0.555 (-11.00)	-0.625 (-9.32)	-0.578 (-8.72)	-0.506 (-11.59)	-0.576 (-10.22)	-0.530 (-9.58)
Parent occup.	42.873 (28.76)	43.784 (21.82)	43.249 (21.63)	48.590 (32.92)	49.108 (24.54)	48.498 (24.58)	39.191 (30.69)	39.138 (23.27)	38.407 (23.32)
Teacher salary per student hour	–	0.003 (0.22)	–	–	-0.022 (-1.40)	–	–	-0.035 (-2.66)	–
Min. teach. sal.	–	–	0.001 (3.74)	–	–	0.002 (5.16)	–	–	0.001 (5.23)
Educ. and seniority index	–	–	4.978 (2.63)	–	–	3.295 (1.76)	–	–	2.628 (1.68)
Teacher FTE per student hour	–	–	-1011.427 (-2.04)	–	–	-1281.997 (-2.62)	–	–	-2051.424 (-5.02)
Intercept	186.646 (52.05)	184.479 (34.07)	167.214 (17.43)	166.252 (46.84)	169.273 (31.34)	146.224 (15.45)	193.195 (62.90)	198.893 (43.83)	183.913 (23.28)
R^2	0.530	0.569	0.574	0.609	0.634	0.647	0.582	0.620	0.638
N	3034	1679	1679	3034	1679	1679	3034	1679	1679
F	1137.20	551.70	375.61	1574.63	726.47	510.16	1407.06	682.93	490.30

Table 3

Regressions for grade 3 achievement, 1985-86
(t-statistics in parentheses)

Unweighted

Variable	Math			Reading			Writing		
AFDC	-0.703 (-15.11)	-0.712 (-14.98)	-0.633 (-13.34)	-0.625 (-14.59)	-0.633 (-14.51)	-0.556 (-12.81)	-0.628 (-14.90)	-0.637 (-14.79)	-0 573 (-13 29)
LES	-0.180 (- 4.64)	-0.177 (- 4.46)	-0.079 (- 1.97)	-0.393 (-11.02)	-0.392 (-10.76)	-0.301 (-8.18)	-0.428 (-12.19)	-0.427 (-11.85)	-0 349 (-9 54)
Parent occup.	43.235 (22.81)	42.832 (22.03)	43.697 (22.73)	54.867 (31.45)	54.319 (30.40)	55.028 (31.18)	49.188 (28 63)	48.664 (27.59)	49.160 (28 10)
Teacher salary per student hour	–	0.023 (1.85)	–	–	0.034 (3.03)	–	–	0.028 (2 54)	--
Min. teach. sal.	–	–	0.002 (8.14)	–	–	0.002 (9.37)	–	–	0 002 (8.24)
Educ and seniority index	–	–	5.247 (2.55)	–	–	7.303 (3.86)	–	–	6.982 (3 72)
Teacher FTE per student hour	–	–	-437.651 (-0.91)	–	–	-154.083 (-0.35)	–	–	-462 336 (-1.05)
Intercept	211.906 (46.25)	207.740 (39.96)	166.032 (17.67)	186.848 (44.30)	180.450 (37.58)	134.097 (15.54)	204 226 (49.18)	199.103 (42.01)	160.149 (18 73)
R^2	0.418	0.421	0.439	0.557	0.561	0.575	0.536	0.539	0 550
N	3673	3538	3536	3673	3538	3536	3673	3538	3536
F	878.47	642.54	459.78	1534.63	1128.20	795.04	1415.43	1033.03	718 73

Table 3. cont'd.

Weighted

Variable	Math			Reading			Writing		
AFDC	-0.737 (-16.33)	-0.747 (-16.22)	-0.662 (-14.41)	-0.672 (-16.10)	-0.678 (-15.93)	-0.596 (-14.07)	-0.659 (-16.09)	-0.667 (-15.95)	-0.599 (-14.31)
LES	-0.189 (-5.16)	-0.182 (-4.85)	-0.075 (-1.97)	-0.399 (-11.79)	-0.396 (-11.45)	-0.297 (-8.47)	-0.442 (-13.31)	-0.438 (-12.87)	-0.353 (-10.19)
Parent occup.	42.130 (22.15)	42.009 (21.52)	42.793 (22.25)	53.262 (30.27)	53.042 (29.43)	53.691 (30.25)	48.133 (27.87)	47.861 (26.99)	48.311 (27.53)
Teacher salary per student hour	–	0.017 (1.37)	–	–	0.032 (2.73)	–	–	0.026 (2.25)	--
Min. teach sal	–	–	0.002 (8.39)	–	–	0.002 (9.62)	–	–	0.002 (8.42)
Educ. and seniority index	–	–	5.360 (2.60)	–	–	7.544 (3.97)	–	–	7.213 (3.84)
Teacher FTE per student hour	–	–	-818.349 (-1.64)	–	–	-405.786 (-0.88)	–	–	-757.899 (-1.66)
Intercept	213.984 (46.67)	210.483 (40.06)	169.009 (17.83)	190.233 (44.85)	183.718 (37.87)	136.831 (15.64)	206.349 (49.56)	210.304 (42.16)	162.591 (18.80)
R^2	0.435	0.440	0.459	0.571	0.577	0.592	0.556	0.559	0.571
N	3673	3538	3536	3673	3538	3536	3673	3538	3536
F	942.27	692.89	499.33	1628.19	1202.73	851.95	1530.00	1121.12	782.81

Table 4

Regressions for grade 6 achievement, 1985-86
(t-statistics in parentheses)

Unweighted

Variable	Math			Reading			Writing		
AFDC	-0.627 (-15.49)	-0.636 (-15.18)	-0.580 (-13.72)	-0 661 (-16.95)	-0.674 (-16.71)	-0.614 (-15.16)	-0.579 (-15.89)	-0.606 (-16 04)	-0 543 (-14 38)
LES	-0.279 (-5.67)	-0 282 (-5.59)	-0.245 (-4.88)	-0.614 (-12.96)	-0.616 (-12.68)	-0.573 (-11.89)	-0 488 (-11.03)	-0.482 (-10.61)	-0.442 (-9.83)
Parent occup.	42.886 (26.32)	42.720 (25.66)	42.392 (25.66)	46.768 (29.78)	46.475 (29.02)	46.258 (29.21)	37.306 (25.45)	37.061 (24.72)	36 617 (24 79)
Teacher salary per student hour	–	0.034 (2.84)	–	–	0.023 (1.96)	–	–	-0.008 (-0.76)	–
Min. teach. sal.	–	–	0.002 (7.13)	–	–	0.002 (7.17)	–	–	0 001 (6 66)
Educ. and seniority index	–	–	8.176 (4.58)	–	–	5.316 (3.11)	–	–	3 947 (2 47)
Teacher FTE per student hour	–	–	-617.360 (-1.23)	–	–	-172.798 (-0.36)	–	–	-1311.983 (-2.93)
Intercept	196.979 (50.80)	190.684 (41.86)	157.664 (18.37)	184.629 (49.39)	180.949 (41 28)	148.122 (18.00)	212.419 (60.87)	214.933 (52.39)	190.327 (24 80)
R^2	0.495	0.495	0.505	0.587	0.587	0.598	0.522	0.522	0 537
N	2897	2789	2789	2897	2789	2789	2897	2789	2789
F	944.13	682.84	472.24	1371.13	989.16	688.60	1051.13	758.62	537.75

Table 4 cont'd.

Weighted

Variable	Math			Reading			Writing		
AFDC	-0.630 (-15.86)	-0.639 (-15.57)	-0.574 (-13.86)	-0.663 (-17.39)	-0.673 (-17.13)	-0.607 (-15.34)	-0.583 (-16.18)	-0.604 (-16.26)	-0.533 (-14.31)
LES	-0.285 (-5.95)	-0.287 (-5.82)	-0.247 (-5.05)	-0.601 (-13.07)	-0.600 (-12.71)	-0.557 (-11.90)	-0.491 (-11.31)	-0.483 (-10.82)	-0.440 (-10.00)
Parent occup.	43.847 (27.12)	43.776 (26.47)	43.354 (26.46)	48.025 (30.93)	47.928 (30.23)	47.591 (30.40)	38.693 (26.40)	38.564 (25.72)	38.001 (25.79)
Teacher salary per student hour	–	0.029 (2.40)	–	–	0.014 (1.24)	–	–	-0.015 (-1.39)	–
Min. teach. sal.	–	–	0.002 (7.27)	–	–	0.002 (7.04)	–	–	0.001 (6.80)
Educ. and seniority index	–	–	8.303 (4.63)	–	–	4.956 (2.89)	–	–	4.012 (2.49)
Teacher FTE per student hour	–	–	-748.154 (-1.47)	–	–	-304.044 (-0.62)	–	–	-1489.781 (-3.25)
Intercept	194.202 (50.43)	188.[illegible]68 (41.57)	154.526 (17.86)	180.935 (48.92)	17[illegible].482 (41.01)	145.998 (17.67)	208.684 (59.78)	212.287 (51.59)	186.530 (23.98)
R^2	0.517	0.518	0.528	0.610	0.610	0.621	0.545	0.546	0.562
N	2897	2789	2789	2897	2789	2789	2897	2789	2789
F	1033.75	747.39	518.85	1509.97	1091.28	760.74	1155.99	835.80	595.39

Table 5

Numbers of significantly positive, significantly negative, and non-significant coefficients in alternative versions of the regression model

	Teacher salary per DSCH			Minimum salary		Mean/min. or mean/max.		Teacher FTE per DSCH		Max./min. salary		
	sig. pos.	not sig.	sig. neg.	sig. pos.	not sig.	sig. pos.	not sig.	not sig.	sig. neg.	sig. pos.	not sig.	sig. neg.
More restricted salary range, all schools												
Without max/min salary ratio or school size	6	5	1	12	0	8	4	4	8	–	–	–
With max/min salary ratio	–	–	–	12	0	10	2	4	8	7	3	2
With school size	3	5	3	12	0	8	4	3	9	–	–	–
With max/min salary ratio and school size	–	–	–	12	0	10	2	3	9	4	6	2
Less restricted salary range; L.A. excluded												
Without max/min salary ratio or school size	11	1	0	12	0	12	0	11	1	–	–	–
With max/min salary ratio	–	–	–	9	3	12	0	11	1	7	5	0
With school size	11	1	0	12	0	12	0	11	1	–	–	–
With max/min salary ratio and school size	–	–	–	9	3	12	0	11	1	8	4	0