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How Money Matters: The Effect of School District Spending on Academic Achievement

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Because of the prestige of the Coleman Report, few sociologists of education assert that school spending is associated with students' achievement. Instead, most either emphasize the influence of school social environment or question the ability of schools to make any difference. The study presented here applied LISREL to a new database synthesized from the 1992 National Assessment of Educational Progress in mathematics for eighth graders and the Common Core of Data for the universe of U.S. school districts to test the hypothesis that school spending is associated with achievement. It found that per-pupil expenditures for instruction and the administration of school districts are associated with achievement because both result in reduced class size, which raises achievement.

A widely discussed question in the sociology of education is whether schools "make a difference." Many researchers claim that most variation in academic achievement and other educational outcomes is attributable to differences among students, rather than differences among schools, and consequently that schools make little difference. Other researchers, while not denying that social background plays a role in students' achievement, suggest that the various social resources that schools bring to bear because of their social environments add to students' achievement above and beyond what would be expected on the basis of students' social backgrounds.

The findings of the study presented in this article suggested a third alternative, that schools can make a difference when their economic resources are allocated in a fashion conducive to positive school social environments. The study tested the notion that through a certain "path," economic resources are associated with academic achievement.[1] The path begins with the hypothesis that per-pupil expenditures on instruction and the administration of school districts' central offices are positively related to class size, with more spending leading to smaller classes. Class size is, in turn, positively related to school social environment, with schools having more cohesive social environments when they have smaller classes. Finally, cohesive school social environments are positively related to students' achievement above and beyond students' social backgrounds. In this way, the economic resources of schools are associated with students' achievement.

My study tested the described path model by applying LISREL 8, which permits the measurement of relationships among a sequence or path of variables, to a new database synthesized for the study from the 1992 National Assessment of Educational Progress (NAEP) and the Common Core of Data (CCD). NAEP measures students' achievement in mathematics, school social environment, and teacher-student ratios for a nationally representative sample of eighth graders, and CCD measures per-pupil expenditures on instruction, central office administration, school-level administration, and capital outlays for the universe of school districts. In addition, data from the Teachers' Cost Index (TCI) were added to control for regional variations in the cost of hiring teachers. The study is an advance over previous research primarily in two ways: It used a newly synthesized database, thereby permitting the use of pure spending measures, such as spending on instruction, and it analyzed the data by testing a sequence of variables with LISREL, rather than testing a single set of relationships, as is done with more conventional techniques like regression analysis.

BACKGROUND

Sociologists of education have identified a variety of factors that influence students' performance during school and afterward. Many of the earliest studies suggested that the most important influence on students' performance is the socioeconomic status (SES) of students before they attend school. These studies hypothesized that the more affluent the background from which a student comes, the better he or she will perform in school. In other words, students do not enter school on an equal footing, but in a state of relative advantage or disadvantage. These studies suggested that affluent students will not only evince higher levels of academic achievement than less affluent students, but will attain higher educational degrees and, as a result of this higher achievement and attainment, will obtain better jobs. Empirical support for the hypothesis that SES is associated with academic achievement came from studies by Coleman et. al. (1966) and Jencks et. al. (1972), and for the hypothesis that high SES and high levels of achievement are, in turn, associated with high levels of educational and job attainment, from studies by Blau and Duncan (1967) and Sewell, Hauser, and Featherman (1976). In this article, these studies are referred to as "status-attainment research."

Implicit in the conclusions of status-attainment research is the notion that schools do not make a difference for students' achievement. These studies found that students' background is an important influence on students' performance, but that the characteristics of schools are not. Coleman et al. (1966), for instance, found that a series of measures of school economic characteristics, such as teacher-student ratios and the number of years of teachers' experience, are either weakly or not at all associated with academic achievement when SES is taken into account.[2] Hauser, Sewell, and Alwin (1976) found that neither a series of organizational characteristics of schools nor the demographic composition of schools influence academic achievement or educational attainment. These findings imply that when students leave high school, they have achieved at levels no higher than could be predicted from their SES before they entered high school. They do not mean that students do not progress during high school, but that they do so at predictable rates that depend on their own demographic characteristics, regardless of the characteristics of their schools.[3]

A series of studies, known as "effective-schools research," responded to the status-attainment model. These studies identified schools in which students of low SES evince high levels of achievement. They found that such schools display a series of relatively uniform characteristics that, they concluded, are associated with high levels of achievement among low SES students (Austin and Garber 1985; Brookover, Beady, Flood, Schweitzer, and Wisenbaker 1979; Edmonds 1979). These characteristics include the social environment of the school, the relations between teachers and principals, and teachers' morale. Although these studies were initially conducted on small samples of students and schools, later research confirmed the influence of these characteristics for nationally representative populations (see Lee, Bryk, and Smith, 1993, for a review).

The ability of these school characteristics to influence achievement above and beyond SES implies that schools can indeed make a difference for students. Particularly in the case of students whose background would predict relatively low levels of achievement, schools with a positive climate and good relations among principals, teachers, and students can expect to produce relatively high levels of achievement in students. This finding was generally reconciled to the findings of the Coleman Report (Coleman et al. 1966) and other studies that emphasized the importance of SES by noting that status- attainment studies tended to measure the economic, rather than the social, characteristics of schools. Although effective-schools research granted the minimal importance of economic resources in influencing achievement above and beyond SES, it suggested that the social characteristics of schools could have an influence. Indeed, Coleman and Hoffer (1987:63) later made this point as well.

There is a third possibility, however, that schools make a difference, as researchers on effective schools assert, but in an area that researchers on both status attainment and effective schools have assumed to be unimportant: the economic resources of schools. If this is the case, then schools can both make a difference and reinforce inequality. Because 47.4 percent of all school expenditures are financed by local property taxes, school districts with predominantly low-SES populations tend to have fewer economic resources than those with predominantly high-SES populations (General Accounting Office 1995:42). While state and federal equalization funds offset funding inequalities to some degree, the mean SES of a school district is nevertheless strongly associated with its economic resources (NCES 1995a:17).

If economic resources are strongly associated with students' achievement, then schools in high-SES areas will be more conducive to high achievement than schools in low-SES areas. That is, schools will produce the highest gains in achievement in students who are already expected to evince high levels of achievement on the basis of their SES and the lowest gains in achievement in students who are expected to evince low levels of achievement on the basis of their SES.

Meta-analyses of the literature on school spending (Hanushek 1989; Hedges, Laine, and Greenwald 1994) have suggested that the debate on the relationship between spending and achievement has not been resolved in the 30 years since the Coleman Report. Therefore, a reassessment of this relationship, in light of new data analyzed in this study, is useful, since the existence or nonexistence of this relationship has far-reaching implications for how schools make a difference and whether they reinforce inequality.

In the past, research on school spending generally used a methodology known as "production function" research. This methodology applies multivariate techniques, such as regression analysis, to a database of students or schools and measures the relationship between various economic inputs and academic achievement while holding constant the background characteristics of students and the organizational characteristics of schools (Monk 1992). The inputs have ranged from pure spending measures, such as per-pupil expenditures, to measures of the types of services these expenditures buy, such as teacher-student ratios and teachers' average salaries. The results of these studies have been mixed, fueling, rather than resolving, the debate on whether money matters to educational achievement.

The meta-analyses by Hanushek (1989) and Hedges et al. (1994) summarized the findings of these studies. They identified 38 studies, conducted between 1967 and 1987, that examined the relationship between economic resources and students' achievement and included a total of 187 regression equations. These equations measured the impact of seven inputs: per-pupil expenditures (55 equations, 11 studies), teachers' experience (131 equations, 25 studies), teachers' education (88 equations, 18 studies), teachers' salaries (43 equations, 10 studies), student-teacher ratios (116 equations, 23 studies), administrative inputs (35 equations, 6 studies), and facilities (77 equations, 17 studies).

The meta-analyses came to different conclusions about the implications of these studies for the question of whether spending contributes substantially to achievement. Hanushek (1989) noted that for each input, only 7 percent to 29 percent of the relationships to educational outcomes were positive and statistically significant and concluded that "there is no strong or systematic relationship between school expenditures and student performance" (p. 47). Yet, in their meta-analysis of the same studies, Hedges et al. (1994) drew the opposite conclusion, noting that far more of the equations indicated positive, statistically significant relationships than would be expected from a random sample of equations; that 70 percent of the statistically insignificant relationships were in the positive direction; and that the mean magnitude of the effects in the studies were often strong enough to be of substantive interest. Meta-analyses of other samples of production-function studies have been similarly inconclusive (Glass and Smith 1979; Odden 1990).[4]

To some degree, the lack of consensus among the meta-analyses reflects the limitations of the methodologies of the original studies. First, the studies generally were not nationally representative, most investigating an individual state or school district. Second, they did not distinguish between different types of pure spending and so risked missing certain dynamics in the relationship between school spending and academic achievement to the extent that different allocations of resources may result in different educational outcomes. Third, they did not take into account the ways in which other influences on the learning process may mediate between spending and achievement, failing to measure aspects of the school environment that the effective-schools literature suggests are related to achievement and may themselves be influenced by allocations of resources. Fourth, many of the studies did not provide adequate measures of SES, tending to use only father's education or some other single measure as a proxy (Hedges et al. 1994:12).

Current thinking about the influences on students' achievement suggests the importance of some factors, but neglects others. According to status-attainment research, students' SES plays an important role in students' achievement, and according to effective-schools research, the social environment of schools is similarly important. Yet the role of economic resources is uncertain. Research on its role has tended not to use specific pure spending measures (even the Coleman Report specified only different types of input, using total per-pupil expenditures as the only pure spending measure) and has not specified possible sequences for the interrelationships among these various factors.

HYPOTHESES

My study posited a path for the relationship between economic resources and students' achievement (see Figure 1). School social environment is conceived of as playing a mediating role between resources and achievement, and students' SES is seen as a characteristic that operates independently of school processes in influencing achievement. Four steps were hypothesized:

1. Per-pupil expenditures on instruction positively influence teacher-student ratios and the average level of education of teachers. The more money spent on instruction, the more teachers who can be employed by a school or school district and the higher the salaries they can be paid. The ability to pay teachers higher salaries means that teachers with more experience or education can be hired.[5]

2. Per-pupil expenditures on central office administration positively influence teacher-student ratios. Although much of the popular literature on school spending assumes that money spent on administration is wasted, this notion combines spending on central office administration with many other types of spending, including spending

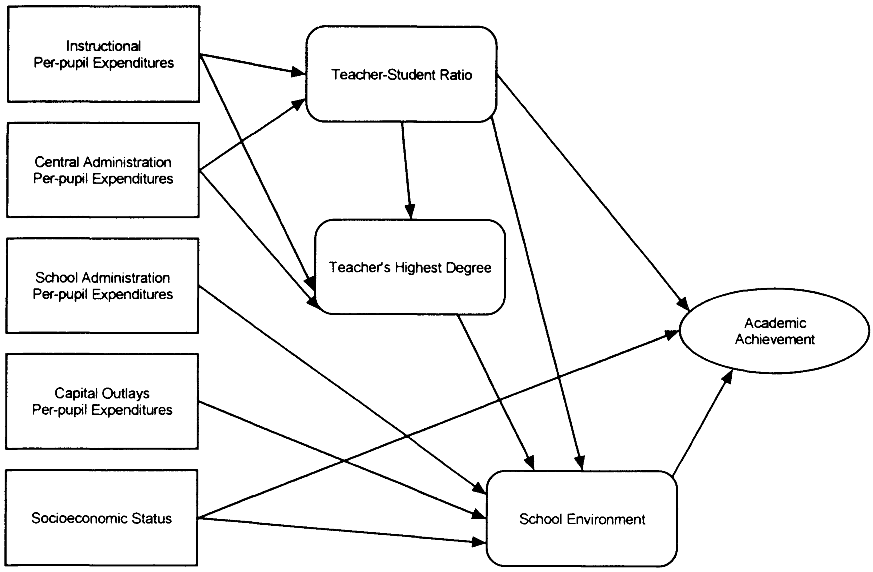

Figure 1. Hypothesized Paths to Achievement

on ancillary services like transportation and custodial services. It is suggested here that administrative spending devoted solely to the governance of the school district increases resources available in other areas because a well-supported central administration makes better decisions about the allocation of resources that lead to improved teacher-student ratios.

3. Teacher-student ratios positively influence the school environment. It is hypothesized that the key resource that affects the social environment of the school is the number of teachers available per student.[6] Teachers who are responsible for a large number of students tend to be demoralized because they have trouble developing relationships with all their students; if there are more teachers per student, teachers' morale should improve because this situation is rectified and the workload of each teacher is less. Students' morale increases because students receive more individual attention and are more easily able to participate in group discussions. Relations between principals and teachers improve because the teachers' morale is higher and the principals do not have to devote the attention to individual students that overworked teachers cannot give them. Thus, the overall social environment of the school improves when there are more teachers for students.

4. School social environment positively influences achievement. It is hypothesized that when a school has a positive social environment, students perform better. As the effective-schools literature suggests, when teachers and principals have more positive attitudes about their schools, they do their jobs better. Furthermore, when teachers have higher expectations of their students and students identify more closely with their teachers and school, students achieve at a higher level.[7]

DATA

Data Sources

To test these hypotheses, I measured per-pupil expenditures on instruction and central office administration, teacher-student ratios, teachers' education, school social environment, and students' academic achievement. Students' SES was also measured to control for its influence on school social environment and academic achievement. In addition, per-pupil expenditures on administration at the school level (the principal's office) and per-pupil capital outlays—two other measures of per-pupil expenditures—were included, although these factors were not hypothesized to influence the learning process. A total of nine variables were measured. All the data on expenditures were adjusted for regional variations in the cost of education as well; hence, a cost-of-education measure was used to modify the expenditure measures.

As was mentioned earlier, the data used to generate these measures were drawn from three sources: NAEP, CCD, and TCI. NAEP is a nationally representative database of students and schools, collected by the Educational Testing Service (ETS) under a contract from NCES; CCD is a database consisting of the universe of school districts in the United States, collected by NCES; and the TCI was developed by NCES to measure regional variations in the price of teachers. Three data sources had to be used because none of them contained all the necessary measures.

NAEP is administered by ETS every two years to nationally representative samples of 4th-, 8th-, and 12th graders and their teachers and principals. The subject areas tested vary, but have included at one time or another mathematics, reading, history, geography, and science. The information collected is used to assess what students around the country know; to compare the levels of knowledge of various regional, ethnic, socioeconomic, and gender subgroups; and to measure the progress of students in the nation, both over time and between grades (see Johnson 1994 for an overview of NAEP, and Mullis, Dossey, Owens, and Phillips 1993 for a report on the 1992 mathematics assessment). The 1992 mathematics assessment of 8th-grade students was used in this study.[8] It contains measures of mathematics achievement, school environment, teachers' educational levels, teacher-student ratios, and student- and school-level SES.[9]

CCD is a database of financial information provided by the universe of U.S. school districts. All school districts send this information to the U.S. Department of Education each year. Although the information provided can be used to measure district-by-district per-pupil expenditures in broad spending categories, such as instruction or capital outlays, CCD cannot be relied on for more detailed information because differences in the charts of accounts of school districts result in their categorizing specific expenses in different ways. Therefore, CCD was used to provide measures of expenditures on instruction, central office administration, school-level administration, and capital outlays only. It was used even though the school district is its lowest level of aggregation because no nationally representative database exists that measures different types of expenditures at a lower level of aggregation.

The TCI is the result of a study, conducted by NCES (1995b), to develop an index of the cost for a particular region of the country to hire teachers. The cost of hiring teachers, even those of similar levels of education and experience, can be expected to vary regionally because the cost of living, quality of life, and other factors all differ from region to region. The TCI was developed by applying regression analysis to the Schools and Staffing Survey, a NCES survey conducted in 1990–91. The regression analysis estimates the influence of various factors on teachers salaries, including factors under the control of schools and school districts, such as teachers' experience and education, and characteristics that are not under the control of schools, including the cost of living and quality of life in a region. The resulting estimates of the impact of these nondiscretionary characteristics on teachers' salaries can then be used as estimates of the cost of teachers in a particular region, holding the discretionary factors constant. TCI scores have been estimated for each state, and these estimates were used in the analysis to adjust the per-pupil expenditure measures (NCES 1995b:51).

Selection of Cases and Variables

To analyze data from these three sources, all three needed to be placed at a single level of analysis. I chose the district level because it is the lowest level of aggregation for CCD. The NAEP data, collected at the individual and school levels, were aggregated to the district level by calculating the means for all selected variables for each district. Only NAEP data for eighth graders who took the 1992 mathematics assessment were included. This decision resulted in data for 230 districts. These data were then linked to the 1991–92 CCD database using identification numbers provided by Westat, a subcontractor that collects NAEP data for ETS. This linking procedure made it possible to link 177 of the 230 school districts included in the NAEP sample. Of the remaining 53 school districts, 5 were linked through their addresses; the other 48 are private schools that were not included in CCD. For the resulting combined database, TCI scores for the state in which each district was located were entered manually into the database. The database took on the sampling characteristics of NAEP because NAEP was the only database for which cases were a sample, rather than the national universe. Thus, the new database is a nationally representative sample of public schools, and the weighting techniques and standard error adjustments required by NAEP apply.

This new database was then used to produce measures of the nine variables needed to test the hypotheses (see Table 1 for means and standard deviations and the appendix for full definitions). Variables in the combined database were recoded to produce the needed measures. The database included four measures of expenditures, the number of pupils in a school district, and the TCI score for the state in which the school district was located. Cost-adjusted per-pupil expenditures in the four areas were calculated by dividing each by the number of pupils and multiplying by the TCI.

The database also included seven SES measures that were summed to create an SES variable; seven school-environment measures that were summed to create a school-environment variable; a measure of teachers' highest degrees attained; the number of full-time teachers and students in the school, the ratio of which was used to measure the school's teacher-student ratio; and five measures of mathematics achievement, known as "plausible values," the use of which is discussed later.

METHODS

A structural equation modeling program, LISREL 8, was used to analyze the relationships among these nine variables. LISREL requires input rules regarding which variables are allowed to be related to one another and which are not and a covariance matrix calculated from data. The program then estimates the parameters among the variables allowed to be related while maximizing the goodness of fit between the covariance matrix these parameters imply and the input covariance matrix. LISREL produces three principal outputs: estimates of the direct effects among variables; estimates of the total effects among variables; the goodness of fit, as measured by a chi-square test; the standardized root mean residual; and an adjusted goodness-of-fit index. Models are considered to have a satisfactory fit when the chi-square is statistically insignificant (connoting that there is no significant difference between the input covariance matrix and the implied covariance matrix), the standardized root mean residual is less than .05, and the adjusted goodness-of-fit index is more than .9.

LISREL also allows for the comparison of the goodness of fit between the hypothesized model (referred to here as "the full model") and a model in which the important hypothesized relationships are fixed as being unrelated to one another (referred to here as "the nested model"). By running such a nested model and comparing the chi-squares to those of the full model, it is possible to

Table 1. Means and Standard Deviations

Variables	*M*	*SD*
Instructional per-pupil expenditures[a] (thousands of $)	3.08	.77
Central administration per-pupil expenditures[a] (thousands of $)	.11	.10
School administration per-pupil expenditures[a] (thousands of $)	.29	.09
Capital outlays per-pupil expenditures[a] (thousands of $)	.50	.53
Socioeconomic status (summated scale)	2.40	2.21
Teacher-student ratio (number of teachers/students)	.06	.03
Teacher's highest degree[b]	2.56	.47
School environment (summated scale)	5.48	2.91
Mathematics achievement (mean for five plausible values)	262.74	18.85

[a] Adjusted for regional variations in the cost of education.
[b] 1 = less than a BA, 2 = BA, 3 = MA, and 4 = more than an MA.

test the full model in relation to the nested one (Hayduk 1987).[10]

First, full and nested models were designed to test the four hypotheses. For the full model, the four cost-adjusted per-pupil expenditure measures and the SES index were treated as exogenous variables; their values were not allowed to depend on those of the other variables. Per-pupil expenditures on instruction and central office administration were allowed to affect school environment, and SES was allowed to affect school environment and academic achievement. Teacher-student ratio was allowed to affect teachers' education, school environment, and academic achievement. Teachers' education was allowed to affect school environment and academic achievement. Finally, school environment was allowed to affect academic achievement.[11] For the nested model, the relationships considered in the hypothesis were fixed at zero (making them unrelated to one another). These are the relationships between instructional per-pupil expenditures and teacher-student ratio, between central office per-pupil expenditures and teacher-student ratio, between teacher-student ratio and school environment, and between school environment and academic achievement.[12]

A design effect was then calculated by running a series of preliminary LISREL models. LISREL parameter and standard error estimates assume a simple random sample, and since NAEP is a clustered, stratified sample, these estimates are inaccurate (Johnson 1989). To adjust parameters for the NAEP sample design, covariance matrices used in all analyses were weighted by a student base weight, provided by the NAEP database. Covariance matrices were also weighted by the number of students in each school district. To adjust standard errors for the NAEP sample design, a design effect had to be calculated that estimated the amount by which the standard error estimate was downwardly biased in assuming a simple random sample. This design effect was calculated by first running a LISREL analysis for the full model on a covariance matrix weighted by only the student base weight and the number of students per school district, producing baseline estimates. LISREL analyses were then conducted for the full model on 56 covariance matrices, each weighted by the jackknife replicate weight provided by the NAEP database. For three representative relationships, the variance of the 56 estimates was calculated and the variance for the baseline model was divided by this jackknife variance, producing three estimated design effects, the most conservative of which (1.75) was used for subsequent analyses.

Five full models were then run on five covariance matrices. They needed to be run to take into account plausible-values methodology in the measurement of academic achievement in an appropriate fashion. Students who take the NAEP examination each receive only a subset of the items. To impute total scores, it is necessary to use models that take into account other information about the students, including their demographic characteristics. Five achievement scores are produced for each student, each based on slightly different models. The variability of the scores needs to be taken into account in estimating the standard errors of all coefficients in which achievement scores are involved (Johnson, Mislevy, and Thomas 1994).

This analysis used a standard methodology, conducting five LISREL analyses for the full model on five covariance matrices, each using one of the plausible values as its achievement measure; calculating parameters as the mean of those for the five analyses; and then adjusting the mean of the standard errors for the five analyses by multiplying by the square root of the design effect and, for the parameters involving achievement, adding the product of 1.2 and the variance of the five parameter estimates (O'Reilly, Zelenak, Rogers, and Kline 1996:78–79). To assess goodness of fit, five nested models were run on the same covariance matrices as were used for the full models, and the goodness of fit statistics from the full and nested models were compared.

To confirm the hypotheses described earlier, four results must occur. First, the direct effects measured for the four hypothesized relationships must be statistically significant; if they are not, the reliability of the model is brought into doubt. Second, the total effects measured for the four hypotheses must be substantial; otherwise, the relationships will not be of practical significance. Third, the goodness-of-fit measures for the full models must all confirm the models, while those for the nested models must be unsatisfactory; if not, the null hypothesis may hold.

RESULTS

The maximum likelihood estimates of direct effects suggest that some spending measures play a role in students' achievement while others do not (see Table 2). The first hypothesis, that instructional spending is associated with teacher-student ratios, is confirmed, with a positive, statistically significant standardized coefficient of .51. The hypothesis also predicts that instructional spending is associated with higher levels of teachers' education, and this, too, is confirmed, with a positive, statistically significant standardized coefficient of .27.

The second hypothesis, that expenditures for central office administration is also related to teacher-student ratios is also confirmed, with a positive, statistically significant standardized coefficient of .28. The third hypothesis, that teacher-student ratios are, in turn, related to school social environment is supported by the maximum likelihood estimates, with a positive, statistically significant standardized coefficient of .19. Finally, the fourth hypothesis, that school environment is associated with mathematics achievement, is confirmed, with a positive, statistically significant standardized coefficient of .22.

Although the maximum likelihood estimates support the hypothesized relationships, they also rule out certain other relationships. It appears that the relationship between school-level spending and school social environment is not statistically significant when it is estimated with controls. Nor is the relationship between capital outlays and school social environment statistically significant. Also, while greater instructional spending is associated with improved levels of teachers' education, teachers' education is not, in turn, associated with school social environment or mathematics achievement.

The hypotheses pertained to the direct relationships among variables and therefore specified a path through which spending may affect achievement. However, the quantification of the effect of spending on achievement requires the calculation of the total effects of the different types of spending on achievement, including indirect effects as mediated by school inputs and school social environment (see Table 3).[13] This quantification is important for determining whether the

Table 2. Maximum Likelihood Estimates of Direct Effects

Variables	Teacher-Student Ratio	Teacher's Highest Degree	School Environment	Mathematics Achievement
Instructional Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	.02**	.17**	—	—
Standard errors	.00	.05	—	—
Standardized parameters	.51	.27	—	—
Central administration Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	.08**	–.59	1.18	—
Standard errors	.01	.37	2.17	—
Standardized parameters	.28	–.12	.041	—
School administration Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	—	—	–2.96	—
Standard errors	—	—	2.29	—
Standardized parameters	—	—	–.08	—
Capital Outlays Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	—	—	.18	—
Standard errors	—	—	.37	—
Standardized parameters	—	—	.03	—
Socioeconomic Status (summated scale)				
Unstandardized parameters	—	—	.50**	5.81**
Standard errors	—	—	.09	.55
Standardized parameters	—	—	.38	.68
Teacher-student ratio (number of teachers/students)				
Unstandardized parameters	—	1.13	19.94*	30.30
Standard errors	—	1.55	7.84	41.69
Standardized parameters	—	.07	.19	.05
Teacher's highest degree[a]				
Unstandardized parameters	—	—	.52	–1.80
Standard errors	—	—	.42	2.42
Standardized parameters	—	—	.08	–.04
School environment (summated scale)				
Unstandardized parameters	—	—	—	1.43**
Standard errors	—	—	—	.43
Standardized parameters	—	—	—	.22
Mathematics achievement (plausible values scale)				
Unstandardized parameters	—	—	—	—
Standard errors	—	—	—	—
Standardized parameters	—	—	—	—

* $p < .10$
** $p < .05$.
[a] 1 = less than a BA, 2 = BA, 3 = MA, and 4 = more than an MA.

relationships between money and achievement are strong enough to be substantively meaningful. It appears that the two hypothesized relationships are strong enough: every $1,000 in spending on instruction is associated with nearly a 1-point increase in mathematics achievement, and every $1,000 in spending on central administration is associated with nearly a 7-point increase in mathematics achievement. A $1,000 increase in instructional spending represents an increase of only somewhat more than one standard

Table 3. Maximum Likelihood Estimates of Total Effects

Variables	Teacher-Student Ratio	Teacher's Highest Degree	School Environment	Mathematics Achievement
Instructional Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	.02**	.19**	.47**	.91
Standard errors	.00	.05	.16	.89
Standardized parameters	.51	.31	.13	.04
Central administration Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	.08**	–.50	2.52	6.92
Standard errors	.02	.35	1.99	5.39
Standardized parameters	.28	–.11	.09	.04
School administration Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	—	—	–2.96	–4.22
Standard errors	—	—	2.29	4.51
Standardized parameters	—	—	–.09	–.02
Capital Outlays Per-pupil Expenditures (thousands of $)				
Unstandardized parameters	—	—	.18	.25
Standard errors	—	—	.37	.70
Standardized parameters	—	—	.03	.01
Socioeconomic Status (summated scale)				
Unstandardized parameters	—	—	.50**	6.52**
Standard errors	—	—	.09	.55
Standardized parameters	—	—	.38	.63
Teacher-student ratio (number of teachers/students)				
Unstandardized parameters	—	1.13	20.52**	57.56
Standard errors	—	1.55	7.81	42.92
Standardized parameters	—	.07	.20	.09
Teacher's highest degree[a]				
Unstandardized parameters	—	—	.52	–1.06
Standard errors	—	—	.42	2.55
Standardized parameters	—	—	.08	–.03
School environment (summated scale)				
Unstandardized parameters	—	—	—	1.43**
Standard errors	—	—	—	.43
Standardized parameters	—	—	—	.22
Mathematics achievement (plausible values scale)				
Unstandardized parameters	—	—	—	—
Standard errors	—	—	—	—
Standardized parameters	—	—	—	—

* $p < .10$
** $p < .05$.
[a] 1 = less than a BA, 2 = BA, 3 = MA, and 4 = more than an MA.

deviation and thus is feasible. On the other hand, a $1,000 increase in central office administration is not feasible, since one standard deviation is $100. However, a $100 increase in central office administration would raise achievement significantly, by more than half a point.[14]

The robustness of the hypothesized model (full model) was tested by assessing its goodness of fit and comparing it to a model in which the hypothesized path is zero (nested model). The goodnesses of fit for the five full models are satisfactory (see Table 4), with chi-squares ranging from 10.208 to 11.196 and with significances ranging from .797 to .856; standardized root mean residuals of .025 and .026; and adjusted goodness-of-fit indices ranging from .962 to .965. On the other hand, the goodnesses of fit for the nested models were unsatisfactory, with chi-squares ranging from 100.895 to 102.265; standardized root mean residuals of .075; and adjusted goodness-of-fit indices ranging from .773 to .776. The exclusion of the hypothesized relationships, then, seems to reduce the goodness of fit of the model to below acceptable limits.

It can therefore be concluded that the hypothesized path relating some spending measures to mathematics achievement is supported by the data. The hypothesis of the path from instructional and central office spending to teacher-student ratios to school environment to mathematics achievement produces a model in which these coefficients are large and significant, the goodness of fit is strong, and the goodness of fit is better than that of a nested model in which the path is fixed at zero.

CONCLUSION

This study significantly advances knowledge about the relationship between school spending and academic achievement. The findings indicate that the methodological shortcomings of earlier research were responsible, to some degree, for the lack of a consensus on this issue. The failure of previous studies to distinguish among different types of spending proved to be important, in that this study found that some types of spending were associated with achievement while other types were not. The failure of previous studies to include the social environment of the school and other aspects of the learning process in their models proved to be important because the impact of spending patterns seems to be indirect, mediated by school social environment. The failure of previous studies to measure SES fully also appears significant, in that this study found a strong relationship between SES and achievement. Finally, the development and use of a nationally representative data set for the first time since the Coleman Report is, by definition, necessary for testing hypotheses that are national in scope.

The preceding analysis supports the notion that spending patterns affect the learning process in two ways. First, instructional spending influences the number of teachers hired per student. The resulting teacher-student ratio has an influence on the social environment of the school, with higher ratios promoting a more cohesive environment. And a more cohesive social environment raises mathematics achievement above and beyond the level expected on the basis of students' SES. Second, spending on central office administration also leads to the hiring of more

Table 4. Goodness of Fit Between Full and Nested Models

	Plausible Value 1		Plausible Value 2		Plausible Value 3		Plausible Value 4		Plausible Value 5	
	Full	Nested	Full	Nested	Full	Nested	Full	Nested	Full	Nested
Chi-square	10.21	102.27	11.20	101.53	10.99	100.90	10.52	102.19	10.20	101.00
Significance	.86	.00	.80	.00	.81	.00	.84	.00	.86	.00
Standardized root mean residual	.03	.08	.03	.08	.03	.08	.03	.08	.08	.08
Adjusted Goodness-of-fit index	.97	.77	.96	.77	.96	.78	.96	.77	.97	.78

teachers, with the same consequences as for instructional spending.

The fact that economic resources are associated with students' achievement does not mean that all allocative decisions are equally productive. The findings of this study also suggest that some spending patterns create paths that are dead ends in that they do not lead to increases in achievement. Instructional spending leads to smaller classes because it makes more money available for hiring more teachers. Yet that money can just as easily be spent on maintaining the same number of teachers, but at higher salary levels. This research suggests that although reduced class size leads to higher achievement, measures of the quality of teachers, such as teachers' educational levels, do not. In addition, the fact that central office administration is positively associated with class size suggests that when more money is spent on it, the central office is better able to make allocative decisions. On the other hand, the findings indicate that other forms of spending are also dead ends. Neither spending on capital outlays nor spending on school-level administration has an impact on students' achievement.

The conclusions that the findings suggest are mixed. When schools or, more typically, their district-level offices, invest their resources to reduce class size, they can raise students' achievement levels. However, there are two obstacles to school district expenditures raising students' achievement. First, since school districts with students from the least affluent backgrounds have the fewest instructional dollars, they have the largest class sizes and are the least able to raise students' achievement. Second, these school districts have the least amount of money for central office administration; therefore, they are less likely to spend their dollars on reducing class size and more likely to spend their funds on dead-end paths. The conundrum of school spending is that spending can make a difference to achievement, but it seems that the least spending occurs in precisely those school districts where the students need it the most on the basis of their SES, thereby militating against the ability of those schools to make a difference.

The status-attainment researchers, then, were correct in identifying schools as potential reinforcers of inequality, but may have overemphasized one way in which the schools could do so. They have posited a unidimensional model, in which low SES students evince lower levels of academic achievement and other educational outcomes simply because of their social backgrounds. In this view, schools are neutral, neither adding to nor subtracting from the potential of students on the basis of their SES. This study suggests that the reintroduction of the notion that resources may make a difference is warranted. Schools may reinforce inequality on two levels because, all things being equal, lower SES students will not fare as well in school as higher SES students, and since all things are not equal, low SES students are more likely to attend schools with poor resources that lack the administrative capacity to make sound fiscal decisions, thus producing levels of achievement even lower than would be expected on the basis of students' SES.

APPENDIX

Definitions of Variables

Instructional per-pupil expenditures: Derived from data in CCD for fiscal year 1992. Calculated by dividing the total expenditures on instruction, as defined in CCD, for each school district, by the number of students in the school district and multiplying by the TCI. Measured in thousands of dollars.

Central administration per-pupil expenditures: Derived from data in CCD for fiscal year 1992. Calculated by dividing the total expenditures on central administration, as defined in CCD, for each school district, by the number of students in the school district and multiplying by the TCI. Measured in thousands of dollars.

School administration per-pupil expenditures: Derived from data in CCD for fiscal year 1992. Calculated by dividing the total expenditures on school-level administration, as defined in CCD, for each school district, by the number of students in the school district and multiplying by the TCI. Measured in thousands of dollars.

Capital outlays per-pupil expenditures: Derived from data in CCD for fiscal year 1992. Calculated by dividing the total capital outlays, as defined in CCD, for each school district by the number of students in the school district and multiplying by the TCI. Measured in thousands of dollars.

SES: Derived from NAEP data for mathematics for 1992. Calculated as the summated scale of the following items: for each individual respondent to the NAEP, whether or not (1) the family receives a newspaper, (2) there is an encyclopedia in the home, (3) there are more than 25 books in the home, and (4) the family subscribes to magazines; the highest level of education attained by the mother; the highest level of education attained by the father; and for each school in NAEP, the percentage of students who receive reduced-price or free lunches. Measured as the total of that scale.

Teacher-student ratio: Derived from the NAEP data for mathematics for 1992. Calculated by dividing the total number of teachers in a school by the total number of students in that school.

Teacher's highest degree: Taken from the NAEP data for mathematics for 1992. Consists of the highest level of education attained by a teacher responding to NAEP on behalf of an individual student. Responses were coded 1 for less than a bachelor's degree, 2 for a bachelor's degree, 3 for a master's degree, and 4 for more than a master's degree.

School environment: Derived from the NAEP data for mathematics for 1992. Calculated as the summated scale of the following items: for each school in NAEP, the degree to which (1) teachers' absenteeism is not a problem, (2) students' tardiness is not a problem, (3) students' absenteeism is not a problem, (4) class cutting is not a problem, and (5) there is a regard for school property; for each teacher in NAEP, the degree to which teachers have control over (1) instruction and (2) the content of courses. Measured as total of that scale.

Mathematics achievement: Taken from the NAEP data for mathematics for 1992. Consists of the five plausible values for students responding to NAEP. Means and standard deviations presented in this article are means of these statistics for the five plausible values. For all maximum likelihood estimates, plausible values were analyzed in accordance with plausible values methodology. Measured on a common proficiency scale for all grades (4th, 8th, and 12th).

NOTES

1. *Path* refers to a hypothesized sequence of statistical associations and hypothesized directions for those associations, otherwise known as causal modeling.

2. For the purposes of this article, *economic resources* refers to school characteristics that can be readily monetarized, including both district-level spending measures, such as per-pupil expenditures, referred to here as "pure spending measures," and characteristics of schools that are dependent on dollars, such as teachers' salaries and teacher-student ratios, referred to here as "school inputs."

3. Recent research suggested that the range of students' background characteristics associated with academic achievement may be broader than those commonly placed under the rubric of SES. Wenglinsky (1996) and Sui-Chu and Willms (1996) found that the activities of parents, in assisting their children with their homework, valuing education, and being involved in the school, were all conducive to students' achievement above and beyond SES for nationally representative samples of high school and middle school students, respectively.

4. Hanushek (1996) and Hedges and Greenwald (1996) also analyzed other samples of production-function studies, but these, too, have failed to break the stalemate.

5. Thus, it is assumed that the quality-of-teachers issue can be addressed equally well by measuring teachers' salary, experience, or education.

6. For a small-scale study of the ways in which reduced class size changes the social dynamics of both the class and school, see Bourke (1986). A meta-analysis of 59 studies of the effects of class size on social dynamics was conducted by Glass and Smith (1980).

7. These hypotheses assume a single causal direction (a recursive model).

8. The findings for 8th graders may differ markedly from what would be found for 4th and 12th graders; studies of these grades would be necessary before a complete picture of the influence of spending on achievement could be painted.

9. The student SES variables have been criticized on three grounds: (1) they do not include certain measures, such as family

income, needed to produce a more reliable measure of SES; (2) they are based on students' self-reports, which may not be as accurate as parents' reports; and (3) measures of social context in addition to SES, such as the language spoken at home, are not included. The first criticism may be valid for data at the student level; however, this study aggregated data to higher levels and thus was able to use a school SES variable—the percentage of students obtaining a reduced-price lunch—which makes an SES index highly reliable.

In terms of the second criticism, Berends and Koretz (1995) found that in large-scale databases that used both students' and parents' reports, the results did not differ significantly, suggesting that the use of students' self-reports in NAEP is not a problem. With regard to the third criticism, it is true that studies can benefit from the inclusion of numerous social context controls above and beyond SES and that these controls may reduce between-school differences. Wenglinsky (1996) found, in analyzing the National Educational Longitudinal Study of 1988, that differences in achievement between students attending public and private schools are reduced or eliminated when social-context controls are added to SES. Nevertheless, most studies still rely on SES controls only because the impact of interactions between social context variables and school effects on academic achievement is not well known.

10. This study took a SEM approach, rather than a multilevel modeling approach, because SEM has some capabilities that the other approach lacks. SEM permits the measurement of the goodness of fit of multiple equations, the comparison of goodness of fit between full and nested models, and the measurement of the standard errors of total effects.

Although it is possible, in theory, to address all three issues by running a series of regression equations, calculating the goodness-of-fit measures for both the full and nested models for all equations and the standard errors of the total effects would be computationally expensive. Since hierarchical linear modeling and other multilevel modeling programs are also single-equation programs, using them would be not be feasible for producing the desired output and would therefore preclude obtaining the information needed for a rigorous test of multiple equation hypotheses.

11. To keep the model recursive, teachers' education was not allowed to have a reciprocal effect on teacher-student ratio. The choice of having teacher-student ratio precede teachers' education was arbitrary, but, as indicated by modification indices, did not significantly affect the goodness of fit of the model.

12. For both the full and nested models, it may be suggested that measurement models should be included to permit covariation between the error terms of the expenditures variables. Since these variables are all measured at the school district level, their error terms may be highly correlated with one another, and the failure to take this possibility into account may result in the downward bias of estimates of standard errors.

This clustering of errors, though not taken into account specifically for school districts, was taken into account for the sampling units in NAEP through a design effect approach, discussed later. Since the sampling units are either school districts or a few school districts, taking sample clustering into account through design effects should largely address school district error covariation.

13. It should be noted that Table 3 shows a negative total effect of teachers' education on mathematics achievement, a counterintuitive finding. However, this total effect is based on a negative direct effect that is statistically insignificant.

14. Of course, these numbers represent only a rough approximation of the effect of spending on achievement, since they assume that the relationship is linear and continuous. It may be that the relationship between spending and achievement is not linear, with money making more of a difference or less of a difference, depending on how much is being spent. It also may be the case that while changes in spending levels in $1,000 packets make a difference in achievement, changes in spending levels in $100 packets do not.

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