EXPENSE PREFERENCE AND STUDENT ACHIEVEMENT IN SCHOOL DISTRICTS

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INTRODUCTION

The widely held view that our system of public education performs poorly has motivated a broad range of proposals for reform. Some policies, like the recent "No Child Left Behind" Act, seek to improve student outcomes by introducing accountability and changing the incentives within current administrative structures. Other proposals (for example, vouchers and charter schools) stress the possibility of improving student performance by exposing current administrative structures to competitive pressures. A behavioral assumption that often motivates both kinds of proposals is that many school districts are characterized by some form of bureaucratic malfeasance. Though this controversial assumption is widely held, there is little direct and unambiguous evidence that it is accurate. For instance, one of the most widely voiced criticisms of public schools is that they misallocate resources by directing too few "to the classroom."[1] Criticisms like this focus on how districts allocate available resources across different functions. However, most of the controversial empirical research on school quality examines the effects of additional resources without much attention to how those resources are spent [for example, Burtless, 1996]. The present study is motivated by the notion that modeling within-district decisions regarding the allocation of expenditures might generate more robust and convincing insight into the relationship between school expenditures and student achievement.

More specifically, this research explores the widely held assumption that school districts allocate too few of available resources to student instruction. This view of school district behavior closely parallels Williamson's [1963] "expense preference" model of managerial discretion in regulated firms. The managers of school districts are typically thought to exhibit a relative preference for non-instructional resources that reflects their self-interest or a persistent ignorance about the efficacy of such resources in promoting student achievement. In this study, I present evidence on whether school districts are characterized by expense preference. The first test parallels the empirical literature on expense preference in regulated firms and consists of evaluating the responsiveness of the allocation of school resources to the presence of competition. If expense preference exists, competition should limit the ability of school district managers to spend outside the classroom. However, because the composition of spending

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in public schools may also affect the demand for private schools, ordinary least-squares (OLS) estimates may lead to biased estimates. Therefore, both OLS and two-stage least-squares (2SLS) estimates of the effect of competition on the allocation of public school resources are presented. These estimates, which are based on the 10,188 unified school districts in 47 states, indicate that increased competition does lead some school districts to allocate more of their available funds to student instruction.

I then discuss the extensive literature on educational production functions and its controversial interpretation that there is no relationship between school expenditures and student achievement. This body of research is widely interpreted to imply that public schools exhibit production inefficiency and that additional outlays will not increase student achievement. However, the existence of expense preference suggests that this traditional educational production function is misspecified. This misspecification is characterized not just by the frequent omission or aggregation of non-instructional resources but also by the simultaneous determination of the allocation of resources and the level of student achievement. I present estimates of educational production functions that suggest that both of these specification issues are important. These evaluations are based on a unique data set that contains, for the unified school districts in 18 states, a consistently defined high school graduation rate as well as a variety of data on the characteristics of the students, parents, districts, and communities.

Conventional OLS specifications based on these data suggest that resource levels have little or no effect on the level of student achievement in these districts. However, 2SLS estimates indicate that the level of instructional spending is a highly effective determinant of student achievement when conditioned on the decision to spend on less effective functions outside the classroom. These results have important policy implications. In particular, they suggest that both sides of the "Does money matter?" debate may, in an important sense, be correct. On the one hand, school districts appear to be inefficient. This production inefficiency seems consistent with the hypothesis of expense preference. However, an econometric approach that recognizes the joint dependence of the allocation of resources and the level of student achievement also contradicts some of the previous literature and finds that additional instructional spending can generate improvements in the level of student achievement in public schools. These results are consistent with the recent evidence from Tennessee's class-size experiment, which generated an isolated increase in instructional resources that increased student achievement [Krueger, 1999].

THE EXISTENCE OF EXPENSE PREFERENCE

The dramatic, long-term growth in the amount of real per-pupil resources devoted to public elementary and secondary education is an increasingly well-known stylized fact. Hanushek [1996] notes that, from 1890 to 1990, real expenditures per pupil rose at a fairly stable annual rate of around 3.5 percent.[2] By contrast, the decline in the share of available resources spent directly on instruction is less well documented. The historical data on staffing in public elementary and secondary schools indicate that, during the 1949-50 school year, there were roughly 2.4 teachers for every non-teaching employee. By the fall of 1993, there were fewer than 1.1 teachers for every non-teaching

employee [U.S. Department of Education, 1995]. Unfortunately, the inconsistent and aggregated historical data on resource allocations make it difficult to characterize these intriguing changes fully.[3] Nonetheless, the trend towards increased spending "outside the classroom" is consistent with conventional criticisms of public schools. Since this trend could also represent a rational institutional response to some deteriorating socioeconomic priors or the changing goals of public schools, however, it could be misleading. This section presents less ambiguous evidence on whether the allocation of available resources in public schools is consistent with the hypothesis of expense preference.

Competition and Expense Preference

The specification of a utility function for firm managers that includes personal goals as well the profit motive has been a provocative development in the theory of the firm [Alchian and Kessel, 1962; Becker, 1957; Baumol, 1967]. The theory of expense preference [Williamson, 1963] is a version of these models that has received some attention, particularly in the context of regulated industries. Williamson [1963] developed a model in which firm managers receive utility from profits and from "staff expense, managerial emoluments and funds available for discretionary use." A central implication of this model is that firms with managerial discretion will choose levels of these preferred expenditures in excess of their profit-maximizing levels. Edwards [1977] noted that an additional implication of this theory is that a firm with discretionary management that faces little competition will have a greater opportunity to indulge in preferred expenditures than similar firms in more competitive markets. Based on this observation, Edwards [1977] tests the expense preference hypothesis for the banking industry by estimating the responsiveness of the preferred expenditures to an index of the firm's monopoly power. The expense preference hypothesis is supported since the preferred expenditures increase with monopoly power.

A similar test of the expense preference hypothesis would appear to be appropriate for school districts. As public agencies, school districts are regulated entities that may have considerable scope for managerial discretion. Furthermore, some school districts may face little or weak competition. The hypothesis of expense preference can be tested by estimating how the level of competition in state s and county c, P_{sc}, affects S_{sci}, the non-instructional expenditure share for district i. More specifically, the equation of interest is:

$$S_{sci} = \mathbf{W}_{sci}\Pi + P_{sc}\gamma + \mu_s + \varepsilon_{sci}\,, \tag{1}$$

where $\mathbf{W}_{sci}$ is a vector of student, parent, and community characteristics likely to affect how school districts allocate resources, μ_s is a state-specific effect, and ε_{sci} is a mean-zero random error. The measure of the competition faced by each school district, P_{sc}, has been defined as the proportion of all students within district i's state and county that are enrolled in private schools.[4] The hypothesis of expense preference is supported if an increase in competition reduces the share of resources spent "outside the classroom."

There is a countervailing reason that increases in P_{sc} are likely to increase the non-instructional share, S_{sci}. This is because many non-instructional costs, particularly

those associated with administration, are relatively fixed. As more students attend private schools, there is less opportunity for districts to recoup the fixed costs associated with running a school district. Educational authorities in Texas recognized that "expenditure patterns vary with enrollment differences" [Lewis, 1994]. The 1993 Texas statute that limits administrative expenditures allows the smallest districts to spend as much as 36 percent of what is spent on instruction on administration whereas the largest districts can only spend on administration 11 percent of what is spent on instruction. This issue raises the possibility that the effect of competition on resource allocation is nonlinear. This possibility is addressed by including a quadratic term for P_{sc} in estimates of Equation (1).

Another important specification issue is that the popularity of private schools may not be independent of the spending decisions made by neighboring public schools [Hoxby, 1994]. For example, if parents do not value higher shares of non-instructional spending, some may decide that private schools are more attractive. This simultaneous determination would bias OLS estimates of Equation (1) against the hypothesis of expense preference. Because of this potential simultaneity, 2SLS estimates of γ are also presented. The identification strategy for the 2SLS models exploits the variation in P_{sc} generated by variation in the county-specific population concentration of Catholics. More specifically, the first-stage equation is

$$P_{sci} = \mathbf{W}_{sci}\Omega + \mathbf{C}_{sc}\delta + \mu_s + \nu_{sci}\,, \tag{2}$$

where $\mathbf{C}_{sc}$ is a vector of instrumental variables based on the population share of Catholics.[5] The i subscript is included to indicate that school districts are the unit of observation in these regressions. The estimates of Equations (1) and (2) presented here are based on data from the 10,188 unified school districts in 47 states.[6] A final specification concern is that, because the school districts are of varying sizes, the error terms in Equations (1) and (2) might be heteroskedastic. Therefore, corrected standard errors [White 1980, 1982] are reported.

Data

Much of the data employed in this study comes from the National Center for Education Statistics' (NCES) Common Core of Data (CCD). The CCD is a "comprehensive, annual, national statistical database of all public elementary schools and school districts, which contains data that are comparable across states." Data on instructional and non-instructional spending in each district have been drawn from the Census Bureau's 1991-92 Survey of Local Government Finances (F33), which is included among the current CCD files and contains the most current and comprehensive detail on the level and allocation of educational expenditures. The NCES divides nearly all current operating expenditures broadly between instruction and support services [Fowler, 1990]. Instructional spending refers to all activities "dealing directly with the interaction between teachers and students." Support services encompass current expenditures for several different activities "designed to enhance instruction." Non-instructional expenditures have been defined as expenditures for support services, excluding those funds spent on student transportation, plant operation, and maintenance.[7] More specifically,

the functional categories that do constitute non-instructional expenditures include the administration of schools and districts, the supervision and development of instruction, and a variety of support services for pupils. The construction of this variable is intended to identify spending that, at the margin, could have but did not "reach the classroom." The amount of current spending on these non-instructional items is not trivial. On average, the non-instructional expenditure share, S_{sci}, is 23.4 percent. This measure exhibits considerable variation with a minimum of 9.1 percent, a maximum of 68.8 percent, and a standard deviation of 4.4 percent. However, the determinants and consequences of this variation in the allocation of expenditures have been ignored by research that assumes that school districts are fully characterized by their level of available resources.

The measure of competition from private schools, P_{sc}, is based on enrollment data from the 1991-92 CCD and from the NCES' 1991-92 Private Schools Survey (PSS). The 1991-92 PSS is a universe survey comparable to the CCD for public schools. Data on the proportion of a county's population that is Catholic were constructed using population data from the 1980 Decennial Census and data on the Catholics from the Association of Statistics of American Religious Bodies (ASARB).[8] The allocation of expenditures and the success of private schools may also be influenced by socioeconomic priors, $\mathbf{W}_{sci}$.[9] The CCD includes a broad range of appropriate covariates taken from the 1990 Decennial Census and defined by public school district boundaries. Included among these variables are the median household income in households with children, the reported race of children within a school district, and the educational attainment of householders in a district. Two relatively unusual regressors that reflect the likelihood of a child to do well in school are also included: the percent of children who do not speak English well and the percent of school-age children who are defined as "at risk." An "at-risk" child lives with a mother who is not a high school graduate, who is divorced or separated, and who is below the poverty line. $\mathbf{W}_{sci}$ also includes six dummy variables that reflect the degree of urbanicity in the school district. Table 1 contains summary statistics for the key variables in Equations (1) and (2).

TABLE 1
Summary Statistics: Unified School Districts in 47 States

Variable	Mean (Std. Dev.)	Min.	Max.
Non-Instructional Expenditure Share	23.4% (4.4)	9.1%	68.8%
Instructional Expenditures Per Pupil	$3,024 (1040)	$810	$17,609
Non-Instructional Expenditures Per Pupil	$935 (414)	$210	$7,313
County Students in Private School	7.3% (7.4)	0%	58.8%
Catholic in County	17.5% (16.3)	0%	100%
Non-White Children	12.0% (17.5)	0%	100%
Children At Risk	2.8% (3.5)	0%	38.4%
Children Who Speak English "Not Well" or "Not At All"	0.9% (2.0)	0%	80.0%
Householders with High School Degree or Less	62.6% (14.5)	3.1%	100%
Householders with Some College	22.2% (3.5)	0%	38.4%
Log of Median Income in Households with Children	10.4 (0.3)	8.5	11.8

TABLE 2
OLS and 2SLS Estimates: Non-Instructional Expenditure Share Equation

	Model (1)		Model (2)	
Variables	OLS	2SLS	OLS	2SLS
% County Students in Private School	.014	–.008	.040	.162
	(2.42)	(0.45)	(3.10)	(2.08)
% County Students in Private School Squared	—	—	–.092	–.660
			(2.40)	(2.05)
% Nonwhite Children	.034	.034	.033	.033
	(9.22)	(9.11)	(9.09)	(8.78)
% Children At-Risk	–.002	–.002	–.004	–.010
	(0.13)	(0.10)	(0.21)	(0.52)
% Children Who Speak English "Not Well" or "Not At All"	–.001	–.0004	–.002	–.004
	(0.04)	(0.02)	(0.08)	(0.18)
% Householders with High School Degree or Less	–.048	–.048	–.049	–.052
	(9.14)	(9.14)	(9.22)	(9.19)
% Householders with Some College	–.051	–.051	–.053	–.066
	(5.28)	(5.30)	(5.43)	(5.38)
Log of Median Income in Households with Children	–.002	–.002	–.003	–.004
	(0.77)	(0.59)	(1.00)	(1.35)
R^2	.361	.361	.361	.356
Test of Overidentifying Restrictions	—	5.76	—	1.35

Notes: Heteroskedastic-consistent [White, 1980, 1982] absolute values of t-statistics are reported in parentheses. Regressors included but not reported are an intercept, state dummy variables, and six dummy variables for the degree of urbanicity. The statistic for the test of overidentifying restrictions is distributed as a chi-squared [Newey, 1985]. The 95 percent critical value is 7.82 for the first 2SLS regression, which has 3 degrees of overidentification. For the last 2SLS regression, which has 2 degrees of overidentification, the critical value is 5.99. In both models, we cannot reject the null hypothesis that the model is correctly specified.

Identification Strategy

In order for 2SLS estimation to generate consistent estimates of the effect of private school competition on the allocation of resources, the instrumental variables must be exogenous determinants of the presence of private schools that are rightfully omitted from Equation (1). The population share of Catholics is likely to satisfy both criteria [Evans and Schwab, 1995; Hoxby, 1994]. Conditional on other socioeconomic covariates, the population share of Catholics is driven by historical events and should be uncorrelated with how public schools currently spend available funds. Furthermore, the concentration of Catholics should be a strong determinant of the demand for private schooling. In the 1993-94 school year, roughly 51 percent of private school enrollment was in Catholic schools [U.S. Department of Education, 1995]. A high proportion of Catholics also implies increased availability of private schooling. In densely Catholic areas, the costs of establishing private schools are reduced through several mechanisms [Hoxby, 1994]. Church fund-raising reduces the cost of tuition in Catholic schools. Scale effects can also reduce the costs of Catholic schools through savings on transportation, various fixed costs, and the availability of religious and volunteer staff.

Instrumental variables for the level of competition from private schools were formed by ranking school districts, in descending order, by the proportion of the county population that is Catholic. The instrumental variables are the four dummy variables associated with each quintile.[10] First-stage estimates of Equation (2), which are not

reported here, indicate that the population concentration of Catholics has a large and statistically significant effect on the popularity of private schools. For example, P_{sc} in counties with the lowest concentration of Catholics is over 9 percentage points lower than in counties with a high proportion of Catholics. Each of the four instrumental variables is a statistically significant determinant of P_{sc}; no t-statistic has an absolute value of less than 16. Furthermore, these precisely measured effects are plausibly monotonic. Lower concentrations of Catholics imply significantly less competition from private schools.

Results

The results of estimating Equation (1) by OLS and 2SLS are reported in Table 2. The effects of socioeconomic characteristics on the allocation of school resources are mixed. Conditional on state and urbanicity dummies, neither the level of income, the proportion of children at-risk, nor the proportion of children not speaking English well has a statistically significant effect on the non-instructional expenditure share, S_{sci}. School districts with the most highly educated parents, however, spend significantly more of available resources on non-instructional support. Increases in the proportion of nonwhite children also imply that the non-instructional share is higher.[11]

The instrumental variables, $\mathbf{C}_{sc}$, perform well in the second stage. The test of overidentifying restrictions [Newey, 1985] cannot reject the null hypothesis, which states the model is correctly specified. Comparison of the OLS and 2SLS estimates of Models (1) and (2) implies that OLS underestimates the effect of competition in reducing the non-instructional expenditure share. The direction of this bias in Model (1) suggests that a high non-instructional expenditure share in public schools increases the attractiveness of private schools. A comparison of Models (1) and (2) also implies that the effect of private schools on the allocation of resources in public schools is highly nonlinear. When competition is low, increases in the proportion of students attending private schools raises the share of resources spent outside the classroom. This is consistent with the fact that non-instructional costs are relatively fixed and that low levels of competition may be less likely to curtail managerial discretion. However, once the share of county students attending private schools exceeds roughly 12 percent, increased competition implies that school districts spend more of available resources on instruction. This statistically significant effect is consistent with the hypothesis of expense preference. Over 20 percent of unified districts face such high levels of competition from private schools. Furthermore, these districts are responsible for educating nearly 34 percent of public school students. This responsiveness of resource allocations to competition suggests that some school districts are characterized by expense preference. Furthermore, these results imply that a misallocation of resources can be an equilibrium outcome in the absence of strong competition.

THE ENIGMA OF SCHOOL QUALITY AND AVAILABLE RESOURCES

Concern over the performance of public schools has motivated an extensive literature that has attempted to identify the structural effect of school resources on school quality. One widely held but still controversial interpretation of this literature is that

there is "no systematic relationship between school expenditures and student performance" [Hanushek, 1986]. The evidence used to buttress this conclusion has been based upon estimates of educational production functions:

$$Q = F(I, \mathbf{W}) . \tag{3}$$

The observed "output" in such evaluations, Q, is often performance on a standardized test. The "inputs" usually include a measure of the level of school resources, I, and those attributes of students, their families, and communities likely to affect achievement, $\mathbf{W}$. The measure of school resources is generally per-pupil expenditures or some determinant of instructional expenditures like pupil-teacher ratios, teachers' salaries, teachers' education, or teachers' experience.

Typically, those measures of school resources are poor predictors of student achievement when conditioned on $\mathbf{W}$. However, the stylized conclusion that traditional measures of school resources have no systematic relationship to school quality has not gone unchallenged. Several recent studies that use district-level data similar to that employed here report a partial correlation between resource levels and student achievement [Ferguson, 1991; Sander, 1993; Ferguson and Ladd, 1996]. Convincing evidence also suggests that targeted class-size reductions raise student achievement [Krueger 1999]. Similarly, a meta-analytic review of the literature on educational production functions concludes that there is a policy-relevant link between resource levels and student achievement [Hedges, Laine, and Greenwald, 1994]. One of the most widely discussed criticisms of traditional education production functions, however, has come from studies that define student achievement by labor market success rather than by test scores. Card and Krueger [1992] argue that test scores may be a poor proxy for student outcomes of interest like subsequent earnings. Furthermore, they demonstrate that state-level measures of school quality like pupil-teacher ratios and average teacher salaries appeared to have a substantive impact on the earnings of white males born between 1920 and 1949. Subsequent researchers have raised questions about the earnings/school resources link, however, and the traditional "Does Money Matter?" question is not a settled one [Burtless, 1996].

The ongoing controversy over the effect of resource levels on school quality has largely ignored how the allocation of resources to particular functions relates to achievement. Adherents of the position that "money does not matter" argue that schools must be inefficient since they "pay for attributes that are not systematically related to achievement." Proponents of this view, however, have not identified the nature of this inefficiency and argue that, in the presence of such uncertainty, the appropriate policy response is a system of output-based incentives for schools. For example, Hanushek [1991] recommends that "one might simply give up on the idea of being able to identify the relevant inputs and to design policies that directly altered these inputs. Instead policies could be developed that keyed on performance, regardless of how that was produced." A better understanding of whether and how school districts are inefficient, though, could motivate a first-best reform of public education. Unfortunately, the traditional specification of educational production functions is ill-suited to identify the existence and nature of this inefficiency since it typically assumes that school districts are completely characterized by a single exogenous input. Many current reform proposals are based on testable assumptions about the nature of decision making within

school districts. An econometric approach that investigates these assumptions by modeling within-district behavior may offer more convincing and empirically robust policy guidance than the traditional specifications.

Bureaucracy and Achievement

Though many proposals focus on decision making within districts, there is remarkably little evidence on how these decisions affect school quality. In particular, there is little empirical evidence to support the widely held assumption of bureaucratic malfeasance and the quantitative evidence that does exist has several troubling features. The most widely known evidence on the relationship between school quality and bureaucracy comes from Chubb and Moe's [1990] controversial book. They demonstrated that an index of "good" school organization relates positively to test scores and that indices of administrative strength relate negatively to their index of good school organization. Several important concerns have been raised about this evidence.[12] Little attention has been paid, however, to a fundamental ambiguity of the partial correlations identified by Chubb and Moe [1990]. They took their results to mean that administrative strength lowers student performance; however, the partial correlations they identify are also consistent with the reasonable hypothesis that schools respond to poor student performance by increasing their administrative support. Chubb and Moe [1990], recognizing this ambiguity, discuss some conflicting evidence on the responsiveness of bureaucracy to performance and argue that the bias in their OLS estimates is not severe. They concede, however, that "the test is not definitive, for it is impossible to tell through individual equations what a system of simultaneous equations might reveal."

Other evidence on the relationship between bureaucratic behavior and school quality has been based on evaluating the effects of allocated resources. Anderson, Shughart and Tollison [1991] examine the variation in 48 observations of state-level test scores for public and private school students and high school completion rates among public school students. They find that the size of educational bureaucracies in terms of employment per pupil correlates negatively with educational achievement.[13] Based on these results, they conclude that there exists a "bureaucratic substitution effect" through which the size of educational bureaucracy causes poor student performance. There are several reasons to question whether these results will prove to be robust. Some of the more obvious criticisms of these models concern the limited observations and the failure to condition their results upon the broad set of socioeconomic and community characteristics traditionally employed in this literature. More troubling is that the socioeconomic covariates that are included [that is, state per-capita income and the ratio of urban to rural population] are poor predictors of their achievement measures. This directly contradicts perhaps the only point upon which there has been substantial agreement in the literature modeling student achievement. A more fundamental problem with this result, however, is that, because the composition of resources may be determined endogenously, the partial correlations identified by such OLS estimates could be misleading.[14] For instance, it may be that school district managers increase non-instructional support in response to poor student performance. This response would produce a downward bias in the OLS estimate of the effect of non-instructional

resources on achievement. Brewer [1996] finds that the relationship between administrative spending and student achievement is sensitive to such model specifications.[15]

Expense Preference in School Districts

The model of bureaucratic behavior implicit in many reform proposals is that school districts, motivated by either self-interest or persistent ignorance, choose an inefficient mix of inputs.[16] A testable implication of this controversial hypothesis can be identified by specifying an educational production function that includes per-pupil non-instructional inputs, N:

$$Q = F(N, I, \mathbf{W}) . \tag{4}$$

Under the hypothesis of expense preference, the managers of school districts receive utility not just from the level of achievement, Q, but also from the levels of resources, N and I:

$$U = U(N, I, Q) . \tag{5}$$

The hypothesized preference for non-instructional resources implies that $U_N > U_I$. In deciding how to allocate expenditures, the level of available resources is considered to be exogenous:

$$E(\mathbf{Z}) = N + I . \tag{6}$$

The variable $\mathbf{Z}$ represents variables that are exogenous determinants of the amount of resources available to a district. Maximizing Equation (5) over N subject to Equations (4) and (6) yields the following first-order condition:

$$U_N - U_I = -U_Q(F_N - F_I) . \tag{7}$$

The main implication of the preference for non-instructional inputs ($U_N > U_I$) is that too few resources are spent on instruction. Assuming diminishing returns in the production function, the use of too few instructional resources implies a testable hypothesis: marginal products such that $F_N < F_I$. In other words, school districts that exhibit expense preference will not equate the marginal product of instructional and non-instructional inputs as a social planner would. An important but less obvious implication of this model is that the equilibrium levels of N, I, and Q are all determined simultaneously.

In the next section, the key prediction of this model is tested by generating OLS and 2SLS estimates of the educational production functions in Equations (3) and (4). More specifically, the empirical strategy employed is to use $\mathbf{Z}$ to identify the structural effects of N and I on the level of student achievement. Little can be said, *a priori*, about the direction of bias in OLS estimates of the educational production functions in Equations (3) and (4). However, the conventional finding that "money doesn't matter" in estimates of Equation (3) could be consistent with the existence of expense preference. Estimates of the effect of instructional resources would be biased downward if they have a positive covariance with omitted and less effective non-instructional spending.

In other words, studies that find no effect of per-pupil expenditures on achievement may have confounded the very different effects of resources spent inside and outside the classroom. OLS estimates of Equation (4) could also lead to biased inferences in the presence of expense preference. For example, it is plausible that OLS estimates of Equation (4) would underestimate the effectiveness of instructional resources as well as overestimate the effect of non-instructional resources. This would occur if managers have increased scope for discretionary spending outside the classroom in districts where students are performing well. The results reported in the next section suggest that both of these potential biases are important.

SCHOOL RESOURCES AND HIGH SCHOOL COMPLETION

This section presents a unique data set that is used to generate OLS and 2SLS estimates of the educational production functions in Equations (3) and (4). A central question is whether or not the model of expense preference can generate new insights into the relationship between resources and student outcomes. The educational outcome to be modeled is a district-level high school graduation rate based on data from the CCD. In the first stage of the 2SLS models, reduced-form equations for the variables N and I are estimated. The construction of N and I was discussed earlier. The first-stage equations for district i in state s take the following form:

$$\ln(N_{si}) = \mathbf{W}_{si}\Omega + \mathbf{Z}_{si}\delta + \mu_s + \xi_{si}\,, \tag{8}$$

$$\ln(I_{si}) = \mathbf{W}_{si}\Delta + \mathbf{Z}_{si}T + \nu_s + \omega_{si}\,. \tag{9}$$

As in the earlier evaluations, $\mathbf{W}_{si}$ is a vector of variables reflecting the socioeconomic priors of district i in state s. The variable $\mathbf{Z}_{si}$ represents a vector of instrumental variables that are discussed in a subsequent section; μ_s and ν_s represent state fixed effects. Log transforms of the independent variables in Equations (8) and (9) have been employed only when there are non-zero observations for those variables.

The predicted values from Equations (8) and (9) have been used in second-stage models of some educational production functions. The reported specification for the educational production functions is log-linear.[17] More specifically, the estimated production function takes the following form:

$$\ln(Q_{si}) = \alpha\ln(N_{si}) + \beta\ln(I_{si}) + \mathbf{Z}_{si}\Pi + \mu_s + \varepsilon_{si}\,. \tag{10}$$

Given this functional form, estimates of α and β can be interpreted as the elasticities of student achievement with respect to non-instructional and instructional expenditures. The hypothesis of expense preference is supported if the marginal product of instructional expenditures implied by β is greater than the marginal product of non-instructional expenditures implied by α.[18] OLS and 2SLS estimates of traditionally specified educational production functions (that is, excluding N or combining N and I) are also presented. Heteroskedastic-consistent standard errors are reported for all models [White, 1980,1982]. Summary statistics for all the key variables are reported in Table 3.

TABLE 3
Summary Statistics: Unified School Districts in 18 States

Variable	Mean (Std. Dev.)	Minimum	Maximum
Graduation Rate	88.1% (9.4)	46.9%	100.0%
Instructional Expenditures Per Pupil	$3,255 (1219)	$1,492	$17,609
Non-instructional Expenditures Per Pupil	$978 (425)	$295	$5,801
Nonwhite Children	12.4% (17.2)	0%	100%
Children At-Risk	2.9% (3.7)	0%	29.9%
Children Who Speak English "Not Well" or "Not At All"	1.3% (2.4)	0%	34.1%
Householders with High School Degree or Less	61.5% (15.3)	7.5%	100%
Householders with Some College	22.4% (6.9)	0.0%	50.7%
Log of Median Income in Households with Children	10.5 (0.4)	8.9	11.8
1982 County-Level Expenditures Per Person on Parks and Recreation	$12 (12)	$0	$152
1982 County-Level Expenditures Per Person on Streets and Highways	$61 (44)	$5	$450
1982 County-Level Expenditures Per Person on Public Buildings	$7 (5)	$0	$59
1982 County-Level Expenditures Per Person on General Control	$25 (16)	$0	$291
Court-Mandated Education Finance Reform	0.21 (0.41)	0	1.00

High School Completion

One controversial feature of much of the prior literature relating resources and achievement has been the use of test scores as a measure of student achievement. What such tests actually measure and whether students take them seriously is of general concern. More importantly, higher test scores appear to have only a modest impact on economic outcomes like wages [Hanushek, Rivkin and Jamison, 1992]. In contrast, the economic consequences of educational attainment are well-known. In particular, it has been shown that high school completion is associated with significantly higher wages and an increased likelihood of employment [Markey, 1988; Murphy and Topel, 1987; Levy and Murnane, 1992]. The educational outcome modeled here is a district-level high school completion rate. The 1993-94 CCD files contain dropout data by school district and by grade for 18 states that report dropouts according to a consistent definition. More specifically, according to this definition, a dropout is a student who was enrolled at any time during a particular school year and was not enrolled in October of the next school year and had not graduated or transferred and was not absent due to temporary disciplinary action. The student outcome modeled in this chapter is the district-level high school graduation rate implied by these dropout data and the corresponding enrollment data. The final data set consists of the 4,159 unified school districts that are operational in the 18 states that use this definition.[19] The graduation rate implied by these data does not track a single cohort but instead reflects, not unlike a moving average, the rate of grade completion by four cohorts. Given the number of dropouts from grade j of district i, D_{ij}, and the fall enrollment in that same grade and district, E_{ij}, a grade completion rate can be formed as:

$$G_{ij} = \left[\left(E_{ij} - D_{ij}\right)/E_{ij}\right] \in [0,1].$$

Since each grade completion rate is conditional on having arrived at that grade, an implied high school graduation rate for a district can be calculated as the product of four grade completion rates:

$$Q_{ij} = \prod_{j=9}^{12} G_{ij} \in [0,1].$$

This graduation rate has a mean of 88.1 percent and ranges from 46.9 percent to 100 percent. Because this measure of educational attainment is defined by the schooling decisions made by school-age teens, those who eventually go on to obtain high school equivalencies are not identified as graduates. Some evidence suggests that this construction is appropriate [Cameron and Heckman, 1993].

Identification Strategies

Because the allocation of expenditures and the level of student achievement may be determined endogenously, identifying the effect of expenditures on student achievement requires instrumental variables that influenced expenditures but can be rightfully omitted from a structural equation modeling student achievement. The models presented here rely on two sets of instrumental variables. One set is based on court-mandated education finance reform. Between 1971 and 1992, legal challenges to systems of education finance based on property taxes had been mounted in 42 states.[20] In 12 of those states, the Supreme Court ruled that the system of education finance was unconstitutional. Recent research has shown that these rulings had a dramatic effect on the availability of educational resources within "reform" states [Evans, Murray, and Schwab, 1997; Card and Payne, 2002; Murray, Evans, and Schwab, 1998]. For example, Evans, Murray, and Schwab [1997] conclude that "court-mandated reform of school finance systems significantly reduces within-state inequality in expenditures" through higher state taxes whose revenues were directed to a state's poorest districts.

The court rulings on the constitutionality of the system of education finance provide a plausibly exogenous source of variation in school expenditures. Generally, even in reform states, districts that spent little on education continue to spend little. Conditional on having been a low-spending district, however, the interaction of being in a reform state and having been a low-spending district is an exogenous determinant of current expenditures. More specifically, a school district that had few resources before court-mandated reform of the education finance system is likely to have more afterward. Furthermore, controlling for a district's pre-reform within-state expenditure ranking and state effects, this change in a district's current spending is attributable to the interpretation of state constitutions by state courts and should therefore be orthogonal with the current level of student achievement in the district.

States experiencing court-mandated education finance reform are well represented in this data set. Five of the 18 states in this data set (Arkansas, California, Kansas, Kentucky, and Texas) have had their system of education finance declared unconstitutional.[21] The reform states contain 21 percent of the school districts in this data set. Four instrumental variables have been constructed by interacting an indicator for court-mandated reform with dummy variables representing the within-state quintile

ranking of a school district's current expenditures for the 1976-77 school year.[22] These expenditures predate the first successful property tax revolt and the movement towards equalizing school resources in the reform states. The expectation is that districts that spent little before the impact of reform currently spend more. First-stage estimates of Equations (8) and (9), which are reported in Table 4, confirm the impact of court-mandated education finance reform on school spending. For example, a district that spent the least within its state in the fall of 1976 and is located in a reform state now spends 8.4 percent more on instruction and 11.4 percent more on non-instructional support than a similar district in a state without reform (Models (1) and (4)). These effects are statistically significant. Other things being equal, school districts in reform states that spent little before the court-mandate (that is, those in the third, fourth, and fifth quintiles) now have significantly higher expenditures.

TABLE 4
First-Stage Estimates: Log Expenditures Per Pupil Equation

	Instructional			Non-Instructional		
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Court Mandate*Quintile 2	.0330	—	.0375	.0041	—	.0078
	(1.60)		(1.84)	(0.14)		(0.26)
Court Mandate*Quintile 3	.0831	—	.0874	.0759	—	.0795
	(4.08)		(4.35)	(2.67)		(2.82)
Court Mandate*Quintile 4	.0879	—	.0899	.1052	—	.1034
	(4.33)		(4.50)	(3.78)		(3.75)
Court Mandate*Quintile 5	.0835	—	.0896	.1140	—	.1151
	(3.90)		(4.27)	(3.86)		(3.91)
1982 County-Level Expenditures Per	—	.0010	.0009	—	.0017	.0016
Person on Parks and Recreation		(3.13)	(2.94)		(3.67)	(3.44)
1982 County-Level Expenditures Per	—	.0003	.0003	—	.0000	.0000
Person on Streets and Highways		(3.42)	(3.55)		(0.09)	(0.32)
1982 County-Level Expenditures Per	—	.0027	.0028	—	.0043	.0044
Person on Public Buildings		(3.65)	(3.98)		(3.96)	(4.14)
1982 County-Level Expenditures Per	—	.0005	.0005	—	.0008	.0008
Person on General Control		(1.90)	(1.94)		(2.07)	(2.04)
R^2	.819	.822	.823	.695	.698	.700

Notes: Heteroskedastic-consistent [White, 1980] absolute values of t-statistics are reported in parentheses. Regressors included in the first stage but not reported are an intercept, log of median family income, percent of children nonwhite, percent householders with a high school degree or less, percent householders with some college, percent of children at-risk, percent of children who speak English "not well" or "not at all", state dummy variables, six dummy variables for the degree of urbanicity, and four dummy variables for within-state quintile ranking in 1976-77 current expenditures per pupil.

A second set of instrumental variables for school spending is based on the Tiebout hypothesis. Charles Tiebout's [1956] seminal article on local public goods outlines how the mobility of citizens can yield an equilibrium in which the provision of local public goods "reflects the preferences of the population." In choosing where to live, a voter, like the consumer of a private good, will reveal his preferences by selecting the tax and expenditure combinations most to his liking given his budget constraint. This self-sorting of citizens according to their "preference pattern for public goods" provides another potentially valid set of instruments for educational spending. The determinants of the demand for local public goods will include not only the level of wealth

within a community but also the unique taste for such goods among its citizens.[23] The taste for local public goods that is independent of other demand determinants is, theoretically, a valid instrument: it should explain variation in expenditures for a local public good like education but be omitted from a structural model of student achievement.

Public education is a classic Tiebout good in that it is an important determinant of the location decision for many home buyers and renters. Other local public goods are likely to matter as well, however. Tiebout [1956] noted that "the availability and quality of such facilities and services as beaches, parks, police protection, roads, and parking facilities will enter into the decision-making process." This study uses the levels of spending on such non-educational public goods—conditional on other demand determinants—as proxies for a community's idiosyncratic taste for local public goods and as instruments for the level of educational spending in a school district. Data for non-educational per capita expenditures have been drawn from the county-area file of the 1982 Census of Governments. The county-area file aggregates by function expenditures by all governments within a county. These models employ four instrumental variables: the 1982 current operating expenditures per person on parks and recreation, streets and highways, general public buildings, and general control. The decade lag in these non-educational expenditures is appropriate since the long-term Tiebout characteristics of a community can still be identified, while the lag implies it is less likely that these expenditures are generating services or capturing unobserved socioeconomic conditions that could affect more recent educational achievement. Given that many studies are unable to demonstrate a partial correlation between contemporaneous educational expenditures and achievement, however, the reasonable concern that these lagged non-educational expenditures could be correlated with student achievement may be overdrawn.[24] Table 4 reports how these instruments perform in first-stage models. The coefficients on all four variables in each model are positive. This is consistent with the theoretical motivation for these instruments since it shows that communities that, *ceteris paribus*, spend more on non-educational local public goods will also choose to spend more on education. Controlling for other demand characteristics, the levels of non-educational local public goods are jointly significant determinants of educational spending. Except for "Streets and Highways" expenditures in the first-stage equation for non-instructional expenditures, each of these variables is individually significant as well.

Results

OLS and 2SLS estimates of traditional education production functions are reported in Table 5. These specifications only address the impact of resource levels on student achievement. Like prior research on student attainment, the results consistently indicate that student, family, and community characteristics are strong predictors of educational achievement. Districts whose students come from wealthier families or have more educated parents have higher graduation rates. For example, a 10 percent increase in median income implies an increase in the graduation rate of roughly 0.3 percent. Districts whose children are nonwhite, at-risk, or do not speak English well have lower graduation rates. An increase of 10 percentage points in the proportion of children at-risk implies the graduation rate falls by nearly 6 percent.[25]

TABLE 5
OLS and 2SLS Estimates: Log of High School Graduation Rate Equation

Variables	OLS (1)	2SLS (2)	2SLS (3)	OLS (4)	2SLS (5)	2SLS (6)
Log of Instructional Expenditures Per Pupil	.044 (3.86)	.107 (1.48)	–.036 (0.27)	—	—	—
Log of Non-Instructional and Instructional Expenditures Per Pupil	—	—	—	.047 (4.23)	.085 (1.30)	–.059 (0.48)
% Nonwhite Children	–.077 (4.16)	–.081 (4.19)	–.071 (3.52)	–.075 (4.24)	–.082 (4.16)	–.068 (3.14)
% Children At Risk	–.573 (6.58)	–.562 (6.38)	–.587 (6.54)	–.577 (6.61)	–.571 (6.52)	–.587 (6.63)
% Children Who Speak English "Not Well" or "Not At All"	–.490 (4.43)	–.484 (4.40)	–.497 (4.44)	–.493 (4.47)	–.492 (4.48)	–.495 (4.40)
% Householders with High School Degree or Less	–.106 (5.21)	–.089 (3.11)	–.128 (3.04)	–.103 (5.03)	–.090 (3.05)	–.138 (3.00)
% Householders with Some College	–.199 (5.75)	–.155 (2.53)	–.255 (2.58)	–.194 (5.57)	–.166 (2.76)	–.274 (2.77)
Log of Median Income in Households with Children	.030 (3.04)	.029 (2.98)	.030 (3.06)	.029 (3.03)	.029 (2.99)	.030 (3.06)
R^2	.334	.332	.331	.334	.332	.331
Test of Overidentifying Restrictions	—	4.16	8.73	—	4.99	8.73

Notes: Heteroskedastic-consistent [White, 1980, 1982] absolute values of t-statistics are reported in parentheses. All models include an intercept, state dummy variables, six dummy variables for the degree of urbanicity, and four dummy variables for within-state quintile ranking in 1976-77 operating expenditures per pupil. Models (2) and (5) are identified by the non-educational expenditures. Models (3) and (6) are identified by court-mandated education finance reform. The statistic for the test of overidentifying restrictions is distributed as a chi-squared [Newey, 1985]. The 95 percent critical value is 7.82 for these 2SLS regressions, which have 3 degrees of overidentification.

The OLS estimates presented in Models (1) and (4) also suggest that resource levels might have a statistically significant impact on the graduation rate. For example, the elasticity of the graduation rate with respect to current per-pupil operating expenditures (Model (4)) is 0.047. Other recent research using similar district-level data and OLS models also report such partial correlations [Ferguson, 1991; Sander, 1993; Ferguson and Ladd, 1996]. However, since these relationships are not robust to 2SLS estimation (Models (2), (3), (5), and (6)), these partial correlations may only reflect the presence of omitted variable bias. The 2SLS estimates of traditional production functions are consistent with prior research that finds small and statistically insignificant effects of resource levels on achievement.[26] Furthermore, these results also support recent research that argues that unobserved heterogeneity is an important specification issue when modeling the effect of resources on student achievement with aggregated data [Hanushek, Rivkin, and Taylor, 1996].

Table 6 presents OLS and 2SLS estimates of an education production function that disaggregates N and I. The OLS results for this production function (Model (1)) suggest that both instructional and non-instructional resources are somewhat effective in promoting student achievement. Furthermore, given these elasticities, the average levels of both expenditure categories are roughly consistent with a "social planner" view of school district behavior. More specifically, it is not clear, from OLS estimates, that non-instructional resources are overutilized by school districts. The model of expense preference presented in the previous section, however, suggests

that the misspecification in traditional estimates of educational production functions may stem not only from the exclusion or aggregation of some resources but also from the simultaneous determination of the level of student achievement and the allocation of resources. The 2SLS estimates reported in Models (2), (3), and (4) suggest that both specification issues are important. For example, the traditional production functions in Table 5 that exclude or aggregate expenditures appear to confound the very different effects of instructional and non-instructional resources. The simultaneous determination of student achievement and resource allocation also appears important. The OLS estimates of α and β in Model (1) underestimate the effect of instructional resources and overestimate the efficacy of non-instructional expenditures. The biases in these OLS estimates are consistent with the hypothesis that school districts with high student achievement also have increased managerial discretion to spend outside the classroom.

TABLE 6
OLS and 2SLS Estimates: Log of High School Graduation Rate Equation

Variables	OLS (1)	2SLS (2)	2SLS (3)	2SLS (4)
Log of Instructional Expenditures Per Pupil	.030	.422	.626	.469
	(2.12)	(2.00)	(1.37)	(2.40)
Log of Non-Instructional Expenditures Per Pupil	.016	–.261	–.508	–.327
	(1.75)	(1.78)	(1.60)	(2.36)
R^2	.335	.277	.203	.259
Class of Instruments				
1982 Non-Educational Government Expenditures		x		x
Court-Mandated Education Finance Reform			x	x
Test of Overidentifying Restrictions	—	0.42	2.91	4.99

Notes: Heteroskedastic-consistent [White, 1980, 1982] absolute values of t-statistics are reported in parentheses. Regressors included in the first stage but not reported are an intercept, log of median family income, percent of children nonwhite, percent householders with a high school degree or less, percent householders with some college, percent of children at-risk, percent of children who speak English "not well" or "not at all," state dummy variables, six dummy variables for degree of urbanicity, and four dummy variables for within-state quintile ranking in 1976-77 current expenditures per pupil. The statistic for the test of overidentifying restrictions is distributed as a chi-squared [Newey, 1985]. The 95 percent critical value is 5.99 for the first two 2SLS regressions, which have 2 degrees of overidentification. For the last 2SLS regression, which has 6 degrees of overidentification, the critical value is 12.59. In all three models, we cannot reject the null hypothesis that the model is correctly specified.

The 2SLS results suggest that the effects of instructional and non-instructional expenditures on student achievement are not trivial. For example, the results from Model (4), which includes both classes of instrumental variables, imply that the elasticity of the graduation rate with respect to non-instructional expenditures is not just small but significantly negative. An increase of 10 percent in per-pupil non-instructional expenditures implies that the graduation rate falls by 3.3 percent. These negative estimates are somewhat surprising. However, two points should be emphasized. First, it is important to recall that these estimates are point elasticities that describe only the marginal effect of such spending. Second and more importantly, these negative estimates could reflect the confounding influence of other, unobserved educational

practices that are positively related to non-instructional spending and that harm student achievement. For example, it may be that districts with high non-instructional spending engage in other management practices (for example, curriculum, hiring) that reduce school quality. To the extent that this interpretation is true, it suggests that the research focus on the effects of resources presents a somewhat misleading picture of the district behaviors that influence quality.

The results in Table 6 also suggest that, conditional on the effect of non-instructional spending, instructional resources have a strong effect on high school completion. A 10 percent increase in per-pupil instructional expenditures raises the graduation rate 4.7 percent. The effects in Models (2) and (3) are of similar magnitudes but less precise. While the 2SLS elasticities are large with respect to the OLS estimates, these results do not appear to be a specious result of instrumental variables estimation. Two very different classes of instruments generate this result and both classes of instruments perform well in the first and second stages. For each of the 2SLS models in Table 6, the test of overidentifying restrictions [Newey, 1985] cannot reject the null hypothesis that the model is correctly specified. Like the results presented earlier, these estimates lend support to the view that school districts exhibit an unproductive preference for non-instructional resources. The 2SLS elasticities imply that non-instructional resources are overutilized relative to instructional resources.[27] However, unlike like much of the literature that argues that public schools are inefficient, these results also indicate that public school districts do use some resources effectively. Resources spent by these districts on instruction appear to have a large and significant impact on achievement when properly conditioned on a district's allocative decision.

CONCLUSIONS

Although most educational reforms are motivated by concerns about district decision making, the traditional approach to educational production functions has assumed that school districts are simply characterized by a single resource level. The research presented here was motivated by the notion that modeling within-district decisions might generate more robust and convincing insight into the controversial relationship between school expenditures and school quality. More specifically, this research has explored the view that some school districts exhibit a relative preference for non-instructional expenditures. The results suggest that this widely held view is accurate: instructional resources are underutilized and school districts facing strong competition from private schools spend more of available resources on instruction.

These results have important policy implications. Adherents of the traditional view that "money doesn't matter" argue that, because school districts are inefficient, output-based incentives and an end to additional spending should be adopted. The estimates presented here do support the conventional wisdom that school districts do not use all available resources effectively. However, they also indicate that, *ceteris paribus*, the money that is spent on instruction does "matter." This suggests that additional spending that is targeted for student instruction can promote educational attainment. More generally, the existence of expense preference implies that appropriately designed institutional reforms, which reduce managerial discretion in school districts, could be preferred to output-based incentives that do not address the underlying source

of production inefficiency. Future research that articulates the testable implications of reform proposals and recognizes the simultaneity between school quality and the decisions made within school districts should provide more insight into these important questions.

NOTES

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1. This view has influenced policy. For example, a 1993 statute in Texas limits administrative expenditures to a fixed proportion of instructional expenditures [Lewis, 1994]. Similarly, the Chicago School Reform Act, which was enacted in 1988, was designed to constrain non-instructional costs [Hess, 1995].
2. Rothstein and Miles [1995] argue that this growth is overstated by the use of general price indices. They conclude, however, that, even with an appropriate index, the growth in resources devoted to public education has been "substantial."
3. Because special education has drawn an increased share of instructional dollars, however, the amount of new resources going to regular instruction may be particularly overstated by the overall expenditure growth [Rothstein and Miles, 1995; Lankford and Wyckoff, 1995].
4. The recent literature on competition and public school quality suggests that this is an appropriate construction [Hoxby, 1994; Dee, 1998]. An additional reason to focus on competition from private schools as opposed to that from other public schools is that plausible instrumental variables are more readily available.
5. The quality of this identification strategy is discussed in a subsequent section. A separate first-stage estimation was generated for the quadratic term, $(P_{sci})^2$.
6. Hawaii was excluded because it lacked within-state variation, Montana because it has no unified districts, and Wyoming because population data on Catholics were unavailable. The remaining school districts have a collective enrollment in excess of 33.7 million students. The focus on unified districts is appropriate since they are the majority of districts and share similar structures and goals.
7. The rationale for excluding these items is that it is not clear that they have a direct bearing on achievement, that the managers of school districts have an unusual preference for such items, or that there is much scope for discretionary spending on such items. Furthermore, unlike other support services, the proportion of resources spent on these items has declined slightly over the last several decades.
8. The data on the number of Catholics by county were drawn from a survey of over 200,000 congregations with total membership of nearly 115 million. See Quinn et al. [1982] for more information on these data.
9. *A priori*, it is unclear how certain socioeconomic characteristics should affect the allocation of resources. Both poor and wealthy districts might conceivably choose to spend more on non-instructional support.
10. School districts in the most densely Catholic counties were the reference. This approach creates four instrumental variables and overidentifies Equation (1) so that the orthogonality assumption can be formally tested.
11. The effects associated with race and parental education might seem contradictory. However, these results could reflect the fact that non-instructional spending is a fairly broad category that could mean different things in different communities. In less affluent, minority communities, non-instructional spending could involve social services and remedial support. In contrast, communities with relatively high levels of educational attainment may direct this spending towards different programs and amenities. In this context, however, the question seems to be moot; the inclusion of these covariates does not influence the key inferences.

12. One source of contention over Chubb and Moe's [1990] conclusions has been the selection and unusual transformation of an achievement measure. See Bryk and Lee [1992] and Elmore [1991] for extensive reviews of Chubb and Moe's [1990] research.
13. The magnitudes of these effects are not trivial. The elasticity of the high school completion rate to teachers per pupil is 0.26. With respect to nonteaching staff per pupil the elasticity is –0.17.
14. Anderson, Shughart, and Tollison [1991] consider the endogeneity of the pupil-teacher ratio, but they address the question of simultaneity by employing highly implausible instrumental variables (state per-capita income, average teacher salaries, and a dummy variable for whether a state had reformed high school graduation requirements since 1981). In a properly specified model, these variables should be highly correlated with achievement.
15. Brewer's [1996] estimations also employ instrumental variables (for example, adult educational attainment and level of owner-occupied housing), however, that have not traditionally been omitted from models of student achievement.
16. Models of expense preference are similar to models of "x-inefficiency." However, unlike some models of x-inefficiency [Frantz, 1988], agents are here assumed to be fully rational. These models are substantively different from Niskanen's [1971] model of bureaucracy, which assumes public agencies attempt to maximize observed output and budget size.
17. This specification facilitates a comparison with prior estimates. Furthermore, some research has argued that the relationship between student achievement and resources is nonlinear. The results presented here also emerge in linear and log-odds specifications. However, since Q_{si} = 100 percent for several districts, any log-odds specification is necessarily *ad hoc*.
18. If school districts equate the marginal products of N_i and I_i, it is straightforward to show that the following condition will hold: $\alpha = \beta(N_i/I_i)$.
19. The 18 states are Arizona, Arkansas, California, Connecticut, Delaware, Kansas, Massachusetts, Mississippi, Missouri, Nebraska, Nevada, New Mexico, New York, North Dakota, Oregon, Pennsylvania, Rhode Island, and Texas. Three hundred twenty-nine districts were deleted because they could not be matched to the 1976-77 F33 file. The motivation for this matching is discussed in the next section. This selection does not appear to be problematic since estimations with these data and the full data set replicate traditional findings.
20. The basis for these challenges was that systems of education finance that made available resources conditional on local wealth violated the "equal protection" clause of state constitutions. The California Supreme Court, in *Serrano v. Priest* (1971), was the first to find such a system of education finance unconstitutional.
21. Since a Texas ruling that overturned the system of education finance was as recent as 1991, however, Texas is not considered a "reform" state here. The second-stage results are robust to a changed definition but the first-stage estimates are more precise when Texas is not considered a reform state.
22. These expenditure data were drawn from the 1976-77 F33 file. The reference districts are those that spent the most in their state in the 1976-77 school year. In the subsequent estimations, the four indicators for the within-state expenditure ranking are included among the socioeconomic priors, $\mathbf{W}_{si}$.
23. Estimates of the demand for educational spending using survey data [Bergstrom, Rubinfeld, and Shapiro, 1982] emphasize that the individual characteristics typically omitted from aggregate data sets are significant demand determinants.
24. Furthermore, the test of overidentifying restrictions confirms that these variables can be omitted from educational production functions.
25. Because these data are aggregated to the district-level, however, these correlations could reflect the impact of a student's own priors and that of his peers [Lankford and Wyckoff, 1992].
26. However, the 2SLS estimates of the effect of the resource level that used the court mandates as instruments have to be interpreted with caution since the test of overidentifying restrictions fails at conventional levels of significance.
27. A test of the linear restriction ($\alpha = \beta(N_i/I_i)$) can be constructed using the chi-squared distribution [Judge *et al.*, 1985]. Using Model (9) and the mean levels of N_i and I_i, the test statistic is 5.84, which exceeds the critical value at standard levels of significance. The hypothesis that school districts allocate resources to equate the marginal products of N_i and I_i is rejected.

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