

Determinants of local school spending: Some consistent estimates

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Introduction

Of all examples of local public goods, none has been subjected to more empirical investigation than local school spending. Unfortunately, the variance of results is as broad as the literature itself. Denzau (1983) surveys 28 recent studies, re-estimating each model on a common dataset. He concludes that while the use of different datasets contributes to the variance of reported results, 'much of the variation . . . in the literature can be attributed to differences in specification.'

This paper uses a specific search technique to test the consistency of estimates of key parameters across a set of regressors chosen from the literature. The next section sets out the technique and explains how the set of regressors was chosen. The following sections present the results of the search and their implications for the theory of local school expenditures.

The search procedure

Economic theory suggests that price and income should be important determinants of the demand for education.¹ A large literature has also developed on the importance of intergovernmental aid.² In addition to these theoretically justified variables, researchers typically include other variables in their regression equations. Denzau found that 40 different variables were used in the studies he surveyed. The choice of these 'conditioning' (atheoretic) regressors is largely a matter of (1) data availability, (2) the prior beliefs of the researcher, and (3) the effect they may have on the key parameters of the model. The large number of different models in the literature indicates that there is no real consensus on the form of the 'true model.' Many of the extreme coefficient values reported may be due

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largely to idiosyncratic specifications. Thus, rather than choosing a single model through exploratory regressions or the imposition of prior beliefs, this paper presents a range of coefficient values derived from estimating a large number of 'reasonable' specifications. This methodology allows the researcher to accomplish three important goals. First, we can examine the robustness of the effects of the theoretically justified variables across specifications and establish upper and lower bounds on their possible values. Second, if any conditioning variables consistently cause extreme values of key coefficients, they can be isolated and examined. Third, we can investigate the range of coefficient values for the conditioning variables, looking for those that have consistent and tightly distributed effects.

The statistical technique, based on the work of Leamer and Leonard (1981), is straightforward. Median family income, marginal taxshare, and dummy variables for SMSA's are the core variables. These variables are included in every possible combination with twelve 'conditioning' variables taken from the literature. The conditioning set was chosen by the following criterion: of the 40 variables in the 28 models surveyed by Denzau, include all that were used by four or more researchers. The variables are defined in the appendix, which also gives summary statistics for the data. The technique requires 4096 regressions with each conditioning variable appearing 2048 times.³ In all cases the dependent variable is current per-pupil spending. The data are 506 unified (grades K-12) New York school districts in 1970-71.⁴

Key results

The range of coefficient estimates and elasticities for income and taxshare are presented in Table 1. Given the wide range of values reported in the literature, these estimates are encouraging. Both variables are consistent in

Table 1. Income and taxprice: Coefficients and elasticities

Variable	Minimum	Maximum	Mean	Standard deviation
Median family income	.019 (.204)	.044 (.472)	.032 (.343)	.0054 —
Median marginal taxshare	-314.66 (-.218)	-38.44 (-.027)	-172.22 (-.119)	83.61 —

N = 4096 Numbers in parentheses are elasticities at the mean.

sign and the income coefficient is distributed rather tightly around the mean of .032. The taxprice values are more loosely distributed, but most of this variation comes from specifications that included equalized assessed value per pupil (EQAVP).

Table 2 shows the effect this single variable has on the distribution of price coefficients and elasticities. Equalized assessed value per pupil effectively bifurcates the sample; the smallest elasticity (in absolute value) of the regressions excluding it exceeds the largest absolute value of those including it. Researchers have expressed concern about the small price effects often reported in empirical studies. We find the use of equalized assessed value per-pupil to be necessary and sufficient for achieving a small price elasticity. The 2048 specifications excluding it uniformly imply substantial price effects. Thus we find robust empirical confirmation of the significance of the two variables implied by economic theory: income and price.

Table 3 summarizes our results for inter-governmental aid. The two variables are Federal revenue per pupil and lump-sum state aid. The state aid variable is the type of grant often found to have 'flypaper' effects, where non-categorical aid generates higher spending effects than does community income. Two separate surveys of block grant effects, Fisher (1982) and Gramlich (1977) report a range of values from .03 to 1.61. This

Table 2. Taxprice coefficients and elasticities with and without EQAVP

Variable	Minimum	Maximum	Mean	Standard deviation
Median taxshare without EQAVP	-314.66 (-.218)	-196.64 (-.136)	-249.40 (-.173)	27.76 —
Median taxshare with EQAVP	-163.07 (-.113)	-38.44 (-.027)	-95.03 (-.066)	35.96 —

N = 2048 per row. Numbers in parentheses are elasticities at the mean.

Table 3. Inter-governmental aid coefficients

Variable	Minimum	Maximum	Mean	Standard deviation
State block grants per-pupil	.031	.237	.137	.055
Federal revenue per-pupil	-.123	.555	.245	.140

N = 2048 per row.

method shows that 2048 specifications all produce estimated effects in the low end of this range. The average state aid coefficient (.137) is larger than the average income coefficient (.032) indicating a modest flypaper effect. However, our procedure shows that even this effect is dependent on the presence of the same conditioning variable, EQAVP, that was found to be vital in determining the size of price elasticities. Table 4 shows the difference in the values of the state aid coefficients with and without equalized assessed value per pupil.

Block grant coefficients are distributed bimodally. The 1024 values without equalized assessed value are clustered tightly around the average value of .085 and the other half around its mean of .189, with no overlap between groups. Any hint of a flypaper effect is completely dependent on the inclusion of EQAVP. Considering the policy importance of accurately measuring aid effects and the widespread findings of flypaper phenomena in the literature, the appropriateness of equalized assessed value in the school spending equation becomes a crucial question. We will return to this issue when examining the range of coefficient values for this powerful variable. The other aid variable, Federal revenue per-pupil, is inconsistent in sign and widely distributed, regardless of the presence of EQAVP.

Table 4. State block grants with and without EQAVP

Variable	Minimum	Maximum	Mean	Standard deviation
State block grants without EQAVP	.031	.142	.085	.021
State block grants with EQAVP	.146	.237	.189	.017

N = 1024 per row.

Table 5. Non-public schooling coefficients

Variable	Minimum	Maximum	Mean	Standard deviation
% in private elementary	6.916	17.221	11.552	2.478
% in parochial elementary	-4.444	-.105	-2.415	.807

N = 2048 per row.

Effect of non-public schools

Fourteen of the studies surveyed by Denzau (1983) used the percentage of elementary students in private and parochial schools in their models. To the extent that public education has direct private benefits to students, higher levels of non-public schooling should, *ceteris paribus*, reduce demand for public education. Table 5 presents the results of the search technique.

Both variables are consistent across all specifications, but the private school effect is always positive. One reasonable explanation for this phenomenon is that the effect of the income distribution on spending is not exhaustively captured by median income. This would cause a variable such as private schooling to pick up some non-linear income effects, since it is likely to be strongly related to the skew or variance of the income distribution.

Other results

Table 6 reports the search results for the eight remaining regressors in the conditioning set. Two variables, median adult education level and percent of population who lived in another county five years ago, are inconsistent in sign and centered close to zero.⁵ Under the assumption that those who

Table 6. Additional conditioning variable coefficients

Variable	Minimum	Maximum	Mean	Standard deviation
Median adult education level	-19.843	14.038	.674	7.359
% in-migration	-1.867	2.036	.267	.714
% Non-white	.906	4.296	2.512	.684
% in poverty	3.729	9.870	6.815	1.225
% Owner-occupied	-3.476	-.159	-1.809	.633
% Public students in high school	258.121	622.377	437.381	79.596
Average daily attendance	-.011	-.994	-.008	.001
Equalized assessed Value per pupil	.003	.005	.004	.0004

N = 2048 per row.

have achieved a higher level of education will, *ceteris paribus*, demand a greater current provision, median education should have a positive effect. The search procedure shows that obtaining a positive coefficient depends entirely on the specification chosen.

The remaining variables are all consistent in sign across the full set of specifications. Interestingly, both percent non-white and percent below the poverty line have positive effects on spending. This reinforces the conjecture made above that median income may not be the only income distribution variable that affects spending decisions. It appears that non-linear income effects of some sort are important.

The negative effect of percent owner-occupied can be rationalized by assuming a renters' illusion effect, where renters do not consider higher property taxes as a tax increase borne by them. Thus, they will desire relatively higher school spending levels than otherwise identical homeowners.

The percent of public school children in high school has a positive and substantial effect, implying that secondary education is relatively more expensive than elementary schooling. Another cost variable, average daily attendance is consistently negative. Taken at face value, this negative effect implies economies of scale for public schooling, and has been interpreted this way in the literature (see Riew, 1966; Hettich, 1968; or Osborn, 1970). However, an examination of the data reveals a simpler statistical explanation. The dependent variable, per-pupil current expenditure is defined as total district expenditure divided by average daily attendance, i.e.,

$$\text{Per-pupil expenditure} = \text{total expenditure} / \text{average daily attendance.}$$

If average daily attendance is not a perfect measure of capacity, estimation of the equation:

$$\text{Per-pupil expenditure} = \alpha_0 + \alpha_1 (\text{average daily attendance})$$

will suffer from an errors in variables bias. Specifically, α_1 will be biased downward because positive errors in measuring capacity will be associated with negative errors in measuring per-pupil spending.⁶

The final variable in the set is equalized assessed value per-pupil. This variable has a very small, but consistently positive effect on spending. Given the dramatic effects it has on two key variables, taxprice and state block grants, and the policy importance of accurately measuring these effects, determining whether inclusion of this variable is appropriate is critical. Feldstein (1975), and others describe equalized assessed value as a wealth variable. Given this, there are three possible views on its inclusion. (1) Wealth is not an important determinant of school spending, so equal-

ized assessed value should be excluded. (2) Wealth belongs, but equalized assessed value is an inappropriate measure of wealth and should be replaced. (3) Wealth is important, equalized value is a correct measure, and the different coefficient values for state aid and taxprice that follow are correct.

While this paper is not designed to address the theoretical question of whether community wealth is an independent determinant of the demand for public education, there is reason to assert that equalized assessed value is a less than ideal measure. Market property value is unavoidably colinear with both the taxshare and block grant variables. Marginal taxshare is defined as follows:

$$\text{Taxshare} = \text{median house value} / \text{total assessed value}(1 - \text{matching tax rate}),$$

and equalized assessed value is merely total assessed value divided by the assessment ratio. In our sample, the simple correlation coefficient between taxprice and equalized value is $-.483$. The colinearity with block grants results from the fact that the size of block grants vary inversely with community income through the operation of the state aid formula. The correlation coefficient for equalized value and block grants in our sample is $-.771$.

Conclusion

The traditional median voter model predicts that median income and tax-price are the primary determinants of local school spending levels. It further implies that lump-sum grants will be utilized like private income, and thus income and grant coefficients should be the same. Our comprehensive search technique shows that, excluding equalized assessed value, these predictions hold up quite well over 2048 specifications. Income and tax-price elasticities are reasonable and tightly distributed, with income and blockgrant effects of the same general size. As noted above, any hint of flypaper effect is completely dependent on the inclusion of equalized assessed value in the regression equation. Since the state of New York has annual district level tax levy elections, it would be hard to rationalize bureaucratic power or agenda control as capable of producing flypaper-type effects, so this absence is not surprising. Future research should (1) Investigate the specification sensitivity of flypaper effects with other datasets and wealth variables; and (2) Examine election and tax rules for the possibility of budget-maximizing actions by school officials. Finally, the consistently positive effects of private schooling, % nonwhite and % in

poverty, suggest that future work should attempt to model non-linear income effects.

NOTES

1. See Bergstrom and Goodman (1973) for an elegant formulation of the importance of price and income.
2. See Fisher (1982) and Gramlich (1977) for extensive reviews of this literature.
3. Though the number of regression equations estimated is large compared to the size of the sample, classical inference tests are valid, conditional on the assumption that the equation in question is the true model. However, we do not report individual coefficients or significance tests in this work. Instead, we are examining the stability of coefficient values across a range of plausible models and focus on the uncertainty due to specification rather than the usual sampling uncertainty.
4. See the Data Appendix for an explanation of the sample selection.
5. Weisbrod (1964) hypothesized a negative effect on spending from *out*-migration through a benefit-spillover argument. However, the variable found in the surveyed literature and therefore used here is net *in*-migration, so inconsistency of this variable has no implication for the importance of the Weisbrod effect.
6. Average daily attendance is directly affected by things like large-scale illness and bad weather, which have nothing to do with measuring capacity, so the assumption of errors in variables is plausible. See Maddala (1977: 292–294) for an exposition of the resulting bias.

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Data appendix

The dataset consists of all unified (K-12) operating school districts for which complete census data and educational data were available. The census data were from the School District Data Tapes (first and fourth counts) and the educational data were from the *New York State Annual Educational Summary*. After removing incomplete observations, the data were also filtered for excessive differences between a district's reported ADA and the census' reported enrollment. Computed as

$$\text{ERROR} = \frac{(\text{Enrollment} - \text{ADA})}{\text{ADA}}$$

districts which were outside a -40% to +30% window were rejected

Appendix table

Variable	Mean	Standard deviation
Current district expenditures per-pupil	1023.59	216.64
Median family income	10994.15	2966.39
Median marginal taxshare	.71	.24
State block grants per-pupil	836.27	231.78
Federal monies per pupil	28.27	27.06
% of elementary students in private (non-parochial) schools	.85	1.68
% of elementary students in parochial schools	7.26	7.74
Median adult education level	12.09	.63
% of population living in a different county five years ago	38.89	7.15
% Non-white	2.42	5.32
% of families below poverty line	7.26	3.69
Average daily attendance in public schools	2945.96	3332.42
Proportion of public students in Grades 9-12	.44	.04
% of dwellings that are owner-occupied	78.16	8.43
Equalized assessed property value per-pupil	28213.41	17530.76