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ABSTRACT

Nine sets of annual data on State school finances are used to test a theory of expenditure determination by public school districts. The results support implications of the theory regarding effects of personal income, State and federal aid, the relative price of education, the pupil/population ratio, and enrollment growth on per pupil spending. A population density variable and a South versus non-South regional variable, both included on the basis of earlier results, also affect spending significantly. The nine cross-sectional equations are generally consistent, but there are some structural shifts over time, and the hypothesis of coefficient homogeneity is not supported. Consequently, a pooled equation that allows for such shifts provides the most useful predictive model. Policy applications of the results are limited by (1) omission of some "taste variables" that affect spending, (2) uncertainty about differential State responses to aid, and (3) the absence of price data for individual States. (Author)

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AN ECONOMETRIC STUDY OF PUBLIC SCHOOL EXPENDITURE VARIATIONS ACROSS STATES, 1951-1967

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AN ECONOMETRIC STUDY OF PUBLIC SCHOOL EXPENDITURE VARIATIONS ACROSS STATES, 1951-1967

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INTRODUCTION

In this paper I use nine annual sets of cross-section data on state school finances to test a theory of expenditure determination and responses to grants-in-aid by local public school districts. The model that is tested is traditional in that it assumes maximizing behavior by a decisionmaking unit, in this case the governing authority (school board) of a local public school system. The analysis differs from earlier work on state-local expenditure determination (a) by *not* assuming that the preferences of the governmental body and those of the community are identical, especially with regard to utilization of grants-in-aid, and (b) by taking account of responses to price variables, which have been omitted in most earlier work.** Both departures seem to be at least conditionally justified by the empirical results.

The original purpose of the exercise was to develop a predictive

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**The standard theoretical approach to the analysis of local expenditure decisions and responses to grants-in-aid has been to view the local government as deciding on the allocation of the community's income between public spending and "other" (private) goods; see *inter alia* Williams (1963, chapter 10) and Wilde (1968). The consequence is that no theoretical distinction is made between the effect of a lump-sum grant to a local government and an equivalent increase in the incomes of its citizens--an equation that does not hold up empirically. Inman (1971) appears to be the only author who has adopted the formulation used here, which is to view the local government as trading off spending against tax burdens with community income influencing the rate of trade-off. However, Inman reverted to the earlier formulation in his empirical work.

model that could be used for evaluating impacts of alternative programs of state or federal intergovernmental aid. However, although the model described here succeeds in the explanatory sense (i.e., a large fraction of the interstate variance in school spending is accounted for and variables have significant effects in the hypothesized directions), and may be useful for certain aggregative predictions, the intended policy role is not fulfilled. This is primarily attributable to failure to identify characteristics of states (e.g., political, social, and historical variables) that give rise to differences in "tastes" for public schooling. One consequence is that only average responses, not differential state responses to grants-in-aid, can be predicted. It appears that further development of the policy simulation model depends on progress in specifying more of the "noneconomic" determinants of public expenditures.

THE MODEL

The brief theoretical discussion presented here covers those aspects of the school district expenditure model that can be tested with data aggregated to the state level. A fuller exposition, which elaborates the model and brings in variables that can only be observed at the individual district level, is available in Barro (1972).

District Preferences

The model represents the local governmental unit, the school district, as having a consistent set of preferences regarding various levels of its current educational program and the tax burdens it imposes on the local community. Specifically, the district is viewed as seeking an optimal balance between real current expenditure per pupil, which is valued positively, and real school taxes per capita, which have disutility, political or otherwise, to district decisionmakers.

It is convenient to represent these preferences with a function that measures the maximum increment in tax (in dollars per district resident) that the district would willingly impose to obtain an expenditure increment of one dollar per pupil. I call that function the *marginal rate of trade-off between expenditures and taxes*. The key assumptions about the shape of the function are as follows:

(a) The willingness of the district to impose incremental taxes to obtain incremental spending declines with the level of spending (i.e., each additional expenditure increment is less "urgent").

(b) The willingness of the district to impose incremental taxes to obtain incremental spending declines with the level of taxes (i.e., each additional tax increment is more "burdensome").

(c) The marginal rate of trade-off between expenditures and taxes varies across districts according to income and, possibly, other characteristics of communities. Specifically, at any given level of spending and taxes a district with a higher income is willing to pay a greater per capita tax increment to obtain a unit increment in per pupil spending.

Symbolically,

$$m = m(e,\ t,\ y_D,\ z)\ , \tag{1}$$

$$\frac{\partial m}{\partial e} < 0,\quad \frac{\partial m}{\partial t} < 0,\quad \frac{\partial m}{\partial y_D} > 0,$$

where m = the marginal rate of trade-off between expenditures and taxes,

e = real current expenditure per pupil,

t = real school taxes per capita for both current and capital purposes,

y_D = real disposable income (after all non-school taxes) per capita, and

z = unspecified community characteristics ("taste variables") that affect district preferences for education.

The Budget Constraint

A district is assumed to be subject to the constraint that total spending must equal total revenue, where revenue includes both local school tax revenue and outside aid provided by state or federal authorities. Although only current educational expenditure is of interest, it is necessary to include capital expenditure also to show how one important variable, the rate of enrollment growth in a district, affects current spending. For this purpose, we introduce three extremely crude assumptions about capital outlays: (a) that a district adds just enough new capacity each year to accommodate its additional enrollment, (b) that there is a fixed, "required" real outlay per unit of capacity, and (c) that capital expenditure is paid for out of current funds. It is shown in the previously cited paper that essentially similar results are obtained when at least the last assumption is relaxed (Barro, 1972, pp. 61-64).

Noting that educational spending (and also outside aid) is defined as a per pupil amount while school taxes are in per capita units, and that all real magnitudes must be multiplied by appropriate price indexes to convert them to dollar amounts, we write the district's budget constraint as

$$P_e Ae + P_c \Delta Ac = P_x Nt + P_e A(s + f), \tag{2}$$

where A = the number of pupils in attendance in the district,

N = district population,

ΔA = the increase in attendance from the previous year,

s, f = real per pupil amounts of state and federal aid, respectively, measured in the same units as e,*

c = the required real capital outlay per pupil,

P_e = an index of prices of current inputs into education,

P_c = a school construction price index,

P_x = an index of prices of "other goods" (general price index).

Define the following four ratio variables: $a = A/N$, the pupil/population ratio; $p_e = P_e/P_x$, the relative price of education; $p_c = P_c/P_x$, the relative price of school construction; and $g = \Delta A/A$, the annual rate of enrollment growth. Using the new variables and

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*It is appropriate to enter the aid variables into the budget constraint in the form shown in Eq. 2 only when all aid takes the form of lump-sum grants from outside agencies to local districts (i.e., the amount of aid provided to a given district does not depend on how much the district raises itself in taxes). Where there are matching grants, the budget constraint must be written differently; see Barro (1972, p. 9). In fact, during the period for which data are available, aid to all districts in most states and to all but a few districts in the remaining states was of the lump-sum type (see, *inter alia*, Benson, 1968, p. 146ff.). We are assuming, in effect, that the amount of matching aid is negligible and restricting ourselves to the simplest form of the model.

rearranging terms, the budget constraint may be rewritten as

$$t = p_e a(e - s - f) + p_c cag \qquad (3)$$

Implications of Maximizing Behavior

Maximizing behavior by the district implies that the marginal rate of trade-off must equal the "price" ratio, or slope, relating t and e. From Eq. (3) it is evident that this ratio is

$$\frac{dt}{de} = p_e a.$$

The maximizing condition, therefore, is

$$m(e, t, y_D, z) = p_e a. \qquad (4)$$

Responses of per pupil spending, e, to changes in the various exogenous variables can be inferred by substituting Eq. (3) into Eq. (4), differentiating totally, and solving for de. The results of this operation are:

$$\frac{de}{dy_D} = -\frac{1}{D}\frac{\partial m}{\partial y_D} \qquad \frac{de}{dg} = -\frac{1}{D} cp_e a \frac{\partial m}{\partial t}$$

$$\frac{de}{dz} = -\frac{1}{D}\frac{\partial m}{\partial z} \qquad \frac{de}{d(p_e a)} = \frac{1}{D}[1 - (e - s - f)\frac{\partial m}{\partial t}]$$

$$\frac{de}{d(s+f)} = \frac{1}{D} p_e a \frac{\partial m}{\partial t} \qquad \frac{de}{d(p_c a)} = \frac{1}{D} cg \frac{\partial m}{\partial t} ,$$

where $D = \frac{\partial m}{\partial e} + p_e a \frac{\partial m}{\partial t}$.

When the assumptions about properties of the marginal rate of trade-off function given in Eqs. (1) are applied to the above, we obtain the following testable hypotheses about relationships between school spending and the exogenous quantities:

$$\frac{de}{dy_D} > 0, \quad 0 < \frac{de}{d(s+f)} < 1, \quad \frac{de}{dg} < 0,$$

$$\frac{de}{d(p_e a)} < 0, \qquad \frac{de}{d(p_c a)} < 0. \tag{5}$$

Two points worth noting about these are (a) that the effect on spending of a change in aid is proportional to $p_e a$ (i.e., expenditure per pupil depends directly on aid per capita rather than aid per pupil), and (b) that the effects on spending of equal dollar increments in income and aid are not equal, in general, even when the fact that the former is measured per capita and the latter per pupil is taken into account. The latter has important implications, some of which will be touched on later.

A linear equation for per pupil spending embodying the foregoing hypotheses is

$$e = b_0 + b_1 y_D + b_2 p_e a(s + f) + b_3 p_c ag + b_4 p_e a , \tag{6}$$

where b_1 and b_2 are expected to be positive, with $b_2\overline{p_e a} < 1$ ($\overline{p_e a}$ denoting the mean of $p_e a$), and b_3 and b_4 are expected to be negative. Additionally, of course, the taste variables (z's) appear in the equation, both additive and interactive terms (e.g., $y_D z$) being permitted. Specific taste variables are defined below.

THE EMPIRICAL ANALYSIS

Aggregation

Since the foregoing theoretical specifications were derived from reasoning about an individual school district while the model is to be tested using average data for states, the question arises of how the equation to be tested is affected by the shift to the higher level of aggregation. It can be shown (Barro, 1972, pp. 67-70) that if the correctly specified individual district model is the same as Eq. (6), with the addition of a stochastic error term on the right-hand side that satisfies the standard linear regression assumptions, then the corresponding state model, also satisfying the standard assumptions, is a *weighted* regression having the same form. The appropriate weight to be applied to the observations for a given state is

$$W = 1/\sqrt{\sum_j (A_j/A)^2},$$

where A_j is the number of pupils in attendance in district j and A is the number in attendance in the whole state. If all districts within a state were of the same size, this would be equivalent to weighting by the square root of the number of districts in a state.

This weighting scheme was *not* used in estimating the relationships presented here (a) because individual district attendance figures for all states were not available for all years, and (b) because of the magnitude of the computational task. The price of this omission is a loss of efficiency in the estimates.

Taste Variables

The current state of knowledge of political, social, and historical influences on public spending decisions is such that the taste variables (z's) must be specified without recourse to any overarching theory of expenditure determination. Variables were selected primarily according to the results of earlier empirical studies of school spending and state-local spending in general. Specifically, a particular variable was included if (a) it was found to be significantly related to expenditures in earlier studies and (b) there is a plausible explanation of its role. Specific variables tested included population density, urbanization (percent of state population in urban areas), educational level of the adult population, and geographic region (South versus non-South).* Only the regional

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*Population density and urbanization appear as explanatory variables in a long line of studies of state-local expenditure. See, *inter alia*, Bahl and Saunders (1966) and Sacks and Harris (1964). The latter refer to both variables as "standard in the literature" and relate the density variable specifically to school spending. Density was also found to be related to school spending in Miner (1963), variable and the population density variable--the latter in the form of a dummy variable designating sparsely populated states--were significant in the equations tested. They are the only taste variables appearing in the results shown below.

Data

The basic data on school spending, revenue, grants-in-aid, and numbers of pupils in average daily attendance, by state, were obtained from the biennial U.S. Office of Education (USOE) reports, *Statistics of State School Systems*. The data are for 48 states (Alaska and Hawaii excluded) for the nine alternate school years from 1951-52 to 1967-68. Data on disposable personal income per capita were obtained from a special tabulation published in the *Survey of Current Business* (Bretzfelder, et al., 1969). Population data consisted of Census estimates included in the biennial USOE reports.

An important limitation of the study is that there are no state-by-state data on the two main price variables appearing in the model, P_e, the price index of inputs into schooling, and P_x, the general price index. As a result, the empirical work is done with price indexes that vary from year to year, but not across states. A P_e index was not constructed; even though data on the most important price, teachers' salaries, were available, because there was no information on interstate variations in teacher quality. In fact, there is not even a satisfactory conceptual framework at present for dealing with variations in quality of teachers or other school inputs. A general price index for individual states has never been constructed by the Bureau of Labor Statistics. Although various rough proxies for either index could have been developed, it appeared that there was little to gain unless both could be developed simultaneously and consistently. This is because the two appear in the model as a *ratio* in the price term, $p_e a$. While it is unrealistic to assume

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but was only marginally significant. The educational level of the adult population entered as a significant determinant of educational outlay in Davis (1965) and James (1966). The South vs. non-South regional variable is implicit in the results of James (1966) and is a central variable in the study by Shapiro (1962).

that P_e and P_x are constant across states, it is probably much less unrealistic to assume that the *relative* price of education, P_e/P_x is constant. Therefore, using a true interstate index of either P_e or P_x, while continuing to treat the other as a constant, could actually result in poorer measurement of the relative price of education.

The national price of education index used in the estimations is computed as follows: A salary component (base year = 1965) is derived from data on instructional staff salaries published in the previously cited USOE reports. Prices of other inputs into schooling are measured by the services (less rent) component of the consumer Price index. The two components are combined with weights of 70 and 30 percent, respectively. The general price variable, P_x, is measured by the national consumer price index.

Cross-Sectional Results

Several forms of the cross-sectional model were tested. These differed mainly in the combinations of taste variables and interaction terms that were included and varied only slightly in values of the main coefficients and overall explanatory power. The expenditure equation for which results are reported is

$$e = \beta_0 + \beta_1 R + \beta_2 y + \beta_3 p_e a(s + f) + \beta_4 p_e a(s + f)R + \beta_5 p_e a + \beta_6 g + \beta_7 LD , \quad (7)$$

where R = 1 for Southern states, 0 otherwise; LD = 1 for states with low population density (less than 30 persons per square mile), 0 otherwise; and the remaining variables are as defined previously. Note that the regional dummy variable, R, appears twice in the equation, indicating that in addition to the additive effect of regional location there is also a differential effect on responses to outside aid. Estimated coefficient values and equation statistics for each of the nine school years are given in Table 1.

Table 1

SCHOOL DISTRICT EXPENDITURE EQUATIONS: CROSS-SECTIONAL RESULTS

School Year	Coefficient Values β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	R^2 (adj.)	Coeff. of Var.	Std. Error of Est.
51-52	431	-186	.146	1.74	4.18	-2260	-290	34.4	.86	.090	43.6
	(3.9)	(3.6)	(4.6)	(3.2)	(2.6)	(3.3)	(2.0)	(1.8)			
53-54	450	-196	.163	1.10	4.64	-2380	-440	78.4	.86	.086	40.5
	(4.7)	(3.4)	(4.8)	(2.5)	(2.8)	(4.3)	(2.1)	(4.1)			
55-56	539	-125	.133	1.60	1.67	-2590	-297	70.8	.85	.090	43.8
	(4.7)	(2.5)	(4.0)	(3.1)	(1.4)	(4.3)	(1.2)	(3.4)			
57-58	440	-169	.144	1.21	2.52	-1873	-28	46.4	.85	.089	44.9
	(3.9)	(3.0)	(4.5)	(3.2)	(2.2)	(3.5)	(.14)	(2.4)			
59-60	449	-190	.151	.87	2.71	-1752	-181	47.8	.83	.093	46.6
	(3.5)	(3.0)	(4.7)	(2.2)	(2.1)	(3.2)	(.78)	(2.3)			
61-62	433	-134	.201	1.08	1.90	-2045	.697	75.4	.86	.083	42.9
	(3.7)	(2.0)	(6.2)	(3.1)	(1.6)	(4.4)	(2.9)	(3.6)			
63-64	472	-144	.195	1.16	1.59	-2057	-686	64.9	.84	.089	46.3
	(3.7)	(1.7)	(5.8)	(3.8)	(1.1)	(4.3)	(2.0)	(3.0)			
65-66	503	-63	.170	1.43	.026	-2094	-459	51.5	.83	.084	46.8
	(3.8)	(.65)	(5.4)	(5.2)	(.020)	(4.7)	(1.5)	(2.4)			
67-68	602	-142	.181	1.76	.91	-2575	-641	62.9	.85	.070	43.2
	(4.6)	(1.4)	(6.7)	(5.9)	(.76)	(5.5)	(1.9)	(2.9)			

NOTE: Values in parentheses are t-ratios.

The results support the hypotheses about effects of the three main variables, income, grants-in-aid, and the composite price variable, $p_e a$. Income and aid coefficients are significantly positive in every case. The magnitude of the income coefficient, which varies from .14 to .20, corresponds to a marginal share for education of roughly 3.5 to 5.0 percent of each marginal dollar of personal income. (Recall that school spending is measured per pupil and income is measured per capita and note that one out of every four or five persons attends public school.) The aid coefficient ranges from five to ten times as great as the income coefficient in each cross-section. Formal F tests comparing sums of squared residuals with and without the constraint that income and aid coefficients must be equal uniformly reject the null hypothesis (of equality) at the .01 level. The estimated values of the aid coefficients correspond to added expenditures of approximately $0.25 to $0.30 out of each marginal dollar of aid in non-Southern states. The value of the response rate, $de/d(s + f)$, which is given by $\beta_3 p_e a$, is less than 1.0 for every state in every year and, of course, for the average value of $p_e a$, as hypothesized. The coefficient of $p_e a$ is always significantly negative. Its values correspond to price elasticities (computed at the respective sample means) of -0.5 to -0.9.

The effect of the enrollment growth variable is negative, as hypothesized, but the coefficient is significantly different from zero (at the .05 level) in only five of the nine cross-sections. The low density, or sparse population, variable has a significantly positive effect in each case. A plausible explanation is that this is a cost or economy of scale effect: Schools in sparsely populated states will either be small, hence subject to diseconomies of small-scale operation, or will have to incur high costs of pupil transportation, or some combination of the two. The regional effect is twofold: Southern school districts tend to spend less per pupil, other things being equal, than districts in the rest of the country. On the other hand, their spending appears more responsive to levels of state and federal grants-in-aid. It is possible that the latter effect is attributable to certain characteristics of state school support schemes in the South not reflected in the expenditure model.* Both regional effects appear to diminish over time and, in fact, are insignificant or only marginally significant in the last two years. This result also shows up in the pooled equations, as will be seen below.

A result that is important in itself is that expenditure equations for the different school years are reasonably consistent, both with respect to values of the more important coefficients (income, aid, and price) and overall "fit." Such consistency has generally been lacking in studies that used cross-sectional data from several years or that attempted to replicate earlier cross-sectional results with later data (Gramlich, 1969). A series of experiments with alternative forms of the model indicated that this consistency arises from the use of the P_e and P_x deflators where appropriate and from inclusion of the $p_e a$ term in the equation. Both factors were absent in most earlier studies.

Pooled Results

The purpose of pooling observations from the several years is, of course, to obtain more efficient estimates of the key equation parameters. The total number of available observations is 9 x 48 = 432.

The equation obtained by simply pooling the nine sets of cross-section data, making no allowance for possible structural changes over time, is the following:

$$\begin{aligned} e = \underset{(12.1)}{218} - \underset{(-7.1)}{109R} + \underset{(24.9)}{.202y_D} + (\underset{(9.7)}{1.15} + \underset{(4.1)}{1.01R})p_e a(s + f) \\ -\underset{(-11.5)}{949p_e a} - \underset{(-6.5)}{372g} + \underset{(5.4)}{34.4LD} \end{aligned} \qquad (8)$$

R^2 (adj.) = .85, Coeff. of Var. = .091, Std. Error of Est. = 47.2

*State aid is a high proportion of total school spending in most Southern states. It is possible that that aid pays almost entirely for certain categories of school services and that local funds, to the extent that they exceed state-mandated levels, go for supplementary services. In that case, Southern districts would have relatively little opportunity to substitute state aid for locally raised revenue and this would show up as an apparently higher state aid coefficient.

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The important thing to note about this result is that a number of the coefficient values are not compatible with those obtained by fitting individual cross-sections. The price coefficient, for example, is much lower than that obtained in any cross-sectional equation, the income coefficient is just outside the range of values obtained cross-sectionally, and the constant term is only half the magnitude shown for any equation in Table 1. This suggests that structural changes have taken place over time that are not accounted for by the variables used in estimating the cross-section model. This impression is reinforced by further examination of the array of coefficients in Table 1. Despite the general consistency of the major coefficients from one equation to another, there are discernible time trends in the income coefficient, the constant term, and the regional variables, as already noted. Some factor operating over time appears not to have been captured by simple pooling.

Given this evidence, a formal test of equation homogeneity was conducted. The statistic for testing the null hypothesis that all coefficient vectors are the same is

$$F = \frac{\frac{P - Q}{(T-1)K}}{\frac{Q}{N - TK}} , ^{*}$$

with degrees of freedom $(T-1)K$, $N - TK$, where

P = the sum of squared residuals from the pooled regression,

Q = the sum of sums of squared residuals from the individual cross-section regressions,

T = the number of cross-section regressions,

K = the number of parameters in each regression,

N = the total number of observations.

The value of the test statistic is 1.90, whereas the value required

*This is an extension to the case of more than two equations of the test for equality of coefficients given in Johnston (1963, p. 137).

to reject the null hypothesis at the .01 level (with degrees of freedom 64, 360) is only 1.63. Therefore, the impression of structural change receives strong support.

Various efforts were made to account for the structural shifts in terms of the taste variables (the same variables as described earlier), but with no success. Neither additive variables nor interaction terms involving products of taste variables and the variables in the original cross-section model proved to be significant when entered into the pooled equation. Therefore, it was necessary to resort to the technique of explicitly allowing time trends in the equation coefficients (Kuh, 1963). The following equation, with three significant time trend terms, was obtained after several trials (the time trend variable, T, is 0 for school year 1951-52, 1 for 1953-54, and so forth):

$$\begin{aligned} e = \underset{(13.1)}{477} - \underset{(-8.1)}{163}R + (\underset{(9.\text{[illegible]})}{.123} + \underset{(4.5)}{.0074}T)y_D + (\underset{(5.2)}{1.35} + \underset{(5.1)}{3.09}R - \underset{(-3.8)}{.22}RT)p_e a(s + f) \\ - (\underset{(-9.9)}{2218} - \underset{(1.6)}{43.2}T)p_e a - \underset{(-4.1)}{241}g + \underset{(8.4)}{52.1}LD \end{aligned} \qquad (9)$$

R^2 (adj.) = .87, Coeff. of Var. = .085, Std. Error of Est. = 40.1

While this procedure is not entirely satisfying from a theoretical point of view (i.e., nothing has been learned about the underlying factors associated with structural shifts over time) some cause for confidence in the results does emerge from a comparison of these coefficients with those in the cross-sectional relationships. The values of the income, aid, and price coefficients and the constant term are all in the range of values obtained cross-sectionally. Also, the regional effect on the aid coefficient diminishes over time, as appeared to be the case in comparing cross-sections. No significant trend term, however, was found to be associated with the additive Southern region dummy variable. On the basis of its greater consistency with the cross-section results and greater overall explanatory power, the estimated equation with time trend terms seems preferable as a predictive tool to the simple pooled equation.

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Prediction

Eq. (9) is useful primarily for predicting *national average* responses to changes in the exogenous variables. Although it should also be useful, in principle, for predicting responses in individual states, certain characteristics of the results, discussed below, raise doubts about the validity of that application. It may be worthwhile to distinguish, however, between attempts to project school spending by state to some future date, where the assumption is that the structure of the system will remain unchanged, and attempts to estimate effects of policy changes, such as changes in intergovernmental aid. The former, which depend on the overall fit of the equation, are likely to be more accurate than the latter, which depend on how closely an individual coefficient (e.g., the aid or price coefficient) approximates the response of a particular state.

Extrapolation of Eq. (9) to school year 1971-72 (T = 10) yields the following expenditure relationship:

$$e = 477 - 163R + .197y_D + (1.35 + .89R)p_e a(s + f) - 1786p_e a - 241g + 52.1LD .$$

The coefficient values imply for the "average" non-Southern state:

a. an increase of roughly $0.045 in real school spending for each one dollar increase in real per capita income (or a corresponding decrease in spending per one dollar increase in state or federal personal taxes);
b. an increase of about $0.31 in real school spending per pupil for each additional dollar per pupil of state or federal aid;
c. a price elasticity of per pupil spending (computed at the mean) of approximately -0.6.

The form of the model requires that the income and aid effects be proportional to the pupil/population ratio, a. States with 20 and 25 percent of their populations in school will have respective income response rates of .039 and .049 and respective aid responses (fraction of incremental aid additive to total spending) of .27 to .34. Since the aid effect is greater than the income effect, the impact of an increase in aid to local districts is *not* balanced out by an equal increase in state or federal taxes to finance the aid. About $0.26 additional spending is predicted for each additional dollar of aid financed in that manner.

Limitations

The quality of the model and its utility for predicting state-by-state responses to changes in aid or other variables are limited by at least three properties of the analysis: (1) the apparent omission of some relevant state characteristics, (2) failure to estimate *differential* state responses to changes in grants-in-aid and other variables, and (3) the lack of price data for individual states. Some comments on each point follow.

Omitted State Characteristics. Examination of the residuals from both the cross-sectional and pooled estimations makes it clear that there are systematic differences among states that have not been accounted for by the variables in the model (or the other variables unsuccessfully tested). Regarding the cross-section results, for example, if the econometric relationship were correctly specified the probability of the residual for a given state being either positive or negative would be one-half and independent from one year to the next. The probability of a given state having only positive or only negative residuals in all nine cross-sections would be only $2/2^9 = .004$ and the probability of having all but one positive or all but one negative would be $2 \times 9/2^9 = .034$. Only about 4 percent of the states, then, would be expected to have as many as 8 of the 9 residuals with the same sign. Yet no fewer than 24 out of the 48 states have either all positive or all negative residuals and an additional 12 states have 8 out of 9 residuals positive or negative. Moreover, these figures would be even higher if it were not for inclusion of the regional and low population density dummy variables in Eq. (7). Thus, the cross-sectional model is extremely likely to produce predictions that are consistently too large in some states and consistently too small in others. Essentially similar findings were obtained from an examination of residuals from the simple pooled equation [Eq. (8)] and only a slightly less assymetrical pattern of residuals was found after the time trend factors were included [Eq. (9)]. Some relevant variable, or set of variables, therefore, has probably been omitted from the expenditure equations.

Differential State Responses. Two different attempts were made to identify or measure differential responses to grants-in-aid by school districts in different states. One approach was to test forms of the model containing interaction terms between the grant-in-aid variable and certain taste variables (also between grants-in-aid and income). As has already been mentioned, no such interaction terms were found to be significant. A second approach was to estimate differential responses in individual states by introducing a set of multiplicative state dummy variables, i.e., replacing the aid term in the pooled equation with a set of 48 terms having the form $b_k D_k p_e a(s + f)$, where $D_k = 1$ if the observation is for state k, zero otherwise. This exercise yielded an unreasonably wide range of estimates of the b_k coefficients, including estimated aid effects much greater than 1.0 in a number of states. On reflection, it became clear that what was happening is that the individual aid terms were picking up the effects of the omitted state variables discussed above. In other words, differences in *levels* of spending among states were showing up as differences in state responses to aid, and the results were not usable. As presently written, therefore, the model implies that the expenditure response to an additional dollar of aid will be the same everywhere (except for the South versus non-South difference and the proportionality of the response to $p_e a$). Progress in specifying the omitted state characteristics appears to be a prerequisite to determining whether there are significant interstate response differences and, if so, to establishing their magnitudes.

Lack of Interstate Price Data. The unavailability of state-by-state data for computing expenditure, aid, and income deflators and the relative price variable may have affected the model adversely in two ways. First, it may have led to biased estimates of some of the expenditure equation coefficients. Second, even if the coefficients were unbiased, incorrect estimates of individual state responses would be produced because of the built-in proportionality of those responses to $p_e a$.

The nature of the biasing effect, if any, would depend on correlations between the "true" price variables and either per pupil spending or independent variables, such as income, and on the relationship between the two price variables, P_e and P_x. As an illustration of the possibilities, suppose that the relative price of education, P_e/P_x, is the same in all states, but that P_e and P_x vary among states and are positively correlated with per pupil spending. Under those assumptions, the effect of using only the national price index would probably be to *underestimate* the strength of the price effect. As a minor experiment on this subject, I computed a new set of cross-section regressions identical to the originals except for the assumption that prices (both P_e and P_x) were 10 percent lower in the low-spending Southern states than elsewhere. The results did show slightly more negative price coefficients, although by only 1 to 3 percent, but were otherwise similar to the originals.

More interesting cases involve differential rates of variations in P_e and P_x among states, i.e., a tendency for the relative price of education to be higher or lower in high spending or high income states. But it is difficult to know what to assume *a priori*. Do teacher salaries, for example, reflect income levels in the states, or is that effect offset by the salary inducement needed to attract "high quality" teachers to low income areas? It seems that little can be said about the probable direction or magnitude of the bias. Nevertheless, the possibility that such a bias exists, and is substantial, diminishes the credibility of the results. It also underscores the need to develop at least rough interstate price indexes as a high priority task in further research on expenditure determinants.

SUMMARY OF RESULTS AND CONCLUSIONS

Cross-sectional and pooled estimates using data aggregated to the state level confirm the main hypotheses generated by a constrained maximization model of local school district expenditure behavior. The variables whose effects are implied by the theory--disposable income, state and federal aid, enrollment growth, the relative price of education, and the pupil/population ratio--all affect per pupil spending significantly and in the expected direction. Two other variables, included on the basis of results from earlier studies, are also significant: Low population density is associated with higher spending. Geographic region has an effect in that Southern school districts tend to spend less, but respond more strongly to aid than districts in the rest of the country. The latter effect is found to diminish over time.

The value of the income coefficient is plausible in that it implies a marginal share of income for education that is just slightly less than the national average share. The value of the price coefficient implies an inelastic response of school spending to relative price changes. It is estimated that about one-third of an increment in lump-sum aid to districts will be translated into increased spending, the remainder going for local tax relief. The additive effect, however, is about six times as great as the effect on school spending of an equivalent increase in community income. This difference suggests that a model that views the local government, or local community, as simply allocating income between public spending and private goods is missing an important aspect of reality (see fn., p. 1). More relevant from a policy point of view, it implies that increased state or federal aid will result in more school spending even when that aid is entirely financed out of increased state or federal taxes.

Cross-sectional results for different years are reasonably consistent with respect to values of the main coefficients and overall fit. Nevertheless, there appear to be structural shifts over time that can not be explained by changes in the variables tested. As a result, a pooled model that allows for time-related

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shifts in the coefficients is more consistent with the cross-sectional results than one that simply retains the cross-sectional form.

The expenditure equations obtained from this analysis are potentially useful for predicting national average responses to changes in the exogenous variables and, possibly, for predicting individual state outlays under the assumption that the existing system will remain unchanged. However, certain features of the analysis raise doubts about the validity of individual state predictions and, especially, about predictions of state responses to changes in outside aid. The main limitations are (1) that some variables that cause expenditure levels to vary among states appear to have been omitted from the analysis, (2) the question of whether there are differential state responses to changes in aid has not been satisfactorily answered, and (3) the lack of interstate price data may have led to biased coefficient estimates or, at least, biased estimates of individual state responses. This list of limitations suggests some of the priority tasks to be addressed in future efforts to improve expenditure determinant studies.

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