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SCHOOL FINANCE REFORM: AID FORMULAS AND EQUITY OBJECTIVES

WILLIAM DUNCOMBE * &
JOHN YINGER *

Abstract - *State education officials have implemented performance standards, but state education aid has not kept up. By focusing on the relationship between spending and property wealth, most existing aid formulas only partially account for cost differences across districts and, thus, fail to fully promote equity in school performance. This paper shows how to estimate comprehensive educational cost indexes that control for school district inefficiency and include them in state aid formulas. It also simulates for New York the impact of several aid formulas on educational performance and evaluates each formula using several equity criteria. The results indicate that outcome-based foundation formulas can achieve adequacy objectives, but that practical policies to promote vertical equity or wealth neutrality do not yet exist.*

*Center for Policy Research, Syracuse University, Syracuse, NY 13244-1020.

INTRODUCTION

School finance equity has been a central issue of educational policy for decades. This paper explores the potential of several school aid formulas to satisfy the most widely discussed equity objectives. For the most part, the school equity debate has focused on the relationship between a school district's expenditure and its property tax wealth. In keeping with the growing emphasis on performance standards in education, states need to refocus their aid formulas toward the achievement of outcome equity objectives. Because educational costs vary widely across districts, an outcome standard is quite different from an expenditure standard. This paper provides one method for estimating comprehensive educational cost indexes and shows how to include them in state aid formulas designed to achieve particular equity goals.

Educational outcomes are influenced by school management and teaching methods as well as by state aid. Many state policies address these other issues. Although questions of school management and teaching reform are beyond its scope, this paper sheds some light on the role of inefficiency in the provision of education services. Inefficiency can prevent a district from reaching minimum outcome standards, even with an outcome-based foundation formula. We illustrate how inefficiency could be taken into account in aid system design without providing incentives for districts to become more inefficient. The analysis is illustrated with detailed school aid simulations for New York state school districts.

AID FORMULAS AND EQUITY OBJECTIVES

Education in the United States is predominantly a local function, but most states fund a large share of local school budgets through intergovernmental aid.[1] Although many categorical aid programs exist, most school aid is distributed through general-purpose aid to support the basic operation of schools. Our focus is on the design of such basic operating aid. In particular, we explain the link between alternative aid formulas and various equity objectives, which are reviewed in Berne and Stiefel (1984) and Monk (1990).

Foundation Aid

The most widely used form of education aid is a foundation grant, which is designed to ensure educational adequacy, defined as a situation in which all districts provide at least some minimum level of education. In its simplest form, a foundation grant provides the difference between the state-selected minimum per pupil spending level, E^*, and the amount of revenue a district can raise at a tax rate that the state decides is fair, t^*. Let V_i stand for the property tax base in district i. Then the district's **expenditure-based** foundation grant per pupil is defined by

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$$A_i = E^* - t^* V_i = E^*\left(1 - \frac{V_i}{V^*}\right) = E^*(1 - v_i)$$

where $V^* = E^*/t^*$ is the property value above which a district receives no aid and $v_i = V_i/V^*$. If taken literally, equation 1 implies that districts with tax bases above V^* actually receive negative aid. This formula is usually modified in practice, through minimum aid amounts or hold-harmless clauses, so that all districts receive some aid, thereby reducing the equalizing power of the formula. Moreover, a foundation grant usually is accompanied by a requirement that each district levy a tax rate of at least t^*; otherwise, some districts might not provide the minimum acceptable spending level, E^*. New York and Illinois are notable exceptions; see Miner (1991) and Downes and McGuire (1994).

Even if one accepts the objective of guaranteeing a minimum level of education, traditional foundation grants are flawed because they do not systematically adjust for educational costs. In practice, some state aid formulas include educational cost adjustments (Gold et al., 1992), but these adjustments inevitably are *ad hoc* and incomplete. In other words, they may ensure a minimum level of spending but not of educational outcomes, such as student learning, thereby leaving higher cost districts at lower outcomes than other districts with the same property value. Because outcomes are what parents and voters care about, they are a more appropriate target of equalization. A less central problem with a standard foundation formula is that wealth is an imperfect measure of a school district's revenue-raising capacity. Districts differ in revenue-raising capacity because of (1) differences in income and (2) differences in their ability to export some of their tax burden to nonresidents. Because it does not explicitly recognize the role of exporting, wealth is an imperfect measure of revenue-raising capacity.[2]

As shown by Ladd and Yinger (1994), these two problems can be solved through the use of an educational cost index and a more general measure of revenue-raising capacity that accounts for exporting. Suppose educational outcomes in district *i* can be measured with an index, S_i, and that S^* is the minimum acceptable value of this index. Moreover, let C_i be the amount the district must spend to obtain one unit of S, so that $E_i = C_i S_i$ (ignoring efficiency for the moment). Now if, $\bar{C}$ is the cost of S in the average district, then we can redefine E^* as the amount that a district with average costs would have to spend to obtain the minimum acceptable level of educational outcomes, namely, $\bar{C}\,S^*$. Finally, let R_i be a general measure of district *i*'s revenue-raising capacity.

To bring all districts up to S^* at an acceptable tax burden on their residents, the **outcome-based** foundation formula should be

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$$A_i = E^*\left(\frac{C_i}{\bar{C}} - \frac{R_i}{R^*}\right) = E^*(c_i - r_i)$$

where $c_i = C_i/\bar{C}$ is the cost index, $r_i = R_i/R^*$ is a revenue capacity index, and R^* is the revenue-raising capacity (set by state policymakers) at which a district **with average costs** would receive no aid. As with equation 1, raising E^* to an extremely high level would, at great cost, result in an equal educational output in every district, and allowing negative grants would boost the equalizing impact of the program.

As discussed earlier, some school districts are more efficient than others. The consideration of efficiency complicates matters because a district might receive enough resources to achieve S^* given its costs and still fall short because it is inefficient. All else equal, inefficient districts not only must spend more to achieve any given level of S but also are likely to select a lower level of S, because efficiency raises the effective price of educational services. This issue is fundamentally different from the issues of costs and revenue-raising capacity, however, because it is inappropriate to compensate a district for its inefficiency, or for anything else within its control. Even though children are penalized for living in inefficient districts, any state program that gives aid based on inefficiency would undermine a district's incentive to provide education as efficiently as possible.

Our resolution of this issue is to define an efficiency index, k_i, with a maximum value of 1.0 in an efficient district; we then employ a foundation formula that gives each district enough resources to achieve S^* so long as its efficiency index is at or above k^*, a state-determined minimum acceptable level. To be specific, this formula sets $E^* = S^* C_i / k^*$.[3] If eligible for this foundation aid, districts with $k_i > k^*$ will receive somewhat more aid than they need to reach S^*, and districts with $k_i < k^*$ will not achieve S^* unless they become more efficient. To protect students in these inefficient districts, the state must place additional requirements on these districts in the form of either management improvements or a higher local sacrifice.

Power-Equalizing Aid

A few states use some form of a "power-equalizing" aid formula, which was popularized by Coons, Clune, and Sugarman (1970). This approach promotes vertical equity in the sense that it lessens disparities in educational outcomes across districts by linking spending to tax effort. Unlike a lump-sum foundation grant, a power-equalizing grant comes in the form of a matching rate, with a higher rate for lower wealth districts. To be specific, an **expenditure-based** power-equalizing grant takes the following form:

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$$A_i = E_i\left(1 - \theta\frac{V_i}{\bar{V}}\right) = E_i\left(1 - \frac{V_i}{V^*}\right) = E_i(1 - v_i).$$

This formula differs from the foundation formula (equation 1) in that it is based on actual spending, E_i, not minimum acceptable spending, E^*. The matching rate, that is, the state's share of total spending, is the expression in parentheses. The local share, which is the local "price" of educational spending, is one minus the state share, or simply v_i. As before, V^* is a policy parameter that indicates the property value at which a district receives no aid. In this case, however, V^* is determined by the size of the aid budget. An equivalent formulation, the first one in equation 3, is that the budget determines a parameter, θ, which is multiplied by the ratio of V_i to the property value in the average district, $\bar{V}$.

A standard power-equalizing grant is designed to help equalize educational spending. As shown by Ladd and Yinger (1994), it can be transformed to help equalize educational outcomes. Moreover, property value can be replaced with a more general measure of revenue-raising capacity. With these two changes, an **outcome-based** power-equalizing grant is

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$$A_i = S_i\left(\frac{C_i}{\bar{C}} - \theta\frac{R_i}{\bar{R}}\right) = S_i\left(\frac{C_i}{\bar{C}} - \frac{R_i}{R^*}\right)$$
$$= S_i(c_i - r_i) = E_i\left(1 - \frac{r_i}{c_i}\right).$$

Strictly speaking, equation 4 implies that some districts will receive negative aid. This negative aid can be eliminated by lowering the value of θ (or, equivalently, raising the value of R^*), which increases the cost of the program, or by placing arbitrary floors on the matching rate, which weakens the program's equalizing impact.

Because it lowers the price of all spending, including wasteful spending, this power-equalizing formula has the disadvantage that it rewards district inefficiency. In principle, this problem can be avoided by basing the grant on spending adjusted for efficiency, not actual spending. Let k_i be a measure of efficiency in district i. Then adjusted spending equals $E_i k_i / k^*$, where, as before, k^* is minimum acceptable efficiency. Unfortunately, this approach is not yet practical because no method for calculating a district's efficiency is well known enough to be acceptable in the calculation of a district's aid amount. Moreover, as shown by Duncombe and Yinger (1997), changes in aid may alter a district's efficiency, so that efficiency and the appropriate aid amount must be simultaneously determined. Solving these problems is beyond the scope of this paper, so we simulate the effects of power-equalizing formulas that have no adjustment for efficiency.

One important equity standard is **wealth neutrality**, which is defined as a situation in which education, measured by spending per pupil or, more appropriately, by educational outcomes, is not correlated with district wealth. As first explained by Feldstein (1975), a standard power-equalizing grant helps equalize educational spending, but it does not lead, except by coincidence, to wealth neutrality. Although it ensures that districts with the same tax rate receive the same revenue, it cannot rule out the possibility that higher wealth districts systematically select higher (or lower) tax rates than low-wealth districts. Moreover, Feldstein showed that this problem could be solved by estimating the relevant behavioral elasticities and incorporating them into a grant formula.

We do not think this is practical. As an alternative, we propose building on the Feldstein intuition by adding a new policy parameter to the standard power-equalizing formula. This parameter alters the impact of wealth on the matching rate, and it can be adjusted over time until wealth neutrality is achieved. This parameter, which we call α, appears in the formula as follows:[4]

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$$A_i = E_i(1 - (v_i)^{\alpha}).$$

For example, if α is set at 1.0 (the standard power-equalizing formula) and the state falls short of wealth neutrality after the formula is implemented, then the next year the value of α would be raised slightly, say, to 1.1. This process would be continued until spending and wealth were not correlated. Eliminating the correlation between spending and wealth does not imply that all districts spend the same amount per pupil. In fact, wide variation in spending within a wealth class, including spending below any definition of adequacy, is consistent with wealth neutrality.

The grant formula in equation 5 focuses on educational spending. The appropriate switch to educational outcomes can be accomplished by applying the Feldstein approach to equation 4 instead of to equation 3. The most straightforward way to do this is to use v_i as a measure of r_i and to insert the policy parameter, now called β, as follows:

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$$A_i = E_i\left(1 - \left(\frac{v_i}{c_i}\right)^{\beta}\right).$$

As before, β could be adjusted over time until the correlation between S_i and v_i equaled zero. Once the role of educational costs has been recognized, it does not make sense to limit the notion of "neutrality" to the revenue side of the budget, and a more general equity objective is fiscal-health neutrality, which exists when educational outcomes are not correlated with a district's fiscal health, defined here as v_i / c_i.

AN EMPIRICAL ANALYSIS OF EDUCATIONAL COST, INEFFICIENCY, AND DEMAND FOR NEW YORK STATE

Our simulations of various aid formulas are based on models of both the costs of producing educational outcomes and community decisions about these outcomes. This section describes our models in general terms and explains how we estimate education cost and demand models for 631 school districts in New York state in 1991.[5] Table 1 provides descriptive statistics.

Cost Model: Theory and Results

The key step in creating outcome-based aid formulas is estimating cost models for education and using the estimates to construct education cost indexes. Our cost model borrows from the large literature in educational production and public sector costs.[6] Expenditures (*E*) in a school district depend on the level of outputs (*G*), such as reading or math classes, the district chooses to provide; the prices (*P*) that it pays for inputs, such as teachers; and unobserved district characteristics (ε):

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$$E = c(G, P, \varepsilon).$$

Bringing outcomes into educational cost functions draws from the long recognized fact that educational outcomes are a function of educational outputs and of "environmental" factors, such as the number of pupils in a district and the share of pupils who live in poverty. In symbols, educational outcomes, *S*, can be written as follows:

8

$$S = f(G, N, F, D).$$

where *N* is the number of pupils in the district, *F* represents students' family backgrounds, and *D* represents other student characteristics. Thus, for example, the same *G* per student might lead to a higher *S* per student in a middle-sized district than in a very small or a very large one.

Solving equation 8 for *G* and substituting the result into equation 7 yields a cost function for outcomes:

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$$E = g(S, P, N, F, D, \varepsilon).$$

In short, the spending required to provide a given level of student achievement is a function of factor prices, environmental factors, and unobserved district characteristics. A district's relative cost is defined as the extent to which input prices and environmental factors require it to pay more than other districts to receive the same level of *S*. In terms of equation 9, a cost index is based on the impact of (*P*, *N*, *F*, and *D*) on *E*, holding *S* and ε constant.

A district's approved operating expense (AOE) per pupil, which is provided by the New York State Department of Education, is our measure of expenditure. The AOE includes salaries and fringe benefits of teachers and other school staff, other instructional expenditure, and all other nontransportation expenditure related to operation and maintenance of schools. Our input price variable is a teacher salary index. This index adjusts for differences in teacher experience, education, and certification to reflect differences in the cost of teachers of equivalent quality. Because of the potential endogeneity of teachers' salaries, which are set by district administrators, we base this index on salaries of teachers with five or fewer

TABLE 1
DESCRIPTIVE STATISTICS FOR COST AND DEMAND MODELS (NEW YORK SCHOOL DISTRICTS IN 1991, *n* = 631)

Variable	Mean	Standard Deviation	Minimum	Maximum
Cost model:				
Dependent variable:				
Log of per pupil expenditures	8.662	0.286	8.060	10.142
Independent variables:				
PEP scores (average percent of students above SRP)	94.243	3.787	64.500	100.000
Percent receiving Regents diploma	40.437	13.072	0.000	75.385
Percent nondropouts	97.593	1.835	88.100	100.000
Log of teacher salaries	10.108	0.122	9.558	10.461
Log of enrollment	7.377	0.879	4.220	10.741
Percent children in poverty	11.569	7.453	0.258	38.040
Percent female-headed households	8.788	2.712	2.464	34.684
Percent handicapped students	10.638	3.371	1.626	30.680
Percent severely handicapped students	4.488	2.120	0.000	14.570
Persons with limited English proficiency (percent)	0.987	1.272	0.000	11.957
DEA index (percent)[a]	66.462	15.765	19.488	100.000
Estimated efficiency index (percent)[a]	69.050	9.780	45.469	100.000
Demand model:				
Dependent variable:				
Index of educational outcomes	4,914.190	1,547.250	810.710	10,284.810
Independent variables:				
Log of median family income	10.554	0.313	9.960	11.631
Ratio of operating aid to median income	0.039	0.025	0.001	0.178
Ratio of other lump-sum aid to median income	0.006	0.008	0.000	0.082
Ratio of matching aid to median income	0.006	0.005	0.000	0.045
Log of tax share	–0.623	0.464	–2.702	1.071
Log of efficiency index	–0.440	0.261	–1.635	0.000
Percent owner-occupied housing	75.362	10.158	36.499	95.381
Relative percent of adults with college education[b]	0.000	5.737	–17.146	22.800
Instruments:				
District population (thousands)	15.634	21.853	0.544	328.123
Population density	1,093.060	1,998.910	2.051	16,330.980
Percent employees managers/professionals	26.445	9.262	11.972	63.067
City district (1 = yes)	0.092	0.289	0.000	1.000
Hourly manufacturing wage (production workers)	12.146	1.853	7.500	17.965
1990 county population (thousands)	388.939	457.034	5.279	1,321.860

[a]Efficient districts have an index of 100. This is based on DEA estimates for the three outcome variables listed and per pupil expenditures.
[b]To remove collinearity with income, this variable is the residual from a regression of the percent of adults with a college education on median income.
Sources: New York State Department of Education, Comprehensive Assessment Report, Basic Education Data System and Fiscal Profile, and National Center for Education Statistics, School District Data Book.

years of experience, and we treat this wage variable as endogenous.[7]

Selecting educational outcomes is clearly difficult and controversial. We began by selecting educational outcome variables that seemed reasonable based on previous literature and that appeared to be valued by voters, as indicated by a correlation with such voter demand variables as income and tax share.[8] These criteria led us to reject average achievement test scores as outcome variables, but supported the use of three other measures. The first is the average percentage of students performing above a standard reference point on Pupil Evaluation Program, (PEP), tests given in New York to all third- and sixth-grade students in reading and math. The second measure is the percentage of students receiving a Regents diploma upon graduation from high school. Regents diplomas are given to students who pass standardized tests given by the state to high school students. The third measure is the percentage of students not dropping out of school before their scheduled graduation, which is the inverse of the dropout rate. These three variables make an appealing package because they reflect a key trade-off that every school district faces in designing its programs, that between bringing up the bottom or raising the top of the achievement distribution.

Since many studies find that expenditure per pupil is a U-shaped function of enrollment, we include a district's enrollment and its square as environmental variables. The studies cited earlier that estimate cost indexes also found that student or family characteristics can be important environmental variables. Thus, our analysis of district costs examines the percentage of children in poverty, the percentage of households with a female single parent, the percentage of children with limited English proficiency, and the percentage of students with severe disabilities (requiring special services out of the regular classroom at least 60 percent of the school day).[9]

We estimate our educational cost model in log-linear form, with the outcome measures, the efficiency index (discussed below), and the price of labor treated as endogenous. The results are reported in Table 2. The specification performs well. The outcome measures all have positive coefficients, as expected; two of the three coefficients are highly significant statistically; and the third has a *t*-statistic of 1.62. The efficiency index has a negative coefficient and is statistically significant; as expected, higher efficiency is associated with lower expenditures. Moreover, five of the seven cost variables have a statistically significant coefficient with the expected sign. The teacher salary variable, child poverty rate, percentage of households that are female-headed, and percentage of students with limited English proficiency are positively related to expenditure and significantly different from zero at least at the ten percent level (with a one-sided test). Both enrollment variables are statistically significant and indicate a U-shaped per pupil expenditure function. The percentage of students with a severe handicap has the expected sign but is not significant, probably because some special education expenditures are not included in AOE.

The cost model in Table 2 is used to construct a comprehensive educational cost index. This index indicates the amount a district must spend, relative to the state average, to obtain a given level of service quality, holding efficiency constant.[10] A district with a high cost index has a high underlying cost of hiring teachers (the opportunity wage), unfavorable environmental factors (such as concentrated student poverty), or both. This index has a range of 74 to 261, with a standard deviation of 19. Seventy-five percent of the districts have indexes below 105, and 75 percent have indexes above 89.

Measuring Inefficiency

One key element of unobserved district characteristics, ε, is school-district inefficiency, which, like relatively high costs, can lead to relatively high spending. Without controlling for inefficiency, cost adjustments in aid formulas may inappropriately reward inefficient as well as higher-cost districts.

TABLE 2
EDUCATIONAL COST AND DEMAND MODEL RESULTS, NEW YORK SCHOOL DISTRICTS, 1991[a]

Variables	Coefficient		*t*-Statistic
Cost model:			
Intercept	–4.9550		–1.53
PEP scores (average percent above standard reference point)*	5.1106		2.50
Percent nondropouts*	4.4757		1.62
Percent receiving Regents diploma*	1.3449		3.19
DEA efficiency index (percent)*	–1.1670		–4.87
Log of teacher salaries*	0.6487		1.57
Log of enrollment	–0.5680		–3.54
Square of log of enrollment	0.0345		3.44
Percent children in poverty	1.0109		3.93
Percent female-headed households	2.2261		3.85
Percent severely handicapped students	0.8584		1.29
Limited English proficiency (percent)	4.0525		2.65
SSE		34.58	
Adjusted *R*-square		0.31	
Demand model:			
Intercept	–1.2552		–1.45
Log of median family income	0.8947		9.65
Ratio of operating aid to median income	3.4337		2.45
Ratio of other lump-sum aid to median income	3.1814		1.38
Ratio of matching aid to median income	–7.8947		–1.53
Log of tax share	–0.3133		–6.47
Log of DEA efficiency index*	0.4637		2.10
Percent owner-occupied housing	0.2148		1.39
Relative percent of adults with college education	0.1591		0.60
n		631	
SSE		37.05	
Adjusted *R*-square		0.47	

[a]Cost and demand models estimated with linear 2SLS regression; variables marked with an asterisk are treated as endogenous. The dependent variables are the logarithms of per pupil operating expenditures in the cost model and the outcome index for the demand model. The outcome index is based on the three outcome variables in the cost model weighted by their regression coefficients.

Our strategy is to measure inefficiency directly, so that our cost indexes—and aid formulas—can be adjusted to avoid this problem.

Our measure of inefficiency is based on data envelopment analysis (DEA). This nonparametric programming technique compares the spending of each district with the spending of other districts that deliver the same quality of public services. In this context, the quality of public services is measured by the *S* variables included in equation 9. A district's inefficiency is measured by the extent to which it spends more than its comparison districts. This inefficiency can arise either because the district uses too many inputs to produce the output (called technical inefficiency) or because it uses the wrong combination of inputs given output prices (called input-allocative inefficiency). For a more detailed discussion of this DEA measure, see Duncombe, Ruggiero, and Yinger (1996) or Ruggiero (1996). A cost "efficiency" index was constructed for each school district in New York State. This index has a value of one (1.0) for a perfectly "efficient" district. The average "efficiency" score is 0.66, 23 districts (4 percent) have an index of 1.0, and 350 districts (55 percent) have an index below 0.7.

The word "efficiency" is in quotation marks here because this DEA measure reflects factors in addition to efficiency. In fact, it reflects any factor that influences the relationship between observed *S* and *E*, including unobserved public service outcomes, cost variables, and a district's past decisions about education. Thus, the DEA variable inevitably duplicates some information in the cost model, and including it in the cost equation may cause multicollinearity. In fact, however, the coefficients of most of these variables are estimated with precision (that is, they are statistically significant at conventional levels), so the DEA variable can be included in our cost equation (and, on similar grounds, in our demand equation) to avoid potential bias from the omission of a control for efficiency. Finally, any efficiency measure might be endogenous; some of the same factors that influence decisions about spending might also influence decisions that lead districts to act in an efficient manner. To account for this possibility, we treat our DEA variables as endogenous, with instruments drawn from the public choice literature.[11]

In the aid simulations, we need to calculate the district expenditure associated with a given outcome level. The DEA variable cannot be used directly in this calculation, because the conversion of our simulated outcome, *S*, into expenditure, *E*, requires a measure of productive efficiency alone, not an index that may reflect other things. In symbols, $E_i = S_i\, c_i / k_i$, where *k* is an efficiency index. To estimate this efficiency index, we regress the DEA measure on the cost factors in equation 9; demand factors (discussed below), which control for omitted educational outcomes; and public choice factors (Duncombe and Yinger, 1997). The efficiency index is the predicted value from this equation, holding cost and demand factors at the state average while allowing public choice factors to vary across districts. The resulting index is rescaled so its highest value is 1.0 (for perfect efficiency). The mean of this efficiency index is higher, and its standard deviation lower, than that of the DEA measure.

Demand Model: Theory and Results

One of the issues that arises in estimating equation 9 is that service quality, *S*, is clearly endogenous; communities make decisions about service quality and spending simultaneously. Moreover, one cannot simulate the impact of a new aid program on educational outcomes without understanding how such outcomes are determined. Thus, a formal analysis of the determinants of the demand for *S* is central to the objectives of this paper.

We draw on the large literature on the demand for educational outcomes (Inman, 1979; Rubinfeld, 1987; Ladd and Yinger, 1991). In particular, we employ the median voter model, in which a district's demand for educational outcomes, as determined through voting, is a function of the median voter's aggregate income, *TY*; her tax price, *TP*; efficiency; and various preference variables, *R*. Following much of the literature, we specify a constant elasticity demand function:

$$S = TY^{\theta}\, TP^{\mu}\, DEA^{\gamma} R^{\nu}. \quad (10)$$

Our demand model uses an index of the three outcomes discussed previously as the dependent variable (Table 1). The weights for these outcomes are derived directly from the cost model.[12] Preference variables include community characteristics, such as the percentage of adults who graduated from college and the percentage of households living in owner-occupied housing, that might affect voting outcomes.[13]

Following the literature (especially Ladd and Yinger, 1991), we define the tax price, *TP*, as tax share, τ, multiplied by the marginal expenditure for educational services. We measure τ with the ratio of median housing value to total property value per pupil. Marginal expenditure equals marginal cost divided by the efficiency index to reflect wasted spending. Assuming constant returns to scale with respect to *S*, average cost equals marginal cost, and the educational cost index from the cost model can be used as a measure of marginal cost. In estimating the demand model, we split marginal expenditure into two pieces. The first piece is τ multiplied by the cost index and the second is the DEA index.

Aggregate income (*TY*) equals the median voter's income plus her share of state aid:

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$$TY = Y + \tau A = Y\left(1 + \tau\frac{A}{Y}\right)$$

where *Y* is median income, *A* is aid per pupil, and τ is the median voter's tax share. Because the term in parentheses is close to one in value, this form can be approximated using the aid-income index ($\tau A/Y$) in unlogged form. New York, like most states, has several education aid programs; together, they fund about 40 percent of school district budgets. The aid distributed by formula (over 95 percent of the total) can be divided into lump-sum and matching grants. The largest program, basic operating aid, is a lump-sum, noncategorical, foundation-type grant, which constitutes 60 percent of total state aid and provided $3.05 billion in 1991. We include this grant separately in the demand model since it is closest in design to the general operating aid programs we simulate. In addition, we combine several smaller lump-sum grants into a second aid variable[14] and several matching aid programs into a third aid variable. Because they are not open ended, the matching grants cannot be expressed as an adjustment to the tax price.[15]

We estimate our demand model in log-linear form, with the DEA index treated as endogenous. Based on the form in equation 11, the aid variables are not expressed in natural logarithms. Following standard practice for percentages, neither are the preference variables. The results are in Table 2. The income elasticity for education is estimated to be somewhat below unity, 0.89. Our estimate is higher than that found in most past research (Inman, 1979), possibly due to our controls for costs and efficiency.[16] The elasticity for the operating aid variable is 3.4. This result is consistent with the so-called "flypaper" effect. In the average district, a $1 increase in state aid is associated with a $0.33 increase in educational expenditure, whereas expenditure rises by only $0.10 when district income increases by $1. The other aid variables are not statistically significant.

The price elasticity for education, μ, is estimated to be –0.31, which is in line with past research on education (Inman, 1979). In addition, the coefficient of the DEA index is positive and statistically significant; as expected, higher efficiency lowers the effective price facing the median voter and increases demand for *S*. The preference variables are positively related to educational outcomes, but are not statistically significant.

SCHOOL AID SIMULATIONS FOR NEW YORK

To evaluate alternative aid formulas on the basis of various equity criteria, we used our results to simulate the choices school districts in New York would make if several different aid formulas were implemented. We are particularly concerned, of course, with their choice of educational outcome, *S*. While simulations have been performed on individual aid systems (Megdal, 1983; Rothstein, 1992), our paper represents one of the first attempts to assess the implications of different school aid formulas for several equity standards.

Simulation Methodology

The first step in our simulation is to construct the aid formulas presented previously. Since foundation aid is exogenous to local behavior, aid can be allocated prior to estimating districts' behavioral responses. Aid given according to equation 1, for example, depends only on a district's tax base. Power-equalizing aid formulas (equations 5 and 6) yield matching rates, not aid amounts. All of the aid simulations are adjusted to keep total state spending approximately at the 1991 level of actual state operating aid and other lump-sum aid, namely, $3.65 billion or $2,427 per pupil.[17]

To simulate service outcomes under different aid formulas, the coefficients of the demand regression (Table 2) are multiplied by actual district data for median income, tax price, efficiency, matching aid, and preference variables. In addition, we include the estimated residual in the simulation to pick up district-specific effects not captured by our demand model. For each foundation plan, the new aid-income ratio is multiplied by the operating aid elasticity to simulate the income effect of the grant. The aid ratio for other lump-sum aid is set to zero because we want to simulate the distribution of all general lump-sum aid through one foundation formula. For power-equalizing grants, the aid-income ratios for both lump-sum aid variables are set to zero, which is equivalent to eliminating lump-sum aid, and the estimated price elasticity is used to simulate the effects of the new matching rate. These steps yield a simulated value of *S* for each grant formula. The value of *E* is found by multiplying *S* by the cost index and dividing it by the estimated efficiency index, *k* (not the DEA index). The estimated matching aid amount is found by multiplying *E* by the matching rate.

We carry out simulations (a) comparing lump-sum (foundation) and matching (power-equalizing) grants (b) with and without negative aid and (c) based on expenditure or outcome as the object of equalization. Outcome-based formulas are constructed using both property wealth and revenue-raising capacity. Foundation formulas are tested for three different foundation levels: the 25th, 50th, and 75th percentiles of the 1991 expenditure or outcome distribution. These foundation levels correspond to E^* (for expenditure) or S^* (for outcome) in the aid formulas. The foundation formulas also set k^*, the minimum acceptable efficiency level, at the 75th percentile of the current efficiency distribution, as defined by *k*, not by the DEA measure. Power-equalizing formulas are constructed for seven values of α in equation 5 (or β in equation 6) to determine how much the standard power-equalizing matching rate formula needs to be dampened or accentuated to achieve wealth (or fiscal-health) neutrality. For comparative purposes, we also include the simplest of all aid plans—a flat grant per pupil. If an aid plan does not do much better at equalizing than a flat grant, then the costs associated with implementing a more complex aid system are probably not worth it.

Simulation Results

The distribution of aid for various aid formulas is presented in Table 3. Three themes emerge from this table. First, systems that allow for negative aid permit more redistribution than those that do not. For example, the aid per pupil received by the five percent of districts deemed most needy by a particular formula is up to $700 higher with negative aid than without it. Second, for foundation plans, increasing the value of E^* (or of S^*) raises the extent of redistribution, but the impact of such an increase is greater if there is negative aid. Third, in both foundation and power-equalizing plans, switching from an expenditure-based to an outcome-based formula tends to increase redistribution. For example, the neediest districts receive about $1,000 more per pupil with the most generous outcome-based foundation plans than with the comparable expenditure-based plan. This table hides another feature of these simulations, namely, that aid to specific districts may be quite different in two plans with similar implications for redistribution.

To explore the impacts of the various plans in more detail, Tables 4 through 7 show how each plan performs according to five different equity standards. Tables 4 and 5 present results for foundation plans (with and without negative aid), and Tables 6 and 7 present results for power-equalizing plans (with and without negative aid). The absolute equity standard in the first two columns is the share of the outcome gap below an absolute standard closed by each aid plan. The first column sets the absolute standard at the current median *S,* and the second sets it at the current 25th percentile of *S*. The outcome gap is defined as the weighted average difference, across districts with outcomes below the absolute standard, between the actual district outcome and the absolute standard. In this definition, the weights reflect the number of students in each district. We calculate the gap for our new aid formulas and the gap for actual aid formulas in 1991 and estimate the percent of the existing gap that would be closed by the new formulas. Thus, the entries in these two columns indicate how far each aid formula goes toward bringing all students up to the stated absolute standard.

In addition, these tables use the Gini coefficient (column 3) as a vertical equity standard, the elasticity of outcomes with respect to property wealth (column 4) as a measure of wealth neutrality, and the elasticity of outcomes with respect to fiscal health (column 5) as a measure of fiscal-health neutrality. A higher percentage indicates a higher ranking for the two absolute standards, whereas a value closer to zero indicates a higher ranking for the other three standards.

Absolute standards

Which aid systems do the best job of boosting students in poor or high-cost districts above some minimum educa-

TABLE 3
DISTRIBUTION OF AID BY TYPE OF AID SYSTEM[a]
NEW YORK SCHOOL DISTRICTS IN 1991 PERCENTILES OF THE AID DISTRIBUTION

Aid System	95th Percentile	75th Percentile	Median	25th Percentile	5th Percentile
Present aid system	$4,135	$3,545	$3,066	$2,106	$921
Foundation plans:					
Expenditure based:					
Negative aid					
E^* = 25th percentile	$3,891	$3,560	$3,153	$2,024	–$1,761
E^* = median	$4,248	$3,837	$3,331	$1,926	–$2,786
E^* = 75th percentile	$5,081	$4,481	$3,744	$1,697	–$5,169
No negative aid					
E^* = 25th percentile	$3,790	$3,421	$2,967	$1,707	$0
E^* = median	$4,084	$3,609	$3,026	$1,406	$0
E^* = 75th percentile	$4,740	$4,010	$3,112	$619	$0
Outcome based (using property values):					
Negative aid					
S^* = 25th percentile	$4,206	$3,302	$2,540	$1,430	–$1,852
S^* = median	$5,081	$3,728	$2,814	$1,009	–$4,117
S^* = 75th percentile	$6,044	$4,311	$3,112	$567	–$7,095
No negative aid					
S^* = 25th percentile	$4,074	$3,025	$2,334	$1,027	$0
S^* = median	$4,690	$3,308	$2,239	$0	$0
S^* = 75th percentile	$5,324	$3,402	$2,005	$0	$0
Outcome based (using revenue raising capacity):					
Negative aid					
S^* = 25th percentile	$4,293	$3,287	$2,650	$1,678	–$453
S^* = median	$5,179	$3,867	$2,958	$1,524	–$1,937
S^* = 75th percentile	$6,180	$4,444	$3,277	$1,335	–$3,540
No negative aid					
S^* = 25th percentile	$4,219	$3,189	$2,540	$1,503	$0
S^* = median	$4,986	$3,578	$2,630	$1,048	$0
S^* = 75th percentile	$5,762	$3,938	$2,615	$307	$0
Power-equalizing plans:[b]					
Expenditure based:					
Negative aid	$5,850	$4,359	$3,459	$2,114	–$5,428
No negative aid	$5,033	$3,752	$2,906	$1,058	$0
Outcome based (using property values):					
Negative aid	$5,993	$4,242	$3,272	$1,876	–$5,288
No negative aid	$5,269	$3,610	$2,696	$732	$0
Outcome based (using revenue raising capacity):					
Negative aid	$6,942	$4,343	$3,325	$2,208	–$2,674
No negative aid	$6,399	$3,949	$2,894	$1,654	$0

[a]All plans are adjusted to have approximately the same budget as 1991 operating and other lump-sum aid—$3.65 billion.
[b]For comparision purposes, the value of α (or β) is held at one; see the text.

tional standard? As shown in Tables 4 and 5, the clear winners in this case are the plans explicitly designed to meet this objective, namely, outcome-based foundation plans that both set S^* high enough and require a minimum t^*. If S^* is set at least as high as the standard that policymakers are trying to meet and districts are required to set t^* high enough to fund this outcome, then at least 70 percent of the outcome gap is closed, regardless of whether there is negative aid. The entire outcome gap is not closed because some of the districts with low values of S are relatively inefficient. Thus, students in these

TABLE 4
EQUITY COMPARISONS FOR DIFFERENT FOUNDATION FORMULAS WITH NEGATIVE AID,
NEW YORK SCHOOL DISTRICTS, 1991[a]

	Absolute Standard		Relative Standard	Fiscal Neutrality[b]	
	Percent of Outcome Gap Closed Minimum Outcome Set at				
Aid System	Median	25th Percentile	Gini Coefficient (Outcome Index)	Elasticity of Outcomes and Property Wealth	Elasticity of Outcomes and Fiscal Health
Present aid distribution	0%	0%	0.203	0.147	0.259
Flat grant	–4%	–1%	0.200	0.235	0.317
Expenditure based:					
No minimum t^*					
E^* = 25th percentile	8%	14%	0.182	0.124	0.218
E^* = median	11%	16%	0.178	0.096	0.194
E^* = 75th percentile	16%	22%	0.173	0.033	0.138
Minimum t^*					
E^* = 25th percentile	22%	36%	0.166	0.098	0.169
E^* = median	34%	48%	0.153	0.054	0.122
E^* = 75th percentile	60%	75%	0.123	–0.048	0.011
Outcome based (using property value):					
No minimum t^*					
S^* = 25th percentile	17%	42%	0.162	0.133	0.200
S^* = median	27%	52%	0.149	0.072	0.139
S^* = 75th percentile	35%	63%	0.140	0.006	0.073
Minimum t^*					
S^* = 25th percentile	43%	84%	0.134	0.114	0.152
S^* = median	74%	98%	0.103	0.021	0.038
S^* = 75th percentile	95%	100%	0.081	–0.074	–0.078
Outcome based (using revenue raising capacity):					
No minimum t^*					
S^* = 25th percentile	13%	36%	0.165	0.163	0.195
S^* = median	20%	44%	0.154	0.120	0.131
S^* = 75th percentile	28%	50%	0.145	0.072	0.062
Minimum t^*					
S^* = 25th percentile	41%	83%	0.135	0.142	0.149
S^* = median	73%	99%	0.103	0.060	0.037
S^* = 75th percentile	95%	100%	0.080	–0.028	–0.073

[a]All grants require approximately the same state budget to fund as the aid system in 1991—$3.65 billion.
[b]The fiscal health index used in the fiscal neutrality calculation uses a general measure of revenue raising capacity.

districts are penalized because of the inefficiency of their school district. One way the state could avoid this problem would be to set the inefficiency standard, k^*, at the minimum efficiency level of all districts. This approach would not provide incentives for districts to be inefficient, and it would require either a substantial increase in either state aid or t^*.

While expenditure-based foundation plans are certainly an improvement over the present system in New York or a simple flat grant per pupil, they do not close as much of the outcome gap as an outcome-based foundation because they neglect high-cost, low-outcome districts. In fact, these aid systems close between 30 and 40 percent less of the

TABLE 5
EQUITY COMPARISONS FOR DIFFERENT FOUNDATION FORMULAS WITHOUT NEGATIVE AID, NEW YORK SCHOOL DISTRICTS, 1991[a]

	Absolute Standard		Relative Standard	Fiscal Neutrality[b]	
	Percent of Outcome Gap Closed Minimum Outcome Set at				
Aid System	Median	25th Percentile	Gini Coefficient (Outcome Index)	Elasticity of Outcomes and Property Wealth	Elasticity of Outcomes and Fiscal Health
Present aid distribution	0%	0%	0.203	0.147	0.259
Flat grant	–4%	–1%	0.200	0.235	0.317
Expenditure based:					
No minimum t^*					
E^* = 25th percentile	6%	11%	0.183	0.147	0.235
E^* = median	8%	13%	0.181	0.133	0.222
E^* = 75th percentile	10%	15%	0.178	0.105	0.195
Minimum t^*					
E^* = 25th percentile	21%	36%	0.170	0.167	0.216
E^* = median	35%	48%	0.160	0.167	0.199
E^* = 75th percentile	64%	77%	0.141	0.189	0.177
Outcome based (using property value):					
No minimum t^*					
S^* = 25th percentile	13%	39%	0.165	0.159	0.221
S^* = median	18%	45%	0.158	0.135	0.192
S^* = 75th percentile	21%	49%	0.155	0.118	0.170
Minimum t^*					
S^* = 25th percentile	41%	84%	0.140	0.191	0.206
S^* = median	75%	99%	0.124	0.224	0.182
S^* = 75th percentile	98%	100%	0.133	0.307	0.211
Outcome based (using revenue raising capacity):					
No minimum t^*					
S^* = 25th percentile	11%	34%	0.167	0.175	0.211
S^* = median	15%	39%	0.160	0.152	0.172
S^* = 75th percentile	18%	42%	0.156	0.132	0.137
Minimum t^*					
S^* = 25th percentile	41%	83%	0.136	0.160	0.173
S^* = median	74%	99%	0.113	0.124	0.125
S^* = 75th percentile	97%	100%	0.110	0.112	0.126

[a]All grants require approximately the same state budget to fund as the aid system in 1991—$3.65 billion.
[b]The fiscal health index used in the fiscal neutrality calculation uses a general measure of revenue raising capacity.

outcome gap. Expenditure-based plans bring approximately the same number of districts above an outcome-based adequacy standard as do otherwise comparable outcome-based plans, but their impact is primarily on low-cost districts currently just below the standard. Even with a high expenditure standard (E^* = 75th percentile) and a required local tax rate, 25 percent of the outcome gap below the 25th percentile would remain after aid distribution. By comparison, this outcome gap would be eliminated entirely under the two outcome-based plans. This finding is particularly important because most existing foundation plans account principally for wealth differences across districts with few adjustments for cost differences.

TABLE 6
EQUITY COMPARISONS FOR DIFFERENT POWER-EQUALIZING FORMULAS WITH NEGATIVE AID, NEW YORK SCHOOL DISTRICTS, 1991[a]

	Absolute Standard		Relative Standard	Fiscal Neutrality[b]	
	Percent of Outcome Gap Closed Minimum Outcome Set at				
Aid System	Median	25th Percentile	Gini Coefficient (Outcome Index)	Elasticity of Outcomes and Property Wealth	Elasticity of Outcomes and Fiscal Health
Present aid distribution	0%	0%	0.204	0.147	0.259
Flat grant	–4%	–1%	0.201	0.235	0.317
Expenditure based:[c]					
$\alpha = 0.7$	13%	18%	0.183	0.084	0.184
$\alpha = 0.8$	16%	21%	0.179	0.053	0.157
$\alpha = 0.9$	19%	23%	0.177	0.022	0.130
$\alpha = 1.0$	21%	26%	0.175	–0.009	0.103
$\alpha = 1.1$	24%	28%	0.173	–0.041	0.076
$\alpha = 1.15$	26%	29%	0.173	–0.056	0.063
$\alpha = 1.4$	32%	35%	0.171	–0.135	–0.004
Outcome based (using property value):[d]					
$\beta = 0.7$	19%	33%	0.169	0.090	0.169
$\beta = 0.8$	23%	38%	0.164	0.059	0.140
$\beta = 0.9$	27%	44%	0.160	0.029	0.111
$\beta = 1.0$	31%	49%	0.156	–0.002	0.082
$\beta = 1.1$	36%	52%	0.152	–0.032	0.053
$\beta = 1.15$	38%	54%	0.151	–0.048	0.038
$\beta = 1.3$	44%	59%	0.146	–0.093	–0.005
Outcome based (using revenue raising capacity):[d]					
$\beta = 0.7$	13%	23%	0.173	0.160	0.152
$\beta = 0.8$	16%	27%	0.168	0.139	0.121
$\beta = 0.9$	20%	31%	0.164	0.118	0.089
$\beta = 1.0$	23%	35%	0.159	0.098	0.058
$\beta = 1.1$	26%	39%	0.156	0.077	0.027
$\beta = 1.15$	28%	41%	0.154	0.068	0.011
$\beta = 1.2$	30%	43%	0.151	0.056	–0.005

[a]All grants require approximately the same state budget to fund as the aid system in 1991—$3.65 billion.
[b]The fiscal health index used in the fiscal neutrality calculation uses a general measure of revenue raising capacity.
[c]The role of α is defined in equation 5.
[d]The role of β is defined in equation 6.

Plans with a required minimum tax rate promote adequacy because they force needy school districts to raise their tax effort. For an outcome-based foundation plan (using a more general capacity measure), where the standard is set at the current median outcome, 80 percent of districts with outcomes presently below the standard would be forced to impose a higher tax rate than the median voter would select. For the median of these districts, the required tax rate would be twice the desired level. Even with required minimum tax rates, however, school tax rates in districts with low fiscal health are slightly lower, on average, than in other districts. If one accepts the property tax rate as a suitable measure of effort, taxpayers in these "unhealthy" districts are not being asked to make a greater effort than are other taxpayers.

Without a minimum t^*, we find, somewhat surprisingly, that power-equalizing formulas designed to achieve

TABLE 7
EQUITY COMPARISONS FOR DIFFERENT POWER-EQUALIZING FORMULAS WITHOUT NEGATIVE AID, NEW YORK SCHOOL DISTRICTS, 1991[a]

	Absolute Standard		Relative Standard	Fiscal Neutrality[b]	
	Percent of Outcome Gap Closed Minimum Outcome Set at				
Aid System	Median	25th Percentile	Gini Coefficient (Outcome Index)	Elasticity of Outcomes and Property Wealth	Elasticity of Outcomes and Fiscal Health
Present aid distribution	0%	0%	0.204	0.147	0.259
Flat grant	–4%	–1%	0.201	0.235	0.317
Expenditure based:[c]					
$\alpha = 0.7$	9%	14%	0.184	0.134	0.219
$\alpha = 0.8$	11%	16%	0.182	0.120	0.206
$\alpha = 0.9$	12%	17%	0.179	0.107	0.194
$\alpha = 1.0$	14%	18%	0.178	0.095	0.183
$\alpha = 1.1$	15%	19%	0.176	0.084	0.172
$\alpha = 1.15$	16%	20%	0.175	0.074	0.161
$\alpha = 3.25$	20%	23%	0.177	–0.058	0.027
Outcome based (using property value):[d]					
$\beta = 0.7$	14%	29%	0.172	0.137	0.205
$\beta = 0.8$	17%	33%	0.169	0.123	0.190
$\beta = 0.9$	19%	37%	0.165	0.110	0.177
$\beta = 1.0$	21%	40%	0.162	0.099	0.164
$\beta = 1.1$	23%	43%	0.160	0.088	0.152
$\beta = 1.15$	25%	45%	0.158	0.079	0.142
$\beta = 3.25$	30%	59%	0.160	–0.002	0.036
Outcome based (using revenue raising capacity):[d]					
$\beta = 0.7$	10%	21%	0.172	0.177	0.177
$\beta = 0.8$	13%	24%	0.168	0.165	0.156
$\beta = 0.9$	15%	28%	0.165	0.153	0.137
$\beta = 1.0$	17%	30%	0.162	0.143	0.119
$\beta = 1.1$	18%	33%	0.160	0.132	0.101
$\beta = 1.15$	20%	35%	0.158	0.123	0.085
$\beta = 2.00$	27%	45%	0.151	0.066	–0.022

[a]All grants require approximately the same state budget to fund as the aid system in 1991—$3.65 billion.
[b]The fiscal health index used in the fiscal neutrality calculation uses a general measure of revenue raising capacity.
[c]The role of α is defined in equation 5.
[d]The role of β is defined in equation 6.

fiscal neutrality with respect to fiscal health close slightly more of the outcome gap below the median than do outcome-based foundation plans (Table 6). Thirty to forty-four percent of the outcome gap below the median level of S^* is closed under power equalization (with negative aid) compared to between 28 and 35 percent for the most redistributive outcome-based foundation plans (S^* = 75th percentile). This finding reflects the well-known fact that the price effect in a matching grant makes it more powerful than a lump-sum grant in raising expenditures and outcomes. Thus, the high matching rates in low-capacity districts are more effective in raising outcomes than are the large amounts of aid in foundation formulas. However, these matching plans are much less effective at targeting aid to districts with the worst current educational outcomes; outcome-based foundation plans close more of the gap below the 25th percentile than do power-equalizing grants.

Vertical equity

We measure vertical equity with the Gini coefficient. Several other measures of vertical equity are available (Berne and Stiefel, 1984), including the coefficient of variation and several range measures; they all yield similar results.

The current aid system, with a Gini coefficient of 0.203, is no more equalizing than a flat grant per pupil for every district. Assuming no restrictions on local tax rates, most aid plans result in a Gini between 0.14 and 0.19, which indicates more equity than the current system. Eliminating negative aid causes a small decrease in equity in most cases. Tables 4 and 5 indicate, for example, that the Gini for an outcome-based foundation plan (when S^* is set at the 75th percentile) goes from 0.14 to 0.155 when negative aid is disallowed. Moving from an expenditure-based to an outcome-based aid system improves equity, with Gini coefficients dropping by 10 to 20 percent.

Under outcome-based foundation plans, requiring a minimum tax rate significantly improves vertical equity, with Gini coefficients falling to as low as 0.08 (when S^* = 75th percentile). This large improvement in equity is achieved because most of the outcome gap below S^* is closed. For example, with an S^* set at the 50th percentile (and negative aid), 73 percent of the outcome gap is closed and there is little variation in S, let alone inequity. As noted earlier, most of this boost in equity is due to forced local spending by low-capacity/high-cost districts rather than to the intergovernmental aid itself.

Fiscal neutrality

We measure fiscal neutrality by the elasticity (at the mean) of the simulated service outcomes relative to either property wealth or fiscal health. The elasticity of the present (1991) aid distribution is 0.147 with respect to wealth and 0.259 with respect to fiscal health. In other words, a 1 percent increase in a district's property wealth (fiscal health) is associated with a 0.147 percent (0.259 percent) increase in S. A flat per pupil aid system would increase both elasticities—and thereby move the system away from neutrality.

Not surprisingly, power-equalizing grants with negative aid do particularly well by these standards (Table 6). For an unadjusted (α or β =1) power-equalizing grant, elasticities range from –0.01 to 0.1 for wealth and from 0.06 to 0.1 for fiscal condition. Expenditure- and outcome-based power-equalizing grants based on wealth both come close to wealth neutrality (as indicated by the very small negative elasticity), but do not achieve fiscal-health neutrality. Outcome-based power-equalizing grants based on a general measure of capacity come closer to fiscal-health neutrality, but do not get all the way there unless β is set at approximately 1.2.

Table 7 shows that power-equalizing grants have a difficult time achieving fiscal neutrality without negative aid. In order for wealth and fiscal-health elasticities to approximate zero, α (or β) must be set at 2.0 or above. Thus, standard formulas must be altered dramatically to come close to neutrality in either sense. Moreover, the more one boosts the matching rate for the lowest wealth (or fiscal-health) districts, the more redistribution occurs among districts that receive aid, but the fewer districts receive aid (to keep the budget constant). As a result, some states may find it impossible to obtain wealth or fiscal-health neutrality without negative aid. Despite their origins, realistic power-equalizing systems (that is, those without negative aid) actually prove to be a difficult way to achieve fiscal neutrality.

Foundation formulas vary significantly in their impact on fiscal neutrality (Tables 4 and 5). Increasing the redistributive power of the grant by raising S^* lowers the elasticities for all types of foundation formulas with negative aid. Forcing districts below S^* to assess a minimum tax rate lowers the elasticities still further, particularly when S^* is set at a high level. For example, with S^* set at the 75th percentile, elasticities with respect to wealth and fiscal health are actually negative for outcome-based aid formulas. The results change dramatically when negative aid is not permitted. Elasticities remain at 0.10 or above for all aid systems and elasticities actually go up with S^* in some cases when a minimum t^* is imposed. In general, similar expenditure- and outcome-based foundation formulas have roughly equivalent impacts on wealth or fiscal-health neutrality.

Conclusions

Expenditure-based foundation grants, which are used by over 80 percent of states, do not perform well by either absolute or vertical equity standards—even when a minimum t^* is imposed. By controlling for costs in an *ad hoc* fashion, the typical foundation formula does not provide sufficient aid to high-cost districts, and therefore leaves many students below any reasonable standard for educational outcomes. The resulting wide disparities also show up in higher Gini coefficients or in other measures of vertical equity. By shifting to performance standards for local schools, states have implicitly recognized the role of input and environmental cost factors, so it is particularly troubling that they continue to rely so heavily on aid formulas that only partially account for these factors, if at all. Moreover, there appears to be a growing emphasis on absolute outcome standards, often called educational adequacy (Clune, 1993). State policymakers need to understand that expenditure-based foundation grants do not and indeed cannot assure that educational adequacy is achieved.

Outcome-based foundation plans cannot be implemented without addressing several difficult issues, such as deciding which educational outputs and environmental cost factors to consider and selecting a way to control for district efficiency. We provide one method for addressing these issues that attempts to find a balance between the precision required by scholars and the simplicity required for actual implementation. Our simulations of the impacts of the resulting outcome-based plans indicate that such plans can be an effective tool for promoting educational adequacy, at least when they include a required minimum tax rate. Indeed, by requiring contributions from local taxpayers, these plans can bring the vast majority of districts up to any educational outcome standard policymakers select. The districts that remain below the standard are relatively inefficient.[18]

The majority of states with foundation plans do require minimum tax rates, but states tempted to drop this requirement (or states considering the adoption of an outcome-based foundation plan without it) should recognize that it is essential to the goal of educational adequacy. Without a required minimum tax rate, many districts will spend below a relatively modest adequacy standard (in this paper, the 25th percentile of the current distribution) even if the foundation level is set very high. Of course, states can minimize the impact of a required minimum tax rate on needy districts by boosting the state budget. Without an extremely generous state plan, however, a significant increase in the tax rate in many districts is necessary, at least in New York, to meet any reasonable adequacy standard. Our simulations for New York also indicate that foundation plans with negative aid and a required minimum tax rate promote vertical equity and fiscal neutrality, at least if the foundation level is set high enough. Indeed, if the outcome foundation level is set at the 75th percentile of the current distribution, the two outcome-based foundation plans have the lowest Gini coefficients of all plans and are close to fiscal neutrality.

We also find, not surprisingly, that power-equalizing grants with negative aid are particularly effective at achieving fiscal-health (or wealth) neutrality, even without boosting their power beyond that in the standard formula. Thus, policymakers concerned with wealth neutrality should continue to consider power-equalizing grants. However, a child is just as disadvantaged by poor education associated with high costs as by poor education associated with low wealth, and it is difficult to justify a neutrality objective that ignores the role of costs. Thus, we believe that fiscal-health neutrality is a more general and more appealing objective than is wealth neutrality. As it turns out, outcome-based power-equalizing grants with negative aid can be effective in promoting fiscal-health neutrality. Such grants cannot be implemented, of course, without overcoming the same challenges that face outcome-based foundation plans. Power-equalizing grants do not do as well in promoting educational adequacy. They have a stronger carrot for low-outcome districts than do foundation plans because they involve a matching rate, and hence have a price effect, but they do not have the same stick in the form of a required minimum tax rate. Without this stick, many districts fall below any reasonable minimum standard even with the most generous power-equalizing formula.

Overall, if policymakers and courts are prepared to focus on outcome-based equity standards, aid formulas are available to help them move toward these goals. Adequacy goals can be achieved with an outcome-based foundation plan that includes a required minimum tax rate. Fiscal neutrality or vertical equity goals can be achieved either with a power-equalizing plan that includes negative aid or with a foundation plan that includes a minimum tax rate combined with a very high outcome target and negative aid. Only the second of these routes will result both in fiscal neutrality and in educational adequacy for high-cost, low-wealth districts.

The problem, of course, is that change in an education finance system seldom comes easily. A required high minimum tax rate, negative aid, or a significant increase in the state budget all imply a greater state role in education finance, and the political fallout from this reduction in local control is likely to be compounded by the inevitable conflict between winners and losers under any new aid system. Moreover, required minimum tax rates are bound to be unpopular, and moving to an outcome-based aid system requires the introduction of new and potentially controversial measures of outcomes, costs, and efficiency. In light of these formidable political hurdles, it is small wonder that states have made so little progress in improving the equity of educational outcomes.

ENDNOTES

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[1] In Michigan and Wisconsin, for example, state funding recently increased from about one-third to about two-thirds of local education budgets (Kearney, 1995; Reschovsky, 1994).

[2] Under some circumstances, wealth may be a reasonable approximation of a more general measure. In the case of Minnesota cities, for example, Ladd, Reschovsky, and Yinger (1991) found the correlation between wealth and a general measure of capacity to be 0.92. In New York, however, the correlation is only 0.7.

[3] Strictly speaking, setting k^* is equivalent to altering the base of the cost index. Because the cost index is serving only to translate S^* into its spending equivalent, however, we see no reason to use a cost-index base other than the cost of the average district.

[4] The Feldstein approach builds on a quasi-behavioral regression. A detailed comparison of our approach with that of Feldstein using expenditures or outcomes is available from the authors upon request.

[5] There were 695 school districts in New York in 1991. Due to missing observations, including New York City and Yonkers, the sample was limited to 631 observations. Except for these two notable omissions, the sample appears representative of the major regions in New York State.

[6] The literature on education production functions and costs is reviewed in Bridge, Judd, and Moock (1979), Hanushek (1986), Cohn and Geske (1990), and Monk (1990). Several recent production function studies include Ferguson (1991) and Ferguson and Ladd (1996). For research on educational cost functions, see Ratcliffe, Riddle, and Yinger (1990), Downes and Pogue (1994), and Duncombe, Ruggiero, and Yinger (1996).

[7] Salaries and teacher characteristics are collected in a self-reporting survey called the "Personnel Master File" of the "Basic Education Data System" (BEDS). Salaries were adjusted to control for teacher characteristics, such as years of experience, level of education, type of certification, and tenure. A number of districts were missing information on salary levels. We filled in for these missing observations by assuming that a district had the same average adjusted salary level as other districts of the same type (e.g., suburban or rural) in its county. As instruments for teacher salaries, we use hourly wages for production workers in manufacturing at the county level and 1990 county population.

[8] For a review of earlier studies and discussion of the outcome selection process, see Duncombe, Ruggiero, and Yinger (1996). A variable was considered to be correlated with demand factors if the R-squared of a regression of that variable on those factors was 0.1 or higher. We also checked our selections using factor analysis, which indicated that the variables we identified explained most of the variation in the set of outcome variables in our data set.

[9] The source of most of these variables is the *1990 Census* as reported in the "School District Data Book" (Washington, D.C.: U.S. Bureau of the Census and the National Center for Education Statistics, 1994). The remaining variables come from the New York Department of Education's BEDS.

[10] To be specific, we multiply regression coefficients by actual district values for each cost factor (and by the state average for outcomes and efficiency) to construct a measure of the expenditure each district must make to provide average quality services given average inefficiency. Similar procedures (without the efficiency variable) are used by Ratcliffe, Riddle, and Yinger (1990), Ladd and Yinger (1991), Downes and Pogue (1994), and Duncombe, Ruggiero, and Yinger (1996). Since the price of labor is treated as endogenous in the cost model, a predicted wage is used to construct the cost index. The predicted wage is based on the predicted value of a first-stage regression between the price of labor and all exogenous and instrumental variables used in the cost model.

[11] Identifying instruments for the efficiency index is difficult. While there is a large literature on bureaucratic behavior (Niskanen, 1975; Leibenstein, 1978), there is little associated empirical literature. The bureaucratic models suggest that greater inefficiency will be associated with larger and wealthier school districts, those facing less competition, and those with poorer performance incentives for their employees. Income is already used as an instrument. Our new instruments include total district population and population density, the occupational mix of the district (the percent of total private employees that are managers or professionals), and whether a district faces a budget referendum. City districts in New York do not have to submit any portion of their budget to voter approval.

[12] Under the assumption of constant costs per unit of output, the coefficients of the cost equation can be interpreted as the weight that voters place on each output variable. The state aid formula requires S^*C_i to be the amount a district must spend to obtain the outcome level S^*. Thus, our outcome index S has to be rescaled. See Duncombe and Yinger (1997) for a proof of the first proposition and an explanation of the scaling process.

[13] Because of a high correlation between the percent of college graduates and median income, we used the residual from a regression of percent college on median income as the college variable.

[14] The other lump-sum grants include aid for large and small city students with compensatory education needs (PCEN and PSCEN), aid for educationally related support services (ERSSA), Attendance Improvement–Dropout Prevention Aid, and Limited English Proficiency Aid. Since some of these grants are for higher cost students, it was important to include them in the model. In total, these aid programs provided approximately $0.6 billion in aid in 1991.

[15] Aid programs included in the matching aid variable include Excess Cost Aid and High Cost Aid for handicapped students and High Tax Aid for districts with relatively high tax effort. The two aid types for handicapped students provide aid to districts based on the actual district operating expenditure and a weighted pupil count of handicapped students. While these aid programs are not traditional matching grants, they are not purely lump-sum since they can be affected by district behavior. Matching aid given by New York State for transportation, buildings, and computer equipment is not included in our analysis since we are focusing solely on nontransportation operating expenditure.

[16] When we estimate a median voter model without the cost index or the efficiency index, the income elasticity drops to 0.5. This result is consistent with the predictions of Schwab and Zampelli (1987), who highlight the potential downward bias in the income elasticity when costs are omitted from the tax price.

[17] For the aid systems without negative aid or for all power-equalizing aid systems, an iterative process was used to adjust V^* (or R^*) to reach approximate budget neutrality. Aid budgets were kept within three percent of the original state operating budget in 1991.

[18] One uncertainty regarding the impact of equalizing grants is whether increased aid for poor districts leads to more inefficiency. Our results from a related study (Duncombe and Yinger, 1997) indicate that the most generous foundation plans actually raise efficiency in the average district, and in the central-city districts, which receive the largest increases in aid, inefficiency increases by at most 15 percent.

REFERENCES

Berne, Robert, and Leanna Stiefel. *The Measurement of Equity in School Finance.* Baltimore: Johns Hopkins University Press, 1984.

Bridge, R. Gary, Charles Judd, and Peter Moock. *The Determinants of Educational Outcomes: The Impact of Families, Peers, Teachers and Schools.* Cambridge, MA: Ballinger Publishing Company, 1979.

Clune, William. "The Shift from Equity to Adequacy in School Finance." *The World and I* 8 No. 9 (September, 1993): 389–405.

Cohn, Elchanan, and Terry Geske. *The Economics of Education.* 3rd ed. New York: Pergamon Press, 1990.

Coons, John, William Clune, and Stephen Sugarman. *Private Wealth and Public Education.* Cambridge, MA: Harvard University Press, 1970.

Downes, Thomas, and Therese McGuire. "Alternative Solutions to Illinois' School Finance Dilemma: A Policy Brief." *State Tax Notes* (February 14, 1994): 415–9.

Downes, Thomas, and Thomas Pogue. "Adjusting School Aid Formulas for the Higher Cost of Educating Disadvantaged Students." *National Tax Journal* 47 No. 1 (March, 1994): 89–110.

Duncombe, William D., John Ruggiero, and John Yinger. "Alternative Approaches to Measuring the Cost of Education." In *Holding Schools Accountable: Performance-Based Reform in Education,* edited by Helen F. Ladd. Washington, D.C.: The Brookings Institution Press, 1996.

Duncombe, William D., and John Yinger. "Why Is It So Hard to Help Central City Schools?" *Journal of Policy Analysis and Management* 16 No. 1 (Winter, 1997): 85–113.

Feldstein, Martin. "Wealth Neutrality and Local Choice in Public Education." *American Economic Review* 61 No. 1 (March, 1975): 75–89.

Ferguson, Ronald. "Paying for Public Education: New Evidence on How and Why Money Matters." *Harvard Journal on Legislation* 28 No. 2 (Summer, 1991): 465–98.

Ferguson, Ronald, and Helen F. Ladd. "Additional Evidence on How and Why Money Matters: A Production Function Analysis of Alabama Schools." In *Holding Schools Accountable: Performance-Based Reform in Education,* edited by Helen F. Ladd. Washington, D.C.: Brookings Institution Press, 1996.

Gold, Steven, David Smith, Stephen Lawton, and Andrea C. Hyary. *Public School Finance Programs of the United States and Canada, 1990–91.* Albany, NY: The Nelson A. Rockefeller Institute of Government, 1992.

Hanushek, Eric. "The Economics of Schooling: Production and Efficiency in Public Schools." *Journal of Economic Literature* 24 No. 3 (September, 1986): 1141–77.

Inman, Robert. "The Fiscal Performance of Local Governments: An Interpretative Review." In *Current Issues in Urban Economics,* edited by Peter Mieszkowski and Mahlon Straszheim. Baltimore: The Johns Hopkins University Press, 1979.

Kearney, C. Philip. "Reducing Local School Property Taxes: Recent Experiences in Michigan." *Journal of Education Finance* 21 No. 1 (Summer, 1995): 165–85.

Ladd, Helen F., Andrew Reschovsky, and John Yinger. "City Fiscal Condition and State Equalizing Aid: The Case of Minnesota." In *Proceedings of the Eighty-Fourth Annual Conference on Taxation.* Columbus: National Tax Association–Tax Institute of America, 1991.

Ladd, Helen F., and John Yinger. *America's Ailing Cities: Fiscal Health and the Design of Urban Policy.* Baltimore: The Johns Hopkins University Press, 1991.

Ladd, Helen F., and John Yinger. "The Case for Equalizing Aid." *National Tax Journal* 47 No. 1 (March, 1994): 211–24.

Leibenstein, Harvey. "On the Basic Proposition of X-Efficiency Theory." *American Economic Review* 68 No. 2 (May, 1978): 328–32.

Megdal, Sharon B. "Equalization of Expenditures and the Demand for Local Public Education: The Case of New Jersey." *Public Finance Quarterly* 11 No. 3 (July, 1983): 365–76.

Miner, Jerry. "A Decade of New York State Aid to Local Schools." Metropolitan Studies Program Occasional Paper No. 141. Syracuse: Center for Policy Research, The Maxwell School, Syracuse University, 1991.

Monk, David. *Educational Finance: An Economic Approach.* New York: McGraw-Hill Publishing Company, 1990.

Niskanen, William A. "Bureaucrats and Politicians." *Journal of Law and Economics* 18 No. 3 (December, 1975): 617–43.

Ratcliffe, Kerri, Bruce Riddle, and John Yinger. "The Fiscal Condition of School Districts in Nebraska: Is Small Beautiful?" *Economics of Education Review* 9 No. 1 (January, 1990): 81–99.

Reschovsky, Andrew. "A Wisconsin Property Tax Primer." *State Tax Notes* 5 (December, 1994): 1735–43.

Rothstein, Paul. "The Demand for Education with 'Power Equalizing' Aid: Estimation and Simulation." *Journal of Public Economics* 49 No. 2 (November, 1992): 135–62.

Rubinfeld, Daniel. "The Economics of the Local Public Sector." In *Handbook of Public Economics*, Volume 2, edited by Alan Auerbach and Martin Feldstein. New York: Elsevier Science Publishers, 1987.

Ruggiero, John. "Efficiency of Educational Production: An Analysis of New York School Districts." *Review of Economics and Statistics* 78 No. 3 (August, 1996): 499–509.

Schwab, Robert, and Ernest Zampelli. "Disentangling the Demand Function from the Production Function for Local Public Services: The Case of Public Safety." *Journal of Public Economics* 33 No. 2 (July, 1987): 245–60.