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ABSTRACT

Improving the quality of public education is high on the policy agenda in Washington and in state capitals throughout the country. Despite disagreement over specific policies, policymakers appear to recognize that an important element in any plan to improve educational quality is the measurement of student performance. Here, it is argued that most state systems of school finance have not adapted to the new emphasis on student performance and educational adequacy. An important reason that they generally have done a poor job in financing an adequate education is that many formulas that allocate state funds to local school districts fail to recognize that the amount of money needed to provide students with an adequate education varies among school districts. A statistical approach to the measurement of the costs of public education and a means of integrating information on costs into school-aid formulas designed to provide funding for educational adequacy are demonstrated in this report. An approach for estimating school-district costs is also described. Finally, a cost-adjusted foundation formula is demonstrated that is designed to guarantee sufficient funding to all school districts in order to provide their students with an adequate education. (Contains 21 references.) (RT)

Achieving Educational Adequacy Through School Finance Reform

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Authors' Notes

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Introduction

In Washington and in state capitals throughout the country, improving the quality of public education is high on the policy agenda. There appears to be a broad consensus that economic success in our increasingly globalized economy requires substantial improvements in the overall quality of education. There is also the realization, especially in light of recent welfare reforms, that the quality of education received by children growing up in poor families must be improved dramatically if these children are to have any hope of escaping poverty. Despite this agreement on broad educational goals, there is considerable debate about which educational policies are most likely to improve the quality of education. Smaller class sizes, charter schools, educational vouchers, higher teacher salaries, and improved teacher training all have their proponents.

Despite disagreement over specific policies, policymakers appear to recognize that an important element in any plan to improve the quality of education is the measurement of student performance. Unless we measure student performance, increase performance standards, and require that schools take steps to improve the educational performance of their students, no educational policy is likely to succeed in improving the quality of education. Over the past few years, a number of states have adopted mandatory statewide student testing. The Clinton Administration has become a proponent of national testing as a means of inducing higher overall standards of student performance. In some states, grade promotion and graduation will depend on successful performance on new high-stakes tests. Individual schools and school districts are beginning to be held accountable if their students fail to meet new student performance standards. This accountability may involve labeling schools with a high proportion of low-performing students as failing schools, the withholding of bonuses for teachers, or in the cases where student performance falls significantly below the new standards, the schools may undergo reconstitution, or may be taken over by state authorities. Conversely, schools (and their teachers) in which student performance meets the new norms may be rewarded in various pecuniary and non-pecuniary ways.

Over the past decade, this emphasis on student performance also has been reflected in a number of state court decisions. In ten states, courts have declared state school financing systems unconstitutional because they have not succeeded in providing all students with a sufficiently high quality or, in the language favored by the courts, an adequate education (Minorini and Sugarman, 1999). For example, in *Claremont School District & a. v. Governor & a.* (1997), the New Hampshire Supreme Court ruled that a constitutional, adequate education should reflect the fact that "a broad exposure to the social, economic, scientific, technological, and political realities of today's society is essential for our students to compete, contribute, and flourish in the twenty-first century."

In this report, we argue that most state systems of school finance have not adapted to this new emphasis on student performance and educational adequacy. In most states, the systems of school finance in place today do not explicitly link the availability of funds and the educational performance of students. Instead, school financing systems focus on equalizing property tax bases and per pupil expenditures across school districts, in part reflecting the impact of a series of earlier school finance court cases starting with *Serrano v. Priest* (1971, 1977).

An important reason that school finance systems generally have done a poor job in financing an adequate education is that, in most cases, the formulas that allocate state funds to local school districts fail to recognize that the amount of money needed to provide students with an adequate education is not the same in each school district.[1] We will provide evidence in this report that the minimum amount of money necessary to meet any given educational standard will vary across school districts for reasons *outside the control of local school officials*. We refer to these amounts as the *costs* of education. Costs are higher in some districts than others largely because more resources are required to provide some students compared to others with any given level of education, and because some districts will have to pay more money than other districts to attract high-quality teachers.

If cost differences among school districts are substantial, then imposing statewide student performance standards without simultaneously reforming the way financial resources are distributed among school districts will result in a situation where school districts with above average costs will not have enough resources to educate their students to meet the new standards. These schools will fail, not necessarily because of their own inability to effectively educate children, but because they were provided with insufficient fiscal resources to do the job. Unless school finance formulas account for these differences in costs, school districts with high costs will face nearly insurmountable burdens. Penalizing such school districts will do little to provide their students with an adequate education. On the other hand, allocating school districts sufficient financial resources to provide an adequate education does not, by itself, guarantee that schools will actually use those resources effectively. Achieving the goal of providing students with an adequate education requires monitoring school and district performance and appropriate action in cases where additional financial resources do not result in improved student performance.

In this report, we demonstrate a statistical approach to the measurement of the costs of public education, using data from K-12 school districts in Wisconsin and Texas. We then demonstrate how to integrate information on costs into school aid formulas designed to provide the funding necessary to achieve educational adequacy. In the next section, we briefly review several alternative approaches to the measurement of costs. We then describe in some detail the approach we follow for estimating school district costs. After presenting the results of this analysis, we demonstrate the use of a cost-adjusted foundation formula designed to guarantee sufficient funding to all school districts in order to provide their students with an adequate education.

Alternative Approaches to Measuring the Costs of Educational Adequacy

Although most state aid formulas do not account in any systematic way for differences in costs among school districts, most state governments provide local school districts with categorical aid to help finance the education of students with certain characteristics that are believed to give rise to higher costs. For example, categorical aid for students with physical or mental disabilities is quite common and aid for students characterized as at risk of academic failure is distributed in some states. Some states also provide special aid to districts that are thought to face higher costs because of their small size or their location in areas with high labor costs.

Categorical aid programs generally operate by providing eligible students with a special *weight.* For example, by assigning a weight of 2.3 to each disabled student, the state signals that it believes the per pupil cost of educating these students is 2.3 times the cost of providing education to regular students. In general, the determination of the magnitude of the weights appears to be completely unsupported by careful research. We suspect that weights are often determined by political and budgetary concerns, rather than by a careful assessment of the costs associated with educating students to meet any given performance standard. In the case of disabled students, Chaikind, Danielson, and Brauen (1993) report that weights tend to be based on detailed surveys of expenditures for special education students in a relatively small sample of school districts. In addition to the inherent difficulty in isolating the spending on these students, especially when they often divide their time in school between regular and special education classrooms, spending data by itself tells us little about the costs of education when they are not directly linked to some measure of student performance. Without systematically linking expenditures on special education to the level and quality of the education actually provided, there is no way of knowing whether the use of any particular weight for special education pupils over- or under-counts the true cost of educating these students.

In recent years, a number of researchers have been attempting to fill this knowledge gap by providing comprehensive estimates of the costs of achieving various student performance goals. The approach we discuss in this report is based on the statistical estimation of a cost function. Examples of this approach applied to education are discussed by Downes and Pogue (1994); Duncombe, Ruggiero, and Yinger (1996); Duncombe and Yinger (1997); and Reschovsky and Imazeki (1998). We believe that the estimation of education cost functions provides a powerful tool for measuring the contribution to total costs of various student and school district characteristics. It is important to emphasize, however, that the recent literature includes four alternative approaches for measuring the costs of education. We briefly discuss each of these approaches in the following paragraphs.

First is the work of Chambers (1981, 1995), who statistically estimates teacher cost indices. Chambers uses regression analysis to identify a set of factors outside the control of local school districts that require some districts to pay higher salaries than others in order to attract teachers with similar qualifications to carry out similar teaching assignments. These cost factors include the racial and ethnic composition of the student body, land costs, and a range of variables that influence the attractiveness of any given geographical area, such as weather conditions and crime rates. Measures of student performance are *not* used in Chambers' calculation of costs. His indices provide useful information about costs, but they almost certainly understate the contribution to costs of various characteristics of school districts. To develop a comprehensive measure of costs, it is necessary not only to account for differences across districts in the cost of hiring teachers, but also for the fact that some districts have to hire more teachers than other districts and spend more non-teacher resources (such as textbooks or social workers) in order to provide their students with an adequate education.

A second approach to measuring educational costs is based on identifying a set of school districts within a state in which students achieve certain performance goals, then defining average spending per pupil in this set of schools as the statewide average cost of educational adequacy.

In defining a set of high performance school districts for inclusion in a study of Ohio public schools, Augenblick, Myers, and Anderson (1997) excluded all districts with particularly high or low levels of property wealth and per pupil spending. This method provides a norm level of per pupil spending, but makes no systematic attempt to measure the likely variation in the costs of adequacy due to characteristics of individual school districts and their students.

A third approach to measuring educational costs relies on the expert professional judgment of a team of educators within a state to identify the set of inputs required to achieve educational adequacy. It is then determined, using standard accounting methods, what amount of money must be spent per student in order to purchase these inputs. This approach has recently been used in Wyoming by Guthrie and Rothstein (1999). It is best suited for providing a single estimate of the average cost of education although experts could offer their judgments concerning the amount of extra resources required to provide certain types of students, such as those from low-income families, with an adequate education. This approach relies on the judgment of perhaps self-interested experts to, in effect, define a production function for education. Whether this process results in credible estimates of the costs of an adequate education depends on the composition of the team of experts and on accuracy of their recommendations.

In recent years a number of comprehensive whole school reforms have been developed with the explicit purpose of improving student performance in schools serving a high proportion of children from low-income families.[2] Although a comprehensive analysis of the effectiveness of these reform models has not yet been undertaken, Odden (1997) has suggested that the calculation of the cost per pupil of operating these programs will provide a useful measure of the costs of educational adequacy, especially in the context of schools serving low-income students. Although much can be learned by carefully analyzing the costs associated with successful best practices approaches to education, care must be taken in drawing general conclusions about the costs of education from a relatively small number of cases of effective school reform. Without knowing whether these whole school methods are transferable to a wide range of schools, it is impossible to assess the accuracy of the cost estimates.

Estimating Cost Functions for K-12 Education

Using data on per pupil school expenditures, student performance, and various characteristics of school districts, we estimate separate *cost functions* for K-12 public education in Texas and Wisconsin. A cost function provides an estimate of the minimum amount of money necessary to achieve various educational performance goals, given the characteristics of a school district and its student body, and the prices it must pay for *inputs* used to provide education.[3] Estimating a cost function allows us to quantify the relationship between per pupil spending, student performance, various student characteristics, and the economic, educational, and social characteristics of school districts. As pointed out by Duncombe and Yinger (1999), estimating cost functions provides a practical way of identifying and quantifying the factors that influence the costs of education, where the *output* of school districts can be measured using multiple measures of school performance. Although student performance can, in principle, be measured in various ways, most states use standardized exams to measure how effectively school districts are improving the academic performance of their students. In Texas, all students in the third through eighth grades and in the tenth grade are examined in reading and mathematics in the spring of each year as part of the Texas Assessment of Academic Skills (TAAS). Considerable media attention is paid to the test score results and improvements in average test scores (or lack thereof) are monitored closely. As a measure of school district output, we compare the composite TAAS score for all students in the fourth through eighth grades and in the tenth grade in 1995-96 with the scores in the third through seventh grades of the same cohort of students in 1994-95 and the eighth grade scores in 1993-94 (to match the tenth grade scores in 1995-96).[4] This provides us with a *value-added* measure of the performance of the students in each school district.[5]

In Wisconsin, we are able to construct a value-added measure of student achievement using data from biannual test scores. In the 1993-94 academic year, Wisconsin began to require that all students take standardized exams during the eighth and tenth grades. These data enable us to construct a value-added measure for students who were eighth graders in 1993-94 and tenth graders two years later in 1995-96.

Our use of additional measures of school district performance or output was constrained by the availability of data. However, in our cost functions for Texas we included student performance on the ACT exams as a measure of the quality of the preparation of students for higher education.[6] In Wisconsin, we used the number of advanced courses offered as a measure of the richness of the course offerings.[7]

The statistical estimation of the cost functions must take special account of the fact that these educational output variables and per pupil expenditures are determined simultaneously. In other words, while local school board decisions to raise the level of student performance are expected to have direct implications for the level of spending, decisions concerning per student spending are likely to influence student performance. To deal with this simultaneity, the cost functions are estimated using a statistical technique called *two-stage least squares.*[8]

Teachers are the single most important factor in the production of education, and teacher salaries account for the largest share of school expenditures. In our estimation of education cost functions, we include only teacher salaries, excluding explicit treatment of other public school employees. It is important to recognize that teacher payrolls are determined by factors under the control of local school boards and by factors that are largely outside their control. In setting hiring policies, districts make decisions about the quality of teachers that they recruit and these decisions have obvious fiscal implications. For example, a district can limit its search for new teachers to those with advanced degrees, to those with high grade point averages, or to those with a certain number of courses in their teaching specialty. Teacher salary levels generally are determined through a process of negotiation with teacher unions, and school boards have a substantial impact on the outcome of these negotiations. At the same time, the composition of the student body, working conditions within schools, and area cost-of-living play a potentially large role in determining the salary a school district must offer in order to attract teachers of any given quality. These factors will be reflected in student and district cost variables as described below.

Our goal is to isolate factors that contribute to higher levels of education spending but are outside the control of local school districts. For our Wisconsin cost function, we developed a teacher salary index that only reflects differences in salaries that are due to factors outside local control. We accomplished this by utilizing detailed information on the characteristics of individual teachers in Wisconsin.[9] In our Texas analysis we used an existing cost index developed by Chambers (1981, 1995).[10] In our cost function estimation, we utilize statistical techniques to account for the fact that the teacher salary indices are *endogenous*, meaning that while higher teacher salaries lead to higher per pupil expenditures, decisions by school districts to raise spending are likely to lead to higher teacher salaries.[11]

Previous research has suggested several student and school district characteristics that have a direct impact on costs. First, there is considerable evidence that there are higher costs associated with the education of children from low-income families. To measure the number of children from economically disadvantaged families, we use the percentage of students who qualify for the federal government financed free and reduced-price lunch program or other public assistance. Second, there is substantial literature that documents the extra costs associated with educating students with various kinds of disabilities and students who enter the schools with limited knowledge of English. Therefore, we include the percentage of students who have been identified as limited English proficient, along with two measures of disabilities—the percentage of students who are classified as having any type of disability and the percentage of students who are classified as autistic, deaf, or deaf/blind. Third, to reflect the possibility that more resources may be needed to provide a high school education as compared to an elementary school education, we also include the proportion of each school district's student body that is enrolled in high school. Finally, to reflect potential diseconomies of scale associated with both small and large school districts, we include each district's enrollment and enrollment squared.

Even after accounting for differences across school districts in cost factors, input prices, and student performance, some districts will have higher levels of per pupil expenditures than other districts. These higher levels of spending could occur because some school districts are inefficiently organized or managed, use ineffective teaching techniques or employ a particularly ineffective group of teachers, or choose to pay higher salaries than necessary to attract the quality of teachers they desire. In addition, some school districts may have higher levels of spending because they provide their students such courses as advanced music or art, and student performance is not measured by standard student exams.

A number of recent papers have used complex statistical techniques to identify spending that is high relative to spending in districts with similar student performance and costs (Bessent and Bessent, 1980; Deller and Rudnicki, 1993; Duncombe, Ruggiero, and Yinger, 1996; McCarty and Yaisawarng, 1993; and Ruggiero, 1996). After controlling for student performance and cost differences, lower-spending districts are considered to be operating with the best practices, while any extra spending is generally interpreted as a measure of school district inefficiency. Although great care must be taken in interpreting this extra spending as a measure of inefficiency, we include in our cost function estimates an efficiency index calculated in this way.[12] We discuss the interpretation of this variable further when we present our cost function results.

Cost Function Results

Table 1 presents our two-stage least squares estimates of a cost function for public education in Texas with exam scores, lagged exam scores, the ACT scores, and the teacher salary index treated as endogenous variables.[13] The first two columns present results that include a measure of school district efficiency, while the second two columns are estimated without that variable. Both equations yield similar results. The test scores have the expected signs: since lagged scores are a proxy for past levels of student achievement, high scores mean that districts can spend less to achieve a given level of educational progress. The cost variables generally have the expected signs and most are statistically significant. In particular, the percentage of students eligible for free and reduced-price lunch is statistically significant in both equations. Consistent with previous studies, we find a U-shaped relationship between spending per pupil and school district size. In our estimates, the bottom of the U is roughly 19,225 students when the efficiency measure is included, and 7,890 when it is not included.[14] In contrast to the results of some other studies, we find that costs do not appear to be higher for high school students. Although, without the efficiency measure included, costs appear to be lower in high schools, the variable is not statistically significant.

Table 1. Texas Education Cost Functions, K-12 School Districts, 1995-96

Independent Variables	Coefficients	t-statistics	Coefficients	t-statistics
Intercept	3.99*	3.284	-1.74	-0.515
Log of composite exam score, 1995-96	2.078*	2.36	5.063*	2.353
Log of lagged composite score, 1993-94	-1.535**	-1.862	-3.279**	-1.825
Log of average ACT score	1.104*	3.344	1.085	1.676
Teacher salary index	0.002*	2.029	0.0003	0.128
Percent of students eligible for free and reduced-price lunch	0.159**	1.752	0.837*	3.405
Percent of students with disabilities	-0.019	-0.081	-0.127	-0.271
Percent of students with severe disabilities	2.106	0.774	6.595	1.216
Percent of students with limited English	0.339*	2.787	0.302	1.273
Percent of students enrolled in high school	0.054	0.164	-0.348	-0.488
Log of student enrollment	-0.182*	-4.88	-0.282*	-3.917
Square of log of student enrollment	0.009*	4.434	0.016*	3.812
Efficiency index	-1.054*	-11.812	-	-
SSE	8.513		8.513	

* *Indicates statistically significant at the 5% level*

** *Indicates statistically significant at the 10% level*

Table 2 presents our estimates of a cost function for public education in Wisconsin. The eighth and tenth grade exam scores, the number of advanced courses, and the teacher salary index are treated endogenously. The results are quite similar to those for Texas. The test scores and the teacher salary index have the expected signs and most of the cost variables have the expected signs and are statistically significant. As in Texas, we find a U-shaped relationship between per pupil spending and district size. The estimated coefficients imply that average costs are lowest in school districts with 5,964 students. Parallel to the Texas results, we also find that costs in Wisconsin appear to be lower in districts with a larger proportion of students enrolled in high school.

Table 2. Wisconsin Education Cost Functions, K-12 School Districts, 1994-95

Independent Variables	Coefficients	t-statistics	Coefficients	t-statistics
Intercept	7.196*	15.32	4.97*	4.74
Log of tenth grade exam score, 1995-96	1.079*	1.96	2.63*	2.20
Log of eighth grade exam score, 1993-94	-0.346	-0.69	-1.519	-1.49
Number of advanced courses	-0.002	-1.20	-0.002**	-1.74
Teacher salary index	1.142*	7.17	1.578*	6.43
Percent of students eligible for free and reduced-price lunch	0.002*	3.17	0.004*	3.24
Percent of students with disabilities	0.0003	0.14	0.004	1.04
Percent of students with severe disabilities	0.076*	2.09	0.122**	1.72
Percent of students enrolled in high school	-0.006*	-2.44	-0.022**	-2.32
Log of student enrollment	-0.495*	-7.77	-0.598*	-4.89
Square of log of student enrollment	0.028*	6.90	0.034*	4.32
Efficiency index	-0.759*	-8.46	–	–
SSE	4.594		4.594	

* *Indicates statistically significant at the 5% level*
** *Indicates statistically significant at the 10% level*

Cost Index Construction

Estimating a cost function provides information about the contributions of various characteristics of school districts to the costs of education. The calculation of a cost index allows summarization of all information about costs into a single number for each district. For example, if we assume that the policymakers in a state define the standard for adequate education as the current average level of student performance, then a cost index can be constructed that will indicate, for any given district, how much that district must spend, *relative to the district with average costs,* in order for its students to meet the state's student performance standards.

To demonstrate the calculation of cost indices, we set the 1995-96 TAAS scores and ACT scores at the average for all Texas districts, and the tenth grade Wisconsin test score and the number of advanced courses at the average for all Wisconsin districts. We wanted to emphasize that alternative standards of adequacy could be used in calculating the cost indices. The use of different standards will not affect the relative ranking of districts in terms of their costs, but it will alter their absolute cost index values, and hence, will influence any distribution of state aid that is dependent on the cost index.

As discussed above, we use a *value-added* measure of student achievement in our cost function. In Texas for example, the coefficient on 1995-96 scores reflects the increase in spending associated with an increase in student performance *given* an initial level of test score performance in 1994-95. Therefore, the amount of expenditure necessary to reach some average level of performance will depend on the level of student performance where the district started in the previous year. Lower lagged student achievement implies that it will be more costly to achieve average achievement.[15]

Using the cost function estimated without the efficiency index and using current average student performance levels as a measure of adequacy, we have calculated that the school district in Texas with average costs must spend $5,608 per pupil (in 1995-96) to reach the adequacy goal, and the school district with average costs in Wisconsin must spend $6,370 (in 1994-95 dollars). For any given school district, the product of this number and its cost index (divided by 100) will indicate the amount that the district must spend in order to provide its students with an adequate education. For example, a Texas school district with a cost index of 125 will need to spend $7,010 per student ($5,608 times 1.25) to provide an adequate education for its students.

The data in the first column of Table 3 show that costs vary tremendously across K-12 school districts in Texas. The district with the lowest costs could achieve an average level of student achievement by spending about one-fifth as much per pupil as the district with average costs. At the other extreme, the district with the highest costs must spend four times more than the average cost district to provide an average educational outcome for its students. The large range of the index reflects in part the values of the index in a few districts. Ignoring the 10 percent of districts with the lowest index values and the 10 percent of districts with the highest values substantially reduces the range of the cost index. The *restricted range* in Table 3 shows that the district at the 10th percentile has costs that are about half of average cost and the district at the 90th percentile has costs that are 68 percent above average.

Table 3. Education Cost Indices for Texas and Wisconsin

	Texas Cost Index		Texas Index	Wisconsin Cost Index	
	With No Efficiency Adjustment	With Efficiency Adjustment	(based on actual aid distribution)	With No Efficiency Adjustment	With Efficiency Adjustment
Mean	100	100	100	100	100
Median	86	97	98	89	97
Standard Deviation	52	20	15	37	12
Range	379	125	83	374	105
Minimum	21	52	75	50	77
Maximum	400	177	158	424	181
Restricted Range	117	48	36	75	28
Minimum at 10%	51	78	83	74	89
Maximum at 90%	168	126	119	149	117

The cost indexes for five school districts exceed 300. The school districts with the highest costs are San Antonio and Edgewood. Almost the entire student body in each of these districts comes from economically disadvantaged families. Test scores in each of these districts are also below average. By contrast, there are three districts with cost indexes below 33.3. These three districts—Fort Davis, Axtell, and Bronte—are all very small, each with fewer than 1,000 students, and their students perform at above average levels on the standardized tests.

The data in the fourth column of Table 3 demonstrate that in Wisconsin, as in Texas, costs vary tremendously across school districts. The standard deviation and the restricted range are somewhat smaller than in Texas, although the maximum cost index value (424) is higher than the maximum value in Texas. Two school districts have cost index values that are much higher than the index values of any other district. Milwaukee's index is 424 and White Lake's is 334, while the district with the next highest index has a cost index of 229. The major reasons for Milwaukee's high cost index are its large size and its high concentration of economically disadvantaged students. With nearly 100,000 students, the district is 45 times the size of the average Wisconsin school district. Seventy-two percent of its students are eligible for free or reduced-price lunch, a proportion that is higher than all but one other Wisconsin school district. White Lake's cost index is high primarily because of its extremely small size—the entire school district has only 250 students—and its very high concentration of children from poor families.

When [the] estimated cost functions include no measure of efficiency, it is possible that we are interpreting extra spending that is caused by inefficiencies on the part of school districts as higher costs. When a measure of efficiency is included in the calculation of the cost index, the maximum cost index falls from 400 to 177 in Texas and from 424 to 181 in Wisconsin. This suggests that the high cost index numbers for some districts may reflect, in part, some degree of inefficiency on the part of these local school districts. It is important to emphasize that even after adjusting cost indices for inefficiency, the variation in costs across districts remains substantial, and large city school districts continue to have high costs. Milwaukee continues to be the district with the highest costs in Wisconsin, and Santa Maria has the highest costs among K-12 districts in Texas.

The correlation between the indices with and without the efficiency measure is 95 percent for both states, suggesting that including a measure of efficiency has relatively little impact on the rank ordering of districts in terms of costs but can significantly reduce the range. As mentioned previously, however, one must take care in interpreting this difference as entirely attributable to inefficiency. The technique we use to measure efficiency captures the effect of *all* factors that lead spending to be higher than the minimum cost of providing any given mix of public school output. Thus, higher spending that is attributable to the higher costs of, for example, educating an above average share of economically disadvantaged students will, in part, be characterized as inefficiency. As pointed out by Duncombe, Ruggiero, and Yinger (1996), the fact that these higher costs will be attributed in part to the efficiency measure, and in part to the cost factors explicitly included in the cost function, will mean that the cost function estimates will provide an underestimate of the full effects of the cost factors on education spending. We suspect that true costs lie somewhere between the levels indicated by the cost indices calculated with and without our efficiency adjustment.

The Design of School Finance Formulas to Achieve Adequacy

Foundation formulas are currently used by the majority of states to distribute state aid to local school districts. The formulas are designed so that each school district that uses a state-determined minimum property tax rate will be able to achieve a foundation level of per pupil spending. If costs were identical in all school districts, then by defining the foundation level as the spending necessary to achieve the state-specified minimum performance level, the state could guarantee that each school district had sufficient resources necessary to provide an adequate level of education.

The results presented in the previous section indicate that costs (at least in Texas and Wisconsin) differ substantially among school districts. Thus, to guarantee the provision of adequate education, it is necessary to develop a foundation formula where the foundation level of spending varies according to differences in costs across districts, and where the average foundation level equals the dollar amount necessary to meet the performance standards associated with educational adequacy in districts with average costs.

A conventional foundation aid formula is presented below in equation (1), where A_i equals foundation aid per pupil in district i; E^* is the foundation level of per pupil spending; t^* the mandated local property tax rate; and V_i the property value per pupil in school district i:

(1) $$A_i = MAX\{E^* - t^*V_i, 0\}$$

The formula indicates that aid equals the difference between the foundation level and the property tax revenue a district can raise at the tax rate t^*. Because *negative aid* is not permitted, school districts with high per pupil property values receive no aid.

The first step in adapting the foundation formula so that it will guarantee that every district has sufficient resources to provide an adequate level of education is to determine a standard of educational performance that is considered adequate. Referring to this standard as S^*, $\widetilde{E}$ can be defined as the amount a school district with average costs must spend to obtain an adequate educational outcome, S^*. A foundation formula designed to guarantee that every school district has sufficient resources to provide S^* can be written as:

(2) $$A_i = MAX\ \{\widetilde{E}\ c_i - t^*V_i, 0\}$$

where c_i is the value of the cost index in school district i.[16] To demonstrate the use of this formula using Wisconsin data, we define $\widetilde{E}$ as the expenditure needed to achieve the average tenth grade test performance in a district with average costs. The amount of aid allocated to district i using this cost-adjusted foundation aid formula will be a function of the per pupil property wealth and the relative costs in district i. Everything else equal, lower average student performance in the previous year (or two years previous in Wisconsin) will lead to higher costs in district i, and hence to additional aid.

To provide a baseline upon which to judge the impact of the cost-adjusted formula, we simulate aid using a conventional foundation formula (equation 1 above). We choose $6,370 as the foundation level of per pupil spending, which is the amount needed to achieve the average tenth grade test performance in a district with average costs.[17] To add some realism to the simulation, we adjust the required property tax rate (t^*) so the total amount of foundation aid distributed is equal to $3.03 billion, the actual amount of equalization aid allocated to K-12 districts in Wisconsin for the 1996-97 school year.[18]

The simulation using the cost-adjusted foundation formula (equation 2 above) uses the same average foundation level and tax rate as the first simulation. Because of our uncertainty about the accuracy of our inefficiency measure, in the simulation we use the cost index based on the cost function calculated without the efficiency index. Because we did not want to ignore the efficiency issue completely, we placed a ceiling of 200 on the value of the index. This adjustment in effect lowered costs in the nine school districts in Wisconsin with the highest cost index values.

The first column of data in Table 4 summarizes the distribution of per pupil foundation aid using a foundation formula without cost adjustments. The average grant equals $3,898 per pupil and the largest grant is $5,401. In nine school districts, per pupil property tax bases are large enough to yield more revenue per pupil at the mandated tax rate than the $6,370 foundation level. These nine districts receive no foundation aid. Milwaukee's grant is equal to $4,633. Although this grant is greater than average, 97 other school districts in the state would receive larger per pupil grants.

Table 4. Distribution of Aid Per Pupil in Wisconsin Under Alternative Foundation Formulas (in dollars)

	No Cost Adjustment	Cost-Adjusted	Revenue-Neutral Cost-Adjusted
Mean	$3,898	$3,836	$3,611
Median	4,168	3,562	3,335
Standard Deviation	1,133	2,317	2,238
Range	5,401	11,528	11,055
Minimum	0	0	0
Maximum	5,401	11,528	11,055
Restricted Range	2,485	5,858	5,705
Minimum at 10%	2,502	1,191	1,040
Maximum at 90%	4,987	7,050	6,745

The second column of Table 4 summarizes the distribution of cost-adjusted foundation aid. Because most of the state's largest school districts have above average costs, total cost-adjusted foundation aid totals $191 million more than non-cost-adjusted aid. This implies that an increase in state aid by as little as six percent could provide Wisconsin's school districts with enough money to finance an adequate education for all of its students. As expected, the standard deviation of per-pupil grants is higher ($2,317 compared to $1,133). Milwaukee receives the largest per-pupil grant; at $11,528, it is over twice as big as the largest grant distributed through the non-cost-adjusted formula.[19] As some relatively high-wealth districts have below-average costs, the number of school districts getting zero aid increases from 9 to 18.[20]

In contrast to Wisconsin, which distributes most state aid using a guaranteed tax base formula that includes no cost adjustments, the school finance system in Texas distributes state aid to local school districts using several formulas that include a number of adjustments for cost differences across school districts. Although the formulas do not include a single cost index, they do include separate adjustments for cost of living differences across districts, for diseconomies of scale in small and mid-size districts, and for the higher costs necessary to provide education to students from economically disadvantaged families, students with disabilities, and students with limited proficiency in English.

The weighing of each cost factor in our cost index comes from the parameter estimates of the cost function. If our cost function is estimated correctly, these weights indicate the relative contribution of each cost factor to the overall costs of achieving a given student performance standard. In contrast, we suspect that the explicit and implicit weights given to each cost factor used in the actual distribution of state aid in Texas were determined as a result of complex political negotiations, and thus are not likely to reflect true cost differences.

In order to determine whether the current cost adjustments used in the distribution of state aid in Texas are compatible with the achievement of educational adequacy, we compare our cost index to the *implicit index* generated from the Texas foundation aid formula. To accomplish this, for each school district we add to the basic foundation level (called the Basic Allotment and equal to $2,387 in 1995-96) the sum of special allotments reflecting adjustment for the "cost of education," for the size of the district (in terms of enrollment), and for bilingual education, special education, and compensatory education programs. This sum is divided by the basic allotment and the resulting ratios are normalized around 100. The column of data in Table 3 labeled Texas Index presents the descriptive statistics of the implicit cost index. Comparing this index to our cost index, it is clear that the range of the cost adjustments implicit in the actual aid formulas used in Texas is much smaller than the range (and restricted range) of our cost index. The implicit index suggests that the district with the highest costs has costs that are 58 percent higher than costs in the district with average costs, and the district with the lowest costs has costs that are three-fourths of average costs.

The simple correlation between the implicit index and our cost index is 18.4 when the cost function includes the efficiency index and 13.2 when the efficiency index is excluded. There appear to be two major reasons for these low correlations. First, our index is highly correlated with the percentage of children from economically disadvantaged families, while the correlation between poverty and the implicit cost index is much weaker. Second, although our cost function indicates that diseconomies of scale contribute to higher costs in small districts, the aid adjustments for small district size in the Texas aid formulas are much larger than the importance of small size indicated in our cost functions.

Conclusion

Spurred by the courts to improve the quality of education provided to its students, states are under pressure to define a set of student performance goals that, if met, will imply that their students have received an *adequate* education. We have argued in this report that if states are going to require their students to meet these more rigorous educational goals, they must recognize that achieving these goals will require more resources in some school districts than in other districts, for reasons outside the control of local school officials. This implies that a necessary, though not sufficient, condition for achieving any given performance goal is that state fiscal assistance to local school districts account explicitly for differences in costs across districts within a state.

In this report, we have used data from Texas and Wisconsin to demonstrate that it is possible to measure cost differences across districts and that these cost differences are large. We then demonstrate that the use of cost-adjusted foundation formulas provides a mechanism for distributing state aid in a way that will enhance the chances that a state can meet its student performance goals. We showed that in Wisconsin, which takes very little account of cost differences in allocating state aid dollars, improvements in student performance could be achieved with only a small increase in state resources dedicated to public education. In Texas, where cost considerations already play a major role in the distribution of state aid to local school districts, we conclude that reforming the existing state aid formulas to provide a heavier weight to children from economically disadvantaged families and a lower weight to small, mainly rural districts would better align the distribution of fiscal resources with the underlying costs of education and hopefully increase the level of student performance in Texas.

Although we believe that the statistical methods outlined in this report provide reasonable estimates of the costs of education, no approach is without shortcomings. The estimation of cost functions requires that we have good data on the *outputs* of schools that are important to citizens. Test score results are important, but other goals of our educational system, while harder to measure, may be of great importance. Also, a consistent result of educational cost studies is that concentrations of children from poor families result in higher education costs. While data on eligibility for the federal free or reduced-price lunch program are commonly used, they provide an imperfect measure of the economic background of students.

As outlined above, other approaches are being developed to measure costs. While they all have their shortcomings, we believe that, whatever cost measures are used, it is essential for the achievement of educational adequacy that state aid formulas account for cost differences in a systematic fashion. In the course of future research examining the costs of education adequacy, it will be important to compare, in detail, the cost estimates made using different methodologies. Future research should also address the important, yet difficult, task of estimating costs on a school by school basis. Over time, the quality of cost measures will undoubtedly improve; however, the fact that school districts are increasingly being held accountable for student performance means that state aid formulas need to be reformed now to include measures of the costs of education, even if existing cost measures are less than perfect.

Our results indicate that large cities in both Texas and Wisconsin will require substantial infusions of new financing if they are to raise student performance to adequate levels. The pattern of aid indicated by our simulations should be interpreted as long-run targets for the distribution of state grants. Even if it were politically possible to implement large grant increases to, for example, urban school districts, it is unlikely that sudden infusions of additional resources would be used effectively to increase student performance. Providing new money to schools and school districts with above average costs is likely to be most effective in increasing student performance if it is phased in over a period of years. The biggest challenge is not the measurement of costs, but the development of the political will to reform state aid formulas in ways that reflect differences in the spatial distribution of resources and costs.

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End Notes

1 Some states, through the use of pupil weights, do recognize that some students, such as those with disabilities, are more expensive to educate than regular students.

2 Examples of these reform models include Roots and Wings and Modern Red Schoolhouse.

3 In algebraic terms, a cost function can be represented by the following equation: $E_{it} = h(S_{it}, P_{it}, Z_{it}, F_{it}, \varepsilon_{it}, u_{it})$, where per pupil expenditures, E_{it}, are specified as a function of public school outputs, S_{it}, a vector of input prices, P_{it}, the characteristics of the student body, Z_{it}, the family and neighborhood environment in which the students live, F_{it}, a vector of unobserved characteristics of the school district, ε_{it}, and a random error term u_{it}.

4 Test scores represent the same students in the two academic years only to the extent that inter-district student mobility is relatively low.

5 See Meyer (1996) provides a strong argument for using a value-added approach in order to isolate the contribution of school resources to increases in student achievement. He points out that the use of average scores from a single grade measures the average level of achievement prior to entering first grade, plus the average effects of school performance, family, neighborhood, and student characteristics on the growth of student achievement from all years of previous schooling. It is thus likely that rather than providing a measure of the contribution of schools to the growth in student achievement, the single grade score primarily reflects the impact of family and neighborhood environment on student achievement.

6 Using scores on these exams as a measure of school quality can be problematic, however, because students decide whether to take the exam. Only students with a particular interest in college will choose to take these exams; these are presumably the best students so their scores may reflect their own abilities and motivation, rather than any influence of the school. By treating these scores as endogenous, we are able to control for this self-selection. As an instrument for ACT scores, we include the percent of students who take a college entrance exam.

7 Although no direct information on the actual number of students enrolled in these courses is available, the fact that few school districts can afford to continue to offer specialized courses unless the courses have reasonable enrollments suggests that the number of courses provides a good measure of the actual richness and diversity of the school curriculum benefiting students.

8 As instruments for the endogenous school output variables, we draw upon a set of variables that are related to the demand for public education. Following a long literature on the determinants of local government spending, we model the demand for public education as a function of school district residents' preferences for education, their incomes, the tax prices they face for education spending, and the intergovernmental aid their school district receives. To the extent that the median voter model provides a reasonable explanation for school district spending decisions, it is appropriate to use median income and the tax price faced by the median voter as instruments.

In the cost functions for both states we use the tax price implied by the aid formula. In the Texas cost function, we include each district's aid from the foundation tier of the Texas aid system as another instrument. In the Wisconsin cost function, we include categorical aid received by each district as an instrument. School districts in Texas receive extra aid to reflect various cost factors such as diseconomies of scale due to small district size or a concentration of students requiring special education services. By controlling in the first-stage regression for the categorical aid districts receive, the coefficients on the cost factors in the cost function regression should represent their full effect on educational spending. Finally, we include as instruments several socioeconomic variables that may be related to the preferences for public education. These include the percentage of households with children, the percentage of household heads who are homeowners, and the percentage of adults who have earned a four-year college degree.

[9] To construct our Wisconsin teacher salary index, we used data collected by the Wisconsin Department of Public Instruction on the salary and fringes, education, and experience of every public school teacher in the state. We regressed the log of the sum of salary and fringes for all full-time teachers on each teacher's background characteristics (including years of teaching experience and highest degree earned) plus a dummy variable for each school district. The coefficients on the district dummies are then used as the values of the teacher salary index. That is, the teacher salary index represents differences in salaries across districts, holding teacher background constant.

[10] The construction of Chambers' index relied on a large national sample of teachers. He used 1990-91 data from the National Center for Education Statistics' *Schools and Staffing Survey.* We were unable to construct our own teacher salary index because we did not have detailed data on individual teachers in Texas.

[11] To deal with this endogeneity in our Texas cost function, we include a cost-of-living index developed by McMahon (1991, 1994) as an instrument for the salary index variable. As an instrument for the salary index in our Wisconsin cost function, we include a variable that reflects differences in the cost of living in various parts of the state based on an analysis completed by Deller, Green, and Voss (1996).

[12] We employ a statistical technique called Data Envelopment Analysis in order to generate our efficiency variable.

[13] To account for the large variance in district size in Texas, we weight the regressions by district enrollment and drop Dallas and Houston from the sample. Because of missing test scores, we also were forced to exclude 163 of the 968 K-12 school districts. The excluded districts tended to be somewhat smaller, poorer, and higher spending than the 803 districts that remain in our sample and provide the basis for the cost function estimation.

[14] This result suggests that relatively large schools tend to operate relatively inefficiently. Once we account for this inefficiency, we observe that economies of scale in education (in Texas) extend to school districts with nearly 20,000 students.

[15] In the estimation of the cost function, lagged student performance is treated as an endogenous variable because, as with current performance, it is, in part, a choice of the district. In creating the cost index, we want to abstract away any variation that is under the control of the district. Thus, to account for the endogeneity of the lagged scores, we calculate the cost index using predicted lagged scores, with the predictions based on the coefficient estimates from the first-stage regression, actual values of the cost factors, and state average values for the demand instruments. That is, a district's predicted lagged score reflects the score expected from a district with average preferences and observed cost factors. Put together with the average 1995-96 score, the level of spending predicted by the cost function is the spending required to reach average achievement given average tastes for education and actual cost factors.

[16] See Ladd and Yinger (1994) for a detailed derivation of a cost-adjusted foundation formula.

[17] The state average expenditure per pupil was $6,084 in 1996-97.

[18] The resulting property tax rate is 11.8 mills (1.8 percent).

[19] Although Milwaukee's total grant would grow by over $600 million, total state spending would increase by less than $200 million because 230 school districts would receive smaller grants under a cost-adjusted formula.

[20] The use of a cost index as part of a state aid formula allows states to simultaneously account for all the factors that lead to cost differences among school districts, but it is possible to use a cost function to develop pupil weights. These weights isolate the contribution to costs of specific cost factors, such as poverty or disabilities. In earlier work, we calculated that our Wisconsin cost function implies a poverty weight of 1.59 (Reschovsky and Imazeki, 1998).

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