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Assessing the Use of Econometric Analysis in Estimating the Costs of Meeting State Education Accountability Standards: Lessons From Texas

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In 2004, over 300 school districts in Texas challenged the constitutionality of the Texas system of school finance. In *West Orange-Cove et al. v. Neeley et al.*, the plaintiffs argued that because most school districts were at or near a state-imposed property tax rate ceiling and because the share of state education funding was declining, most school districts had inadequate funds to satisfy the student performance standards mandated by the Texas Educational Accountability system. To address the empirical question of whether school districts have insufficient resources to meet the state's accountability standards, two cost function analyses were conducted. One study, entered into evidence by the state of Texas, reached the conclusion that "in aggregate,

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the level of education funding in Texas is more than sufficient to meet performance goals consistent with the state's accountability system." The other study, entered into evidence by the plaintiff school districts, concluded that, in aggregate, Texas school districts would need at least $2 billion in additional revenue to satisfy the requirements of the accountability system.

In this article we describe the methodological similarities and differences between the two cost function studies and provide an assessment of why the two studies arrive at such different results. Based on the outcome of the case in district court—a victory for the plaintiffs—the article draws some lessons about the use of statistical-based models in a judicial setting.

With the passage of the No Child Left Behind Act of 2001 (NCLB), all states are required to test students on an annual basis and to ensure that all students make adequate yearly progress (AYP) toward meeting state standards of academic proficiency. In the years prior to the passage of NCLB, courts in a number of states ruled that their systems of public education must be structured so that all children are provided with an adequate education. In these states, the courts, with varying degrees of specificity, have defined the characteristics of an adequate education. It is then left to state legislatures to devise systems of school finance that assure that local school districts have sufficient resources to meet their states' adequacy standards.

State governments throughout the country are being forced to reform their systems of school finance so that all school districts within a state have sufficient resources to meet the rising accountability standards mandated by NCLB and, at least in some states, by court decisions. To have a chance of being successful, these efforts at school finance reform require knowledge about the minimum amount of money needed in each district to meet the academic performance standards. Over the past decade there have been a large number of studies conducted in various states, all designed to provide information to decision makers about the costs of providing what has come to be called an "adequate" education.

Researchers have followed a number of different methodologies in developing estimates of the costs of meeting any given set of education standards. A review of this literature suggests that most studies involve one of three methodological approaches: the professional judgment approach, the successful schools approach, and the cost function (or econometric) approach. For assessments of the advantages and disadvantages of each approach, see Duncombe, Lukemeyer, and Yinger (2004) and Baker, Taylor, and Vedlitz (2004).

Researchers conducting a "professional judgment" study organize several teams of educators within a state and ask them to design an educational program that will achieve the state's educational goals. Once team members have identified the set of inputs required to achieve the stated goals, researchers determine how much money will be needed to fund the specified set of inputs. In many professional judgment studies, members of the panel of experts are also asked about the extra resources that would be required to provide certain types of students, such as those from low-income families, with an adequate education. Cost estimates using the "successful schools" approach start by identifying a set of high-performing schools and then basing estimates of the cost of providing a high-quality education on the lowest level of per-pupil spending among the set of successful schools. Researchers estimating cost functions rely on data from all school districts within a state on per-pupil school expenditures, student performance, and various characteristics of students and school districts. A cost function provides an estimate for each district of the minimum amount of money necessary to achieve various educational performance goals given the characteristics of the school district and its student body. Given that Texas is characterized by a tremendous diversity in both student and school district characteristics, Baker et al. (2004) concluded that conducting a cost function analysis " is the most obvious fit to the challenges of educational cost analysis in Texas" (p. 26).

In this article we describe two cost function studies that were recently conducted in Texas. The explicit purpose of both studies was to determine whether school districts have sufficient resources to meet the state's education accountability standards. Although both studies involved the econometric estimation of cost functions, they reached very different conclusions about the adequacy of education funding in Texas. The results of these two studies are of more than academic interest, as they both played a role in a court case challenging the constitutionality of the system of school finance in Texas. The plaintiffs and intervenors in the court case, *West Orange-Cove et al. v. Neeley et al.* (2004), are a large and diverse group of Texas school districts.[1]

One study, entered into evidence by the state of Texas, reached the conclusion that "in aggregate, the level of education funding in Texas is more than sufficient to meet performance goals consistent with the state's ac-

[1]The *West Orange-Cove et al. v. Neeley et al.* (2004) case has a long history. It was originally filed in April 2001 by four high-property wealth districts. After losing in both district court and the appeals court, in May 2003 the Texas Supreme Court reversed the lower courts and sent the case back to district court. The list of plaintiff school districts in the 2004 case has been expanded to include 47 districts representing both rural areas and the state's largest cities. The case was argued in Travis County District Court in a 6-week trial starting in August 2004.

countability system" (Taylor, 2004b, p. 2). The other study, entered into evidence by the plaintiff school districts, concluded that, in aggregate, Texas school districts would need at least $2 billion in additional revenue to satisfy the requirements of the accountability system.

Both studies used cost function methodology and similar data, but as discussed in greater detail later, they differed with respect to several specification and estimation issues. The first study, issued in March 2004 by Timothy Gronberg, Dennis Jansen, Lori Taylor, and Kevin Booker (hereafter referred to as GJTB), was originally conducted for the Texas Joint Select Committee on Public School Finance. The cost function estimation in that study was based primarily on earlier work by Gronberg and Jansen that was part of a larger project, undertaken at the request of the legislature by the Charles A. Dana Center at the University of Texas–Austin to analyze variations in educational costs (Alexander et al., 2000).

The second study, by Jennifer Imazeki and Andrew Reschovsky (2004a; hereafter referred to as IR), was undertaken at the request of the West Orange-Cove plaintiffs. The cost function estimation in that study was based largely on earlier Texas cost function studies by the authors, conducted as academic research (Imazeki & Reschovsky, 2004b; Reschovsky & Imazeki, 2003). Although the studies were conducted independently, to facilitate comparisons between the two studies, the cost predictions in both studies were based on similar academic performance standards.

In the next section of this article, we briefly describe the system of school finance in Texas. As we explain, even if the Texas Supreme Court reverses the district court ruling in *West Orange-Cove et al. v. Neeley et al.* (2004), there is widespread agreement in Texas that the school funding system is in crisis and will need to be reformed. In the following section, we explain the major elements of the judicial challenge to the system. We explain the evidentiary role played by the two cost function studies and briefly indicate how these studies influenced the ruling of the judge in the case. In the next section, we provide a primer on the basics of the cost function approach to the estimation of the costs of achieving an adequate education. This is followed by a section in which we describe and evaluate the different assumptions and approaches taken by the two cost function studies. We then discuss the contrasting ways in which the two studies use their cost function results to generate estimates of the amount of money needed by school districts in Texas to meet the student performance standards mandated by the Texas accountability system. In the final section of the article, we attempt to draw some general conclusions about the use of cost function analysis in providing estimates of the costs of educational adequacy.

School Finance in Texas

The school finance system in Texas has been shaped by legislative response to a long series of court challenges to the Texas educational finance system.[2] The current system was established in 1993 and was designed to satisfy a series of previous court rulings that had declared the system of education finance unconstitutional. In January 1995, the Texas Supreme Court ruled that the school funding system established in 1993 satisfied constitutional muster. Although there have been some small revisions to the school funding formulas since then, the basic system of state aid remains in place today.

The school funding system is a complex assortment of formulas, adjustments, and weights collectively known as the Foundation School Program (FSP). The three most important elements of the system include (a) a foundation formula (Tier I), which guarantees all school districts a certain amount of money if they agree to levy a minimum property tax rate; (b) a guaranteed tax base formula (Tier II), which guarantees all districts a fixed amount of money for each cent of additional property tax rate above the minimum and below a statutory maximum; and (c) a recapture provision, which caps the revenue-raising capacity of all property-wealthy districts by requiring them to contribute all property tax revenues on property values above the caps to help finance the FSP. This last provision has resulted in the school finance system frequently being described as a Robin Hood system of education finance.

For the 2004–05 school year, the Tier I foundation level called the *basic allotment*, was set at $2,537 per student. This amount was adjusted for each school district to reflect small district size, geographical sparsity, and a cost of education index that reflects differences across districts in factors such as the cost of living and the concentration of low-income students. Each school district's Tier I and Tier II allocations are further adjusted to reflect differences in student characteristics by assigning additional "weights" to students in special education, compensatory education, bilingual education, vocational education, and gifted and talented programs.

In 2004–05, Tier II guarantees each district $27.14 per weighted pupil for each additional penny of property tax rate between the required minimum rate of $0.86 per $100 of assessed value and the statutory limit of $1.50. School districts with property wealth between the Tier II guaranteed tax base of $271,400 per pupil and $305,000 are free to raise additional property tax revenue (as long as their tax rate remains below the $1.50 cap). Dis-

[2]For a brief history of school finance litigation in Texas, see Imazeki and Reschovsky (2004b).

tricts with property wealth above $305,000 per pupil are required to share all property tax revenue generated by property values in excess of $305,000.

The Judicial Challenge to the Constitutionality of School Finance in Texas

School finance reform has been a major topic of public discourse in Texas in 2004. In March, the legislature's Joint Select Committee on Public School Finance issued a final report in which they recommended a number of major changes to the school finance system. In April, Governor Perry called a 1-month special session of the legislature to deal with school finance. The central focus of the special session was on the financing of a major reduction in school property taxes and a repeal of the recapture provision of the current school funding system. Due to its inability to agree on a new source of revenue, the special session ended without the enactment of any new legislation. Finally, in August over 300 Texas school districts joined together as plaintiffs and interveners in a court case, *West Orange-Cove et al. v. Neeley et al.* (2004), challenging the constitutionality of the current system of school finance. In late November 2004, the Travis County District Court's presiding judge, John Dietz, issued a ruling in which he declared the Texas school funding system to be unconstitutional. He gave the legislature until October 1, 2005 to come up with a new funding system that remedied the constitutional violations. Immediately following Judge Dietz's ruling, Texas Attorney General Greg Abbot indicated his intention to appeal directly to the Texas Supreme Court.

To understand the legislature's and the governor's interest in school finance reform, and the basis of the plaintiffs' arguments in the *West Orange-Cove* case, it is necessary to describe several elements of the school finance system and explain how they are forcing changes in the system of school finance. The first element is the state's falling share of education funding. In 2000, the state financed 47% of school funding. Four years later, the state's share had fallen to 38%. The reason for the falling state share of FSP funding is that neither the state's foundation nor its guaranteed tax base formulas are automatically adjusted for the rising costs of education. In fact, the basic allotment has not been raised in 5 years, and the guaranteed tax base was last increased in 2002–03. Therefore, as per-pupil property values grow from one year to the next, both Tier I and Tier II state aid allocations are reduced. As a result, many school districts have been forced to raise their property tax rates, both to make up reductions in state aid and to meet rising education costs.

The ability of school districts in Texas to raise their property tax rates is limited, however, by a state statute that prohibits property tax rates for maintenance and operating expenses in excess of $1.50 per $100 of assessed value (15 mills).[3] For the 2003–04 school year, 828 of the 1,031 school districts in Texas had rates above $1.40, with the majority of them already at the $1.50 cap.[4] From their public pronouncements, it is clear that a very important priority for both Governor Perry and for many members of the legislature is to find a way to substantially reduce school property tax rates. In fact, in their final report, the legislature's Joint Special Committee on Public School Finance concluded that one of the primary goals of school finance reform should be provision of "significant" property tax relief, which the committee defined as property tax rate reductions of at least $0.50 per $100 of valuation.

In addition to providing general property tax relief, the repeal of the "recapture" provision of the school finance system is a high priority of the governor and of many members of the legislature. Over the past decade, the state has failed to adjust the Equalized Wealth Level (the per-student property value above which all property wealth must be shared) to the growth in property values. As a consequence, each year more school districts are subject to the recapture provisions. Those school districts subject to recapture are very tightly constrained in their ability to increase education spending, regardless of whether the increased spending is due to uncontrollable costs caused by enrollment growth, rising accountability standards, or other factors.

The final, and perhaps most controversial, factor that is driving school finance reform is the rising cost of meeting Texas accountability standards. The upward pressure on costs comes from three sources. First, accountability standards are rising over time. Not only has Texas replaced its testing system, the Texas Assessment of Academic Skills (TAAS), with a new and more difficult set of tests called the Texas Assessment of Knowledge and Skills (TAKS), but NCLB requires that the percentage of students passing the tests at a level considered to be "proficient" increase each year over the next decade. In addition, Texas has adopted new, broader curriculum standards and has imposed tougher grade promotion and graduation requirements. It is difficult to imagine that these higher expectations from the public school system can be met without the annual expenditure of addi-

[3]School districts are also able to levy a separate property tax rate, limited to $0.50, for the purpose of meeting debt payments associated with school buildings.

[4]School districts with property tax rates above $1.40 in 2003–04 collectively educated 90% of public school students in Texas.

tional funds. One goal of the two cost function studies was to provide estimates of these additional costs.

The second reason the costs of education are rising over time is due to the steady increase in the number of students that the public education system in Texas must educate. Although enrollments in many parts of the country are projected to decline over the next decade, projections by the National Center for Education Statistics (2003) indicate that Texas will experience an average growth in public school enrollment of about 1% per year over the next decade.

The third reason that the costs of education are rising is that the composition of the student body is changing over time. Enrollment data from the Texas Education Agency (TEA) indicate that in recent years most of the net growth in public school enrollment has come from growth in the number of students from low-income and minority families. According to the Texas state demographer, if current demographic trends continue, the student body in Texas will continue to become more Hispanic and more low income (Murdock et al., 2003). The weight of evidence from a large literature on the costs of education, including the findings of both the GJTB and the IR studies, indicate that the costs of meeting educational accountability standards are substantially higher when a high proportion of students come from economically disadvantaged families and enter schools with limited English proficiency (LEP). Therefore, school districts in Texas will face increased pressure to raise spending not only because of the growth in the number of students but also because their student bodies will, over time, include higher concentrations of students who are relatively expensive to educate.

In bringing their case challenging the constitutionality of the current school funding system in Texas, the plaintiff districts argued that the $1.50 statutory property tax cap has become both a floor and a ceiling for most school districts and that, under the current funding system, school districts do not have access to sufficient resources to provide a constitutionally mandated "general diffusion of knowledge." The plaintiffs argued that because of the falling share of state aid and the rising costs of meeting state accountability standards, school districts have lost all "meaningful discretion" over their property tax rates. Furthermore, because so many school districts have reached the $1.50 rate cap, the school property tax has become a de facto state ad valorem property tax, something that is constitutionally prohibited in Texas. The plaintiffs also presented evidence, based on the IR study and on a "professional judgment study" completed by James Smith and Richard Seder (2004), that most school districts must increase spending to be able to meet the state's accountability standards and satisfy the constitutionally mandated requirement that they provide an adequate education. They argued that the school finance system is unconstitutional because it fails to provide school districts with access to sufficient resources to enable to them to provide an adequate education.

Having a good estimate of the cost of an adequate education, namely the amount of money needed to satisfy the general diffusion of knowledge clause of the constitution, was critically important for both the plaintiffs and the state. If the costs of providing an adequate education and meeting all other state and federal education mandates were clearly below the level of current spending, then the state could argue that local school districts had the ability to lower their current property tax rates to levels that were substantially below the $1.50 cap and still provide for the general diffusion of knowledge. On the other hand, if the cost of providing a constitutionally adequate education to the public school students of Texas requires additional spending beyond the current spending levels, then not only would school districts have no meaningful discretion to lower their tax rates but, given the current level of state funding, they would have no means of satisfying the state's educational accountability standards and the constitutional requirement to provide for the general diffusion of knowledge.

Although, as we discuss later in this article, both of the cost function studies were based on a set of several student performance measures, the single most important outcome measure used in both studies was the passing rate on the mathematics and reading exams that are part of a set of standardized exams that nearly all students must take, the TAKS. Once one has estimated a cost function, it is easy to use the cost function results to calculate the costs, for individual districts and across the entire state, of meeting any reasonable passing rate standard. The GJTB study calculated the costs of education for a single standard, an average composite passing rate on the two exams of 55%. GJTB argued that the 55% passing rate provides a reasonable measure of an adequate education, one that provides for the general diffusion of knowledge.[5] They justified the 55% passing rate as an appropriate standard by pointing out that the TEA has set as its goal a 53.5% passing rate for the reading and language arts exam and 41.7% passing rate for the mathematics exam. GJTB predicted that the cost of assuring that all districts achieve a 55% average passing rate on the two exams, and that districts that are already at

[5]As we discuss later, the plaintiffs in the *West Orange-Cove et al. v. Neeley et al.* (2004) case argued that both the test score that students need to pass the exams and the 55% standard are too low to be considered appropriate measures of an adequate education.

or above the 55% standard improve their passing rate by 2.87 percentage points, equals $6,403 per pupil (in 2004 dollars).[6]

To provide a cost comparison with GJTB, IR also calculated costs on the basis of a 55% passing rate standard. Their estimated cost per pupil is $7,518 per student—over $1,100 per pupil higher than the GJTB estimate.[7] Adding these two predictions over Texas's 4.3 million public school students results in an estimate of $26.1 billion of total predicted costs by GJTB and $30.9 billion by IR, a difference that is equivalent to 18% of total public school revenue in 2003–04.

The Use of Cost Functions to Measure the Costs on an Adequate Education

In both studies, the primary empirical question was whether school districts have sufficient resources to meet the state's accountability standards. This can be broken down into two separate questions. First, how much does it cost for any given district to meet the state's accountability standards? Once that is established, does the current system provide enough funding to cover those costs, or is additional money needed? To answer the first question, both studies estimated cost functions for K–12 education in Texas.

Cost functions provide a practical way to identify and quantify the factors that influence the costs of education, where the *output* of school districts can be measured using multiple measures of student performance. By estimating a cost function based on data on K–12 school districts, we can characterize in detail the relation between spending per pupil by school districts and various measures of student performance while also taking account of the characteristics of each school district's student body; other characteristics of the school district, such as size; and the prices the school district must pay for inputs into the education process.

In algebraic terms, a cost function can be represented by the following equation:

$$E_{it} = h(S_{it}, P_{it}, Z_{it}, F_{it}, \varepsilon_{it}, u_{it}), \tag{1}$$

[6]That is, for districts with passing rates already at or above 52.13% (55.0 – 2.87), the predicted cost reflects the cost of improving their passing rate by 2.87 percentage points. For districts that were below 52.13%, the predicted cost reflects the cost of getting up to the 55% standard.

[7]Both these estimates are based on school operating expenses and exclude all spending on transportation and food services.

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}, other characteristics of the school district, such as its size; F_{it}, a vector of unobserved characteristics of the school district, e_{it}; and a random error term, u_{it}. Once a functional form is chosen for Equation 1, it can be estimated with district-level data for a given state. The resulting coefficients indicate the contribution of various district characteristics to the cost of education, holding constant the level of output. These cost function results can then be used to predict the cost of any given level of performance on the included outcome variables. These predictions are generated by multiplying the cost function coefficients by the actual values of the student and district characteristics while holding the output variables constant at the desired level. For the *West Orange-Cove* case specifically, the GJTB and IR studies used their respective cost functions to predict the costs associated with the performance standards set out in the Texas accountability system.

In any empirical analysis, there are a number of choices that the researcher must make. For example, before estimating Equation 1 one must first specify a functional form (e.g., linear, log linear, etc.). Choices must be made about which student performance, school district, and student characteristics to include, as well as how to define those variables. Although these choices are guided by an underlying model of public decision making and assumptions about cost minimization, researchers still have considerable latitude in choosing specific variables and functional forms. Furthermore, in the real world, some schools may fail to minimize costs; hence, they may operate inefficiently. Although these potential inefficiencies are not directly observed, researchers can follow different strategies in an attempt to address school district inefficiencies. Public finance economists also generally assume that school district spending decisions have a direct impact on student performance goals, and decisions about what goals to meet have direct implications for the level of per-pupil spending a district must undertake. Therefore, researchers must make decisions about how to account for this simultaneous relation between per-pupil spending and student outcome.

Each of these choices has implications for the final cost function results and any subsequent cost predictions that are derived from those results. The authors of the IR and GJTB studies estimated a version of Equation 1, and in certain respects, their results were qualitatively similar. Both studies found that costs increase with the percentage of low-income, LEP, and disabled students as well as finding higher costs for small districts and for districts that must pay higher teacher salaries. In almost all cases, however, the estimated effects are smaller in the GJTB analysis. This is due, in part, to the different choices made by the authors with regard to a number of the estimation issues mentioned earlier and discussed in greater detail in the next section.

How the Two Cost Functions Studies Differ

In this section, we discuss some of the major differences between the two studies in the specification and estimation of a cost function for K–12 education in Texas.

Measuring Test Scores

As noted by Baker et al. (2004), "a central difficulty of performance-oriented analysis involves the politics of achieving consensus regarding *important outcomes* and the empirics of precisely measuring those outcomes" (p. 20). Fortunately, for the most part, the choice of outcomes and the measurement of those outcomes have already been made in Texas. The Texas accountability system is built around a set of standardized tests. Since the early 1990s, Texas has had a well-developed testing system for the majority of its students. Until 2002–03, all students in Grades 3 through 8 and in Grade 10 were tested in the spring of each year as part of the TAAS. In 2002–03, the TAAS was replaced with the TAKS, a more rigorous test, and testing was extended to students in Grades 9 and 11. Passing rates on the TAKS are the primary basis for assessing the performance of schools and school districts as part of the Texas accountability system.

Both the GJTB and IR studies included test scores as an outcome measure—specifically, changes in passing rates in reading and math on the TAAS for students in Grades 5 through 8 and 10. It is appropriate to focus on *changes* in student performance (as opposed to *levels*) in estimating a cost function because a primary objective of schools is to improve, on an annual basis, the knowledge and skills of students. An additional reason for using a "value-added" measure of student performance is that both NCLB and Texas accountability standards call for students to make AYP toward the achievement of the accountability standards. To generate a value-added measure of test scores, however, it was necessary to use scores from the TAAS because multiple years of data on the TAKS were not available.

Unfortunately, using data from the TAAS presents a problem for any analysis of the state's accountability standards because those standards are based on performance on the TAKS exams. As mentioned earlier, the TAKS exams are more rigorous than the TAAS exams, and scores on the two exams are not directly comparable. To further complicate matters, the state is phasing in passing standards on the TAKS, increasing the score required to pass each year.[8] Therefore, a given passing rate in 2003 still represents a lower level of performance than the same passing rate in 2005 because the individual score needed to pass is higher in 2005.

To predict costs associated with performance on the TAKS, each study took a somewhat different approach. In the GJTB study, the cost function was estimated with changes in TAAS passing rates. The resulting coefficient on the test score variable thus reflects the marginal effect of a 1 percentage point increase in the TAAS passing rate. Those coefficients are then used to predict the cost of achieving changes in passing rates on the TAKS. This assumes that the cost of achieving a 1 percentage point increase in the passing rate on the TAKS (regardless of the cut score) is the same as the cost of achieving a 1 percentage point increase in the passing rate on the TAAS. If improvements on the TAKS are more (or less) costly than improvements on the TAAS, then this assumption will lead to lower (or higher) predictions of the costs of achieving standards on the TAKS.

In the IR study, the cost function was estimated using a measure of the TAAS scores that had been converted to the TAKS standards. The conversion is based on a conversion schedule developed by the TEA, which indicates how a given score on the TAAS correlates to expected performance on the TAKS; at the 2005 cut scores, that is, a student would need a particular TAAS score to have passed the TAKS at the passing standard in place for 2005. Because the cost function is estimated with converted passing rates, the resulting coefficient on the test score variable reflects the marginal effect of a 1 percentage point increase in the TAKS passing rate, at the 2005 cut scores, and can be used directly to predict the cost of improvements on the TAKS. This approach, however, relies heavily on the accuracy of TEA's TAAS–TAKS conversion.

Measuring Value Added

Whether converted to TAKS scores or not, both studies use a value-added measure of TAAS performance, comparing passing rates in 2001–02 with passing rates in a previous year. Therefore, each study estimates the cost of achieving a certain *gain* in passing rates. GJTB used a

[8]Note that there are several elements involved in determining standards for these exams: First is the decision of what grade on any examination will be considered passing (which we refer to as the "cut score"), and second are the passing rates, or the increase in passing rates, that are considered high enough to meet the standard (which we refer to as the "passing rate" standard). Between 2002 and 2005, the state accountability system is increasing the cut scores; after 2005, the passing rate standard will increase each year.

2-year lag, and they matched passing rates in 2001–02 for Grades 5 through 8 and 10 with passing rates for the same students 2 years earlier (1999–00), when those students were in Grades 3 through 6 and 8.[9] The coefficient on the test score variable thus reflects the marginal effect of a 1 percentage point increase on the TAAS over a 2-year period. However, GJTB's dependent variable, per-pupil expenditures, was for the 2001–02 school year, and the predicted costs were presented as annual costs. However, as Lori Taylor (2004c, pp. 54–55) pointed out at the trial, the coefficient estimated by GJTB was, at best, only one half of the marginal effect of a 1-year gain. To see this, take two equations: $y = a + bx$ and $y = a + c(x/2)$. For a given x, b must be equal to $c/2$. If x is a 2-year gain in test scores (as in the GJTB estimation), and x/2 is a 1-year gain (assuming the gain is equal in each year, which may, in itself, be a strong assumption), the coefficient in the GJTB estimation (i.e., b) is only half of the marginal effect of a 1-year gain (i.e., c). This implies that the GJTB study probably underestimates the cost of achieving a given *annual* improvement in test scores.

IR used a 1-year lag and matched passing rates in 2001–02 for Grades 5 through 8 and 10 to passing rates in 2000–01 for Grades 3 through 8 and 10. Given available data, this was the only way to have a 1-year lag. The resulting variables, however, do not exactly match the same cohort of students. This fact may create statistical noise, and perhaps bias, in the resulting estimates, although the direction of that bias is not clear (i.e., it may lead to under- or overestimates of the marginal effects).

Pupil Weighting

Because the dependent variable in a cost function is per-pupil spending, and available data on spending is almost always at the district level, cost functions are estimated with variables aggregated to the district level (percentage of students from low-income families, percentage disabled, etc.). The data thus represent average characteristics of each district. Using this kind of data may be problematic, however, when those averages are calculated over districts of varying sizes. This is certainly likely in a state such as Texas, where there are vast differences in district size. For example, Houston ISD, the state's largest district, serves over 210,000 students, whereas there are 343 school districts with enrollments of less than 500 students. The 775 smallest Texas districts educate only 20% of public school students, whereas another 20% of students are educated in the state's 8 largest districts.

[9]Their measure does not include any students who drop out during those 2 years or any who enter the Texas schools during that time.

Using data that represent averages for districts of such varying sizes may lead to a common econometric problem, known as *heteroskedasticity*.[10] A quite standard way to account for this problem is by weighting each observation by group (district) size. This was the approach taken by IR. As a result, their estimated cost function coefficients reflected the cost relations that exist for the average student in the state. Pupil weighting means that each of the larger districts contributes more information to the estimation than each small district. The authors argued that this is appropriate because the majority of students are educated in relatively large districts.

GJTB also accounted for heteroskedasticity in their estimation, but they used a different econometric technique and did not pupil weight. Because the GJTB study did not pupil weight, their cost function results still reflected the relationships between per-pupil spending, student performance, and student characteristics in the average district. The consequence of not pupil weighting is that a very small district contributes the same amount of information to the estimation as an extremely large district. Because there are so many small districts, this means that the relationship between spending and district size is easier to identify among small districts. However, because there are only a few large districts, there is more "noise" in the estimation, and any relation between spending and district size will be more difficult to identify among large districts. This may lead to an overemphasis on the relationship between spending and small district size but an understatement of the relationship between spending and large district size.

Teacher Salaries

Teacher salaries account for the largest share of school expenditures and are arguably the most important input in the educational process. Any educational cost function must therefore include some measure of the price of this input. However, the goal of cost function analysis is to isolate factors that contribute to higher spending but are outside the control of local school districts. However, districts make decisions about the quality of teachers that they recruit, and those decisions can affect spending levels. Teacher salary levels are also generally determined through a process of negotiation with teacher organizations, and school boards have a substantial impact on the outcome of these negotiations. Therefore, rather than using actual teacher salaries, it is more appropriate to use a measure of teacher salaries that minimizes the influence of school district decisions.

[10]Heteroskedasticity refers to a situation where the error term cannot be considered random.

In estimating their cost function, GJTB used the average salary for beginning teachers in a district (those with less than 5 years' experience). They pointed out that this "is a better measure of the wage level in a district than the average wage paid to all teachers because beginning teacher wages are less influenced by differences in the experience profiles of districts" (p. 10). They also included the average salary of teacher aides and auxiliary personnel. However, because actual wages are subject to district control, GJTB's estimated effect of salaries on spending may have been biased downward.

IR instead used an index of teacher costs developed by Taylor (2004a). Her index separated variations in compensation arising from uncontrollable district characteristics (such as area cost of living) from variations arising from factors that districts can influence (such as teacher experience and educational background). Therefore, the estimated coefficient reflects the higher spending associated with only those salary costs that are outside the control of the local district.

Functional Form

Both studies estimated some version of Equation 1 but must first specify a functional form for that equation. IR estimated a log-linear model in which continuous variables, other than variables measured as percentages, are transformed by taking natural logarithms. To capture possible economies and diseconomies of scale, they also included quadratic (squared) terms for the percentage of LEP students, percentage of severely disabled students, and the log of district enrollment. In their model, the coefficients on most variables can be interpreted directly as the marginal effect of a one-unit change in the variable.[11] The resulting coefficients are then used to predict the costs of achieving any given level of student performance.

GJTB estimated a *translog* model in which continuous variables, other than variables measured as percentages, are transformed by taking natural logarithms, all of the variables are interacted with (multiplied by) all other variables, and quadratic terms for all variables are also included.[12] This is a very flexible specification, but the flexibility comes at the cost of complexity. The model GJTB estimated has 109 independent variables (compared to 19 in the IR specification), and the numerous interactions and quadratic

[11]With the three variables for which quadratic terms are also included, the marginal effects must be calculated from the coefficients on both the variable itself and the quadratic term; therefore, this will change with the level of the variable.

[12]The Gronberg, Jansen, Taylor, and Booker (2004) model also included a cubic term for district enrollment.

terms make the resulting coefficients much harder to interpret. Also, it is much more difficult to assess the impact of a change in any one variable on per-pupil spending while holding other variables constant. The presence of the interaction terms means that these so-called *marginal effects* will depend on the value of the variable of interest and the values of all the other variables. For example, the impact on per-pupil spending of a 1 percentage point increase in the percentage of poor students in a district will depend on school district size, on the salary of beginning teachers, on the percentage of a district's students enrolled in high school, plus the other cost factors and outcome variables included in the cost function.

Rather than exploiting the full flexibility inherent in the translog functional form, GJTB chose to calculate the marginal effects of each cost factor on per-pupil spending by setting the value of all variables equal to their average values. These calculated marginal effects were then used to predict costs.[13] This approach has the advantage of being relatively easy to explain. The cost of using this simpler specification, however, is that one loses much of the potential advantage of estimating a cost function with a more flexible form than the log-linear specification used by IR. Because the converted coefficients are the marginal effects calculated at the averages, using the converted specification will lead to lower predicted costs for some districts and higher predicted costs for others, relative to using the translog coefficients directly. The net impact on estimated total costs is unclear.

Efficiency

It is very difficult to determine whether any given school district is operating efficiently. At a conceptual level, a school or school district is operating efficiently if it meets its stated educational goals while spending as little money as possible. Although the concept of cost minimization is straightforward, the actual measurement of efficiency is complicated because it is exceedingly difficult to identify and quantify both the goals of each school district and all the factors that influence the achievement of those goals and contribute to school district spending. Despite these difficulties, it is important that any attempt to measure the costs of meeting student performance goals deducts from costs any spending that is inefficient, namely, spending that does not contribute to achieving those goals.

Given that inefficiencies cannot be directly observed, any analyst faces the problem of finding an indirect way to identify the magnitude of ineffi-

[13]That is, they take the translog results and condense them to create a simpler log-linear equation with one term for each variable and coefficients that reflect the marginal effects evaluated at the average values of all variables.

cient spending in each school district. Therefore, it is not surprising that the authors of the two cost function studies use quite different approaches to the measurement of efficiency.

GJTB accounted for school district inefficiency by estimating their cost function with a *stochastic frontier.* This technique considers all spending by a school district that is in excess of estimated minimum costs to be inefficient. The stochastic frontier procedure allowed the authors to identify the minimum level of spending among school districts with similar characteristics and similar levels of student performance. Among the set of similar districts, all spending that is in excess of minimum spending is considered to be inefficient; hence, it is not counted in the calculation of costs.

GJTB correctly pointed out that one must view this efficiency measure with caution. They recognized that efficiency measured using the stochastic frontier is sensitive to the way that school district output is defined. School district spending associated with outputs other than those explicitly included in the cost function estimation will be counted as inefficient. For example, resources that school districts devote to vocational education or arts and music subjects not directly measured by scores on math and reading exams will be classified as inefficient spending. This misclassification is particularly troublesome because state-imposed curriculum requirements mandate that school districts provide students with courses in subjects beyond the core academic subjects—for example, art and music.

The stochastic frontier model may also misclassify spending as inefficient because the cost function estimation is unable to measure the impact of some important "inputs" in the educational process. For example, parental involvement, whether by volunteering in the schools or by helping children with homework, may be an important factor in improving student test scores. This implies that a school district with extensive parental involvement will have lower measured costs and will thus define the frontier spending level for districts with similar characteristics, yet less parental involvement. By definition, higher spending in districts with relatively less parental involvement will be classified as inefficient, despite the fact that the school district has little control over the behavior of the parents of their students.

GJTB recognized that their stochastic frontier analysis systematically overestimates inefficiency; therefore, they based their cost estimates on their average estimated level of inefficiency. However, as their underlying estimate of inefficiency was at best very imprecise, their resulting predictions of costs provided an imprecise measure of the costs of meeting the state's accountability standards. Nevertheless, using the GJTB results, Taylor (2004b) presented point estimates of the inefficiency of individual school districts, for example, showing that about 11% of the Austin school district spending is inefficient. In a recent article, however, Street (2003) demonstrated that efficiency estimates based on stochastic frontier methods are highly sensitive to estimation decisions and argued that little confidence should be placed in the resulting estimates of inefficiency when applied to individual units such as school districts or hospitals.

IR used a completely different approach in their attempt to estimate the impact of school district inefficiency. Rather than attempting to measure efficiency directly, IR assumed that school districts would operate more efficiently if they operate in a competitive local educational market. Although this assumption may be considered controversial, after reviewing a number of studies of government competition, Taylor (2000) concluded that "almost across the board, researchers have found that school spending is lower, academic outcomes are better, and school-district efficiency is higher where parents have more choice in their children's education provider" (p. 7). To measure public school competition, a county-level Herfindahl index is constructed.[14] The index increases with the amount of competition; therefore, if district efficiency is correlated with the amount of competition that the district faces, then spending should be lower in districts with higher values of the Herfindahl index. In predicting costs, IR held the value of the Herfindahl index constant at a relatively high level of efficiency. It is important to point out that, as with the GJTB model, this method does not explicitly capture spending on public school outputs other than those included in the estimation. However, using the Herfindahl index, spending directed to other outcomes, such as music courses, is picked up in each school district's random error term; thus, it is not classified as "inefficient."

Estimation Methods

As mentioned earlier, school districts make decisions about spending levels and student outcome levels simultaneously. That is, although decisions by local school boards to raise the level of student performance presumably will require additional spending, decisions concerning

[14]A Herfindahl index for school districts in county k can be calculated using the following formula:

$$\text{Herfindahl Index} = 1 - \sum_i \left(\frac{enrollment_i}{enrollment_k} \right)^2$$

For a county with just one district and no competition, the index will equal zero. For a county with n equally sized districts, the index will equal $1 - 1/n$. Therefore, the index approaches 1 as the number of districts, and presumably competition, increases. This construction assumes that counties can be used to define local "markets" for education.

per-student spending are likely to directly influence student performance. If not appropriately addressed, this simultaneity can lead to bias in estimation of the cost function coefficients, implying that the estimated values of the coefficients may be systematically larger or smaller than the "true" values. One of the more common statistical techniques to deal with potential simultaneity is *two-stage least squares* estimation. This estimation procedure was used by IR. It requires that the analyst find variables, referred to as *instruments,* which are correlated with the student performance measures but are not correlated with school district spending. The advantage of using two-stage least squares is that it removes the bias created by the simultaneous relation among variables and thus provides more confidence that the coefficients reflect the true relations. On the other hand, the use of two-stage least squares may result in a reduction in the statistical significance of some of the estimated coefficients of the cost function.

The GJTB study did not address the simultaneity issue. The authors argued that they ran statistical tests to check for the existence of bias and, on the basis of the test results, concluded that adjustments for simultaneity bias were not necessary. However, the complexity of the translog functional form, combined with the stochastic frontier estimation, would most likely make identification of bias more difficult with the standard tests. Therefore, there is still the possibility that the GJTB coefficient estimates are biased.

Differences in Predicted Costs From the Two Cost Function Studies

The previous section outlined a number of ways in which the two cost function analyses differ. Not surprisingly, each of these differences contributes to differences in the magnitudes and distribution of the predicted costs of meeting any given student performance standard. As mentioned previously, the GJTB study predicted that the cost of all districts achieving a composite passing rate of 55% on the reading and mathematics exams is $6,403 per pupil (in 2004 dollars). Using a slightly different definition of the 55% standard, IR calculated costs of $7,518 per student. Not only do the two studies predict different costs, but they differ considerably in their prediction of which districts have relatively high costs and which districts have relatively low costs. To compare predicted costs across districts, both studies calculate *cost indexes* by using their cost function results to predict the cost of meeting the 55% passing rate standard for each school district as well as the cost of achieving that standard in a district with average values for all the cost factors. The index is the ratio of these two numbers. The index values thus provide a measure of a school district's costs relative to the average district. For example, an index value of 1.25 indicates that a district has predicted costs that are 25% higher than in the average cost district.

As a means of comparing the distribution of the cost indexes generated by the two studies, we have divided school districts into quintiles defined in terms of the percentage of poor students in each district and district size. In defining quintiles, we weight districts by student enrollment so that each quintile contains 20% (one fifth) of all Texas K–12 students. Therefore, the first poverty quintile in Table 1 includes the 133 districts with the lowest percentage of poor students, and these districts enroll approximately 20% of all public school students. Tables 1 and 2 both display for the two studies the average cost index value in each quintile and the minimum and maximum cost index value in each quintile.

As clearly shown in Table 1, both studies indicate that the costs of meeting the accountability standard are higher in districts with heavier concentrations of students from poor families. The IR study, however, found that poverty is a much more important factor contributing to high costs than did the GJTB study. The average cost index associated with the IR study is 1.19 in the fourth poverty quintile and 1.39 in the highest quintile. This contrasts with the much lower average cost index values produced by the GJTB study—1.09 in both the fourth and fifth poverty quintiles.

Table 2 displays the cost index values by district size quintile. It demonstrates that although both studies find a substantial variation in costs in each district size quintile, the IR study predicted that costs would be higher than average in both the smallest and the largest districts. This prediction contrasts with that of the GJTB study, which found that, with the exception of the smallest size quintile of school districts, the value of the average cost index is below average. The difference between the two studies is particularly striking among the state's largest districts, where IR calculated an average cost index of 1.02 (slightly above average); GJTB calculated an average cost index value of 0.87 (substantially below average). As we discussed previously, these different predictions are probably due to the fact that GJTB chose to estimate their cost function without the use of pupil weights.

How the Studies Differ in Assessing Educational Adequacy in Texas

By providing estimates of the amount of money each district needs to meet the state's accountability standards, the two cost function studies answer one of the questions before the court in the *West Orange-Cove et al. v.*

Table 1

Cost Index Values by Poverty Quintiles

		IR Cost Index Value			*GJTB Cost Index Value*		
Student Weighted Quintiles	*No. of School Districts*	*Average*	*Minimum*	*Maximum*	*Average*	*Minimum*	*Maximum*
1 (lowest)	133	0.73	0.53	1.03	0.86	0.72	1.21
2	256	0.88	0.67	1.56	0.96	0.78	1.60
3	283	0.98	0.72	1.69	1.01	0.79	1.50
4	214	1.19	0.81	2.65	1.09	0.84	1.70
5 (highest)	82	1.39	0.93	3.54	1.09	0.74	1.99
Total	968	1.00	0.53	3.54	1.00	0.72	1.99

Note. IR = Imazeki and Reschovsky (2004a); GJTB = Gronberg, Jansen, Taylor, and Booker (2004).

Table 2

Cost Index Values by District Size Quintiles

		IR Cost Index Value			GJTB Cost Index Value		
Student Weighted Quintiles	*No. of School Districts*	*Average*	*Minimum*	*Maximum*	*Average*	*Minimum*	*Maximum*
1 (smallest)	775	1.03	0.55	3.54	1.04	0.77	1.99
2	125	0.87	0.53	1.40	0.85	0.72	1.07
3	40	0.92	0.54	1.17	0.86	0.72	1.02
4	20	0.84	0.61	1.33	0.82	0.75	0.91
5 (largest)	8	1.02	0.69	1.32	0.87	0.77	0.93
Total	968	1.00	0.53	3.54	1.00	0.72	1.99

Note. IR = Imazeki and Reschovsky (2004a); GJTB = Gronberg, Jansen, Taylor, and Booker (2004).

Neeley et al. (2004) case. The answer to a second question was also important. The plaintiffs claimed that the current school funding system is failing to provide for the general diffusion of knowledge. This requires a determination of whether the current system of school finance provides enough funding to cover the costs of providing an adequate education for public school students in Texas. Because of the differences in the specification and estimation of the cost functions, the two studies generate different cost predictions; therefore, it is not surprising that they reach different conclusions about the adequacy of the current system. It is important to point out, however, that because the two studies made very different assumptions about the constraints imposed by the current system, even if they had used the exact same cost function and had identical predictions of costs, they would have reached different conclusions about the adequacy of current funding.

In their study, GJTB compared their predicted costs of meeting the 55% passing rate standard to the actual spending of each district. Only school districts with per-pupil expenditures less than predicted costs are considered to need additional funding. Any district that has spending equal to or greater than their predicted costs is assumed to have adequate funds to achieve the goals of the state's accountability system. This calculation assumes that if a district is currently spending more than it needs to spend to achieve the performance target, then it can reallocate its resources so as to meet the standard. Furthermore, by computing the tax rate, each district would need to raise revenue equal to the predicted level of spending and then conclude that "most West Orange-Cove Plaintiffs could lower their tax rates and still have enough revenue to cover their projected costs" (p. 11). Taylor (2004b) appeared to be arguing that if current spending is above the estimated costs of meeting the 55% passing rate standard, then this spending is not being used effectively and could be reduced or reallocated.

Taylor's (2004b) assessment of the adequacy of education funding in Texas was based on the premise that school districts have complete discretion to reallocate or eliminate all funding that is not directly associated with achieving the accountability standards included in the GJTB cost function analysis. For this premise to be justified, one must ignore the fact that the Texas accountability system includes a number of other requirements that are not included in the GJTB calculation of costs. These include requirements for proficiency in both science and social studies and requirements for raising graduation rates, stiffening grade promotion requirements, and reducing dropouts. In her testimony, Taylor (2004c, p. 179) argued that the costs of meeting these additional requirements and performance standards are included in the GJTB cost estimates, as long as those requirements and performance standards are highly correlated with the outcome measures included in the cost function. However, to the extent that reallocating funds toward efforts to increase math and reading scores reduces the ability of school districts to achieve these other requirements of the state's accountability system, the GJTB cost estimates underpredicted the cost of the accountability system as a whole. In addition to the accountability system, the state imposes a set of curriculum requirements on school districts, plus minimum class size requirements for the lower grades. These requirements further reduce the discretion of school districts in reallocating funds.

In their study, IR measured the additional costs of fulfilling the accountability standards by comparing their predicted cost of meeting the standards to the predicted cost of the district's current level of student performance. That is, the cost function results are used to calculate, for each school district, the predicted cost of the current passing rate. This amount is then subtracted from the predicted cost of meeting the 55% passing rate standard. This means that if a school district is already achieving the standard, they require no additional funding. Both the Texas accountability system and NCLB specify that in school districts where current student performance is substantially below the standards, districts are not required to meet the standard in a single year; rather, they must demonstrate AYP toward the standard. In calculating the additional cost of meeting the 55% passing rate standard, IR defined AYP as requiring school districts with current student performance below 52% to reach the standard over a 3-year period (i.e., moving one third of the way toward meeting the goal each year). Following this methodology, IR determined that the additional cost of meeting the 55% passing rate standard would be $1.7 billion (in 2004 dollars). This amount, which is equivalent to $405 per pupil, is equal to 6% of public school revenue in 2004.[15]

IR's additional cost calculations implicitly assumed that if school districts are currently spending more than what they need to spend to achieve their student performance goals, they are not able to reallocate current spending to meet the goal. This assumption is based on the premise that current spending is needed to meet accountability standards that are not included in the cost function estimates of additional costs, or to pay for needed resources that are not directly related to student performance measures. For example, many urban school districts may have little discretion over whether to spend money on security guards, and, perhaps especially in Texas, political realities may make it impossible to cut spending on school sports teams.[16]

[15]If all school districts were required to achieve a composite 55% passing rate standard on the reading and math exams in a single year, additional costs would be $5.4 billion.

[16]The recent film *Friday Night Lights* (Cameron, Whitaker, & Berg, 2004) illustrates the importance that high school football plays in many Texas communities.

The two studies take opposite views on the degree of discretion school districts have to eliminate or reallocate actual spending in excess of estimated costs. In drawing conclusions about whether public education in Texas is adequately funded, GJTB assumed that all spending in excess of estimated costs could be reallocated toward efforts to attain higher test scores. IR assumed that none of this excess spending is available for reallocation. These are both strong assumptions. Although we continue to believe that given state and federal mandates, contractual and other legal constraints, and political realities, most school districts have very little discretion in the reallocation of available funds; the true answer most likely lies somewhere in between the assumptions made by the GJTB and the IR studies.

The discussion so far has focused on a specific measure of educational adequacy, namely a 55% composite passing rate on the reading and mathematics exams. One issue raised by the plaintiffs in the *West Orange-Cove* case was whether this passing rate and the underlying cut scores (i.e., the number of correct answers needed to pass an exam) are sufficiently high to meet the constitution's general diffusion of knowledge requirement. Although the GJTB study estimated costs only for the 55% passing rate standard, IR provided additional cost estimates for several higher passing rate standards. Using the same procedures they followed in determining additional costs for the 55% rate standard, they calculated that additional costs (in 2004 dollars) would be $2.7 billion, $4.7 billion, and $10.1 billion to achieve the 60%, 70%, and 90% standards, respectively.

Primarily because of data limitations, both cost function studies almost certainly provide underestimates of the costs of meeting the accountability standards and provide an adequate education in Texas. Although the IR study discussed these shortcomings, the GJTB study did not. Three issues stand out. First, the cost calculations in both studies are based on a subset of the full array of accountability standards with which school district must comply. Not only do the TAKS accountability standards for 2005–06 include passing standards for social studies and science examinations, but there are new examination-linked standards for promotion from Grades 3, 5, 8, and a new 11th-grade examination that will be required for graduation. Second, although the accountability system requires that all the subgroups of students (White, Hispanic, African American, economically disadvantaged, and special education) within each school district must meet the academic standards, econometric problems forced the authors of both studies to assume that a school district met the standards if its overall passing rate exceeded the standard. Given that in many districts current student academic performance of economically disadvantaged, Black, and Hispanic students is substantially lower than their district's average performance, meeting the accountability standards separately for each subgroup of students will almost certainly require additional resources. Finally, the accountability system requires that school districts meet established passing rates in each subject. Both studies could only use passing rate data based on the average of the mathematics and the reading passing rates. It is again probable that additional resources beyond those calibrated in either study will be needed in districts where high reading passing rates mask low mathematics passing rates.

Lessons Learned

This article provides two examples of the use of econometric models in estimating the costs of meeting state education accountability standards. Despite the fact that the two econometric studies both involved the estimation of education cost functions and both provided estimates of the cost of meeting identical student performance standards in Texas, the authors of the two studies came to strikingly different conclusions. One study concluded that the current school funding system in Texas provides more than enough money to achieve the student performance goals set by the state's accountability system. The other study reached the conclusion that to meet the state's accountability standards, education spending would need to rise by several billion dollars. In this article, we spell out the various methodological choices made by the authors of both studies and, where possible, explain how these choices influenced both the econometric results and the policy conclusions that flowed from the results.

In discussing the strengths and weaknesses of the econometric approach to measuring educational adequacy, Baker et al. (2004) pointed out that "the underlying methodologies may rest on theoretical and analytical assumptions with which informed parties may disagree" (p. 20). Such disagreements are not uncommon in academic work. Academics often "agree to disagree" about their assumptions and leave the normative assessment of those assumptions to their readers. When the empirical findings of econometric analysis are used in judicial or legislative proceedings, however, it is particularly important that researchers both articulate and justify their assumptions and indicate how their assumptions affect their empirical results and policy recommendations. Policymakers and judges are much more likely to find the results convincing and credible if the underlying assumptions are sensible and are clearly articulated.

Among the lessons we take away from our experience in Texas is that to provide useful policy advice, it is important to make all assumptions clear and explicit and to discuss them fully. The plaintiffs in the *West Or-*

ange-Cove et al. v. Neeley et al. (2004) case adopted a strategy of highlighting the specification and estimation differences between the GJTB and IR studies, and noting how those differences affected the final conclusions about adequacy as we have done (albeit in more detail) in this article. It was a strategy that ultimately was persuasive to the court.

As Baker et al. (2004) also pointed out, it can be challenging to explain and communicate the assumptions, methodologies, and outcomes of econometrics methods such as educational cost functions. Guthrie and Rothstein (1999) criticized the use of cost function estimation, relative to professional judgment and successful schools approaches to estimating costs, because they believe that the cost function approach is too complex to explain to policymakers. The *West Orange-Cove* case demonstrates, however, that the courts *are* capable of understanding and using the results of complex statistical analysis. In his ruling, not only did Judge Dietz choose to rely on the IR cost function study rather than on the professional judgment study submitted by the plaintiffs, but his Findings of Fact (*West Orange-Cove et al. v. Neeley et al.*, 2004) specifically discussed many of the issues we have detailed in this article. For example, the judge questioned the decision of GJTB *not* to pupil weight, and he disagreed with their assumption regarding equivalent costs for improvement on the TAAS and TAKS exams.

At the same time, there is no question that econometric methods are generally less familiar to the courts and policymakers than more qualitative methods for estimating costs. Therefore, for those using econometric and other statistical techniques, it is important to choose a modeling strategy that is not overly complex. In conducting statistical analysis in a policy context, it is obviously important that the researcher be able to explain not only the results but also the methodological approach to an educated layperson.

It is also essential for researchers to recognize the limitations of whatever methodology they choose to employ. It is a mistake to "oversell" one's results. In the case of estimating the costs of providing an adequate education (or meeting any state accountability standard), it is important to recognize that no methodology has the ability to generate precise cost estimates.

The lawyers for the plaintiffs in the *West Orange-Cove* case understood this. They did not try to use the results of the IR study to argue that Texas would need to increase spending on education by a specific amount (e.g., nearly $2 billion to meet a 55% passing rate standard or about $5 billion to achieve a 70% standard). Rather, they used the IR study to provide evidence that the additional costs of meeting the standards exceeds, by a substantial amount, the money available for education funding under the current school funding system. In our view, none of the existing methodologies used to estimate the cost of meeting any educational standard is capable of providing precise cost estimates.

We conclude by underscoring our belief that econometric analysis has much to contribute to the measurement of educational costs. The *West Orange-Cove et al. v. Neeley et al.* (2004) case is the first time that cost functions have been used to assess adequacy in a judicial proceeding. We hope that it has demonstrated that although statistical methods may be more complicated than more qualitative approaches to estimating costs, they certainly need not be inaccessible. When presented carefully and with a full discussion of the limitations and underlying assumptions, econometric analysis can provide policymakers and the courts with a rigorous accounting of the costs of adequacy.

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