Competing Perspectives on the Cost of Education

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Introduction

As discussions about education finance shift from considerations of fiscal equity to adequacy, researchers and policymakers are paying increasing attention to geographic variations in the costs of education. Unfortunately, there is no consensus about the best approach to measuring geographic cost variations. Each strategy for making cost adjustments to address these variations has certain conceptual strengths and limitations. Moreover, the picture of geographic cost variations can vary considerably across different strategies for making cost adjustments.

In 1999, the 76th Texas Legislature commissioned the Charles A. Dana Center at The University of Texas at Austin to study different approaches to adjusting school district funding to reflect geographic cost variations. The ensuing study was the most comprehensive of this issue previously attempted in any state, and included researchers from The University of Texas at Austin, Texas A&M University, and the Federal Reserve Bank of Dallas. In this article, after a brief discussion of current theory and practice regarding geographic cost adjustments, we compare and contrast the study's findings about the costs of public education in Texas as well as estimates generated by Jay Chambers and Jennifer Imazeki and Andrew Reschovsky. Notably, we find that different indexing strategies yield considerably different estimates of the costs of education in Texas. As such, we argue that there is a pressing need for greater theoretical guidance about appropriate strategies for cost adjustments. Neither the current strategies nor the estimates they generate should be applied lightly.

Geographic Cost Adjustment in Theory and Practice

The literature on strategies for adjusting school district funding to reflect geographic cost variations can be divided into two broad categories—cost-of-living and cost-of-education strategies.

The basic premise of cost-of-living strategies is familiar: areas with relatively higher costs of living have to pay higher salaries to attract school employees, thereby increasing the cost of operating schools and districts. The cost of living therefore acts as a proxy for the cost of education.

There are two basic strategies for estimating variations in the local cost of living. One strategy is to examine the cost of a specified "market basket" of goods and services used by consumers in each community. The total costs of the market basket of consumer goods and services in each community are then compared to illustrate differences in the costs of living. This sort of strategy is used, for example, to create the Consumer Price Index.

A second strategy for estimating geographic variations in the costs of living is the "comparable wage" strategy. Because all types of workers tend to demand higher wages in areas with a higher cost of living, economic theory suggests that systematic regional variations in wages will reflect variations in the cost of living. Therefore, one should be able to approximate the cost of living for educators by observing salaries of comparable workers who are not educators (Rothstein and Smith 1997; Guthrie and Rothstein 1999; Goldhaber 1999; Stoddard 2002).

Regardless of the strategy used, there are a number of advantages to using cost-of-living indexes to capture geographic variations in the costs of education. The principal advantage is that cost-of-living indexes measure costs that are clearly beyond the control of school administrators. In most areas, district officials are unable to manipulate the general labor market, which means that researchers do not have to draw controversial distinctions between controllable and uncontrollable costs. Furthermore, the calculation of a cost-of-living index can be quite straightforward and need not employ sophisticated statistical techniques. While there are still many complex measurement issues involved (Rothstein and Smith 1997; Wynne and Sigalla 1994), either cost-of-living approach produces cost measures that can be compared relatively easily and directly. Finally, a cost-of-living approach is easily understood by policymakers and easily communicated to the public. Variations on cost-of-living approaches have been used to adjust district funding to reflect geographic variations in Florida, Colorado, and Wyoming.

The principal advantage is that cost-of-living indexes measure costs that are clearly beyond the control of school administrators.

Cost-of-living strategies also have a number of limitations. First, high-quality consumer price data can be quite expensive to collect. For example, the state of Florida reports that it spends more than $100,000 per year collecting consumer price data for use in calculation of its cost index. Second, and more significantly, a cost-of-living strategy relies on comparability among market baskets and among workers. If either sort of comparability breaks down, a cost-of-living index then becomes a poor proxy for the cost of hiring educators. For example, if people choose radically different market baskets in one setting than in another, perhaps because in a rural community they grow more of their own food whereas in a city they eat more restaurant meals, then it would be inappropriate to use the same market basket of goods to measure the cost of living in both settings. Similarly, if tastes for goods and services or local amenities differ according to worker types, perhaps because professionals are more susceptible to the lure of city lights than other types of workers, then it would be inappropriate to include all types of workers in a comparable-wage index. Of course, a market-basket index or a comparable-wage index based on an overly small sample of workers or products would be susceptible to large measurement error.

A third limitation of cost-of-living strategies, which pertains only to market-basket indexes, is that they do not reflect local variations in community characteristics such as climate, crime rates, or cultural amenities.[1] Therefore, cost adjustments based on market baskets of consumer goods may overcompensate districts that face high costs of goods and services but that also have a number of amenities that make them desirable places to work (Rothstein and Smith 1997). Finally, on a related note, cost-of-living indexes measure the cost of living in broad labor markets. By design, they do not capture variations in the costs of education within labor markets.[2] Therefore, cost-of-living strategies may generate the same index

[1] To the extent that these factors influence the price of goods and services such as housing and haircuts, they would be partially reflected in a market basket. However, the weights are likely to be inappropriate.

[2] As McMahon (1996) argues, because teachers may live outside the district in which they teach, it would be misleading to construct cost-of-living index values for districts.

value for an advantaged school district as for its disadvantaged crosstown rival.

A different set of strategies for estimating geographic cost variations involves the construction of cost-of-education indexes (CEIs). This set of strategies uses data on district expenditures to estimate either the costs of providing comparable levels of educational services (Chambers 1998) or the costs of producing comparable educational outcomes (Duncombe, Ruggiero, and Yinger 1996; Imazeki and Rechovsky 1999). The former strategy generates an estimate of the additional amount each district would have to spend to operate a typical school—or at least, to hire a typical teacher. Chambers' Teacher Cost Index and Geographic Cost of Education Index are both examples of this approach. The latter strategy generates estimates of how much more or less each district would be predicted to spend to achieve a certain level of educational achievement—frequently, the average level of educational achievement.

Strategies for estimating geographic cost variations use expenditures to estimate either the costs of providing comparable levels of educational services or the costs of producing comparable educational outcomes.

Cost-of-education strategies have a number of attractive features. First, instead of using indirect proxies for education cost differences, as cost-of-living strategies do, they not only directly examine school district expenditures but also use statistical analyses to estimate the costs of providing equivalent levels of educational services or outcomes in particular districts. Cost-of-education strategies can therefore be used to take account of cost variations within labor markets—an option not available with cost-of-living adjustments. Second, for states that already maintain data on educator salaries and district expenditures, it can be much less expensive to construct a CEI than to apply a market-basket approach. Finally, CEIs that measure the costs of achieving educational outcomes can correct both for variations in the prices paid for resources and for the intensity with which those resources must be used. Cost-of-living indexes, on the other hand, only capture price variations.

Cost-of-education indexing strategies also have a number of potential disadvantages. For one, it is impossible to account completely for all relevant controllable and uncontrollable cost factors. For example, important differences in teacher quality or educational outcomes may not be observable in the data (Hanushek 1999; Goldhaber 1999; Alexander et al. 2000). Therefore, estimation bias is always a concern for researchers. In addition, there are good reasons to believe that existing patterns of district expenditure do not always reflect cost-minimizing behavior. For example, McMahon (1996) argues that district officials can manipulate expenditures, while Hanushek (1999) emphasizes the noncompetitive nature of most educational markets. As Rothstein and Smith (1997) rightly point out, CEIs can reward inefficiency by directing additional state aid to districts that spend the most.

The Texas Cost-of-Education Index Study

Texas is an ideal laboratory for examining geographic differences in the costs of public education. There are a large number of school districts and labor markets in the state, and the significant variation in demographics and economic conditions across those areas implies that the cost of education should vary substantially. Texas also maintains richer data on the financing and performance of its schools than any other state, which facilitates the construction of CEIs. Finally, the state has a decades-long history of adjusting its school finance formula to reflect geographic differences in the cost of education. Since 1984, Texas has incorporated some form of a CEI in its finance formula. The Current Texas CEI represents the systematic variation in teacher salaries arising from five uncontrollable factors—district size, district type, the percentage of low income students, the average beginning teacher salary in surrounding districts, and location in a county with a population less than 40,000—holding constant at the mean variations in property wealth per teacher, the total effective tax rate, the graduation rate, the percent minority teaching staff, nonsalary benefit expenditures per pupil and teacher characteristics (years of experience and indicators for whether the teacher has at least a B.A. or teaches at the secondary level).[3] The Current Texas CEI is somewhat dated, however, because it has not been updated since its adoption in 1990.

A number of researchers have estimated CEIs for Texas. Monk and Walker (1991) developed a Teacher Cost Index that was subsequently incorporated into the state's school finance formula as the Current Texas CEI. The Dana Center study (Alexander et al. 2000, 2002) faithfully updated the Texas CEI and then developed a new Teacher Cost Index (the Texas TCI).[4] Chambers used data from the National Center for Education Statistics Schools and Staffing Survey to estimate a nationwide Geographic Cost-of-Education Index (GCEI), which he also applied to Texas school districts (Chambers 1999). More recently, Imazeki and Reschovsky (2002) and Alexander et al. (2000) estimated cost functions from which they developed indexes (denoted as the I&R Cost Function Index and the A&A Cost Function Index, respectively) of the costs of producing average educational performance in Texas.[5] Finally, Alexander et al. (2000) followed a comparable-wage strategy to generate a cost-of-living index for each Texas school district.

Table 1 provides descriptive statistics on these seven Texas cost indexes. To facilitate comparisons, all the indexes have been rescaled so that the least cost Texas district is assigned an index value of one.

Although all these indexes point to substantial variations in the cost of education, they paint very different pictures of Texas. The Teacher Cost Indexes (the Current Texas CEI, the Updated Texas CEI, and the Texas TCI) range from 1 to 1.34, implying that the cost of education in the highest cost school district is no more than 34 percent greater than in the lowest cost school district. The GCEI ranges from 1 to 1.45, implying a somewhat greater range of educational costs. In contrast, both the cost-of-living index (COL Index) and the I&R Cost Function Index imply that the cost of education nearly doubles as one moves from the lowest cost district to the highest cost district. The A&A Cost Function Index shows the greatest range,

3 For districts with average daily attendance between 1,600 and 2,000 students, an adjusted CEI is used. The adjusted CEI = CEI × (1.0 + ((2000 – ADA) × .00014)).

4 Alexander et al. (2000, 2002) developed a series of Teacher Cost Indexes, and found that a comparatively parsimonious model generated index values that were highly correlated with those of a more complete specification. They demonstrated that their models were remarkably insensitive to the inclusion of health insurance benefits in the dependent variable.

They also demonstrated that index values from their models were reasonably stable across time. The discussion here focuses on the 3-year average salary and benefits index. Alexander et al. (2002) used data from the 1997–98, 1998–99 and 1999–2000 school years to calculate average values for the uncontrollable cost factors in each district. These 3-year average values were then multiplied by the estimated coefficients from the parsimonious salary and benefits model described in Alexander et al. (2000) to generate index values.

5 Our thanks to Jennifer Imazeki and Andrew Reschovsky for graciously making their index available.

Table 1. Descriptive statistics of Texas school districts measured by seven cost indexes

Variable	Number of school districts	Mean	Standard deviation	Minimum	Maximum
Current Texas CEI	1,041	1.06	0.03	1.00	1.18
Updated Texas CEI	1,042	1.07	0.04	1.00	1.20
Texas TCI	1,042	1.10	0.05	1.00	1.34
GCEI	1,042	1.20	0.10	1.00	1.45
A&A Cost Function Index	973	1.41	0.26	1.00	2.84
I&R Cost Function Index	879	1.35	0.15	1.00	1.94
COL Index	1,042	1.37	0.26	1.00	1.94

NOTE: All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

with the index value for the highest cost district nearly triple the index value for the lowest cost district.[6]

As table 2 illustrates, there is little agreement *across the indexes* about the characteristics of high- and low-cost districts. The price indexes (the Teacher Cost Indexes, the GCEI, and the COL Index) indicate that the highest cost districts tend to be large and urban. Those are common characteristics of *low*-cost areas according to the cost function indexes, however. Expenditures per pupil are high relative to teacher salaries in the districts assigned high index values by the cost function indexes, and low relative to teacher salaries in the districts assigned high index values by the price indexes. For all the price indexes, average expenditures per pupil are higher for low-cost areas than for high-cost areas; both of the cost function indexes appear to suggest that teacher salaries are higher in low-cost areas than in high-cost areas.

There are also substantial differences *within index types*. High-cost areas are generally assumed to have a greater share of limited English proficient students than low-cost areas, but not according to the COL Index. According to the GCEI and the COL Index, *low*-cost districts have a much greater share of economically disadvantaged students than do high-cost districts. In contrast, according to the Teacher Cost Indexes, the share

[6] Both Imazeki and Reschovsky and Alexander et al. estimated their cost functions from data on districts that serve grades K–12. Imazeki and Reschovsky provided index values only for those districts included in their analysis, while Alexander et al. (2000) published cost function index values for all school districts. Given the obvious technological differences, however, Alexander et al. (2000) caution against relying on the cost function to impute index values for school districts that do not have a high school. In this analysis, we treat as missing the cost function index values for districts that do not serve all grades. If they were included, the A&A Cost Function Index would range from 1 to 5.93.

Table 2. Comparing the characteristics of high- and low-cost Texas school districts across seven cost indexes

	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
10 percent of districts with highest index values							
Expenditures per pupil (in dollars)	6,484	6,366	6,576	6,489	9,843	7,759	6,644
Average monthly salary for teachers with less than 5 years' experience (in dollars)	3,058	3,131	3,148	3,101	2,682	2,752	2,955
Average daily attendance	16,193	19,880	20,087	15,812	182	1,430	10,270
Economically disadvantaged (in percent)	57.18	45.47	46.54	42.31	56.86	70.94	34.86
Limited English proficient (in percent)	19.80	15.57	14.94	12.73	6.27	14.09	6.07
Miles to major urban area	82	33	42	26	179	137	0
Urban (in percent)	84.30	93.46	99.05	100.00	7.14	21.35	100.00
10 percent of districts with lowest index values							
Expenditures per pupil (in dollars)	6,839	7,575	7,640	9,488	6,191	6,350	8,045
Average monthly salary for teachers with less than 5 years' experience (in dollars)	2,651	2,665	2,641	2,665	2,964	2,954	2,694
Average daily attendance	635	487	305	175	9,078	8,606	749
Economically disadvantaged (in percent)	44.37	43.60	47.03	53.17	22.54	19.32	57.33
Limited English proficient (in percent)	3.10	2.78	3.72	4.79	3.30	2.71	9.43
Miles to major urban area	110	122	114	141	41	37	182
Urban (in percent)	27.67	21.26	37.38	0.88	81.63	92.13	0.00

NOTE: All district characteristics are as of the 1999–2000 school year. All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

of economically disadvantaged students is either higher in high-cost districts or insignificantly different between high- and low-cost districts. Low-cost urban districts are virtually unheard of according to the GCEI and the COL Index, while the Teacher Cost Indexes imply that they are relatively common. The average high-cost district is larger than the state median according to the I&R Cost Function Index but much *smaller* than the median according to the A&A Cost Function Index.

Further confirmation of the dramatic differences across metrics can be found in table 3, which presents the Pearson correlations among the index values. The upper right-hand section of the table presents correlation coefficients for urban school districts; the lower left-hand section presents correlation coefficients for rural school districts.

As table 3 illustrates, the Teacher Cost Indexes and the GCEI are reasonably well correlated with one another in urban areas, but much less so in rural areas. The cost function indexes are well correlated with each other in rural areas and urban areas, but either uncorrelated or *negatively* correlated with the price indexes. None of the indexes are highly correlated with the COL Index, in part because the COL Index does not vary within labor markets as the other indexes do.

Table 4 provides another perspective on the differences within indexes between urban and rural areas. The Cur-

Table 3. Pearson correlation coefficients for urban and rural Texas school districts across seven cost indexes

	Urban school districts						
	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
Current Texas CEI		0.8148	0.7521	0.6646	−0.1716	0.1183	0.1869
		0.0001	0.0001	0.0001	0.0005	0.0194	0.0001
		429	429	429	404	390	429
Updated Texas CEI	0.6797		0.7967	0.7688	−0.3063	−0.0550	0.4079
	0.0001		0.0001	0.0001	0.0001	0.2783	0.0001
	612		429	429	404	390	429
Texas TCI	0.4500	0.4503		0.8290	−0.4020	−0.0331	0.3646
	0.0001	0.0001		0.0001	0.0001	0.5152	0.0001
	612	613		429	404	390	429
GCEI	0.1943	0.3733	0.3562		−0.4034	−0.0864	0.4930
	0.0001	0.0001	0.0001		0.0001	0.0882	0.0001
	612	613	613		404	390	429
A&A Cost Function Index	0.0378	−0.2664	−0.1358	−0.6693		0.7969	−0.2816
	0.3687	0.0001	0.0012	0.0001		0.0001	0.0001
	568	569	569	569		390	404
I&R Cost Function Index	0.0523	−0.0817	−0.1505	−0.4283	0.7328		−0.2224
	0.2480	0.0711	0.0008	0.0001	0.0001		0.0001
	489	489	489	489	489		390
COL Index	−0.1153	0.0067	−0.1583	0.1376	−0.2039	−0.2115	
	0.0043	0.8681	0.0001	0.0006	0.0001	0.0001	
	612	613	613	613	569	489	
	Rural school districts						

NOTE: Each cell presents Pearson correlation coefficients; Probability > |R| under H_o : Rho = 0; and number of observations. The upper right-hand section of the table presents correlation coefficients for urban school districts; the lower left-hand (shaded) section presents correlation coefficients for rural school districts.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

Table 4. Geographic variations in Texas school districts across seven cost indexes

	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
Very sparse rural counties							
Mean	1.05	1.06	1.10	1.11	1.69	1.46	1.16
Standard deviation	0.03	0.03	0.02	0.04	0.33	0.14	0.13
Number of districts	185	186	186	186	177	133	186
Other rural counties							
Mean	1.05	1.06	1.07	1.15	1.41	1.38	1.23
Standard deviation	0.03	0.03	0.02	0.04	0.20	0.13	0.11
Number of districts	427	427	427	427	392	356	427
Small urban areas							
Mean	1.06	1.07	1.10	1.26	1.33	1.30	1.43
Standard deviation	0.04	0.04	0.05	0.06	0.20	0.15	0.11
Number of districts	228	228	228	228	211	200	228
Major urban areas							
Mean	1.09	1.12	1.16	1.34	1.26	1.29	1.79
Standard deviation	0.03	0.04	0.05	0.07	0.15	0.14	0.16
Number of districts	201	201	201	201	193	190	201
Mexican border							
Mean	1.09	1.10	1.13	1.23	1.47	1.46	1.27
Standard deviation	0.04	0.04	0.05	0.10	0.24	0.15	0.17
Number of districts	154	155	155	155	143	128	155

NOTE: All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

rent Texas CEI and the Updated Texas CEI are much higher for major urban areas, but indicate little difference in cost between rural areas and small urban areas, such as Waco or Texarkana. In contrast, the Texas TCI suggests that costs are higher in sparsely populated rural areas than in some urban areas! Both the GCEI and the COL Index strictly increase with urban density. But the cost function indexes generally *decrease* with density.

The cost function indexes are highest in rural areas for a very simple reason—that's where the small schools are. And as figure 1 illustrates, both of the cost function indexes exhibit striking economies of scale.

Table 5 illustrates another perspective on this issue. According to the A&A Cost Function Index, the average school with less than 100 students has *twice* the index value of the average school with more than 10,000 students.[7] All but one rural school district has fewer than 10,000 students; only two urban K–12 districts have fewer than 100 students.

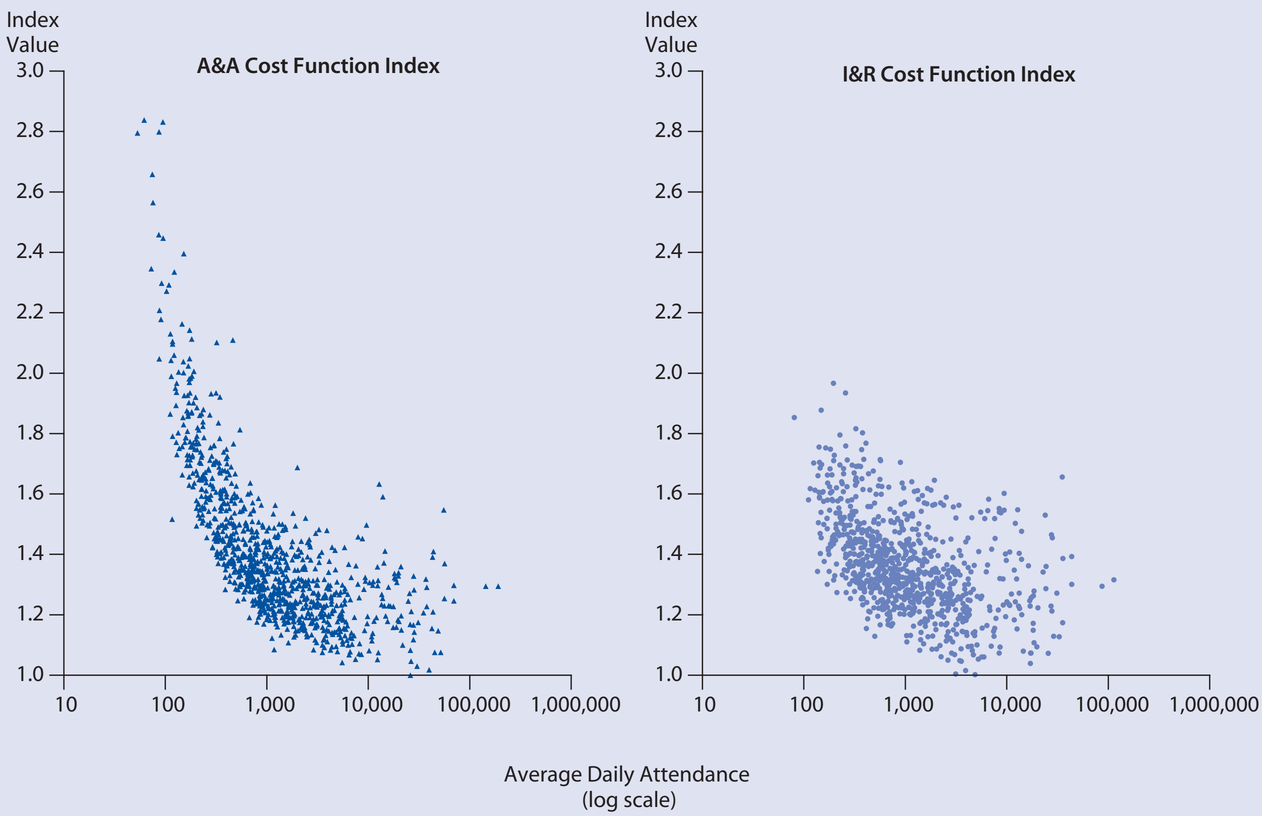
Not only do economies of scale explain most of the variation in the cost function indexes (78 percent for the A&A Cost Function Index, 82 percent for the I&R Cost Function Index), they also explain much of the difference in findings across the methodologies. More than half of the difference between any of the price indexes and the A&A Cost Function Index can be explained by school district size.[8] One-third of the difference between the I&R Cost Function Index and the other indexes can be explained by size.[9]

[7] Imazeki and Reschovsky did not provide index values for school districts with fewer than 100 students.

[8] This conclusion is based on the R-squares from a regression of the difference in the two indexes on the log of average daily attendance, its square, cube, and quartic.

[9] Size has less power to explain the difference between the I&R Cost Function Index and the other indexes because the I&R Cost Function Index is not available for districts with less than 100 students in average daily attendance.

Figure 1. The cost function indexes suggest striking economies of scale



SOURCE: A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002).

Table 5. Variations in Texas school districts according to average daily attendance across seven cost indexes

	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
Houston Independent School District	1.15	1.18	1.23	1.38	1.30	1.31	1.84
Dallas Independent School District	1.14	1.19	1.24	1.42	1.30	1.29	1.94
Average daily attendance is greater than 10,000 students and less than 100,000 students							
Mean	1.12	1.15	1.20	1.36	1.23	1.28	1.61
Standard deviation	0.03	0.03	0.04	0.06	0.12	0.15	0.23
Number of districts	73	73	73	73	73	73	73
Average daily attendance is greater than 1,000 students and less than 10,000 students							
Mean	1.07	1.09	1.12	1.25	1.26	1.30	1.43
Standard deviation	0.03	0.04	0.04	0.08	0.11	0.13	0.27
Number of districts	395	395	395	395	395	390	395
Average daily attendance is greater than 100 students and less than 1,000 students							
Mean	1.04	1.05	1.08	1.15	1.53	1.42	1.29
Standard deviation	0.02	0.03	0.03	0.06	0.22	0.14	0.22
Number of districts	525	526	526	526	490	413	526
Average daily attendance is less than 100 students							
Mean	1.05	1.06	1.06	1.07	2.50	—	1.26
Standard deviation	0.02	0.03	0.02	0.06	0.27	—	0.17
Number of districts	46	46	46	46	13	—	46

—Not available.

NOTE: All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

Interestingly, these economies of scale tend to fade away at relatively low attendance levels. The correlation between average daily attendance (or its logarithm) and either of the cost function indexes is negligible for school districts with more than 2,000 students. Consequently, the indexing strategies generally indicate little difference in cost between the state's two largest districts—Houston and Dallas. With nearly 200,000 students, the Houston Independent School District has one-third more students than the Dallas Independent School District, yet the cost function indexes make little distinction between them. Only the COL Index identifies a substantial cost difference between the Houston Independent School District and the Dallas Independent School District, and it gives the nod to Dallas as being the higher cost area.

Another dimension about which the indexes yield very different perspectives involves the socioeconomic status of the students. As table 6 illustrates, the Teacher Cost Indexes and the GCEI exhibit a "U-shaped" or slightly "J-shaped" relationship. Apparent costs are high in districts with a high proportion of economically disadvantaged students (disadvantaged districts), and in districts with a low proportion of economically disadvantaged students (advantaged districts). On average, costs are lowest in districts in the middle of the range. For the Texas TCI and the Updated Texas CEI, there is no significant difference in index values between advantaged districts and disadvantaged districts. The Current Texas CEI is somewhat skewed, with the index values significantly higher in disadvantaged districts; the GCEI is skewed in the other direction, with significantly higher values in *advantaged* districts.

The other indexes yield linear, but contradictory relationships. The COL Index is lowest in disadvantaged districts and highest in advantaged districts. The cost function indexes are highest in disadvantaged districts, and lowest in advantaged districts. However, the I&R Cost Function Index is much more responsive than the A&A Cost Function Index to variations in the percent of disadvantaged students. Fully 61 percent of the variation in the I&R Cost Function Index can be explained by variations in the socioeconomic status of the students, while only 22 percent of the variation in the A&A Cost Function Index can be explained by students' socioeconomic status.

Table 6. Economically disadvantaged Texas school districts across seven cost indexes

	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
Greater than 75 percent economically disadvantaged							
Mean	1.10	1.10	1.13	1.22	1.61	1.59	1.28
Standard deviation	0.04	0.04	0.06	0.12	0.33	0.11	0.19
Number of districts	98	99	99	99	87	71	99
Economically disadvantaged greater than 25 percent and less than 75 percent							
Mean	1.05	1.07	1.10	1.19	1.42	1.36	1.34
Standard deviation	0.03	0.04	0.04	0.09	0.23	0.12	0.25
Number of districts	809	809	809	809	767	696	809
Less than 25 percent economically disadvantaged							
Mean	1.07	1.10	1.12	1.27	1.24	1.16	1.58
Standard deviation	0.03	0.05	0.05	0.11	0.26	0.09	0.27
Number of districts	134	134	134	134	119	112	134

NOTE: All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

Conclusions and Implications

All of the estimates of the cost of education in Texas find substantial variations across the state. The most conservative estimate implies that costs in the highest cost districts are 18 percent higher than in the least cost districts. More liberal estimates imply a range *more than ten times* greater than the most conservative estimates. It is important to note, however, that these estimates are highly sensitive to the indexing strategy employed. No estimate can explain more than 69 percent of the variation in any other estimate. Estimates for rural Texas districts are even more inconsistent across models. To take an extreme example, index values for Allison Independent School District in rural Wheeler county range from 1.02 to 2.83.

So why the dramatic differences? Changes in the underlying characteristics of districts or shifts in the cost technology can explain some differences. However, they are clearly not the primary source of variation. Four of the seven indexes are drawn from data on the 1998–99 school year (Alexander et al. 2000, 2002), and the fifth was drawn from data on the 2000–2001 school year (Imazeki and Reschovsky 2002). Only the GCEI (1993–94) and the Current Texas CEI (1988–89) measure educational costs at markedly different points in time. Furthermore, despite a 10-year gap between estimates, the update to the Current Texas CEI is more highly correlated with its predecessor than with any of its contemporaries.

The primary differences across indexes are attributable to differences in methodology. Such sharp differences across estimation strategies support four important conclusions.

First, the lion's share of variations in input prices arises from variations across labor markets. Table 7 illustrates the extent of within-market variation in the indexes. As the table illustrates, between 66 and 82 percent of the variation in the Teacher Cost Indexes or the GCEI reflects variations across labor markets. Because within-market variations are relatively small compared to the between-market variations, the cost-of-living approach appears to be a viable indexing strategy.

Second, a somewhat crude estimate of comparable wages is only moderately successful at explaining these market-level variations. The modest correlation between the COL Index and the other price indexes implies that the COL Index is unduly noisy, that the population used to generate the COL Index is not comparable to educators, or that the hedonic salary models are all misspecified in some way. Given the imprecision with which the COL Index is measured, excessive noise is the most likely explanation. However, the fact that the COL Index is more than twice as correlated with the GCEI (which includes wage measures for classified personnel) as with the Teacher Cost Indexes (which reflect only teacher compensation) suggests that comparability might also be important. In either case, more refined analysis of a comparable-wage model could promise significant benefits.

Table 7. Within-market and between-market variations in Texas school districts across seven cost indexes

	Current Texas CEI	Updated Texas CEI	Texas TCI	GCEI	A&A Cost Function Index	I&R Cost Function Index	COL Index
Within-market variation	0.28	0.53	0.83	1.91	29.17	10.09	0.00
Between-market variation	0.97	1.32	1.62	8.67	35.46	9.91	69.87
Total variation	1.25	1.84	2.45	10.59	64.63	20.00	69.87
Share of variation that is within market (in percent)	22.5	28.7	33.9	18.1	45.1	50.4	0.0

NOTE: All indexes have been rescaled so that the least cost Texas district is assigned an index value of 1.

SOURCE: Current Texas CEI: Monk and Walker (1991), and Texas Education Agency; Updated Texas CEI: Alexander et al. (2000, 2002); Texas TCI: Alexander et al. (2000, 2002); GCEI: Chambers (1999); A&A Cost Function Index: Alexander et al. (2000); I&R Cost Function Index: Imazeki and Reschovsky (2002); COL Index: Alexander et al. (2000).

Third, there are significant variations across different specifications within each modeling strategy. Although the Teacher Cost Indexes are well correlated with one another in urban areas, the relationship is much weaker in rural parts of the state. Similarly, while the cost function indexes are highly correlated with one another in large school districts, they are much less so in small ones. The sensitivity of the index values to specification differences suggests that researchers should carefully examine the stability of their estimates and formally incorporate the imprecision of their estimates into their policy recommendations concerning finance formula adjustments.

Finally—and most importantly—the differences across these indexes strongly imply that the cost of educational inputs is a poor proxy for the cost of educational outcomes. There is at best no correlation and at worst an *inverse* correlation between cost estimates based on input prices and cost estimates based on educational outputs. Of course, serious measurement issues impede our ability to model the cost of producing educational outcomes, but the Texas estimates strongly imply that these problems must be addressed. As policy discussions about education finance shift from considerations of tax equity to considerations of educational adequacy, there will be an increasing need for accurate measures of the cost of producing educational outcomes. And the ability of researchers to address this need will in no small part depend on advancements in the area of geographic cost adjustments.

References

Alexander, C.D., Gronberg, T.J., Jansen, D.W., Keller, H., Taylor, L.L., and Treisman, P.U. (2000). *A Study of Uncontrollable Variations in the Costs of Texas Public Education* (Summary report prepared for the 77th Texas Legislature). Austin: Charles A. Dana Center, The University of Texas at Austin. Available: *http://www.utdanacenter.org*

Alexander, C.D., Gronberg, T.J., Jansen, D.W., Keller, H., Taylor, L.L., and Treisman, P.U. (2002). *A Study of Uncontrollable Variations in the Costs of Texas Public Education: Technical Supplement* (Supplement to summary report prepared for the 77th Texas Legislature). Austin: Charles A. Dana Center, The University of Texas at Austin. Available: *http://www.utdanacenter.org*

Chambers, J.G. (1998). *Geographic Variations in Public School Costs* (NCES 98–04). U.S. Department of Education. Washington, DC: National Center for Education Statistics Working Paper.

Chambers, J.G. (1999). Patterns of Variation in the Salaries of School Personnel: What Goes on Behind the Cost Index Numbers? *Journal of Education Finance, 25*(2): 255–280.

Duncombe, W., Ruggiero, J., and Yinger, J. (1996). Alternative Approaches to Measuring the Cost of Education. In H.F. Ladd (Ed.), *Holding Schools Accountable: Performance-Based Reform in Education* (pp. 327–356). Washington, DC: The Brookings Institution.

Goldhaber, D.D. (1999). An Alternative Measure of Inflation in Teacher Salaries. In W.J. Fowler, Jr. (Ed.), *Selected Papers in School Finance, 1997–99* (NCES 1999–334) (pp. 29–54). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Guthrie, J., and Rothstein, R. (1999). Enabling 'Adequacy' to Achieve Reality: Translating Adequacy Into State School Finance Distribution Arrangements. In H.F. Ladd, R. Chalk, and J.S. Hansen (Eds.), *Equity and Adequacy in Education Finance* (pp. 209–259). Washington, DC: National Academy Press.

Hanushek, E.A. (1999). Adjusting for Differences in the Costs of Educational Inputs. In W.J. Fowler, Jr. (Ed.), *Selected Papers in School Finance, 1997–99* (NCES 1999–334) (pp. 13–28). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Hanushek, E.A., and Taylor, L.L. (1990). Alternative Assessments of the Performance of Schools: Measurement of State Variations in Achievement. *Journal of Human Resources, 25*(2): 179–201.

Imazeki, J., and Reschovsky, A. (1999). Measuring the Costs of Providing an Adequate Public Education in Texas. In H. Chernick (Ed.), *Proceedings of the 91st Annual Conference on Taxation* (pp. 275–290). Washington, DC: National Tax Association.

Imazeki, J., and Reschovsky, A. (2002). *School Finance Reform in Texas: A Never-Ending Story?* Unpublished manuscript.

McMahon, W.W. (1996). Intrastate Cost Adjustments. In W.J. Fowler, Jr., (Ed.), *Selected Papers in School Finance, 1994* (NCES 96–068) (pp. 89–114). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Monk, D.H., and Walker, B.D. (1991). The Texas Cost of Education Index: A Broadened Approach. *Journal of Education Finance, 17*(2): 172–192.

Rothstein, R., and Smith, J.R. (1997, May). *Adjusting Oregon Education Expenditures for Regional Cost Differences: A Feasibility Study* (Submitted to Confederation of Oregon School Administrators). Sacramento, CA: Management Analysis & Planning Associates, L.L.C.

Stoddard, C. (2002). *Adjusting Teacher Salaries for the Cost of Living: The Effect on Salary Comparisons and Policy Conclusions.* Unpublished manuscript.

Wynne, M., and Sigalla, F. (1994). The Consumer Price Index. *Economic Review* (Research Journal of the Federal Reserve Bank of Dallas) 1994, 2nd quarter: 1–22.