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Still Unknown: The Impact of School Capital on Student Performance

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It's Elementary

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Still Unknown:
The Impact of School Capital on Student Performance

One of the great unanswered questions in education finance is whether the quantity and quality of school capital—buildings, classrooms, laboratories, and so on—has an impact on student performance.

Gronberg, Jansen, and Taylor (henceforth GJT) estimate educational cost functions using data from Texas and claim that, if anything, school capital, also called infrastructure, raises educational costs holding student performance constant.[1] This claim leads them to reject the possibility that "infrastructure inequalities lead to academic disadvantages" (p. 207).

This conclusion is not warranted. Despite their careful estimation techniques, GJT misinterpret their findings. Their main result is that total costs (or costs per pupil) increase with the amount of school capital, holding student performance constant. The link between infrastructure inequalities and academic disadvantages refers, however, to a different question, namely, whether an increase in school capital leads to an increase student performance. GJT do not provide an answer to this question.

This policy brief explains where GJT went wrong. This column is somewhat more technical than my usual column, because it involves long-run and short-run cost curves, but these concepts should be familiar to anyone who has taken a class in microeconomics.

In the case of public schools, a short-run cost curve indicates the relationship between student performance and educational costs, holding school capital constant. School capital is altered much less frequently than the number of teachers or other school inputs, so it often makes sense to consider school capital as fixed in the short run and to explore educational costs under this assumption. A long-run cost curve does not hold school capital constant. Instead, a long-run cost curve indicates the relationship between student performance and educational costs when school capital is adjusted to the lowest-cost level for each level of student performance.

These cost curves are usually illustrated as average cost curves, that is, as costs per unit of quantity, which in this case is cost per unit of student performance. The issue here is not cost per pupil. A school district's costs per pupil may depend, of course, on its enrollment, and

[1] Timothy J. Gronberg, Dennis W. Jansen, and Lori L. Taylor. 2011. "The Impact of Facilities on the Cost of Education." *National Tax Journal* 64 (1) (March): 193–218.

several of my earlier columns have addressed this issue.[2] The concepts at issue in this column, however, hold the number of pupils constant and average over the units of student performance.

Figure 1 illustrates what these types of cost curves look like.[3] Student performance is on the horizontal axis and average cost is on the vertical axis. Several short-run cost curves, each at a different level of school capital, are illustrated. The long-run cost curve is the set of lowest points on the short-run curves, that is, it is the set of points that describe the lowest possible cost at each level of student performance. Recall that the long-run curve can be interpreted as the curve that applies once school districts have adjusted to the quantity of school capital that is optimal for the student performance they wish to achieve.

GJT do not plot average cost curves. Instead they plot the relationship between the capital stock per pupil and total cost per pupil.[4] The assumptions that lead to Figure 1 can be used to replicate this type of plot. The result is given in Figure 2 below. This figure presents capital stock per pupil and total cost per pupil for different values of student performance, Q1 to Q7. The thicker line does not hold student performance constant, but instead shows the long-run relationship between capital stock and performance when the capital stock is set at the optimal value for each level of student performance.

Figure 2 makes it clear that for a given level of student performance, costs decline with the capital stock if the capital stock is too low (that is, below its optimal level) and costs increase with the capital stock when the capital stock is too high. This figure also makes it clear that a district cannot obtain a higher student performance in the long run without spending more on school capital. The figure in GJT holds student performance constant at the state-wide average, so it corresponds to one of the short-run curves in this figure.

GJT interpret their figure as an indication of "gross overutilization of capital relative to an efficient allocation" (p. 205). This interpretation is not correct. Because they hold school performance constant at the mean value in the sample, they are simply tracing out one of the constant-performance curves in Figure 2, such as the one associated with quantity Q2, which looks a lot like their figure. In fact, however, school districts provide different quantities of education and therefore fall on different curves. All districts could fall on or close to the long-run curve in my Figure 2, along which cost increases with capital stock even though there is no overutilization of capital. Thus, the GJT figure does not show that districts are using too much school capital; instead, it only shows what it would cost if a district provided the state-wide average student performance using more capital than necessary.

GJT go on to say that "the estimates provide no evidence that increases in facilities capital will help districts to reduce the costs associated with maintaining or improving the test

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[2] See the August and September columns from 2007, for example.

[3] For readers with some background in economics, this figure is derived from a constant-elasticity-of-substitution production function in the case of decreasing returns to quality scale. The points in the text also apply with other production functions or scale assumptions.

[4] See Figure 1 in Gronberg, Jansen, and Taylor, *op cit*.

score performance of their students, or that infrastructure inequalities lead to academic disadvantages" (p. 207). These claims are overstated, if not incorrect. Consider a district producing a student performance that is above the point where its short-run cost curve (i.e., the short-run cost curve associated with its school capital) touches the long-run cost curve. Figure 1 shows that this district can lower its costs by increasing its school capital. As just discussed, this point is also made in Figure 2: At a given level of student performance, increasing school capital lowers costs for a district with a capital stock that is below the optimal (=long-run) value for that performance level. GJT only plot a school-capital/total-cost curve for one level of student performance; at other levels of student performance, this curve could have a very different shape.

Moreover, the results in GJT are consistent with the possibility that higher "facilities capital," which is the term they use, results in higher student performance, which implies, of course that they are consistent with the possibility that infrastructure inequalities lead to academic disadvantages. As shown in Figure 2, a positive long-run relationship between facilities capital and cost arises even when no inefficiency exists—a model that is perfectly consistent with the GJT results. In other words, perfectly efficient districts (i.e., those on the long-run curve) have to spend more on facilities capital to obtain higher student performance. Thus, it is premature to conclude that infrastructure inequalities do not lead to academic disadvantages.

GJT could resolve this issue by finding the long-run cost curve associated with the short-run cost curves they estimate. This type of calculation has appeared in non-school cost studies that use methods similar to those of GJT. An estimate of this type would make it possible to determine the extent to which some districts deviate from the lowest-cost level of school capital for their student performance level and the extent to which some districts have levels of school capital that are below the optimal value for the student performance that the State of Texas would like them to provide. Neither of these questions can be answered with the information provided by GJT.

In short, despite the claims of GJT, we still do not know the extent to which increases in school capital lead to increases in student performance. Moreover, we still cannot reject—or prove—the hypothesis that infrastructure gaps contribute to gaps in student performance.

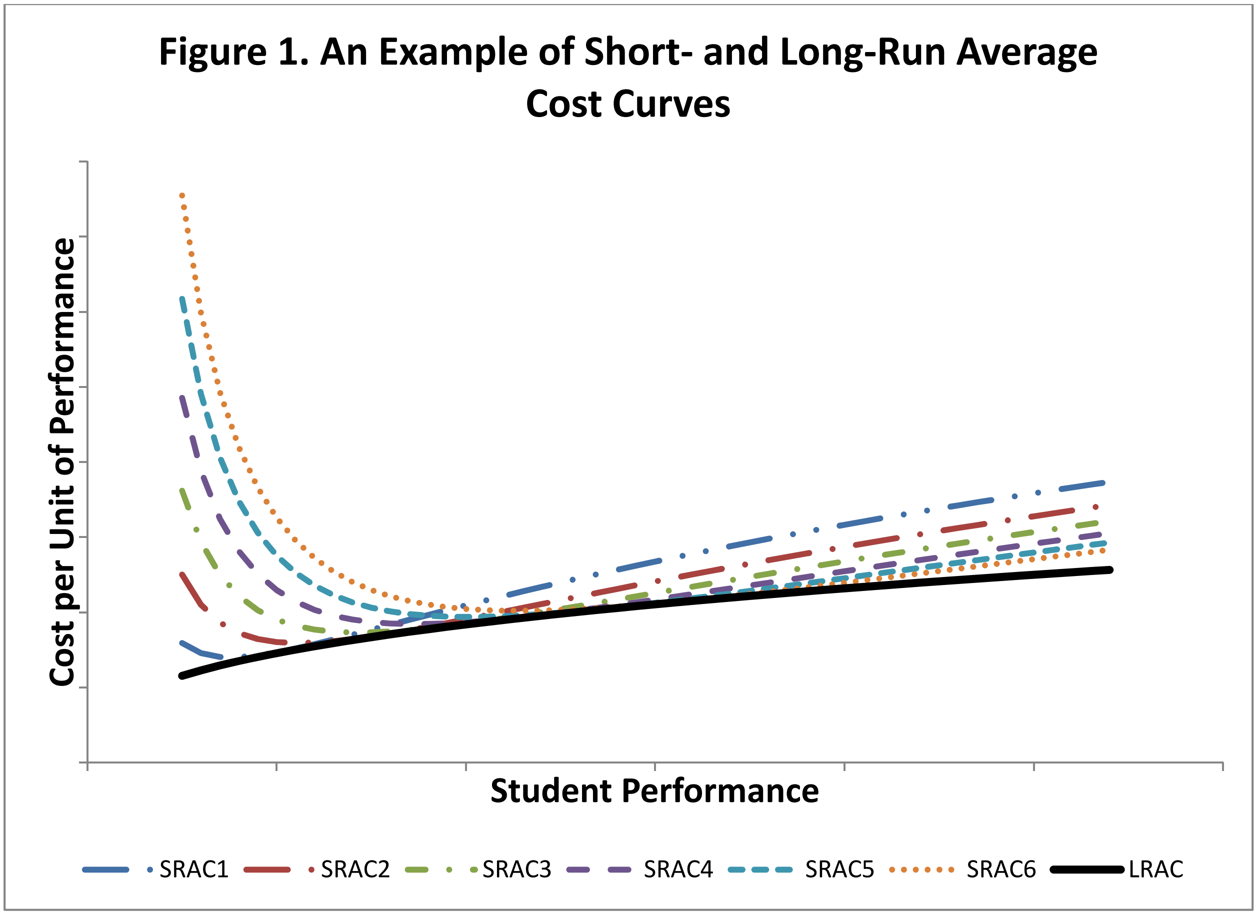
Figure 1. An Example of Short- and Long-Run Average Cost Curves
Cost per Unit of Performance
Student Performance
SRAC1
SRAC2
SRAC3
SRAC4
SRAC5
SRAC6
LRAC

Figure 2. The Relationship between Capital Stock per Pupil and Total Cost per Pupil