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Estimating school efficiency

A comparison of methods using simulated data

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Abstract

Developing measures of school performance is crucial for performance-based school reform efforts. One approach to developing such measures is to apply econometric and linear programming techniques that have been developed to measure productive efficiency. This study uses simulated data to assess the adequacy of two such methods, Data Envelopment Analysis (DEA) and Corrected Ordinary Least Squares (COLS), for the purposes of performance-based school reform. Our results suggest that in complex data sets typical of education contexts simple versions of DEA and COLS do not provide adequate measures of efficiency. In data sets simulated to contain both measurement error and endogeneity, rank correlations between efficiency estimates and true efficiency values range from 0.104 to 0.240. In none of these data sets were either DEA and COLS able to place more than 31% of schools in their true performance quintile. © 2001 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Performance-based school reform has received much attention in recent years. Key elements of this reform movement include setting standards of student, teacher and school performance, granting autonomy to local actors in the educational process, and establishing rewards for high performance and remedies for low performance. These elements are prominently featured in

the 1994 reauthorization of the federal Title I program as well as several state level reform initiatives.¹

These reforms have been advanced as a remedy for several perceived problems with existing public education systems. Prominent among these perceived problems are the lack of incentives and the lack of knowledge about how to improve student performance. Some have argued that given current systems for determining compensation, professional advancement and school funding, the incentives of school officials are insufficiently linked to student performance (Hanushek, 1994; Levin, 1997).

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¹ For examples and analysis of state level efforts in South Carolina, Mississippi, Kentucky, Texas and Indiana, see Richards and Sheu (1992), Elmore, Abelman and Fuhrman (1996) and King and Mathers (1997).

Performance-based school reform attempts to provide stronger incentives for improving student performance by developing measures of achievement and tying financial and other rewards to those measures. Some also believe that we know very little about how to manage classrooms, schools and districts in ways that consistently result in higher levels of student achievement. By granting local actors the autonomy to experiment with new approaches and providing the means to assess the impact of local experiments on student performance, performance-based school reform is seen as a way to learn how to meet the ever-increasing demands placed on our public education systems (Hanushek, 1994).

Developing valid and reliable measures of school performance is crucial both for efforts to establish incentives and to assess management practices. There is a growing consensus that measures of school performance should be based on the performance of students in the school. However, there is also recognition that any measure of school performance that is based on the performance of students needs to account for the differences in resources available to and service delivery environments faced by different schools. One approach to developing measures of school performance is to apply the conceptions of productive efficiency, and techniques for measuring it, that have been developed in the fields of economics and operations research.

Several such techniques or methods have been developed, and several have been applied to estimate the efficiency of educational organizations. These include econometric approaches that utilize ordinary least squares regression and stochastic frontier estimation as well as a group of linear programming approaches falling under the rubric of Data Envelopment Analysis (DEA). Bessent and Bessent (1980), Bessent, Bessent, Kennington and Reagan (1982) and Bessent, Bessent, Charnes, Cooper and Thorogood (1983) have applied the basic formulation of DEA developed by Charnes, Cooper and Rhodes (1978) to schools in Houston. Färe, Grosskopf and Weber (1989) have applied a version of DEA that allows for variable returns to scale to school districts in Missouri. More recently, Ray (1991), McCarty and Yaisawarng (1993), Ruggiero, Duncombe and Miner (1995) and Kirjavainen and Loikkanen (1998) have applied DEA-based approaches that attempt to control for the different environmental factors faced by educational organizations. Johnes and Johnes (1995) have used DEA to investigate the technical efficiency of university departments of economics. Barrow (1991), Deller and Rudnicki (1993) and Cooper and Cohn (1997) have applied the stochastic frontier estimation methods developed by Aigner, Lovell and Schmidt (1977) to estimate the efficiency of districts, schools and classes. Stiefel, Schwartz and Rubenstein (1999) reviews the various methods available for measuring efficiency and explains

how they can be implemented in programs designed to improve school performance measurement.

The availability of these methods for estimating school efficiency raises two questions. The first is whether or not the methods provide accurate estimates of efficiency. The second question is, if there are multiple methods of measuring efficiency that may perform differently, which method is best to use. Studies that have applied different methods to the same data have found that they provide different results (Banker, Conrad & Strauss, 1985; Nelson & Waldman, 1986). The problem is that without knowing the true efficiency of the organizations studied, there is no way to determine which measures provide better estimates.

Studies that use simulated data with specified, and thus known, technological relationships and levels of efficiency can help to answer these questions. A limited number of such studies have been conducted. However, no attempt has been made to use the results of such simulation studies to assess how appropriate existing efficiency measures are for the purposes of performance-based school reform. This paper is intended to fill this gap in the literature. Section 2 identifies the specific set of challenges that the educational production process poses for methods of estimating school efficiency. Section 3 reviews existing studies that have used simulated data to evaluate methods of estimating organizational efficiency, and determines what these studies imply for the estimation of school efficiency. Section 4 describes a simulation study that we conducted. Section 5 presents an analysis of how well two methods, the Charnes et al. (1978) version of DEA and Corrected Ordinary Least Squares, did in estimating the known efficiencies of the simulated schools. Section 6 offers concluding remarks concerning the current state-of-the-art in measuring school performance and the implications this has for performance-based school reform efforts.

2. Educational production

Analysis of educational production is notoriously difficult.² The first difficulty is that education involves production of multiple outputs. Not only are schools charged with developing cognitive skills in several subject areas, but they are also charged with developing affective traits, promoting democratic values and furthering other social outcomes. Assumptions that these multiple outcomes are complimentary or even mutually consistent are difficult to maintain, and attempts to develop a priori weights that reflect the relative value of various outcomes are problematic.

² For discussions of these difficulties, see Bridge, Judd and Mook (1979) and Monk (1990).

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