education production functions

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Abstract

The accumulated economic analysis of education suggests that current provision of schooling is very inefficient. Commonly purchased inputs to schools – class size, teacher experience, and teacher education – bear little systematic relationship to student outcomes, implying that conventional input policies are unlikely to improve achievement. At the same time, differences in teacher quality have been shown to be very important. Unfortunately, teacher quality, defined in terms of effects on student performance, is not closely related to salaries or readily identified attributes of teachers.

Keywords

education production functions; random assignment; school attainment; school resources; student outcomes; teacher quality

Article

A simple production model lies behind much of the analysis in the economics of education. The common inputs are things like school resources, teacher quality, and family attributes; and the outcome is student achievement. Knowledge of the production function for schools can be used to assess policy alternatives and to judge the effectiveness and efficiency of public provided services. This area is, however, distinguished from many because the results of analyses enter quite directly into the policy process.

Historically, the most frequently employed measure of schooling has been attainment, or simply years of schooling completed. The value of school attainment as a rough measure of individual skill has been verified by a wide variety of studies of labour market outcomes (for example, Mincer, 1970; Psacharopoulos and Patrinos, 2004). However, the difficulty with this common measure of outcomes is that it assumes a year of schooling produces the same amount of student achievement, or skills, over time and in every country. This measure simply counts the time spent in schools without judging what happens in schools – thus, it does not provide a complete or accurate picture of outcomes.

Recent direct investigations of cognitive achievement find significant labour market returns to individual

differences in cognitive achievement (for example, Lazear, 2003; Mulligan, 1999; Murnane et al., 2000). Similarly, society appears to gain in terms of productivity; Hanushek and Kimko (2000) demonstrate that quality differences in schools have a dramatic impact on productivity and national growth rates. (A parallel line of research has employed school inputs to measure quality but has not been as successful. Specifically, school input measures have not proved to be good predictors of wages or growth.)

Because outcomes cannot be changed by fiat, much attention has been directed at inputs – particularly those perceived to be relevant for policy such as school resources or aspects of teachers.

Analysis of the role of school resources in determining achievement begins with the Coleman Report, the US government's monumental study on educational opportunity released in 1966 (Coleman et al., 1966). That study's greatest contribution was directing attention to the distribution of student performance – the outputs as opposed to the inputs.

The underlying model that has evolved as a result of this research is very straightforward. The output of the educational process – the achievement of individual students – is directly related to inputs that both are directly controlled by policymakers (for example, the characteristics of schools, teachers, and curricula) and are not so controlled (such as families and friends and the innate endowments or learning capacities of the students). Further, while achievement may be measured at discrete points in time, the educational process is cumulative; inputs applied sometime in the past affect students' current levels of achievement.

Family background is usually characterized by such socio-demographic characteristics as parental education, income, and family size. Peer inputs, when included, are typically aggregates of student socio-demographic characteristics or achievement for a school or classroom. School inputs typically include teacher background (education level, experience, sex, race, and so forth), school organization (class sizes, facilities, administrative expenditures, and so forth), and district or community factors (for example, average expenditure levels). Except for the original Coleman Report, most empirical work has relied on data constructed for other purposes, such as a school's standard administrative records. Based upon this, statistical analysis (typically some form of regression analysis) is employed to infer what specifically determines achievement and what is the importance of the various inputs into student performance.

Measured school inputs

The state of knowledge about the impacts of resources is best summarized by reviewing available empirical studies. Most analyses of education production functions have directed their attention at a relatively small set of resource measures, and this makes it easy to summarize the results (Hanushek, 2003). The 90 individual publications that appeared before 1995 contain 377 separate production function estimates. For classroom resources, only nine per cent of estimates for teacher education and 14 per cent for teacher–pupil ratios yielded a positive and statistically significant relationship between these factors and student performance. Moreover, these studies were offset by another set of studies that found a similarly negative correlation between those inputs and student achievement. Twenty-nine per cent of the studies found a positive correlation between teacher experience and student performance; however, 71 per cent still provided no support for increasing teacher

experience (being either negative or statistically insignificant). Studies on the effect of financial resources provide a similar picture. These indicate that there is very weak support for the notion that simply providing higher teacher salaries or greater overall spending will lead to improved student performance. Per pupil expenditure has received the most attention, but only 27 per cent of studies showed a positive and significant effect. In fact, seven per cent even suggested that adding resources would harm student achievement. It is also important to note that studies involving pupil spending have tended to be the lowest-quality studies as defined below, and thus there is substantial reason to believe that even the 27 per cent figure overstates the true effect of added expenditure.

These studies make a clear case that resource usage in schools is subject to considerable inefficiency, because schools systematically pay for inputs that are not consistently related to outputs.

Study quality

The previous discussions do not distinguish among studies on the basis of any quality differences. The available estimates can be categorized by a few objective components of quality. First, while education is cumulative, frequently only current input measures are available, which results in analytical errors. Second, schools operate within a policy environment set almost always at higher levels of government. In the United States, state governments establish curricula, provide sources of funding, govern labour laws, determine rules for the certification and hiring of teachers, and the like. In other parts of the world, similar policy setting, frequently at the national level, affects the operations of schools. If these attributes are important – as much policy debate would suggest – they must be incorporated into any analysis of performance. The adequacy of dealing with these problems is a simple index of study quality.

The details of these quality issues and approaches for dealing with them are discussed in detail elsewhere (Hanushek, 2003) and only summarized here. The first problem is ameliorated if one uses the ‘value added’ versus ‘level’ form in estimation. That is, if the achievement relationship holds at different points in time, it is possible to concentrate on the growth in achievement and on exactly what happens educationally between those points when outcomes are measured. This approach ameliorates problems of omitting prior inputs of schools and families, because they will be incorporated in the initial achievement levels that are measured (Hanushek, 1979). The latter problem of imprecise measurement of the policy environment can frequently be ameliorated by studying performance of schools operating within a consistent set of policies – for example, within individual states in the USA or similar decision-making spheres elsewhere. Because all schools within a state operate within the same basic policy environment, comparisons of their performance are not strongly affected by unmeasured policies (Hanushek, Rivkin and Taylor, 1996).

If the available studies are classified by whether or not they deal with these major quality issues, the prior conclusions about research usage are unchanged (Hanushek, 2003). The best quality studies indicate no consistent relationship between resources and student outcomes.

An additional issue, which is particularly important for policy purposes, concerns whether this analytical approach accurately assesses the causal relationship between resources and performance. If, for example, school decision-makers provide more resources to those they judge as most needy, higher resources could

simply signal students known for having lower achievement. Ways of dealing with this include various regression discontinuity or panel data approaches. When done in the case of class sizes, the evidence has been mixed (Angrist and Lavy, 1999; Rivkin, Hanushek and Kain, 2005).

An alternative involves the use of random assignment experimentation rather than statistical analysis to break the influence of sample selection and other possible omitted factors. With one major exception, this approach nonetheless has not been applied to understand the impact of schools on student performance. The exception is Project STAR, an experimental reduction in class sizes that was conducted in the US state of Tennessee in the mid-1980s (Word et al., 1990). To date, it has not had much impact on research or our state of knowledge. While Project STAR has entered into a number of policy debates, the interpretation of the results remains controversial (Krueger, 1999; Hanushek, 1999).

Magnitude of effects

Throughout most consideration of the impact of school resources, attention has focused almost exclusively on whether a factor has an effect on outcomes that is statistically different from zero. Of course, any policy consideration would also consider the magnitude of the impacts and where policies are most effective. Here, even the most refined estimates of, say, class size impacts does not give very clear guidance. The experimental effects from Project STAR indicate that average achievement from a reduction of eight students in a classroom would increase by about 0.2 standard deviations, but only in the first grade of attendance in smaller classes (kindergarten or first grade) (see Word et al., 1990; Krueger, 1999). Angrist and Lavy (1999), with their regression discontinuity estimation, find slightly smaller effects in grade five and approximately half the effect size in grade four. Rivkin, Hanushek and Kain (2005), with their fixed effects estimation, find effects half of Project STAR in grade four and declining to insignificance by grade seven. Thus, from a policy perspective the alternative estimates are both small in economic terms when contrasted with the costs of such large class size reductions and inconsistent across studies.

Do teachers and schools matter?

Because of the Coleman Report and subsequent studies discussed above, many have argued that schools do not matter and that only families and peers affect performance. Unfortunately, these interpretations have confused measurability with true effects.

Extensive research since the Coleman Report has made it clear that teachers do indeed matter when assessed in terms of student performance instead of the more typical input measures based on characteristics of the teacher and school. When fixed effect estimators that compare student gains across teachers are used, dramatic differences in teacher quality are seen.

These results can also be reconciled with the prior ones. These differences among teachers are simply not closely correlated with commonly measured teacher characteristics (Hanushek, 1992; Rivkin, Hanushek and Kain, 2005). Moreover, teacher credentials and teacher training do not make a consistent difference when

assessed against student achievement gains (Boyd et al., 2006; Kane, Rockoff and Staiger, 2006). Finally, teacher quality does not appear to be closely related to salaries or to market decisions. In particular, teachers exiting for other schools or for jobs outside of teaching do not appear to be of higher quality than those who stay (Hanushek et al., 2005).

Some conclusions and implications

The existing research suggests inefficiency in the provision of schooling. It does not indicate that schools do not matter. Nor does it indicate that money and resources never impact achievement. The accumulated research surrounding estimation of education production functions simply says there currently is no clear, systematic relationship between resources and student outcomes.

See Also

- human capital
- local public finance
- returns to schooling

Bibliography

Angrist, J.D. and Lavy, V. 1999. Using Maimondides' rule to estimate the effect of class size on scholastic achievement. *Quarterly Journal of Economics* 114, 533–75.

Boyd, D., Grossman, P., Lankford, H., Loeb, S. and Wyckoff, J. 2006. How changes in entry requirements alter the teacher workforce and affect student achievement. *Education Finance and Policy* 1, 176–216.

Coleman, J.S., Campbell, E.Q., Hobson, C.J., McPartland, J., Mood, A.M., Weinfeld, F.D. and York, R.L. 1966. *Equality of Educational Opportunity*. Washington, DC: US Government Printing Office.

Hanushek, E.A. 1979. Conceptual and empirical issues in the estimation of educational production functions. *Journal of Human Resources* 14, 351–88.

Hanushek, E.A. 1992. The trade-off between child quantity and quality. *Journal of Political Economy* 100, 84–117.

Hanushek, E.A. 1999. Some findings from an independent investigation of the Tennessee STAR experiment and from other investigations of class size effects. *Educational Evaluation and Policy Analysis* 21, 143–63.

Hanushek, E.A. 2003. The failure of input-based schooling policies. *Economic Journal* 113, F64–F98.

Hanushek, E.A., Kain, J.F., O'Brien, D.M. and Rivkin, S.G. 2005. The market for teacher quality. Working Paper No. 11154. Cambridge, MA: NBER.

Hanushek, E.A. and Kimko, D.D. 2000. Schooling, labor force quality, and the growth of nations. *American Economic Review* 90, 1184–208.

Hanushek, E.A., Rivkin, S.G. and Taylor, L.L. 1996. Aggregation and the estimated effects of school resources. *Review of Economics and Statistics* 78, 611–27.

Kane, T.J., Rockoff, J.E. and Staiger, D.O. 2006. What does certification tell us about teacher effectiveness? Evidence from New York City. Working Paper No. 12155. Cambridge, MA: NBER.

Krueger, A.B. 1999. Experimental estimates of education production functions. *Quarterly Journal of Economics* 114, 497–532.

Lazear, E.P. 2003. Teacher incentives. *Swedish Economic Policy Review* 10(3), 179–214.

Mincer, J. 1970. The distribution of labor incomes: a survey with special reference to the human capital approach. *Journal of Economic Literature* 8, 1–26.

Mulligan, C.B. 1999. Galton versus the human capital approach to inheritance. *Journal of Political Economy* 107(pt. 2), S184–S224.

Murnane, R.J., Willett, J.B., Duhaldeborde, Y. and Tyler, J.H. 2000. How important are the cognitive skills of teenagers in predicting subsequent earnings? *Journal of Policy Analysis and Management* 19, 547–68.

Psacharopoulos, G. and Patrinos, H.A. 2004. Returns to investment in education: a further update. *Education Economics* 12, 111–34.

Rivkin, S.G., Hanushek, E.A. and Kain, J.F. 2005. Teachers, schools, and academic achievement. *Econometrica* 73, 417–58.

Word, E., Johnston, J., Bain, H.P., DeWayne Fulton, B., Zaharies, J.B., Lintz, M.N., Achilles, C.M., Folger, J. and Breda, C. 1990. *Student/Teacher Achievement Ratio (STAR), Tennessee's K-3 Class Size Study: Final Summary Report, 1985–1990*. Nashville: Tennessee State Department of Education.

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