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Estimating effects of school quality using multiple proxies

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HIGHLIGHTS

- We estimate a proxy variable model to identify the effect of latent school quality.
- We find significant effects of teaching and resource quality on student achievement.
- The effects are relatively small, but imply sizable life-time increases in earnings.
- Conventional estimates understate the effect of school quality by about 50%.
- Measurement error may reconcile the ambiguous evidence on effects of school quality.

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ABSTRACT

The recent literature on school quality has shown that the school a child attends has significant effects on achievement. However, the literature relating different school characteristics to student achievement has produced mixed results, particularly when using student-level data. Using data from the ECLS-K and a proxy variable model that addresses the problem of measuring school quality, we show that significant effects of teaching and resource quality can be detected from student-level data. We find a significant, positive relationship between school quality and student achievement if school characteristics such as class size and teachers' schooling are treated as noisy measures of school quality. However, this effect is not detected when using models which do not account for measurement error in school quality. Our results suggest that conventional approaches underestimate the effect of school quality by about 50%.

1. Introduction

The impact of school quality on student achievement has been heavily debated since the publication of the Coleman Report, which found relatively small effects of differences in the measured attributes of schools on student outcomes (Coleman et al. (1966)). On the one hand, the importance attached to school choice and resources invested by parents and policy makers in schools suggests school quality plays an important role in child development. This is supported by evidence of the importance of good teachers (e.g. Rockoff (2004); Rivkin et al. (2005); Jackson (2013); Chetty et al. (2014)) and school level comparisons using quasi-random variation in school assignment which show significant effects on student outcomes (e.g. Hastings and Weinstein (2007); Pop-Eleches and Urquiola (2013)). On the other hand, several similar school-level studies fail to find an impact on student achievement (e.g. Clark (2010); Cullen et al. (2005)). The evidence from the vast literature analyzing the effect of school quality using measures such as class size, teacher characteristics, or expenditure per capita on student outcomes is also mixed. For example, Hanushek's (2003) review finds that among 276 estimates of the effect of student-teacher ratio on student performance, 14% of studies found positive and statistically significant effects while another 14% found significant, negative effects.

This paper seeks to re-investigate the link between school attributes, school quality and test score achievement. We argue that school attributes – such as teacher's schooling and class size – that are often used to explain student achievement measure school quality, which is

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unobserved, with considerable error. To the extent that these measures proxy latent school quality with error, existing estimates of school quality may exhibit substantial biases. Consequently, the fact that the past literature does not consistently detect a significant impact of school quality may not be due to the absence of a relation between school quality and student outcomes. Understanding the role of school quality in determining student achievement is important given the significant returns to better test scores (e.g. school attainment: Currie and Thomas (1999); Murnane et al. (2000) and wages: Murnane et al. (1995)). It is also important to account for the role of school quality to avoid bias in studies of skill formation (e.g. Cunha and Heckman (2008); Cunha et al. (2010); Todd and Wolpin (2003)). For example, ignoring the role of school quality is likely to lead to overestimates of the own-productivity of skills.

This study estimates the effect of school quality on student achievement using multiple measures of school characteristics in an extension of the proxy variable model developed by Black and Smith (2006). We find that two latent dimensions of school quality – teaching and resource quality – affect achievement. We also develop a test of the validity of the model by deriving the results one would expect to obtain from a model that does not account for the measurement error, and comparing the implied results with the actual results obtained from estimating such a model. The results of this exercise and several other analyses we perform provide strong evidence in favor of the latent quality approach, which accounts for the presence of measurement error.

We use the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) data to estimate the effect of school quality, since it contains information on student, parent, teacher and school characteristics. We provide evidence that suggests the rich set of student-level controls we use is sufficient to account for the endogeneity of school quality. The ECLS-K provides us with several measures of school characteristics to use as proxies for school quality. We use commonly used measures of teachers' schooling, certifications and related college courses as proxies for teaching quality, and measures such as class size, access to instructional computers and specialized staff as proxies for resource quality.

Using the proxy variable model, we find significant, positive impacts of school teaching and resource quality on student achievement.[1] While we do not detect an effect of school quality on math achievement, we find a significant effect on reading achievement that is small but important. An increase of one standard deviation in both teaching quality and resource quality is associated with an improvement of 0.071 standard deviations in reading test scores between the spring of kindergarten and the spring of first grade. This effect on reading achievement corresponds to roughly 55% of the additional widening of the black-white reading test score gap that takes place between the fall of kindergarten and spring of first grade.

Since the effect of school quality is small and the proxies are noisy, we find that ignoring measurement error in school quality leads to substantial bias. We show that models that do not account for this measurement error tend to conceal the positive impact of school quality on student achievement: they yield estimates that are 50% attenuated, on average, relative to the estimates we find using our proxy variable model. The consequences of measurement error for estimation in combination with the small effect of school quality on student achievement can explain the conflicting evidence from past studies. Our proxy variable model detects a significant effect of school quality in individual-level data, suggesting that taking measurement error into account may also reconcile the discrepancy in evidence from aggregate or school level studies, which tend to find significant effects, with that from individual level studies where such effects have been harder to detect.[2]

The rest of the paper proceeds as follows: Section 2 discusses how we define school quality and how it relates to previous definitions. Section 3 formulates the education production function, and Section 4 describes our estimation strategy. Sections 5 and 6 describe the ECLS-K data and our choice of proxies for school quality. Section 7 presents our results, tests of the validity of our model and discusses policy implications, and Section 8 concludes.

2. Defining school quality

Many previous studies have analyzed the effect of school quality using measures such as class size, teacher characteristics, or expenditure per capita to infer their impact on student outcomes (e.g. Angrist and Lavy (1999); Chetty et al. (2011); Dynarski et al. (2013); Goldhaber and Brewer, (2000); Hanushek (1997); Rivkin et al. (2005)). These studies consider these variables to be direct inputs in the achievement production function. Since it assumes a direct causal relationship between the input variables and outcomes, this approach does not need the concept of school quality. While some of these studies find a significant effect, others do not (see e.g. Hanushek (2003) for an overview). We argue that the failure to detect an impact is not due to the absence of a relation between school quality and student outcomes, but that a positive and significant relationship is detected when these variables are treated as noisy measures of school quality.

Recent studies comparing the outcomes of students across different schools (e.g. Pop-Eleches and Urquiola (2013); Hastings and Weinstein (2007)) and teachers (e.g. Rivkin et al. (2005); Rockoff (2004); Jackson (2013); Chetty et al. (2014)) using fixed effects approaches and quasi-experimental methods have provided credible evidence that schools and teachers matter. There is still some disagreement on the existence and size of these impacts, see e.g. Clark (2010) or Cullen et al. (2005) for studies that do not find an impact. However, these studies leave some important questions unanswered. Many of the studies that establish a link between schools and student outcomes make a binary comparison between school types, showing that attending private schools, charter schools or more selective schools leads to better student outcomes. These comparisons leave the measurement of school quality implicit, which has downsides. First, it makes it hard to identify the mechanisms that lead to improved student outcomes because the schools differ in many ways and it remains unclear which differences matter for student learning (see e.g. Angrist et al. (2013)). Second, the magnitude of the effects is difficult to interpret. Since school quality is not explicitly measured, it remains unclear whether moving from, for example, a less selective to a more selective school constitutes a small or large change in school quality. Tying the improvements in outcomes to an interpretable metric of school quality is important to identify good schools and to answer policy questions, such as what the likely effects of higher investments in schools or transferring between schools that were not explicitly studied would be.

Similar arguments apply to the literature on teacher fixed effects, which demonstrates that teacher quality is an important determinant of student achievement but is uninformative about how to identify a good teacher. Rockoff et al. (2011) attempt to address this issue by aggregating noisy measures to scores that predict teacher quality before hiring them. We take a similar approach to the problem of school quality. We argue that the variables that are commonly used as measures of school quality – such as class size and teacher education – can be considered noisy proxies for school quality. School quality produces achievement, but is latent and unobserved. The essence of our method is to use several of these noisy proxies to extract the signal they contain about school quality, which allows us to detect an impact of teaching[3]

[1] Teaching and resources are not necessarily the only dimensions that matter, but they are the ones we are able to detect in our data. Examples of other possible dimensions include parental involvement and peer effects (see Smith and Stange (2015), for the case of college quality). We did not find an impact of these dimensions (possibly due to a lack of power or good proxies), so we leave this issue for future research.

[2] Betts (1995) and Hanushek et al. (1996) point out this pattern of results by aggregation level in studies.

[3] It is important to distinguish teaching quality from the effect of a particular teacher in the literature on teacher fixed effects. Teaching quality as we define it is a school level characteristic and not tied to particular teachers and classrooms. See Section 6 for further discussion.