Research in Economics 70 (2016) 158–169

Contents lists available at ScienceDirect

Research in Economics

journal homepage: www.elsevier.com/locate/rie

The dynamic relationship between school size and academic performance: An investigation of elementary schools in Wisconsin

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ARTICLE INFO

Article history:
Received 25 February 2015
Accepted 21 July 2015
Available online 30 July 2015

Keywords:
Test scores
Open enrollment
Correlated random effects

ABSTRACT

This paper constructs a panel model of school-level performance in which the key explanatory variable is school size. Typical panel models with unobserved effects impose the strict exogeneity assumption, which in this paper, implies a school's academic performance *cannot* impact its future school size. Yet it seems appropriate that, with school-level standardized test scores publicly available and widely reported, school size and school performance should be analyzed dynamically and jointly. We construct a panel model that explicitly allows for "feedback" from academic performance to future school size. We show that, not only is such feedback important, but once it is taken into account, the estimated relationship between school size and academic performance becomes far more negative, relative to models that ignore feedback.

1. Introduction

Proponents of small schools argue that small-school environments foster closer relationships between students and teachers, while large schools lead to feelings of alienation. Furthermore, small-school administrators might have more time to dedicate to student curriculum activities and pedagogical improvements, whereas large school administrators might spend more time managing employees. However, proponents of large schools argue that these touted benefits of small schools are exaggerated, and perhaps altogether incorrect. (For more details on arguments for and against small schools, see Ready et al. (2004), Kuziemko (2006), Leithwood and Jantzi (2009), and references therein.)

The link between *school* size and academic performance has received less attention than the effect of *class* size on performance, but the two literatures clearly are linked. This paper, although empirical in focus, draws inspiration from the enormous literature, both theoretical and empirical, on the effects of class size. A series of literature summaries by Hanushek (1986), (1989), (1996), (1997) provides the most comprehensive summary of evidence on the links between class size and achievement. His primary conclusion from those summaries is that class size shows "no strong or consistent relationship" with student performance. However, other researchers, both before and after Hanushek's summaries, have

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http://dx.doi.org/10.1016/j.rie.2015.07.006
1090-9443/

developed models that dispute that finding. Mulligan (1984) develops a model in which students compete for teacher attention, with achievement suffering as class size grows. Correa (1993) finds similar results, but with the emphasis being on teacher behavior in small-class settings. Angrist and Lavy (1999) reported that the impacts of class size appear to be more pronounced among disadvantage students. A widely-read study by Lazear (2001) finds, somewhat contrary to expectations, that better-behaved students actually perform better in *larger* classes, which Lazear argues partly explains muddled findings from previous studies. Krueger (2003) argues that findings from such meta-studies crucially hinge upon how individual studies in a meta-study are weighted, with different weighting schemes leading to different conclusions. McKee et al. (2010) created a theoretical framework which incorporates time lost to disruption, with disruption increasing with class size.

Turning to literature on *school* size, early research mostly examined cross sectional data and did not attempt to address unobserved heterogeneity (see reviews by Andrews et al. (2002) and Leithwood and Jantzi (2009)). More recent studies have employed panel data methods sometimes coupled with instrumental variables estimators (Kuziemko, 2006; Schwartz et al., 2013; Barrow et al., 2013). Other studies attempt to exploit the "natural experiment" introduced by the New School Public School District "quasi-lottery," which randomly assigns students to schools of various sizes (Abulkadiroglu et al., 2013; Bloom and Unterman, 2014).

In this paper, we present evidence that the lack of understanding of how school size relates to student performance stems from two separate econometric complications. First, schools exhibit substantial unobserved heterogeneity, both in their specific attributes, and in the ways in which they harness their sizes for academic purposes. For example, certain school districts might have populations with strong "tastes" for quality education, and those same families, presumably having high-performing children, might lobby for smaller (or larger) schools. Relatedly, families might chose to reside in areas with schools of particular sizes. This first econometric complication has been acknowledged in several recent studies on school size, and several attempts have been made to employ panel data estimators to address it.

But the use of panel data leads to the second empirical complication, not mentioned in the extant literature. Panel data models that use school-specific effects to account for unobserved heterogeneity must (implicitly) impose the strict exogeneity assumption. This assumption states that a school's academic performance *cannot* impact its future school size. Yet it seems appropriate that, with school-level standardized test scores publicly available and widely reported, school size and school performance should be analyzed dynamically and jointly. In many states, switching schools might impose prohibitive relocation costs, but Wisconsin has several robust open enrollment programs, which greatly reduce costs of changing schools. To use panel data jargon, low costs of switching schools imply that academic performance might dynamically "feed back" to future school size.

Feedback models for microeconomic dynamic models first were proposed by Wooldridge (2000). They since have been applied to study dynamics of poverty status (Biewen, 2009), health insurance and employment (Zimmer, 2010), and, in the paper most closely related to this one, inter-district transfer programs (Welsch and Zimmer, Forthcoming). Using district-level data from Colorado, Welsch and Zimmer find that families respond to perceived district quality by moving their children to competing districts. However, to our knowledge, feedback models have yet to be applied to school-level transfers, despite obvious incentives for parents to move their children in response to school performance.

Our main conclusion is that, when feedback is ignored, school size appears to exert a small, and often statistically insignificant, impact on school-level academic performance. That finding applies to a variety of approaches to accommodating unobserved heterogeneity, including a specification that permits school-specific random slopes. On the other hand, the results demonstrate that, when academic performance and school size are modeled *jointly* accounting for feedback, not only are feedback effects statistically significant, but the link between school size and student performance becomes far more negative and economically meaningful.

2. Data

Introduced in the 1998/99 school year, Wisconsin's Open Enrollment Program allows families to send their children to any district outside their resident district. Families may petition up to three outside districts for admission, including specific schools within those three districts. Transferring students are not required to reapply each year, although some districts require reapplication upon entering middle school, junior high school, and high school. Furthermore, students are permitted to transfer at any grade level. Resident districts have virtually no way to prevent out-transfers, and resident districts very seldom restrict the number of in-transfers. Because district-level state funding is tied to enrollment, districts with positive net in-transfers stand to gain funding, while districts with positive net out-transfers stand to lose funds. Wisconsin's open enrollment program has grown over time, from 2464 transfers in the program's initial year (1998/99) to more than 28,000 transfers in recent years. For sake of perspective, the second largest district in the state has enrollment of approximately 25,000 students, implying that the number of students participating in the program is larger than nearly every district's total enrollment.

We obtained data from the Wisconsin Department of Public Instruction for all non-charter Wisconsin elementary schools for the 10 school years 2002/03–2010/12. The panel contains school-level standardized test scores, student characteristics, and funding numbers. Information on district-level socioeconomic traits comes from Bureau of Labor Statistics census reports. Our final estimation sample includes 946 elementary schools, each observed for 10 academic years, for a total of 9460 school/year observations.

The two most important variables in this paper are academic performance and school size. Information on academic performance comes from the Wisconsin Knowledge and Concepts Examination (WKCE), a statewide assessment of student