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Peer effects and textbooks in African primary education ☆

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ABSTRACT

Textbooks could be a cheap and efficient input to primary school education in Africa. In this paper, we examine the effects of textbooks on student outcomes and separate between direct effects and externalities. Using the rich data set provided by the 'Program on the Analysis of Education Systems' (PASEC) for five Francophone, sub-Saharan African countries, this paper goes beyond the estimation of direct effects of textbooks on students' learning and focuses on peer effects resulting from textbooks owned by students' classmates. Using nonparametric estimation methods, we separate the direct effect of textbooks from their peer effect. The latter clearly dominates but depends upon the initial level of textbook availability.

1. Introduction

In this paper we estimate the direct and indirect effects of textbooks on educational achievement. Improving the quality of primary education in developing countries belongs to the central development objectives put forward by the international community in the context of the 'Education for All' initiative and the 'Millennium Development Goals' (UNESCO, 2000; Worldbank, 2003). In Francophone sub-Saharan Africa, this challenge seems to be greater than anywhere else in the world. Identifying effective measures for improving education quality has proven difficult. The impacts of class size reductions or increases in teacher salaries, for example, were often found to be insignificant and small, particularly when contrasted with the rather high costs (see e.g. Hoxby (1996); Hanushek (1998); Pritchett and Filmer (1999); Wössmann and West (2006) and Hanushek and Luque (2003).

Textbooks, on the other hand, could be an effective and rather inexpensive means to improve cognitive development and educational achievement.[1] While Glewwe et al. (2000, 2004) have argued that these effects may be overestimated due to omitted variable bias, we suggest that they could also be underestimated because of neglected peer-effects. At the same time, the existence of peer effects may help to explain why books are underprovided.

Using data from the 'Program on the Analysis of Education Systems' (PASEC) for 5th grade students in Burkina Faso, Cameroon, Cote d'Ivoire, Madagascar and Senegal, we estimate separately the direct effect of a student having a textbook, and the effect of his or her classmates having textbooks. The latter will be considered as a peer effect or externality. Moreover, we take into account that, if resources are insufficient to provide textbooks to all children, the impact of textbooks might depend on the *allocation* of books within and between schools.

To estimate the direct effect of textbooks and their externalities, we use nonparametric estimation techniques in order to permit for nonlinearities in the relationship between books and academic achievement. Such nonlinearities appear extremely plausible considering the nature of potential externalities.

Identification is based on controlling for confounding variables. In contrast to most other data sets, which often contain only very limited information on important variables such as ability, the PASEC data set includes very comprehensive information about student ability, family background, teachers, school principals, classrooms and schools. Achievement data are available for the two central subjects mathematics and French and are collected both at the beginning and at the end of the academic year. Measures of ability at the beginning of the year are particularly relevant since they enable us to pursue an

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[1] See e.g. Glewwe et al. (1995); Lockheed et al. (1986); Lockheed and Verspoor (1991); Fuller and Clarke (1994) and Michaelowa (2001) for textbooks, or OECD and UNESCO-UIS (2003); Glewwe and Jacoby (1994) and Mullis et al. (2000) for the impact of the general availability of books.

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added value approach (Hanushek, 1986) and to measure the effect of textbooks on learning within a given year, rather than on the overall level of cognitive skills which may be related to a variety of variables that would have had to be measured in earlier years, prior to the sampling, and are therefore unavailable in the data set. The availability of pre-test information at the beginning of the year is therefore a major advantage of the PASEC data, not only over other data for developing countries, but even over data from major international surveys on student achievement such as the OECD Programme on International Student Assessment (PISA) or the Third International Mathematics and Science Study (TIMSS).

The estimation results provide some evidence for the relevance of textbook externalities which may have important policy implications. In the Francophone African countries considered here, textbooks are predominantly privately provided. Parents, however, will take their decision on buying a textbook merely on the grounds of their own children's anticipated benefits and will not take into account the positive externalities on other children. In other words, private purchasing of textbooks is likely to be socially suboptimal because only parts of the benefits accrue to the own child.

We also compare the nonparametric estimation results to simple OLS estimators with various specifications of the regressor sets. In all specifications we find a large externality of textbooks. When using very restrictive linear specifications, the estimated effects are downward biased, though. Once the parametric forms are made sufficiently flexible, the parametric and nonparametric effects are quite similar. For estimating the *shape* of the externalities, parametric approaches were not very successful, though. For permitting interesting non-linearities we need at least a third order polynomial, which delivered rather noisy results. A supplementary appendix with technical details and additional robustness analyses is available from the authors.

2. Textbooks and externalities

The availability of textbooks among classmates may affect one's own learning through a variety of channels. The conventional peer effects argument asserts that students with books learn faster and that these more knowledgeable peers are then beneficial for one's own learning because of enhanced motivation or competition or sharing of knowledge. This peer effect should increase with the share of classmates having books, and this increase could be more or less than proportional depending on whether homogeneous or heterogeneous classes provide a more efficient learning environment (Hoxby, 2000).

In addition, there may be more direct channels through which one's classmates' textbooks can become effective. First, students may share books in class, e.g. two or three students may read from the same book. Unless reading from the same book is not disrupting them, educational achievement would increase with the number of books until all students have access to a book and would be flat from there onwards. If students benefit from taking the book home after class, the marginal benefit of a book would remain positive throughout, but saturation effects are to be expected well before all students of the class have a book at their disposal.

Second, the total number of books in a class is likely to change the instructional methods used by the teacher. This may lead to a non-linear relationship between textbook provision and student achievement. In a class where all students have books, the teacher can use pedagogical methods that require books. In a class without any textbooks, the teacher is forced to resort to alternative teaching methods. It is conceivable that there may be threshold effects, with textbooks remaining unused below a certain minimum provision. Alternatively, teachers may increase the time spent on textbook based learning proportionally to the share of students possessing a book. In this case, the positive effect of additional textbooks should rise with the share of classmates already equipped. However, if only a fraction of the class has access to books, the teacher may find it hard to adapt his mode of instruction, addressing partly those with books and partly those without books. The overall educational achievement might then even be lower than in a class without books, leading to a U-shaped relationship between books and educational achievement.

Textbook externalities can have important policy consequences as they are likely to distort parents' decisions on buying textbooks for their children, leading to allocative inefficiency. In addition, non-linearities in the peer effects affect the optimal allocation of books both within classes and between classes and schools.

Given the above considerations, the functional form of the relationship between textbooks and educational achievement is not a priori obvious, and we therefore follow a nonparametric approach to estimating the impact of textbooks and to disentangle direct and peer effects. Let Y_i denote educational achievement at the end of a school year, which is measured by the percentage of correct answers in an achievement test. Denote by B_i the number of textbooks possessed by child i, and denote by C_i the average number of textbooks among child i's *classmates*. In PASEC surveys, each child is asked whether it has a French and/or a Math textbook, such that B_i can take the values 0, 1 or 2. Accordingly, the average number of books among classmates is $C_i \in [0,2]$.

We aggregate the two textbooks here as we expect strong feedback effects between subjects. As both subjects are taught and assessed in French language, proficiency in French is relevant for doing well in Math. In addition, the ability tests themselves were conducted in French language. Thus, indirectly, the French book can also be expected to impact on Math test achievement. At the same time, a Math textbook written in French can be a relevant substitute (or a complement) of a French textbook for learning French. (In the Supplementary appendix, we also examine the effects of a French and a Math book separately.)

Denote the potential outcomes as

$$Y_i^{b,c} \quad \forall\ b \in \{0,1,2\} \quad \text{and} \quad 0 \le c \le 2.$$

$Y_i^{b,c}$ is the educational achievement that student i would obtain if her number of books were changed to b and the number of books among her classmates were changed to c. The two variables b and c are both taking values within [0, 2], with b being an integer and c essentially being a continuous variable.

The potential outcome for a student who is *randomly* drawn from the population is

$$E[Y^{b,c}]. \tag{1}$$

Examining $E[Y^{b,c}]$ for different values of b and c traces the direct and the peer-effects of textbooks. Keeping c constant, the difference

$$E[Y^{b'',c}] - E[Y^{b',c}]$$

gives the impact of increasing the number of own books from b' to b'' for a randomly chosen student, when the number of books among her classmates remains unchanged. This captures the *direct* effect of books. The externality or peer effect of books can be characterized through

$$E[Y^{b,c''}] - E[Y^{b,c'}],$$

which is the average effect on a student with b books when the number of books among her classmates is changed from c' to c''.