Economics Letters 119 (2013) 311–315

Contents lists available at SciVerse ScienceDirect

Economics Letters

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

When do textbooks matter for achievement? Evidence from African primary schools

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HIGHLIGHTS

- We gauge the impact of textbook access on test scores with a within-student analysis.
- We focus on primary school students in 11 sub-Saharan African countries.
- Textbook access has no effect on average.
- Only one form of textbook access – sharing – has an impact at the margin.
- Textbook sharing positively affects the achievement of the richest students.

ARTICLE INFO

Article history:
Received 13 November 2012
Received in revised form
5 March 2013
Accepted 6 March 2013
Available online 15 March 2013

JEL classification:
A12
I21
N37

Keywords:
Textbooks
Educational quality
Sub-Saharan Africa
SACMEQ

ABSTRACT

Using a within-student analysis, we find no average impact of textbook access (ownership or sharing) on primary school achievement. Instead, it is only for students with high socioeconomic status that one form of textbook access – sharing – has a positive impact.

1. Introduction

Improving access to textbooks via ownership or sharing seems an obvious way to increase student achievement in African countries where resources are particularly limited. Retrospective studies of both Francophone and Anglophone African countries find significant positive correlations between access to textbooks and student test scores in both reading and mathematics.[1] However, such analyses are at risk from bias due to omitted variables that may influence both textbook access and educational outcomes. Alternatively, randomized experiments have allowed researchers to avoid such endogeneity biases and isolate the impact of schooling inputs on learning outcomes. Glewwe et al. (2009) analyze the only randomized experiment conducted in Africa that focuses on the impact of textbook access, specifically sharing, on pupils' achievement. They find that, due in part to overly ambitious curricula not suited for the average student, textbook sharing in Kenya improves test scores only for those students who were already high achievers prior to the intervention.[2]

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1 For evidence that is both recent and comprehensive, see Fehrler et al. (2009).

2 This finding contrasts with the results by Jamison et al. (1981). Relying on a randomized experiment in Nicaragua, these authors show that allocating a textbook to each student improves mathematics test scores by one-third of a standard deviation on average. This diverging conclusion may be due to the fact that the curriculum is less ambitious in Nicaragua than in Kenya. Moreover, the average student in Nicaragua is better off than his/her Kenyan counterpart. Because he/she faces lower barriers to learning, textbook access may have a greater positive

0165-1765/$ – see front matter
http://dx.doi.org/10.1016/j.econlet.2013.03.012

Table 1
Summary statistics.

	Mean	Standard deviation	Observations		Mean	Standard deviation	Observations
Panel A: Dependent variable				Teacher has a wall chart	0.61	0.49	2,659
Student mathematics score	494.04	92.26	36,829	Teacher has a cupboard	0.41	0.49	2,659
Student reading score	498.36	96.58	37,062	Teacher has bookshelves	0.27	0.44	2,659
Panel B: Student and subject-specific characteristics				Teacher has a class library	0.40	0.49	2,659
Student has access to a mathematics textbook	0.88	0.33	37,062	Teacher has a table	0.69	0.46	2,659
Student has access to a reading textbook	0.89	0.31	37,062	Teacher has a chair	0.70	0.46	2,659
Student owns a mathematics textbook	0.78	0.41	21,049	Panel E: Reading teacher characteristics			
Student owns a reading textbook	0.79	0.40	19,631	Gender (female)	0.53	0.50	2,713
Student shares a mathematics textbook	0.78	0.42	20,589	Age	35.36	8.24	2,747
Student shares a reading textbook	0.81	0.39	21,458	Qualification (primary)	0.12	0.32	2,747
Panel C: Student-specific characteristics				Qualification (junior secondary)	0.20	0.40	2,747
Student home possession	0.37	0.24	37,062	Qualification (senior secondary)	0.47	0.50	2,747
Panel D: Mathematics teacher characteristics				Qualification (A-level/tertiary secondary)	0.21	0.41	2,747
Gender (female)	0.46	0.50	2,644	Test score	30.75	5.66	2,729
Age	35.38	8.13	2,679	Frequency of correcting homework	2.55	0.37	2,656
Qualification (primary)	0.11	0.31	2,679	Importance of encouraging students	2.76	0.48	2,747
Qualification (junior secondary)	0.21	0.41	2,679	Frequency of assessing students	5.28	0.90	2,747
Qualification (senior secondary)	0.50	0.50	2,679	Teacher has a writing board	0.94	0.23	2,731
Qualification (A-level/tertiary secondary)	0.19	0.39	2,679	Teacher has chalk	0.94	0.24	2,731
Test score	25.75	6.84	2,625	Teacher has a wall chart	0.60	0.49	2,731
Frequency of correcting homework	2.65	0.34	2,657	Teacher has a cupboard	0.40	0.49	2,731
Importance of encouraging students	2.77	0.47	2,646	Teacher has bookshelves	0.27	0.44	2,731
Frequency of assessing students	4.88	0.91	2,660	Teacher has a class library	0.43	0.49	2,731
Teacher has a writing board	0.94	0.24	2,659	Teacher has a table	0.69	0.46	2,731
Teacher has chalk	0.93	0.25	2,659	Teacher has a chair	0.70	0.46	2,731

Notes: Our data include 37,062 students, 2,679 mathematics teachers and 2,747 reading teachers. In Panel B, the mean number of students with access to a textbook is the number of students with textbook access divided by the total number of students in the dataset (37,062). For mathematics and reading, 88% and 89% of students have textbook access, respectively. By subject (not reported here), 43% share a mathematics textbook while 45% own one, and 47% share a reading textbook while 42% own one. Also in Panel B, the mean number of students owning a textbook is the number of students owning a textbook divided by the number of students who either own a textbook or do not have textbook access. Similarly, the mean of students sharing a textbook is the number of students sharing a textbook divided by the number of students who either share a textbook or do not have textbook access.

Our paper aims to improve upon this result in two ways. First, we do not restrict our attention to the impact of textbook sharing alone. Instead, we expand our analysis to include textbook ownership, as these two forms of textbook access are expected to create differential effects. For instance, Frölich and Michaelowa (2011) demonstrate, based on African data, that textbook sharing is associated with positive externalities (notably through knowledge sharing) which simple textbook ownership does not allow. Second, instead of relying on only one African country, we cover 11 sub-Saharan African countries from the second round of the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) survey from 2005.[3] Our identification strategy treats endogeneity through a within-student analysis (across subject rather than across time). Doing so ensures that there are no unobserved student characteristics which are correlated with both textbook access and achievement, at least when these unobservables remain constant across subjects.[4] Moreover, with a rich set of controls at the teacher level, we mitigate the possibility of unobserved teacher characteristics being correlated with both textbook access and test scores.

2. Data

The SACMEQ II survey administers questionnaires and standardized reading and mathematics examinations to both students and teachers to compare cross-country achievement in the final year of primary school. We measure achievement with the scores obtained by students on standardized tests in reading and mathematics. For textbook access we use an indicator variable which is equal to 1 if a student has access to a textbook in mathematics or reading (whether via ownership or sharing) and 0 if a student has no access to a textbook. We then disaggregate this variable into two dummies: one that is equal to 1 if a student owns a textbook (and 0 if a student has no access to a textbook) and another that is equal to 1 if a student shares a textbook (and 0 if a student has no access to a textbook). We do so in order to examine the potentially different effects of textbook ownership versus sharing.

Glewwe et al. (2009) find that textbook access in Kenya improves test scores only for those students who were already high achievers before receiving textbook access. However, socioeconomic status (SES) is known to be an excellent predictor of academic ability. In sub-Saharan Africa, for instance, Lee et al. (2005) find that a pupil with a high SES strongly outperforms his/her low SES counterparts. We therefore test, later in the analysis, whether textbook access may make a significant difference only for students from the most privileged backgrounds. We do so by interacting our indicators for textbook access with student socioeconomic status, a proxy derived from an average of 14 home possessions (a newspaper, magazine, radio, television, VCR, cassette, telephone, refrigerator, car, motorcycle, bicycle, water, electricity, and table) present in each student's household.

impact on his/her achievement. The same reasoning applies to Hungi (2008), who shows that textbook ownership positively impacts test scores in mathematics and reading in Vietnam, as well as to Tan et al. (1999), who demonstrate that providing teachers with learning materials leads to a significant decline in dropout rates in the Philippines.

3 These include Botswana, Lesotho, Kenya, Malawi, Mozambique, Namibia, Seychelles, Swaziland, Tanzania, Uganda, and Zambia. We are forced to exclude Mauritius and South Africa as they report no test scores for teachers, a crucial control variable.

4 To be sure, a student fixed effect approach does not allow us to control for students' subject-specific propensities for achievement. However, this potential endogeneity problem is expected to be weak, given that our data reveal a very strong correlation (equal to 76%) between students' achievements across subjects. This correlation suggests that students' unobserved propensities for achievement are constant across subjects rather than subject specific.

Table 2
Textbook access, ownership, or sharing and test scores: OLS results.

	Dependent variable: Test scores		
	(1)	(2)	(3)
Student has access to a textbook	0.790 (2.818)		
Student owns a textbook		−2.163 (5.387)	
Student shares a textbook			3.060 (3.542)
Mathematics	−3.152* (1.720)	−5.223* (2.722)	0.597 (2.335)
Teacher gender (female)	2.511 (2.356)	1.667 (3.634)	4.290 (3.522)
Teacher age	0.219 (0.156)	0.134 (0.207)	0.206 (0.204)
Teacher qualification (junior secondary)	−3.741 (3.920)	−1.813 (5.728)	−7.771 (5.305)
Teacher qualification (senior secondary)	−3.846 (3.797)	−3.759 (5.712)	−5.937 (6.137)
Teacher qualification (A-level/tertiary)	−3.261 (4.504)	−3.654 (6.896)	−8.223 (6.893)
Teacher test score	0.541*** (0.178)	0.548* (0.286)	0.527** (0.245)
Frequency of correcting homework	1.810 (3.188)	0.475 (4.588)	6.814 (4.798)
Importance of encouraging students	0.834 (2.074)	1.364 (3.129)	0.710 (2.907)
Frequency of assessing students	−0.388 (1.006)	−0.017 (1.709)	−0.606 (1.379)
Teacher has a writing board	1.848 (11.666)	6.522 (15.033)	3.876 (11.805)
Teacher has chalk	−1.584 (5.984)	−0.499 (7.508)	−6.671 (7.786)
Teacher has a wall chart	−0.483 (2.684)	0.953 (4.392)	−2.224 (3.842)
Teacher has a cupboard	−1.429 (3.287)	−1.543 (4.633)	−0.968 (4.713)
Teacher has bookshelves	4.601 (3.198)	8.507** (4.190)	3.170 (5.130)
Teacher has a class library	6.936** (3.159)	7.004 (4.771)	3.022 (4.000)
Teacher has a table	1.031 (3.510)	−1.667 (5.353)	2.929 (5.171)
Teacher has a chair	−2.752 (3.519)	−2.089 (5.164)	−1.603 (5.116)
Student fixed effects	Yes	Yes	Yes
R^2	0.888	0.921	0.898
Observations	68,197	37,626	38,060

Notes: This table reports OLS estimates for test scores. See main text for an explanation of controls. Standard errors are clustered at the school level.
* Indicate significance at the 10% level.
** Indicate significance at the 5% level.
*** Indicate significance at the 1% level.

When we run the within-student analysis, we need control only for the variables that vary across subjects. Regarding teachers, we account for sex (using an indicator for females), age, and highest level of academic qualification obtained (with dummy variables for primary, junior secondary, senior secondary, and A-level/tertiary). To control for characteristics related to teaching competency and practices, we use the raw teacher test scores in mathematics and reading (with maximum scores of 41 and 47, respectively) as well as the frequency with which they correct homework (never, sometimes, always), importance they assign to encouraging their students (not important, of some importance, very important), and frequency with which they assess their students (no test, once per year, once per term, 2–3 times per term, 2–3 times per month, once or more per week). Additionally, we include a set of dummy variables for the presence of specific classroom resources (such as writing board, chalk, wall chart, cupboard or locker, one or more bookshelves, classroom library or book corner, teacher table, and teacher chair). Summary statistics for all variables can be found in Table 1.

3. Empirical strategy and results

Because, for each student, SACMEQ reports pairs of test scores in both mathematics and reading, we are able to exploit these matched pairs by running a within-student analysis similar to Dee (2007), Aslam and Kingdon (2011), and Cho (2012). This analysis allows us to control for student fixed effects that are constant across subjects. Moreover, thanks to a comprehensive set of controls at the teacher level, this approach reduces the possibility that unobserved teacher characteristics are correlated with both a student's textbook access and his/her test scores. We begin with Eq. (1):

$$Y_{ij} = a_i + b \cdot \mathrm{BOOK}_{ij} + c \cdot \mathrm{MATH} + \mathbf{X}_\mathbf{j}' \cdot d + \epsilon_{ij}, \quad (1)$$

where Y_{ij} represents the test score for student i in subject j. We run three estimations in which the coefficient b associated with BOOK stands for the impact of textbook access, ownership, or sharing on the score of student i. We control for student (a_i) and subject (MATH) fixed effects, as well as for a vector of teacher traits ($\mathbf{X}_\mathbf{j}'$). Finally, we include the mean-zero error term (ϵ_{ij}), and cluster standard errors at the school level to account for the undoubtedly similar variation amongst students from the same school. Table 2 presents the ordinary least squares (OLS) estimates of Eq. (1). We observe that neither textbook access, textbook ownership, nor textbook sharing has a significant impact on students' achievements. These results hold if we distinguish between the impact of textbook access in mathematics versus reading. (Results are available upon request.)

However, it is possible that textbook access makes a significant difference only for students from the most privileged backgrounds due to severe constraints faced by poor students (such as hindered cognitive development, sporadic enrollment, low parent and teacher expectations, and — particularly relevant for textbooks — elitist curriculum biases).[5] We test for this possibility by adding to Eq. (1) an interaction term between the indicators capturing textbook access and student SES, as proxied by average level of home possessions:

$$Y_{ij} = a_i + b \cdot \mathrm{BOOK}_{ij} + c \cdot \mathrm{BOOK}_{ij} \times \mathrm{SES}_i + d \cdot \mathrm{MATH} + \mathbf{X}_\mathbf{j}' \cdot e + \epsilon_{ij}. \quad (2)$$

Here, the coefficient of the interaction term $\mathrm{BOOK}_{ij} \times \mathrm{SES}_i$ captures the differential impact of each textbook measure (access, ownership, or sharing) on a student's test score according to the level

[5] See Kuecken and Valfort (2012) for a discussion of these constraints.

Table 3
Textbook access, ownership, or sharing according to SES level and test scores: OLS results.

	Dependent variable: Test scores		
	(1)	(2)	(3)
Student has access to a textbook	−0.575 (4.814)		
Student owns a textbook		5.772 (10.355)	
Student shares a textbook			−3.533 (5.658)
Student has access to a textbook × Home possession	4.371 (11.351)		
Student owns a textbook × Home possession		−22.192 (21.200)	
Student shares a textbook × Home possession			22.453 (14.476)
Mathematics	−3.154* (1.720)	−5.180* (2.702)	0.638 (2.337)
Teacher gender (female)	2.506 (2.356)	1.680 (3.617)	4.273 (3.519)
Teacher age	0.220 (0.156)	0.133 (0.207)	0.209 (0.204)
Teacher qualification (junior secondary)	−3.737 (3.920)	−1.850 (5.731)	−7.729 (5.300)
Teacher qualification (senior secondary)	−3.838 (3.795)	−3.826 (5.710)	−5.875 (6.123)
Teacher qualification (A-level/tertiary)	−3.257 (4.505)	−3.634 (6.891)	−8.125 (6.896)
Teacher test score	0.540*** (0.178)	0.554* (0.284)	0.522** (0.244)
Frequency of correcting homework	1.794 (3.178)	0.589 (4.563)	6.800 (4.791)
Importance of encouraging students	0.835 (2.074)	1.385 (3.129)	0.746 (2.895)
Frequency of assessing students	−0.389 (1.006)	−0.030 (1.708)	−0.626 (1.381)
Teacher has a writing board	1.847 (11.677)	6.775 (14.943)	4.058 (11.864)
Teacher has chalk	−1.560 (5.983)	−0.645 (7.473)	−6.557 (7.767)
Teacher has a wall chart	−0.488 (2.683)	0.959 (4.396)	−2.261 (3.830)
Teacher has a cupboard	−1.421 (3.286)	−1.568 (4.595)	−0.913 (4.711)
Teacher has bookshelves	4.605 (3.199)	8.524** (4.182)	3.268 (5.116)
Teacher has a class library	6.942** (3.160)	6.980 (4.780)	3.025 (3.989)
Teacher has a table	1.020 (3.512)	−1.647 (5.345)	2.846 (5.170)
Teacher has a chair	−2.757 (3.518)	−2.154 (5.159)	−1.698 (5.087)
Wald test *p*-value (Textbook + 0.5(Textbook × Home poss.) = 0)	0.6256	0.3209	0.0870
Wald test *p*-value (Textbook + 0.57(Textbook × Home poss.) = 0)	0.6124	0.2490	0.0740
Wald test *p*-value (Textbook + 0.64(Textbook × Home poss.) = 0)	0.6102	0.2185	0.0696
Wald test *p*-value (Textbook + 0.71(Textbook × Home poss.) = 0)	0.6130	0.2076	0.0689
Wald test *p*-value (Textbook + 0.79(Textbook × Home poss.) = 0)	0.6176	0.2055	0.0698
Wald test *p*-value (Textbook + 0.86(Textbook × Home poss.) = 0)	0.6228	0.2073	0.0715
Wald test *p*-value (Textbook + 0.93(Textbook × Home poss.) = 0)	0.6279	0.2107	0.0734
Wald test *p*-value (Textbook + 1(Textbook × Home poss.) = 0)	0.6326	0.2147	0.0755
Student fixed effects	Yes	Yes	Yes
R^2	0.888	0.921	0.898
Observations	68,197	37,626	38,060

Notes: This table reports OLS estimates for test scores. See main text for an explanation of controls. Standard errors are clustered at the school level.
* Indicate significance at the 10% level.
** Indicate significance at the 5% level.
*** Indicate significance at the 1% level.

of home possessions. We test which percentile of SES is significant by running a Wald test.[6] If we consider the 71st percentile of home possessions, for example, this Wald test consists of computing whether the sum of the coefficient of BOOK and the level of home possessions corresponding to the 71st percentile (0.5) multiplied by the coefficient of BOOK × SES is significantly different from 0.

OLS estimates of Eq. (2) are reported in Table 3. They demonstrate that is it only for students belonging to the 71st percentile of SES and above that one form of textbook access, textbook sharing, has a positive impact on achievement. The alternative textbook measures (access and ownership) have no effect at any level of student SES. This set of results holds if we distinguish between the impact of textbook access in mathematics versus reading. (Results are available upon request.) In terms of magnitude, textbook sharing increases student test scores by a maximum of 0.20 standard deviations (the marginal effect obtained for students in the uppermost percentile of the SES distribution). When compared to other types of educational interventions, this impact is equivalent to that found from merit-based school vouchers (Kremer and Holla, 2009).

6 The level-to-percentile conversions are the following: 0 (1st), 0.07 (2nd), 0.14 (13th), 0.21 (25th), 0.29 (38th), 0.36 (52nd), 0.43 (63rd), 0.5 (71st), 0.57 (77th), 0.64 (82nd), 0.71 (87th), 0.79 (92nd), 0.86 (95th), 0.93 (98th), 1 (100th).

4. Conclusion

Relying on a within-student analysis, this paper aims to improve upon the representativeness of the results from Glewwe et al. (2009) by (i) analyzing the impact of textbook ownership in addition to sharing and (ii) covering 11 sub-Saharan African countries instead of one (Kenya). Our findings are consistent with theirs. We find no average impact of textbooks on student test scores, although we identify a positive impact for a certain margin of students — those at the top of the socioeconomic distribution. Moreover, this impact arises solely from textbook sharing. This result is consistent with the fact that sharing is associated with positive externalities via knowledge transfers, an effect that simple textbook ownership does not produce (see Frölich and Michaelowa, 2011).

Acknowledgments

We thank Pierre Cahuc, Eric Strobl, and an anonymous reviewer for their very helpful comments.

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