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Public Investments in Education and Children's Academic Achievements

CHRIS CUNNINGHAM *, SOLVEIG A. CUNNINGHAM **, NAFISA HALIM[†] & KATHRYN M. YOUNT**

*Research Department, Federal Reserve Bank of Atlanta, Atlanta, GA, USA, **Hubert Department of Global Health and Department of Sociology, Emory University, Atlanta, GA, USA, [†]Department of Global Health, Boston University, Boston, MA, USA

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ABSTRACT *While the benefits of additional schooling in the developing world are widely recognised, the best use of scarce resources to improve academic achievement remains unclear. We compare public investments in school infrastructure, school improvement grants, teacher qualifications, and attendance incentives on independently-gathered measures of academic skills as well as grade progression for 8–11 year olds in India. We match a rich household survey containing a skills-assessment module, the India Human Development Survey (IHDS), with detailed measures of each district's education resources from the District Information Survey on Education (DISE). We also include border-pair fixed effects to control for unobserved heterogeneity. We find that incentives for children to attend school were associated with arithmetic, reading and writing skills, and grade progression. Investment in teachers were associated with greater probability a child could write and do more advanced math. Small improvement grants to schools were associated with better reading skills and writing ability. Investments in school infrastructure were only associated with improved writing ability.*

1. Introduction

Schooling is associated with many positive outcomes, including lower fertility, greater productivity and earnings, enhanced cognitive skills, and better health and nutrition (Behrman et al., 2010; UNESCO, 2008). Based in part on this evidence, improving primary education worldwide is the focus of several international commitments, including UNESCO's Education for All agenda and the Sustainable Development Goals, which include ensuring inclusive, equitable and quality education (UNESCO, 2008; United Nations, 2013). Public investment in elementary education in low-income countries has increased substantially since the 1960s and 1970s, leading to improvements in school enrolment, grade attainment, and time spent in school (Lloyd, Behrman, Stromquist, & Cohen, 2005). Despite these gains, about 12 per cent of children in lower-income countries are out of school, and approximately 130 million children do not complete primary school (UNESCO, 2004, 2008). Further, even when schools are available, the quality of education is often poor. India, home to 30 per cent of the world's children living in poverty (UN Children's Fund [UNICEF], 2016), is exemplar of this problem. In recent decades, India has achieved remarkable increases in school attendance. For example, the proportion of children finishing primary school increased from about 40 per cent in 1998–1999 to about 75 per cent in 2006 (IIPS and ORC Macro, 2001, 2007), yet academic

Correspondence Address: Chris Cunningham, Research Department, Federal Reserve Bank of Atlanta, 1000 Peachtree Street N.E, Atlanta, GA 30309, USA. Email: chris.cunningham@atl.frb.org
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performance has lagged. Nationally, the average pupil responded correctly to only 45 per cent of math questions and 58 per cent of language questions (National Council of Educational Research and Training, 2003). Regional variations in school quality and educational outcomes persist despite substantial governmental efforts to improve education (Govinda & Bandyopadhyay, 2008).

This study evaluated public investments in (1) school infrastructure, (2) improvement grants given to schools, (3) number and qualifications of teachers, and (4) student incentives in terms of children's reading, writing and math skills, and age-appropriate grade attendance. The district investment measures come from the *District Information Survey on Education* (DISE), a national district-level dataset of schools. Data on individual children are from the *India Human Development Survey* (IHDS), a nationally representative household dataset. The study design offers several advantages: the use of a nationally representative sample of children exposed to normal state-determined and administered educational investments compliments the plethora of randomised control trials (RCT) in developing world education (Deaton & Cartwright, 2018). The findings pertain to all children, not just those found in schools, as is the case with school-based studies, and thus reveal the net effect of school investment inclusive of endogenous changes in public school enrolment or attendance. The data also include extensive family characteristics not available in school-based studies. We avoid any concerns about teachers interfering with the skill assessment, for example through teaching to the test or out-right fraud that might contaminate school-based evaluations.

To control for unobservable heterogeneity in the population and to identify plausibly exogenous variation in state educational investments, we employ a border-discontinuity design, restricting the sample to school districts at state borders and including border-pair fixed effects. We also employ a selection correction procedure to control for participation in the academic skills evaluations.

We find that incentives given for children, such as free uniforms or stationary, are associated with large improvements in all academic skills and in grade progression. Small improvement grants for schools are associated with children's reading and writing skills. School infrastructure was only associated with increased probability that a student could write. In the next three sections, we review existing research on public investments across countries, the context in India, and our data. Section five presents the econometric framework and Section six presents the findings. There is a brief conclusion.

2. Literature review

Individual and family characteristics have been recognised as important determinants of children's schooling achievement, including in India (Casassus, Cusato, Froemel, & Palafax, 2000; Dreze & Kingdon, 2001; Hungi, 2011; Kaplan, Liu, & Kaplan, 2001; Kloosterman, Notten, Tolsma, & Kraaykamp, 2011; Pratham, 2007). The salience of public investments in education for individual children's educational outcomes is less clear. A meta study of school inputs and education outcomes found few strong predictors beyond teacher subject matter knowledge, student desks, and teacher absences (Glewwe, Hanushek, Humpage, & Ravina, 2011). The importance of individual and family characteristics may outweigh such investments (Hungi, 2011), but public investments may be especially beneficial for under-privileged children and in poorer settings (Gamoran & Long, 2006). At the same time, the importance of public investments may reach beyond the direct benefits; specifically, expanding school infrastructures and improving school quality may increase school enrolment by demonstrating to families the importance of schooling (Masino & Niño-Zarazúa, 2016; UNESCO, 2004). Below, we summarise the evidence for various types of public investments.

Typical *investments in school facilities* include expanding *quantity of schools* and improving the *quality of school infrastructure* (Behrman, 2009; Glewwe & Kremer, 2007; Orazem, King, & Duryea, 2007). In lower-income countries, opening new schools has been the major type of investment in education; researchers have found positive (Burde & Linden, 2013; Kingdon, 2007) and negative or negligible (Dreze & Kingdon, 2001; Filmer, 2007; Handa & Simler, 2006) associations of number of schools and school infrastructure with pupil achievement. *School quality* is measured by the availability of resources for instruction including blackboards, maps, and libraries. Across countries, instructional materials, as well as sanitation and access to pre-schools were associated with reading and mathematics performance, reductions in dropout, and lower inequality in performance (Casassus et al., 2000; Hungi, 2011; Kazianga, Levy, Linden, & Sloan, 2013; UNESCO, 2004, 2008).

Investments in teacher quantity, through smaller class size, can contribute to pupil achievement (Clotfelter, Ladd, & Vigdor, 2007; Nye, Hedges, & Konstantopoulos, 1999; Rivkin, Hanushek, & Kain, 2005) though effects may not be long-term or universal and may only become observable below 20 students per teacher (Betts & Shkolnik, 1999; Grissmer, 1999). In some lower-income settings, including India, lower pupil-to-teacher ratios predicted pupil achievement and enrolment, especially for girls (Dreze & Kingdon, 2001), but not in others (Alderman, Orazem, & Paterno, 2001; Casassus et al., 2000; Hungi, 2011). In India, providing an additional teacher to single-teacher schools was positively associated with school completion rates, especially for girls and poorer children nationally (Chin, 2005).

Several studies have reported that *teacher quality* is the most important determinant of student achievement, though defining what makes a good teacher is challenging (Hannaway & Woodroffe, 2003): recertification exams, experience, and graduate degree may (Casassus et al., 2000; Goldhaber & Anthony, 2003) or may not (Angrist & Guryan, 2004) improve pupil achievement. In India, as in other lower-income countries, there is interest in increasing female teachers and teacher training (Dreze & Kingdon, 2001; Muliadharan & Sundararaman, 2008; UNESCO, 2004), and indeed the addition of female teachers was associated with higher literacy and numeracy (Banerjee, Somanathan, & Pande, 2007; Hungi, 2011). In India, pay incentives, monitoring, and enforcement for teachers were positively associated with students' test scores (Duflo, Dupas, & Kremer, 2015), but, monetary incentives alone did not improve test performance among public-schools students (Kingdon & Teal, 2007). Many Indian states have used para-teachers, who are less qualified and are paid less, to reduce pupil-to-teacher ratios, with mixed results for pupil test performance (Govinda & Bandyopadhyay, 2008; Kingdon, 2007).

The potential to improve school attendance and performance by providing *incentives* to children and their families is of interest in higher- and lower-income countries. In a systematic review, cash transfers improved school enrolment, attendance, and completion, but not learning outcomes (Snilstveit et al., 2016). In lower-income countries, including India, incentives to attend school, such as food and books, were associated with improvements in enrolment, grade attainment, and test scores (Dreze & Kingdon, 2001; Glewwe, Kremer, & Moulin, 2009). In Bihar, India, a programme that offered secondary-school girls bicycles to travel to school increased their enrolment by 30 per cent (Muralidharan, 2017). Provision of textbooks may be especially important for poorer students (UNESCO, 2004).

A number of studies cited above were randomised controlled trials (RCTs) that tested specific interventions for schools or villages while also following an untreated control group. These studies have isolated the effects of very discrete interventions in education, including student tracking, additional teachers, attendance grants, (Duflo et al., 2015), providing average school test scores to parents (Andrabi et al 2017), and providing remedial education and computer assisted instruction (Banerjee et al., 2007). However, there remains a need for observational studies because of limitations to RCTs highlighted by Deaton and Cartwright (2018) and Banerjee et al. (2017), among others; site-selection bias, equilibrium effects, political reactions and piloting bias limit external validity of RCTs. The use of observational data of actual, implemented investment policies remains essential.

3. Study context: public investments in primary education in India

Since independence, the government of India has committed to achieve universal primary education for all children. India's 1968 and 1986 National Policy on Education called for 'strenuous efforts' to achieve 'free and compulsory education for all children up to the age of 14' and to improve education quality (Tilak, 1996). Through a 2002 Constitutional amendment and the 2009 The Right of Children to Free and Compulsory Education (RTE) Act, India declared free and compulsory elementary education a fundamental right of children ages six to 14 years (Bajpai, 2018).

Commensurate to these commitments, the government has invested heavily to achieve universal access, retention, and achievement for all primary school-age children. Since 2002, the government raised investments in education further, spending 12.7 per cent of total expenditures on education (Crost & Kambhampati, 2010). India introduced a number of centrally sponsored educational interventions including Operation Blackboard for small rural schools (1986), Total Literacy Campaigns (1988), District Primary School Education Program (1994–2002), and mid-day meal schemes. Launched in 1987, Operation Blackboard, specified that an additional teacher be assigned to one-teacher primary schools and 'teaching-learning-materials' (TLM) packets be provided to primary schools (Chin, 2005) with learning materials and equipment or money (about 500 Rupees, ~ US$13). Also available to schools are 'development grants' for the repair and maintenance of equipment, furniture and musical instruments, school beautification, and overall environmental enhancement, in the range of 1,000 Rupees (~ US $26). Government investments subsidise the costs of schooling, especially for disadvantaged children, by providing tuition-free primary schooling and offering various incentives: since 1986, about half of primary schools offered free textbooks and uniforms to poor children and a quarter provided free midday meals to encourage daily attendance (The PROBE Chin, 2005; Team, 1999). Some districts provide other incentives such as bicycles for poor children or girls.

India's primary education system is one of the largest in the world, with 1,191,719 primary schools in 2013–2014 (Bureau of Planning, Monitoring and Statistics, 2014). In 2005, 93 per cent of the rural population lived within one kilometre of a primary school (Chin, 2005), though many of these facilities are single-room and single-teacher schools with minimal infrastructure and the number of teachers has been increased, though many of these teachers were para-teachers (Govinda & Bandyopadhyay, 2008). Consequently, India has significantly increased school enrolment and reduced drop-out rates (Department of Education, 2008; Kingdon, 2007). However, between-state disparities are large, with persistent North-South differences. Two-thirds of the out-of-school children of India live in five of the poorest states of Bihar, Uttar Pradesh, West Bengal, Madhya Pradesh, and Rajasthan (Asadullah & Yalonetzky, 2012; Dougherty & Herd, 2008). State governments (and the central government) provide resources to districts, however, primary school planning ultimately resides with the district (Clots-Figueras, 2011).

4. Data

We used two nationally representative datasets: the 2005 India Human Development Survey (IHDS) and the 2004–2005 District Information Survey for Education (DISE). The IHDS collected information on health, education, employment, economic status, marriage, fertility, gender relations, and social capital from 41,554 households in 1,503 villages and 971 urban neighbourhoods across India (Desai, Vanneman, National Council of Applied Economic Research & IHDS, 2005). The primary sampling units (PSUs) were villages and urban blocks. In urban areas, a random sample of households was drawn; the rural sample consisted of a sample of households from the Human Development Profile of India 1993–1994 survey, refreshed to ensure a nationally representative sample. The IHDS was the first nationally representative study in India to collect direct assessments of reading, writing, and arithmetic in children's homes rather than in schools, thus including children who were not attending school. The non-profit organisation Pratham developed the assessment tools, with local consultation and informed by material taught during the first three years of school and pretested widely. Trained assessors administered the tests in one of 13 languages chosen by the child (Desai, Dubey, Vanneman, & Banerji, 2008). We used the IHDS for outcome measures of academic achievement among children and for control variables on characteristics of the children, their households, and their schools.

The sample for this analysis was children aged 8–11 years. Seventy-two per cent of eligible children participated in interviewer-administered reading, writing, and mathematics assessments. Participation was lower in these modules because interviewers sought parental consent and child assent and were careful not to pressure children to participate; also, this was the last module of a long household survey, and some households stopped the interview before completing this module and children not enrolled in school and from poorer households had lower participation in the tests (Desai et al., 2008).

Reading performance was measured on a five-point scale: (1 = cannot read at all; 2 = can read letters but not form words; 3 = can put letters together to read words but not read whole sentences; 4 = can read a short paragraph of two to three sentences but not fluent enough to read a whole page; 5 = can read a one page short story). The IHDS writing test indicated whether children could write a simple sentence such as ‘I like blue color’ (0 = cannot write; 1 = writes with two or fewer mistakes). Arithmetic performance was measured on a four-point scale (1 = cannot read numbers above 10; 2 = can read numbers up to 99 but cannot do more complex number manipulation; 3 = can subtract a two-digit number from another; 4 = can divide a number between 100 and 999 by another number between one and nine). Using information on the child’s age and grades completed, we created a variable of age-appropriate grade progression – that is, having completed the appropriate number of years assuming they began school at age six. Grade progression is a measure of engagement in schooling, not necessarily learning (Asadullah & Chaudhury, 2015).

We include the following controls: *child characteristics* are age in years, gender, age-order among the household’s children, and the language of testing; *household characteristics* are socio-economic quintile based on ownership of 30 household goods and assets, household caste/religion (Brahmin or High Caste; OBC [Other Backward Classes]; Dalit or Adivasi; Muslim; and Sikh, Jain or Christian), and the highest grade completed by any adult man and by any adult woman in the household; *school characteristics* were type of school attended (government, private, other, or not in school) and distance to school in kilometres; *district characteristics* were average test ranking percentile of IHDS respondents, share population living in urban areas, per cent of the population from scheduled castes or tribes, sex ratio of the population, geographic region (North, Central, East, Northeast, West, or South), and decadal population growth rate.

On average, children were 9.5 years old (Table 1). Almost a third of children were living below the official poverty line and two thirds were social or ethnic minorities (scheduled-caste, scheduled-tribe and ‘Other Backward Classes’). On average, the adult men in children’s households had completed 6.3 grades of school, and the adult women 3.6 grades of school. About 81 per cent of children attended government schools and lived, on average, 1.5 kilometres from school.

Objective assessments showed wide variation in children’s academic achievement. In tests of reading and writing, the largest percentage could read stories (33%) and write three sentences correctly (68%), but 10 per cent could not read at all, and a third could not write. On arithmetic tests, 18 per cent demonstrated no numeracy, over a third knew the numbers up to 99, and another 22 per cent could perform all basic arithmetic skills. About 70 per cent were at the age-appropriate grade or above.

The DISE provides district-level measures of inputs to schooling – the exposure variables of interest – and additional control variables. The DISE is a unique source of data on recognised schools with grades I–VII and on the children attending these schools. Data are collected on infrastructure and receipt of grants; teacher diversity, quality, quantity, and tenure; incentives offered to children; and pupil diversity and performance. In 2005, the DISE had almost complete coverage of India, with 581 districts in 29 States and Union Territories. For this analysis, we only used information on primary-only schools. The IHDS and DISE data were matched on district name. Children living in a district not covered by the DISE in 2005 (n = 374) were dropped.

Table 2 presents average child’s exposure to various government investments. One in five schools had been established since 1995, and most schools had: at least one building (97%), pucca building materials (83%), more than one classroom (89%), classrooms in good condition (65%), and at least one blackboard (95%). Most schools received development (76%) and TLM grants (69%). However,

Table 1. Descriptive statistics, children aged 8–11 years in India, 2004–2005

(n = 16,784)	Mean	(SE)
Child in-home test performance and grade progression		
Reading:		
Cannot read	0.10	(0.01)
Reads letters	0.14	(0.00)
Reads words	0.21	(0.01)
Reads paragraphs	0.22	(0.01)
Reads stories	0.33	(0.01)
Writing:		
Cannot write	0.32	(0.01)
Writes with <3 mistakes	0.68	(0.01)
Math:		
No numeracy	0.18	(0.01)
Knows numbers	0.34	(0.01)
Subtraction	0.26	(0.01)
Division	0.22	(0.01)
Academic progression:		
Behind for age (including those not in school)	0.19	(0. 01)
On schedule or ahead for age	0.81	(0. 01)
Child characteristics		
Age	9.49	(0.01)
Girl	0.48	(0.01)
Age order among household children	2.45	(0.03)
Household characteristics		
Economic situation		
Household assets, count	10.42	(0.12)
Living in poverty	0.31	(0.01)
Caste/Religion		
Brahmin or high caste	0.18	(0.01)
OBC (other backward classes)	0.36	(0.01)
Dalit (scheduled castes) or Adivasi (scheduled tribes)	0.31	(0.01)
Muslim	0.14	(0.01)
Sikh, Jain, or Christian	0.02	(0.01)
Parent's Education		
Highest years completed by men >age 21	5.72	(0.08)
Highest years completed by women >age 21	3.39	(0.08)
School characteristics		
School type		
Government	072	(0.01)
Government-aided school	0.03	
Private	0.21	(0.01)
Other (convent, madrassa, EGS, other/open school or junior college)	0.03	(0.01)
Distance to school (km)	1.36	(0.03)

Note: Statistics estimated using survey-adjusted weights.
Source: IHDS (2005).

only a minority of students attended schools with gender-separate toilets 0.31 per cent and pre-primary programmes, 18 per cent. The average child lived in a district where the mean teacher-to-pupil ratio was low (2.6%), 85 per cent of students had schools with more than one teacher, but 34 per cent had no female teachers. On average, children lived in districts in which 91 per cent of teachers were permanent (not *para-teachers)*, but only 40 per cent of teachers had at least secondary-school training. On average, children lived in districts where 19 per cent of pupils received incentives to attend school, 64 per cent received free books, 4 per cent received free stationery, and 8 per cent received free uniforms.

Table 2. School descriptive statistics matched to IHDS resident children in India, 2004–2005

(n = 16,784)	Mean/Prop	(SE)
Prop. Urban	0.26	(0.01)
Sex ratio, females to 1,000 males	931.10	(1.74)
Prop. scheduled caste or scheduled tribe	0.29	(0.01)
Decadal growth rate	925.67	(1.36)
District-level academic performance		
Performance percentile rank for district IHDS		
Respondents	27.09	(18.62)
Net enrollment rate	49.42	(20.04)
General enrollment rate	86.78	(23.37)
District-level governmental investments in schooling		
School infrastructure (proportion of)		
schools established since 1995	0.22	(0.01)
schools with ≥1 building	0.97	(0.01)
schools made of pucca	0.82	(0.01)
schools with gender-separate toilets	0.30	(0.01)
schools with >1 classroom	0.88	(0.01)
classrooms in good condition	0.65	(0.01)
pupils in schools with ≥1 blackboard	0.95	(0.01)
schools with pre-primary programs	0.18	(0.01)
Grants to schools		
schools receiving development grants	0.24	(0.01)
schools receiving TLM grants	0.69	(0.01)
Teachers		
Teachers/100 pupils	2.59	(0.04)
Prop. schools with >1 teacher	0.85	(0.01)
Prop. schools with ≥female teacher	0.65	(0.01)
Prop. teachers that are permanent teachers	0.88	(0.01)
Prop. teachers with in-service training	0.58	(0.01)
Prop. teachers who are ≥secondary school graduates	0.40	(0.01)
Incentives for children		
Incentives to attend/pupil	0.10	(0.01)
Free books/pupil	0.64	(0.01)
Free stationery/pupil	0.04	(0.01)
Free uniforms/pupil	0.08	(0.01)

Note: Survey-adjusted weights based on IHDS respondents.
Source: DISE 2004–2005

5. Econometric framework

5.1. Principal components

Given the large number of dichotomous investment measures, we used principal components analysis (PCA) to create composite scores by type: *school infrastructure, grants to schools, teacher* number and training, and *incentives* to children or parents. The Chronbach's alphas and Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy for each of these scores were, respectively: 0.57 and 0.65 for school infrastructure, 0.90 and 0.50 for grants to schools, 0.47 and 0.58 for teacher quantity and quality, and 0.41 and 0.50 for incentives to pupils. These measures of fit, while lower than ideal, provide a sufficiently parsimonious aggregation of investment types.

5.2. Border fixed effects

A central challenge to any observational study is finding exogenous variation in the explanatory variables of interest. Unobserved heterogeneity could generate spurious correlations between levels of investment and test scores. For example, wealthier states can collect more tax revenue from their more affluent citizens and spend it on schooling. If children of more affluent households do better in school because they get more instruction at home, are better nourished, or have fewer chores, then we might spuriously associate public investments with greater skill attainment. Conversely, central or state governments may target disadvantaged or poorly performing districts with investments, this purposive placement could understate the efficacy of investments.

We propose to exploit variation in expenditures generated by state administrative boundaries. If economic performance, parental education, cultural norms, and so forth vary continuously over space we might expect that people adjacent to a political boundary will be similar but for their exposure to state investments. This methodology has been employed to test the value of education quality (Bayer, Fernando, & McMillan, 2007; Black, 1999) and the effect of state labour policies (Holmes, 1998). Even if district expenditures just reflect median-voter preferences or per-capita income at the state level, they can generate exogenous variation at the frontier. If states are simply conduits for national funding that is allocated purposively to poorer or less educated states, employing a border discontinuity can still generate plausibly exogenous variations. For example, one district may have the poorest schooling outcomes in its state and receive a lot of funding, and the adjoining district, with otherwise similar levels of educational attainment, may have the best schooling outcomes in its (relatively poorer) state and receive comparatively little funding. We highlight this identification framework in Figure 1.

Given the very low rates of spatial mobility in India (Munshi & Rosenzweig, 2009), we discount the possibility that people sort themselves across borders based on their tastes for educational investment.

To operationalise the border analysis, we limited the sample to districts that abut at least one state border. We then created a fixed-effect dummy variable for each border pair. If a district abuts more than one state border, we employ the following tie-breakers, conditional on maximising the number of border pairs: 1) allocate districts to the state border that touches the most district sub-regions (Talukas); and 2) the longest common border length. This process generates 51 distinct border pairs from India's 33 states and includes 10,308 IHDS children. Figure 2 presents India's state and district boundaries and our generated border pairs.

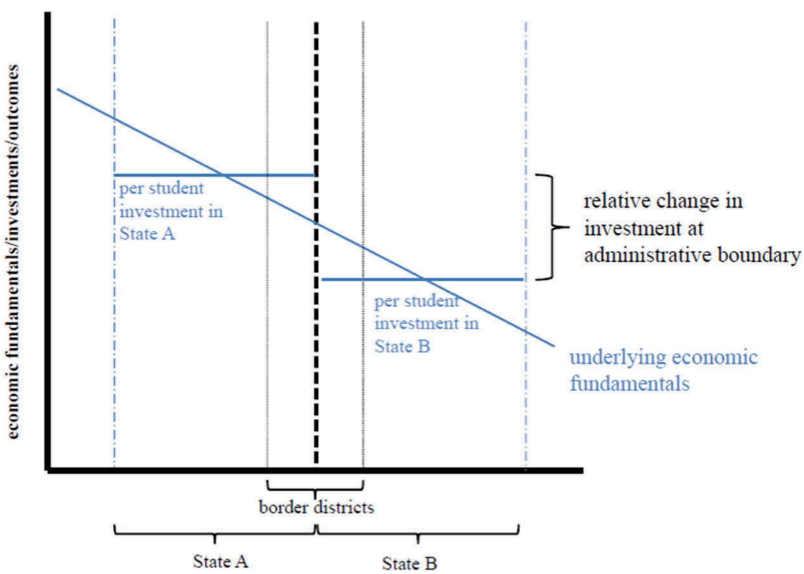

Figure 1. Border discontinuity design.

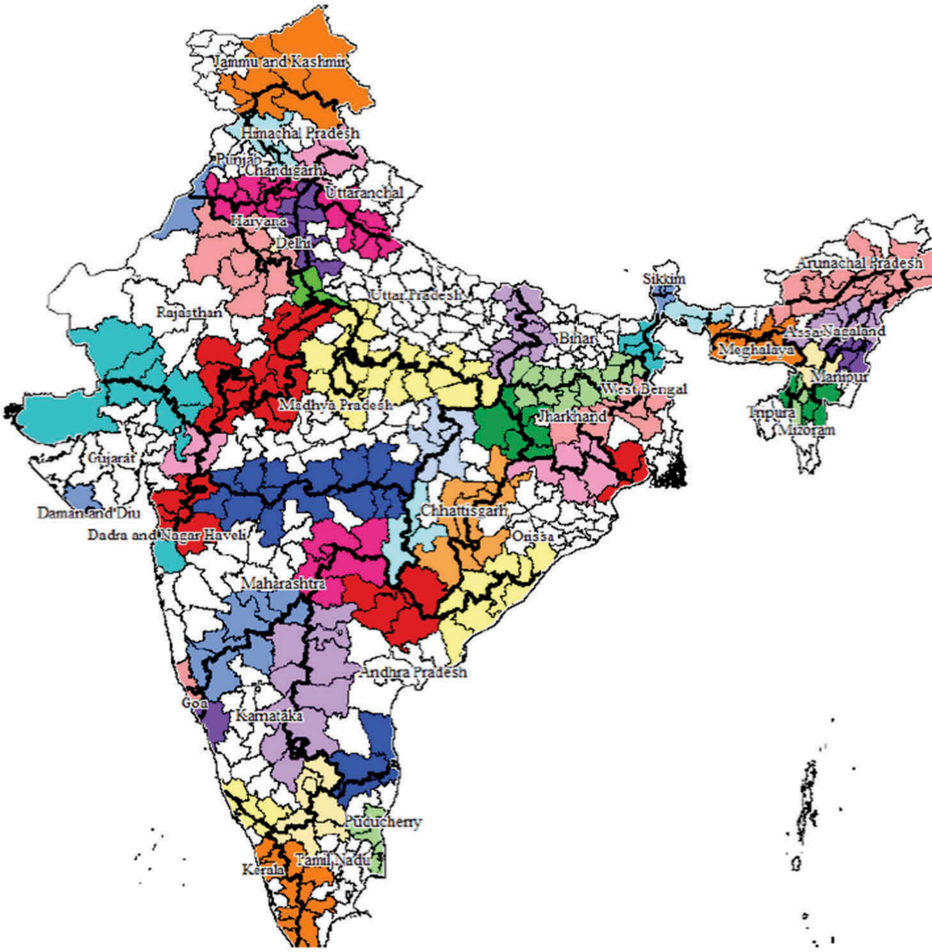

Figure 2. Analysis of districts across state boundaries of India.
Notes: Shaded areas identify border matched pairs. White districts do not abut a state border and are excluded from the analysis.

The identifying assumption is that state-level allocation decisions can generate meaningful variation at state borders. However, states could be carefully targeting the type and levels of expenditures at the district level such that expenditures are not discontinuous at state borders. To check for this, we first regress our independent variables of interest – attendance incentives, teachers, schools, and grants – on a rich set of district average covariates: average adult educational attainment for men and women, caste shares, average household assets, the share of the population that is poor, female, urban, the average distance to school and student age, and latitude and longitude. Table 3 Panel A presents the R^2 statistic for these regressions with and without state dummies. Despite a rich set of control variables, state fixed effects alone can explain between one fifth to half the variation in public investments.

Panel B replicates this specification but limits the sample to districts abutting state borders and includes border pair dummies. Again, state fixed effects dramatically improve model fit absorbing more than half of the variation in incentives and teachers' investments, more than a third of the variation in structure investments and just under a fifth of the variation in grants. Row 4 presents the F statistic on the test of the null hypothesis that state dummies as a whole do not explain variation in educational investments.

Table 3. Predicting district-level variation in public educational investment with and without state fixed effects

Panel A: Without border FE			Incentives	Teachers	Schools	Grants
without state FE	(1)	R^2	0.229	0.594	0.458	0.281
with state FE	(2)	R^2	0.766	0.86	0.839	0.473
	(3)	dif. R^2	0.537	0.266	0.381	0.192
	(4)	F stat/state FE	36.26	29.86	37.395	5.75
	(5)	N	358	358	358	358
Panel B: With border FE			**Incentives**	**Teachers**	**Schools**	**Grants**
without state FE	(1)	R^2	0.232	0.626	0.519	0.413
with state FE	(2)	R^2	0.899	0.876	0.839	0.616
	(3)	dif. R^2	0.667	0.25	0.32	0.203
	(4)	F stat/state FE	19.96	17.35	17.08	4.55
	(5)	N	223	223	223	223

Notes: Panels A and B present select summary statistics for regression estimates of district-level public educational investments with and without border-pair fixed effects. Each regression controls for average adult educational attainment for both men and women in the district, share of the population in each caste, average household assets, the share of the population that is poor, female, urban, the average distance of respondent households to school, the average age of students in the household, and latitude and longitude. The second table include border dummy fixed effects.

Table 3(b) replicates the specification for just the border-pair districts. This is the residual variation we rely upon to identify the effects of school investments on achievement. Even with these fine controls for geography, state of residence remains one of the strongest determinants of exposure to various types of investments.

5.3. Selection correction

To account for some children's non-participation in the testing, as described above, we employ a Heckman probit selection correction employing two excluded variables that we believe are exogenous with respect to academic skills – whether the student consented to anthropometry –, the measurement of height and weight and the number of individuals in the household, because the IHDS collects information on household members, larger households had longer surveys and so may be less willing to also participate in the child tests at the end. F-tests indicated that these variables combined predict selection into the sample. The Wald tests for independent equations indicated that the selection correction is required for reading and arithmetic and may be prudent for writing and grade level (Appendix Table 1A).

6. Findings

6.1. Governmental investments in schooling and children's academic achievement

Table 4 presents the average marginal effects for each category of investments, after controlling for other characteristics of the child, household, and school, limiting the sample to border districts, and adding border-pair fixed effects. Standard error estimates are clustered at the district level of coefficient estimates are available in Supplemental Materials. In Panel A, incentives directed to students and investments in teachers are associated with greater math skills. A marginal increase in incentives raises the probability that a child can do division by almost two percentage points. To provide some context, the marginal effect of an additional year of schooling for the most educated women in the household (often the mother and a strong predictor of educational attainment), was 0.6

Table 4. Average marginal effects of public school investments on arithmetic, reading, writing, and grade progression

Panel A: Arithmetic					Panel B: Reading Ability				
	Incentives	Teachers	Schools	Grants	Can read...	Incentives	Teachers	Schools	Grants
can't read numbers	−0.017**	−0.009^{+}	−0.003	−0.01	Nothing	−0.011**	−0.004	0.000	−0.013**
	(0.005)	(0.005)	(0.005)	(0.007)		(0.003)	(0.004)	(0.004)	(0.004)
knows numbers 0–100	−0.009**	−0.004^{+}	−0.001	−0.005	Letters	−0.008**	−0.003	0.000	−0.009**
	(0.002)	(0.002)	(0.002)	(0.003)		(0.002)	(0.003)	(0.003)	(0.003)
can add/subtract	0.006**	0.003^{+}	0.001	0.004	Words	−0.005**	−0.002	0.000	−0.006**
	(0.002)	(0.002)	(0.002)	(0.002)		(0.001)	(0.002)	(0.002)	(0.002)
can do division	0.02**	0.010^{+}	0.003	0.012	Paragraphs	0.001**	0.000	0.000	0.001**
	(0.005)	(0.006)	(0.006)	(0.008)		(0.000)	(0.000)	(0.000)	0.000
					Stories	0.024**	0.008	0.000	0.027**
						(0.006)	(0.008)	(0.008)	(0.009)
Panel C: Writing Ability					Panel D: Grade Progression				
Writing	Incentives	Teachers	Schools	Grants		Incentives	Teachers	Schools	Grants
can write	0.012^{+}	0.024**	0.025**	0.022^{+}	at grade level	0.019**	0.008	−0.009	−0.005
	(0.007)	(0.008)	(0.009)	(0.013)		(0.005)	(0.009)	(0.006)	(0.009)

Notes: N = 10,207. Each Panel presents the average of marginal effects of four types of public investments on academic achievement based on coefficient estimates from Heckman ordered probits (Panels A and B) and Heckman probit models (Panels C and D). Standard errors clustered by district in parentheses. The sample is limited to districts adjacent to state borders. Specifications include border dummies, latitude and longitude, region dummies, the share of the district that is urban, and children's age, gender, adults' education, poverty, age order, caste of the students and school type. Coefficient estimates available in Supplementary Materials. $^{+,*,**}$ indicate Z-scores for a two-sided test of the underlying parameter estimate is significantly different from zero at the 10, 5 and 1 per cent level respectively, when using standard errors clustered by district.

Source: IHDS, 2005 and DISE, 2004–2005.

percentage points. Investments in teachers were also positive, but more modest. Investments in schools and grants do not appear to improve arithmetic ability.

Panel B presents the average marginal effects of investments for reading performance. Incentives again, as well as in grants to schools, are associated with greater literacy. Marginal increases in attendance incentives and grants are associated with a higher probability that a child can read whole stories by around 2.5 percentage points. The magnitude of these effects is similar to adding almost three years to mother's education and would off-set more than half the effect of living in poverty. Investments in teachers and school infrastructure do not appear to improve reading ability.

Panel C presents the marginal effects of investments on the probability that a child can write. Investments in schools and teachers appear to be the most consequential, associated with a greater likelihood that a child can write by about 2.5 percentage points. Writing is the only academic skill associated with better school infrastructure. Incentives are roughly half as effective as the other investments.

Finally, Panel D presents the average marginal effect of investments on the probability that the child is at grade level. Again, this outcome is problematic. Grade promotion could be another measure of skill acquisition, but bad teachers or weak administration could promote students in the absence of learning or public investments could attract weaker students to attend school where they may be placed in a lower grade. Incentives are associated with more children being at or above their age appropriate grade. Investments in teachers, schools, and grants do not increase the likelihood of being at grade level.

6.2. Disaggregated investments

In Table 5, we present similar specifications to the above, but provide the estimated marginal effects for discrete government investments. While estimates are noisy and the resulting coefficient estimates often insignificant, the results are generally consistent. Columns 1 and 2 present the marginal effects derived from ordered probits on arithmetic and reading and Columns 3 and 4 present marginal effect of specific investments on writing and grade progress.

No measure of school infrastructure, nor grants, were associated with arithmetic skill. Children with more qualified teachers could do more math. The share of students receiving free uniforms was most associated with improved arithmetic skills.

The results for reading skills are broadly similar to those for math skills. Districts with more new schools, or built with pucca, and schools with pre-primary programmes actually have weaker reading skills. No investments in teacher quality improve reading. More schools receiving TLM grants was associated with greater reading ability as was the share of students receiving free stationary.

Having newer and bigger schools and gender-separated toilets in the district were associated with greater probability that a child could write. A higher teacher-to-student ratio was also associated with the probability a child could write. The effect of incentives was mixed. Providing more free books was, strangely, associated with fewer children being able to write, but providing free uniforms was associated with higher probability a child could write.

Column 4 presents the average marginal effect of an increase in specific school investments on the probability a child is at the age-appropriate grade level, again, with the above caveats. Children in districts with a larger fraction of new schools and/or better-made schools were less likely to be on-track. However, kids in districts with bigger schools with more buildings and/or more classrooms were more likely at grade level. Given that these infrastructure investments were not associated with the in-home measures of skill, we wonder if larger schools, perhaps with more grade-separated classrooms, increases the pressure to promote students irrespective of learning.

A higher teacher-to-student ratio and more teacher training were associated with more students being at grade level. However, having fewer one-teacher schools was associated with less grade progression. Having at least one female teacher was also associated with less grade progression.

Table 5. Dis-aggregated marginal effects of public investments on academic skills and grade progress

	(1) Arithmetic				(2) Can read at least…						
	cannot read numbers	knows numbers 0–100	can add/ subtract	can do division	nothing	Letters	words	para- graphs	Stories	(3) Can Write	(4) Grade Progression
School infrastructure (share of)											
schools established since 1995	0.095**	0.047**	−0.034**	−0.108**	0.071*	0.072*	0.049*	−0.005*	−0.188*	0.119*	−0.124*
schools with ≥ 1 building	0.149	0.074	−0.053	−0.17	−0.085	−0.086	−0.059	0.006	0.224	0.55	0.550**
schools made of pucca	0.027**	0.013**	−0.009**	−0.03**	0.094**	0.095**	0.065**	−0.006**	−0.248**	−0.046	−0.278**
schools with > 1 classroom	0.044	0.022	−0.015	−0.05	−0.063	−0.064	−0.044	0.004	0.166	0.236^{+}	0.166*
classrooms in good condition	0.016	0.008	−0.006	−0.019	−0.045	−0.046	−0.031	0.003	0.119	−0.161^{+}	0.056
≥1 blackboard	−0.022	−0.011	0.008	0.025	−0.097	−0.098	−0.067	0.006	0.255	−0.137	0.039
gender-separate toilets	−0.103	−0.051	0.037	0.118	0.011	0.012	0.008	−0.001	−0.03	0.224**	0.079^{+}
pre-primary programs	0.025**	0.014**	−0.01**	−0.033**	0.05**	0.05**	0.035**	−0.003**	−0.131**	−0.103^{+}	0.036
Improvement grants given to schools (share of)											
development grants	0.048	0.024	−0.017	−0.055	0.006	0.006	0.004	0.000	−0.015	−0.114	0.002
schools receiving TLM grants	−0.006^{+}	−0.003^{+}	0.002^{+}	0.006^{+}	−0.039^{+}	−0.039^{+}	−0.027^{+}	0.003^{+}	0.102^{+}	0.039	−0.009
Teacher quantity and quality (ratio/share of)											
teachers/100 pupils	−0.005	−0.002	0.002	0.005	−0.005	−0.005	−0.003	0.000	0.013	0.027^{+}	0.026**
at least one female teacher	0.132**	0.066**	−0.047**	−0.151**	0.007**	0.007**	0.005**	0.000**	−0.019**	0.071	−0.140**
more than one teacher	−0.078	−0.039	0.028	0.089	−0.016	−0.016	−0.011	0.001	0.043	0.071	−0.286**
permanent teachers	−0.082	−0.041	0.029	0.093	0.019	0.019	0.013	−0.001	−0.049	−0.036	0.067
teachers with in-service training	0.065	0.032	−0.023	−0.074	−0.03	−0.03	−0.021	0.002	0.078	0.103	0.189*
teachers' education ≥ secondary	−0.072^{+}	−0.036^{+}	0.026^{+}	0.082^{+}	0.015	0.015	0.01	−0.001	−0.039	0.051	0.033
Incentives given to pupils											
incentives to attend/ pupil	0.025	0.012	−0.009	−0.029	−0.004	−0.016	−0.011	0.001	0.04	−0.023	−0.05
free books/pupil	−0.008	−0.004	0.003	0.009	0.010	0.017	0.011	−0.001	−0.043	−0.120*	0.048*
free stationery/pupil	−0.008	−0.004	0.003	0.009	−0.063**	−0.069**	−0.047**	0.004**	0.181**	0.067	0.021
free uniforms/pupil	−0.166**	−0.082**	0.059**	0.189**	−0.021	−0.021	−0.015	0.001	0.055	0.216**	−0.018

Notes: $^{+}$, *, ** indicate Z-scores for a two-sided test of the underlying parameter estimates are significantly different from zero at the 10, 5 and 1 per cent level respectively when using standard errors clustered by district. Tables with all covariates and standard errors available from the authors upon request. Select coefficient estimates available in Supplementary Materials.

Increasing the number of children receiving free books increased the probability that a child was making adequate grade progress.

These results are robust in samples limited to children attending government schools, using survey-weight-adjusted logistic and ordered logistic regressions in lieu of the Heckman-corrected models. Results available in Supplemental Materials.

7. Conclusions

Faced with limited resources and a pressing need to improve education, policy-makers in lower-income countries must identify the best ways to deploy money, effort, and attention. Accounting for family resources and child, school, and observed and unobserved community characteristics, we find that student and parent incentives are associated with academic skill acquisition and grade progress. Specifically, children in districts distributing more books and uniforms demonstrated higher arithmetic and reading skills, the ability to write, and were in the appropriate grade. We note that student incentives are aimed at poor and disadvantaged students. Thus, our *a priori* expectation was that the level of incentives in a district would largely capture the presence of poverty in the district and would be biased downward. The fact that many incentives remain positively associated with pupil outcomes is encouraging. TLM grants to schools were associated with better literacy and numeracy skills. More and better-trained teachers also appeared to increase some skill acquisition and improve grade progress. Learning associated with investments in school infrastructure were more limited in scope.

Some limitations of this study provide guidance for future research. First, our skill assessments, while clean and independently assessed, are still very coarse. Longer, incentivised tests would better delineate learning. While we control for a wide set of socio-economic and geographic variables that may be determinants of academic achievement, we do not have longitudinal data on children's performance, which would allow us to construct a value-added measure of the education production function and to difference out time-invariant determinants. New investments may be directed to the neediest districts; such endogenous placement would lead us to under-estimate the benefits of such investments. Also, while much of the variation in educational investments appears to originate at the state level, we know from other work that there is considerable heterogeneity within state in school performance (Das, Pandey, & Zajonc, 2012). Still, given the obviously modest costs associated with student incentives and school improvement grants, and the likely policy endogeneity of these interventions, these programmes appear to be highly efficacious. Spending on school buildings may be a lesser priority.

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ORCID

Chris Cunningham http://orcid.org/0000-0002-0278-0069

Solveig A. Cunningham http://orcid.org/0000-0002-2354-1526

References

Alderman, H., Orazem, P. F., & Paterno, E. M. (2001). School quality, school cost, and the public/private school choices of low-income households in Pakistan. *The Journal of Human Resources*, *36*, 304–326.

Andrabi, T., Das, J., & Khwaja, A. I. (2017). Report cards: The impact of providing school and child test scores on educational markets. *American Economic Review*, *107*, 1535–1563.

Angrist, J. D., & Guryan, J. (2004). Teacher testing, teacher education, and teacher characteristics. *American Economic Review*, *94*, 241–246.

Asadullah, M., & Chaudhury, N. (2015). The dissonance between schooling and learning. *Evidence from Rural Bangladesh Comparative Education Review*, *59*, 447–472.

Asadullah, M. N., & Yalonetzky, G. (2012). Inequality of educational opportunity in India: Changes over time and across states. *World Development*, *40*, 1151–1163.

Bajpai, A. (2018). *Child rights in India: Law, policy, and practice*. Oxford, United Kingdom: Oxford University Press.

Banerjee, A., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukerji, S., . . . Walton, M. (2017). From proof of concept to scalable policies: Challenges and solutions, with an application. *The Journal of Economic Perspectives*, *31*, 73–102.

Banerjee, A., Somanathan, R., & Pande, R. (2007). The political economy of public goods: Some evidence from India. *Journal of Development Economics*, *82*, 287–314.

Bayer, P., Fernando, F., & McMillan, R. (2007). *A unified framework for measuring preferences for schools and neighborhoods* (NBER Working Paper 13236). Cambridge, MA: National Bureau of Economic Research.

Behrman, J. R. (2009). Investment in Education – Inputs and Incentives. In D. Rodrik & M. R. Rosenzweig (Eds.), *Handbook of development economics: The economics of development policy* (pp. 4883–4975). Amsterdam: North-Holland Publishing Co.

Behrman, J. R., Hoddinott, J., Maluccio, J. A., Soler-Hampejsek, E., Behrman, E. L., Martorell, R., . . . Stein, A. (2010). *What determines adult skills? Impacts of pre-school, school-years and post-school experiences in Guatemala*. Philadelphia, PA: University of Pennsylvania Mimeo.

Betts, J. R., & Shkolnik, J. L. (1999). The effects of ability grouping on student math achievement and resource allocation in secondary schools. *Economics of Education Review*, *19*, 1–15.

Black, S. E. (1999). Do better schools matter? Parental valuation of elementary education. *The Quarterly Journal of Economics*, *114*, 577–599.

Burde, D., & Linden, L. L. (2013). Bringing education to Afghan girls: A randomized controlled trial of village-based schools. *American Economic Journal: Applied Economics*, *5*(3), 27–40.

Bureau of Planning, Monitoring and Statistics. 2014. *Education at a glance*. Retrieved from http://mhrd.gov.in/sites/upload_files/mhrd/files/statistics/EAG2014_0.pdf

Casassus, J., Cusato, J., Froemel, J. E., & Palafax, J. C. (2000). First international comparative study of language, mathematics, and associated factors for students in the third and fourth grade of primary school. In *Latin American laboratory for assessment of quality in education*. Santiago, Chile: ICFES/UNESCO. Retrieved from http://unesdoc.unesco.org/images/0012/001231/123143eo.pdf

Chin, A. (2005). Can redistributing teachers across schools raise educational attainment? Evidence from operation blackboard in India. *Journal of Development Economics*, *78*, 384–405.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2007). *How and why do teacher credentials matter for student achievement?* (NBER Working Paper W12828). Cambridge, MA: National Bureau of Economic Research.

Clots-Figueras, I. (2011). Women in politics: Evidence from the Indian States. *Journal of Public Economics*, *95*, 664–690.

Crost, B., & Kambhampati, U. (2010). Political market characteristics and the provision of educational infrastructure in North India. *World Development*, *38*, 195—204.

Das, J., Pandey, P., & Zajonc, T. (2012). Learning levels and gaps in Pakistan: A comparison with Uttar Pradesh and Madhya Pradesh. *Economic and Political Weekly*, *47*, 228–240.

Deaton, A., & Cartwright, N. (2018). Understanding and misunderstanding randomized controlled trials. *Social Science & Medicine*, *210*, 2–21.

Department of Education. (2008). *Educational statistics at a glance*. New Delhi, India: Government of India, Ministry of Human Resource Development, Department of Higher Education. Retrieved from http://mhrd.gov.in/sites/upload_files/mhrd/files/statistics/NLES%20-%20At%20a%20Glance.pdf

Desai, S., Dubey, A., Vanneman, R., & Banerji, R. (2008). Private schooling in India: A New educational landscape. *India Policy Forum*, *5*, 1–58.

Desai, S., Vanneman, R., & National Council of Applied Economic Research, New Delhi. India Human Development Survey (IHDS). (2005). *ICPSR22626-v8*. Ann Arbor, MI: Inter-University Consortium for Political and Social Research [distributor], 2010-06-29.

Dougherty, S., & Herd, R. (2008). *Improving human capital formation in India* (OECD Economics Department Working Papers. No. 625). doi:10.1787/241005853765.

Dreze, J., & Kingdon, G. G. (2001). School participation in rural India. *Review of Development Economics*, *5*, 1–24.

Duflo, E., Dupas, P., & Kremer, M. (2015). School governance, teacher incentives, and pupil-teacher ratios: Experimental evidence from Kenyan primary schools. *Journal of Public Economics*, *123*, 92–110.

Filmer, D. (2007). If you build it, will they come? School availability and school enrolment in 21 poor countries. *Journal of Development Studies*, *43*, 901–923.

Gamoran, A., & Long, D. A. (2006). *Equality of educational opportunity* (WCER Working Paper, p. 9).

Glewwe, P., Hanushek, E. A., Humpage, S. D., & Ravina, R. (2011). *School resources and educational outcomes in developing countries: A review of the literature from 1990 to 2010* (NBER Working Paper Series). Cambridge, MA: National Bureau of Economic Research.

Glewwe, P., & Kremer, M. (2007). Schools, teachers, and education outcomes in developing countries. In E. A. Hanushek & F. Welch (Eds.), *Handbook of the economics of education*. Amsterdam: North-Holland.

Glewwe, P., Kremer, M., & Moulin, S. (2009). Many children left behind? Textbooks and test scores in Kenya. *American Economic Journal: Applied Economics*, *1*, 112–135.

Goldhaber, D., & Anthony, E. (2003). *Teacher quality and student achievement*. New York, NY: Eric Clearinghouse on Urban Education.

Govinda, R., & Bandyopadhyay, M. (2008). *Access to elementary education in India: Country analytical review*. Brighton, UK: Create, Consortium for Research on Educational Access, Transitions, & Equity.

Grissmer, D. (1999). Conclusion–class size effects: Assessing evidence, its policy implications, and future research agenda. *Educational Evaluation and Policy Analysis*, *21*, 231–248.

Handa, S., & Simler, K. R. (2006). Quality or quantity? The supply-side determinants of primary schooling in a poor rural economy. *Journal of African Economies*, *15*, 59–90.

Hannaway, J., & Woodroffe, N. (2003). Policy instruments in education. *Review of Research in Education*, *27*, 1–24.

Holmes, T. J. (1998). The effect of state policies on the location of manufacturing: Evidence from state borders. *Journal of Political Economy*, *106*, 667–705.

Hungi, N. (2011). *Accounting for variations in the quality of primary school education* (SACMEQ: Southern and Eastern Africa Consortium for Monitoring Educational Quality Working Papers, p. 7).

IIPS and ORC Macro. (2001). *National family health survey (Nfhs-2) 1998–1999*. Mumbai: International Institute for Population Sciences.

IIPS and ORC Macro. (2007). *National family health survey (Nfhs-2), 1998–1999*. Mumbai: International Institute for Population Sciences.

Kaplan, D. S., Liu, X. R., & Kaplan, H. B. (2001). Influence of parents' self-feelings and expectations on children's academic performance. *Journal of Educational Research*, *94*, 360–370.

Kazianga, H., Levy, D., Linden, L. L., & Sloan, M. (2013). The effects of "girl-friendly" schools: Evidence from the BRIGHT school construction program in Burkina Faso. *American Economic Journal: Applied Economics*, *5*(3), 41–62.

Kingdon, G. G. (2007). The progress of school education in India. *Oxford Review of Economic Policy*, *23*, 168–195.

Kingdon, G. G., & Teal, F. (2007). Does performance related pay for teachers improve student performance? Some evidence from India. *Economics of Education Review*, *26*(4), 473–486.

Kloosterman, R., Notten, N., Tolsma, J., & Kraaykamp, G. (2011). The effects of parental reading socialization and early school involvement on children's academic performance: A panel study of primary school pupils in the Netherlands. *European Sociological Review*, *27*, 291–306.

Lloyd, C. B., Behrman, J. R., Stromquist, N. P., & Cohen, B. (Eds.). (2005). *The changing transitions to adulthood in developing countries: selected studies, panel on transitions to adulthood in developing countries*. Washington, DC: National Academies Press.

Masino, S., & Niño-Zarazúa, M. (2016). What works to improve the quality of student learning in developing countries? *International Journal of Educational Development*, *48*, 53–65.

Muliadharan, K., & Sundararaman, V. (2008). *Teacher incentives in developing countries: experimental evidence from India*. Nashville, TN: National Council of Education Research & Training. Vanderbilt University, National Center on Performance Incentives. Peabody College of Vanderbilt University.

Munshi, K., & Rosenzweig, M. (2009). *Why is mobility in India so low? Social insurance, inequality, and growth* (NBER Working Paper 14850). Cambridge, MA: National Bureau of Economic Research.

Muralidharan, K. (2017). Chapter 3 - Field experiments in education in developing countries. In A. V. Banerjee & E. Duflo (Eds.), *Handbook of economic field experiments* (Vol. 2, pp. 323–385). North Holland: Elsevier.

National Council of Educational Research and Training. (2003). *Learning achievement of students at the end of class V*. New Delhi: Author.

Nye, B., Hedges, L. V., & Konstantopoulos, S. (1999). The long-term effects of small classes: A five-year follow-up of the tennessee class size experiment. *Educational Evaluation and Policy Analysis*, *21*, 127–142.

Orazem, P. F., King, E. M., & Duryea, S. (2007). Chapter 55 schooling in developing countries. In P. Schultz & J. Strauss (Eds.), *The roles of supply, demand and government policy, draft for handbook of development economics* (Vol. 4, pp. 3475–3559). Amsterdam, Netherlands: Elsevier.

Pratham. (2007). *Annual status of education report (Rural) 2006*. New Delhi: Author. Retrieved from http://images2.asercentre.org/ASER_REPORTS/ASER_2006_Report.pdf.
Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools and academic achievement. *Econometrica*, *73*, 417–458.
Snilstveit, B., Stevenson, J., Menon, R., Phillips, D., Gallagher, E., Geleen, M., … Jimenez, E. (2016). The impact of education programmes on learning and school participation in low- and middle-income countries: A systematic review summary report. 3ie Systematic Review Summary 7. International Initiative for Impact Evaluation (3ie), London.
The PROBE Team. (1999). *Public report on basic education in India*. New Delhi: Oxford University Press.
Tilak, J. (1996). How free is 'free' primary education in India? *Economic and Political Weekly*, *31*, 355–366.
UN Children's Fund (UNICEF). (2016). *Ending extreme poverty: A focus on children*. Retrieved from http://www.refworld.org/docid/57f4ac1e4.html
UNESCO. (2004). *Education for all: The quality imperative* (EFA Global Monitoring Report 2005). Paris, France: Author.
UNESCO. (2008). *Overcoming inequality: Why governance matters* (EFA global monitoring report 2009). Paris, France: Author.
United Nations. (2013). *The millennium development goals report 2013*. New York, NY: United Nations.

Appendix

Table 1A. First stage selection models for participation in the math, reading, writing skills evaluation tests and answering grade progression question

	(1) Math	(2) Reading	(3) Writing	(4) Grade Progression
Consented to anthropometric measurements	2.154**	2.164**	2.129**	2.071**
	(0.049)	(0.051)	(0.037)	(0.036)
Number of persons in the home	−0.032**	−0.031**	−0.032**	−0.031**
	(0.007)	(0.006)	(0.005)	(0.005)
Constant	−0.817**	−0.813**	−0.812**	−0.655**
	(0.068)	(0.066)	(0.047)	(0.046)
ρ	−0.106	−0.133	−0.104	−0.080
	(0.051)	(0.055)	(0.065)	(.058)
Wald test H_0: $\rho = 0$	4.38	5.72	2.49	1.87
prob$>\chi 2$	0.036	0.017	0.114	0.171
Observations	10,315	10,309	10,315	10,309
Uncensored	7408	7438	7374	7610
Psuedo R-square	0.336	0.341	0.328	0.330

Notes: Robust standard errors clustered by district. **Indicates significance at the 1 per cent level.