+

Teacher Allocation and Learning: Evidence from the Right-to-Education Act in India

Sonja Fagernäs - Department of Economics, University of Sussex

Panu Pelkonen - Department of Economics, University of Sussex, IZA

16 October 2024

Abstract

The allocation of teachers across schools in developing countries can be highly unequal, with potentially significant implications for learning. The requirements on pupil-teacher ratios in Indian primary schools changed with the introduction of the Right to Education Act (2009). We decompose the compliance of districts with these requirements into the number of teachers available (Ability to comply), and the effort to re-organize teachers to improve compliance (Effort to comply). The Act created a discontinuous jump in the latter, leading to improved teacher allocation. We show that a larger improvement in the Effort to comply is associated with larger improvements in levels of learning across districts and cohorts, especially at the lowest levels of attainment. The findings on learning are indicative of diminishing returns to additional teachers in a context where small schools and multi-grade teaching are prominent.

Keywords: Pupil-teacher ratio, Teacher allocation, Public service delivery, Right to Education.
JEL Codes: H75, I24, J45, M54.

Corresponding author: Panu Pelkonen (p.o.pelkonen@sussex.ac.uk). Jubilee Building, University of Sussex, BN1 9RH, Brighton, United Kingdom.

Acknowledgments: We would like to thank the staff at NUEPA, in particular Professor Arun Mehta for providing us with access to the DISE database and for several helpful discussions. We would like to thank Suman Bhattacharyya at the ASER Centre for providing us with the ASER data. We would also like to thank everyone who has commented on earlier versions of this paper. We acknowledge financial support from the British Academy.

+

1 Introduction

Despite increased focus on Right to Education in developing countries and large increases in public education expenditure and pupil enrolment, survey data on average learning outcomes show stagnation, or even a decline (e.g. Pritchett et al., 2013, World Bank 2018). Academics and policymakers have therefore sought to understand the root causes of this "learning crisis" and identify new agendas for policy and research (see e.g. World Bank, 2018). One key element has been the management of schools and educational systems, and there is a growing literature on the management of schools and teachers in general (e.g. Glewwe and Muralidharan, 2016, Bloom and Van Reenen, 2011, Bloom et al, 2015, Lemos et al 2021).

A less studied aspect in the management literature is the role played by the allocation of resources, in particular teachers, across administrative units. Imbalances in teacher allocation can be widespread in developing countries. Using cross-country data, Figuereido Walter (2020) for instance shows that pupil-teacher ratios (PTRs) are higher and more variable across schools in developing than in developed countries, and suggests, that a more equal allocation of teachers could lead to learning gains.

In the Indian context, poor allocation of teachers in India has been highlighted for instance by Datta and Kingdon (2021) and Agarwal et al (2018) for the state of Haryana. The former emphasize that India doesn't suffer from a lack of teachers per se, but from poor allocation, and that improvements in allocation could in principle be cost-neutral. The latter call for urgent evidence on the implications that teacher imbalances can have for learning. So far, there is limited evidence on what an improved allocation of teachers would do for learning, and none for India to our knowledge.

In this study, we show that the changes to pupil-teacher requirements as part of the Right of Children to Free and Compulsory Education Act (RTE) led to a reallocation of teachers within Indian districts and analyze the implications for learning. The RTE came into force in 2010[1] and it sets a number of requirements for the provision of schooling across India, including stated norms on the required number of teachers per pupil.[2] In order to comply with the norms, districts could hire new teachers, but also reallocate existing ones. The implications of such teacher reallocation for learning are

---

1 See e.g. RTE forum (2015), or http://righttoeducation.in/ (last accessed 11th October 2024).

[2] The initiative follows the global trend that views education as a human right as advocated by the UN and legal scholars (Tomaševski, 2008, UNESCO, 2015).

+

not unambiguous, as they depend on the nature of returns to teachers. Moving a teacher from an over-staffed to an under-staffed school will create a gain for one school, but a loss for another. Under constant returns, we would not expect the re-allocation of teachers to have any implications for district wide learning. However, under the assumption of diminishing returns to teacher inputs, there would be a net gain, since the gain for the under-staffed schools would exceed the loss for the over-staffed schools.[3]

We rely on school-level register data for all primary schools from the District Information System for Education (DISE) between 2005/06 and 2012/13, which includes a period before and after the onset of the RTE. Given that the school register database does not include objective or comparable indicators to measure levels of learning, our learning outcome data come from an annual, cross-sectional household survey on children’s learning levels (Annual Status of Education Report - ASER). Our core analysis is conducted at the level of districts, which tends to be the unit where teacher allocation takes place (NUEPA, 2016). However, we also utilize child level ASER data to validate the presence of diminishing returns to teachers.

Our study provides several contributions. Firstly, we provide a decomposition-based way to measure the allocation of teachers across administrative units. To characterize teacher allocation, we decompose the compliance of districts with the RTE teacher norms into 1) a resource effect – the existing ability of districts to comply with teacher norms, essentially the existing number of teachers per pupil population and schools’ requirements, and 2) a management effect – the efforts to transfer existing teachers or allocate new teachers to schools so that compliance with the RTE is maximized.

Secondly, our study functions as an evaluation of the enforcement of an important element of the Right to Education Act, the implementation of which has had a mixed reception (e.g. RTE Forum, 2015, Shah and Steinberg, 2019). We show that while the number of teachers, and other key school resources grew in a trend-like fashion both before and after the RTE, the onset of the RTE coincided with a noticeable improvement in the effort to transfer or reallocate teachers. This suggests an administrative response to the RTE requirements, the intensity of which varied across Indian districts. This reaction was larger in districts that were initially more behind in terms of allocative effort, less remote and had better legal enforcement.

---

[3] This example assumes that teachers are perfectly substitutable with each other, which is reasonable at the primary level.

Thirdly, we use the regional variation in the effort to reallocate teachers to analyze the implications of changes in teacher allocation for learning. There is limited existing evidence on this question. Given the lack of longitudinal data on learning, we use a synthetic panel of district-level cohorts before and after the RTE and measure the change in the level of learning within cohorts between the age of 6 and 9 years.

To estimate the relationship between teacher allocation and learning, we begin with a cohort-based event study framework. Given that the reallocation effort may correlate with other unobserved RTE induced policy changes, it is possible that we are not capturing a strictly causal relationship. On the other hand, we show that unlike Effort to comply, other key items, such as school resources and numbers of schools or teachers, did not exhibit a visible jump around the time of the RTE. As a robustness check, we provide estimates based on an instrumental variables approach. Additionally, we also estimate models that use the actual, observed teacher transfers at the school level as the dependent variable, instead of the Effort to comply indicator, although these can be imprecise.

Our estimates suggest that the improvement in teacher allocation (Effort to comply) was associated with an increase in learning outcomes, particularly for Reading. The estimates suggest that when holding the other key items in the education production function constant, a 1 standard deviation improvement in Effort to comply in a district is associated with a 3 percentage points larger share of fluent readers (level 2 text). An extrapolation suggests that eliminating all remaining inefficiencies in the allocation of teachers could translate into an up to 10 percentage points larger share of fluent readers among primary school students by the age of 9.

Finally, our results, supported by additional evidence, are indicative of the presence of diminishing returns to additional teachers, in a context where schools on average are fairly small with only a few teachers, and multi-grade teaching being common. While there is an abundance of research on the relevance of pupil-teacher ratios for learning, there is limited explicit evidence demonstrating diminishing returns to teachers. One study that implicitly finds diminishing returns to additional teachers is an evaluation of the hiring of additional contract teachers in India (Muralidharan and Sundararaman, 2013).[4] The importance of "teaching at the right level" has been highlighted for instance

[4] In this randomised controlled trial, an additional contract teacher is provided to treatment schools in Andhra Pradesh, India. In the sample the pre-treatment mean number of teachers in a school is about 3 and the pupil-teacher ratio (PTR) about 40. The paper estimates a specification where the normalized test score is explained with a log of initial PTR and the change in the log of PTR. This specification and its estimates display

+

by Banerjee et al. (2016). However, most of the key studies on the relevance of pupil-teacher ratios for learning, such as Angrist and Lavy (1999), Urquiola (2006), Urquiola and Verhoogen (2009), and Duflo, Dupas and Kremer (2015) focus nearly exclusively on cases where an additional teacher allows for a lower pupil-teacher ratio within a grade level.[5]

To validate the hypothesis of diminishing returns at the school level, we use the ASER household survey data for children in villages where a school survey was conducted. With a pooled cross-section over the time period studied, we find evidence of the presence of diminishing returns to additional teachers, expressed as deviations from the RTE requirements.

It should be emphasized that the current study cannot directly test for neither the optimal class size, nor the extent of diminishing returns in teacher inputs. Such analysis would require classroom level data. In this study, the quality of teacher allocation is observed at district level, and as such, most key analysis takes place at district level. The results on the allocation of teachers in this study are based on marginal adjustments that Indian districts do to comply with the RTE legislation after 2009.

In what follows, we begin with a description of the data (Section 2) and of the indicators used to measure teacher allocation across districts before and after the RTE (Section 3). Section 4 describes the empirical methodology and Section 5 reports on the results. Section 6 focuses on the child-level analysis on the presence of diminishing returns to learning from additional teachers. Section 7 provides a discussion of the results and concludes.

2 Data

The data on teachers and schools come from a register database of all Indian public-sector primary schools, the District Information System for Education (DISE)[6]. We utilize the data for the academic years of 2005/06 to 2012/13, covering a period before and after the RTE. This is an unbalanced panel of schools and includes a separate file for teachers in the schools. For teachers, the database includes information on the name, age, caste, gender, date of birth, starting point of career as a teacher and indicators on educational qualifications. The database also includes variables on school

diminishing returns to teachers even though the paper doesn't explicitly compare it against a linear alternative. Checchi and De Paola (2018) find explicit evidence of negative effects of multigrade teaching in Italy.

[5] The stylized conclusion from the existing literature is, that smaller class sizes probably facilitate learning (at least in a number of experimental set-ups), and that this effect can be larger for some sub-groups of pupils, or some subjects (e.g. Gustafsson, 2003, Ehrenberg et al, 2001, Glewwe and Kremer, 2006, Glewwe at al 2011, Glewwe and Muralidharan, 2016).

[6] We obtained the data from the National University of Education and Planning (NUEPA).

+

resources and management. It covers all public sector schools and teachers and is thus a promising source for studying the distribution of teachers in the Indian primary education sector. A description of the cleaning of the database can be found in the Appendix. The data were collected in the latter half of a calendar year, around September.

Our main sample covers all regular or para (contract) teachers who teach lower primary school students in all Indian states. These teachers teach grades 1 to 5, and in some states, grades 1 to 4.[7] Regular teachers are civil servants, generally with permanent contracts. In addition to regular teachers, many states hire temporary para-teachers to staff schools that lack teachers. Para-teachers tend to be local to the area, less likely to have teacher training and work on short-term contracts and lower pay (see e.g. Kingdon and Sipahimalani-Rao, 2010). Our indicators on pupil-teacher ratios and the allocation of teachers in this study include both regular and para-teachers, but estimate specifications that also control for the share of para-teachers in a district. Throughout the analysis, we exclude districts that have split or merged during the available years.

One disadvantage of the DISE database is that it does not include reliable, or comparable data on learning. For test score data, we rely on the ASER surveys, which are annual, household level, cross-sectional surveys on learning. The ASER only covers rural areas. However, the majority of Indian primary schools at this time were rural; in the DISE register data, 87% of schools are categorized as rural. All children in the households are tested for basic literacy and numeracy, and are surveyed in their homes, not schools. Each survey consists of hundreds of thousands of tested children. We use ASER surveys for the years 2005, 2006, 2008-2010, 2012 and 2013, given our focus on specific cohorts. Given that our analysis on learning takes place at the district level, we calculate the change in test scores for synthetic cohorts of children between the age of 6 and 9, both pre and post the RTE legislation. We discuss this in more detail in Section 4.

The ASER survey also includes an annual survey of public schools in a selected set of villages. The same villages are not surveyed each year. We do not utilize this in our main analysis, but in a final section to validate the presence of diminishing returns to teachers. For the survey years used (2009-2013), ASER samples the largest public school in the village, which often is the only one.

7 In schools that include both lower and upper primary levels, the following categories have been reported for the classes taught by the teachers: “Primary”, “Mostly primary” “Upper primary” or “Mostly upper primary”. In such schools, we include only pupils in grades 1-5 (1-4 in some states), and teachers who report that they teach “Primary” or “Mostly primary”, and exclude teachers who teach “Upper primary” or “Mostly upper primary”.

+

3 Allocative reaction to the RTE

3.1 RTE rules & teacher allocation

Under earlier government guidelines (Sarva Shiksha Abhiyan), the recommended PTR was set to 40:1. Since the RTE of 2009, these norms changed and a legal requirement was established. For smaller schools, the new norm became 30:1 pupils per teacher, and importantly, the minimum number of teachers per school was set to two. For larger schools, the required PTR is 40:1 (NUEPA, 2016, RTE Forum, 2015). The precise RTE norms on the number of teachers per pupils can be found in Appendix Table A3. They became applicable from April 2010 onwards.

Indian regular public sector teachers are civil servants and are employed by states, while their hiring, allocation and transfers usually take place at the sub-state level, typically at the district level (see e.g. NUEPA, 2016). Enforcement of the RTE is largely down to individual states, and in principle, District Education Officers (DEOs) could be held accountable by the states for non-compliance in their districts.[8] To measure compliance with the RTE, we need to make some assumptions about the objective function of the local educational authorities. We assume that under the RTE, the aim of the DEOs is to maximize the proportion of district pupils who attend schools with a sufficient number of teachers according to the RTE.[9]

Compliance with the RTE pupil-teacher norms can be improved either by hiring more teachers or by transferring existing teachers to schools that are understaffed according to the RTE. Practices on teacher transfers have varied across states and many states did not have clearly set policies for teacher transfers during the period analyzed (NUEPA, 2016, Ramachandran et al., 2018).

New, regular teachers need to undergo training and therefore the number of new teachers can be limited and the process time-consuming. The alternative that states can resort to, would be to hire short-term contract teachers more locally. However, the RTE has also sought to phase out the use of

---

8 According to KPMG (2016), “One of the challenges as mentioned by various school principals in our discussions, is the lack of seriousness on the part of the state governments. Though some of the state governments are enforcing RTE, for some RTE does not even come under their agenda. In metro cities like New Delhi, Mumbai, Chennai, Bengaluru, etc. there is a thrust by the department for effective implementation of the RTE Act. As cited by one of the principals, 60 per cent of the implementation has been undertaken in these cities. Whereas, in neighbouring cities such as Faridabad, etc. RTE is still a mirage.”

9 A possible alternative would be to maximise the number of schools that are RTE-compliant. However, this may not be preferable from a political viewpoint, since this wouldn’t maximise the number of parents (voters) whose children are in compliant schools, as the current measure does.

+

un-trained contract teachers, and mandates that they should also hold necessary qualifications.[10] This leaves reallocation of existing teachers as potentially the quickest way to improve compliance with the RTE.

In addition to the teacher norms, the RTE includes a number of provisions such as the right to free education in children's own neighborhood for ages 6-14, the development and enforcement of the national curriculum, detailed requirements on school infrastructure, teacher training, monitoring of student attendance, prohibition of physical punishment and the introduction of school management committees. Despite the legal requirement, the implementation of all features of RTE have been generally behind intended schedules (RTE forum 2015).

3.2 Compliance indicators and trends

The physical ability of a district to comply with the RTE is a function of the total number of teachers and the size distribution of public sector schools in the district. However, overall compliance also depends on the efforts to allocate and move teachers from one school to another based on need. In measuring the reaction to the RTE teacher requirements, we draw a distinction between 1) districts having the teacher resources that they need to comply with the RTE (Ability to comply), and 2) the effort that the district makes to allocate teacher resources in a way that compliance is maximized ('Effort to comply') (Figure 1). The first indicator is closely related to pupil teacher ratios, while the second should reflect compliance enhancing transfers of teachers and allocation of newly hired teachers. These indicators allow us to measure how far the district is from allocating teachers according to the allocation rule. Further, this allows us to compare the compliance efforts across districts and time.

To compute the Ability to comply for each district and year, we simulate the behavior of a hypothetical district level administrator. The objective function of the administrator is to maximize the share of pupils who are in RTE compliant schools. In the first step, each school should have at least one teacher. In the second step, the rest of the available teachers in the district are allocated from the largest to the smallest schools (based on pupil numbers), so that the share of pupils in a district attending a RTE compliant school is maximized. As per the RTE pupil-teacher ratio schedule (Table A3), it is relatively cheaper to satisfy the RTE requirements for larger schools, as the required PTRs are larger. We implement this hypothetical allocation of teachers for each district and year given the number of teachers and schools in the district, and the numbers of pupils in each school. This simulation results in

[10] See e.g. https://educationforallinindia.com/para-teachers-in-india-2023/ (last accessed 14.10.2024).

+

a number between [0,1] which stands for the maximum attainable share of pupils in RTE-compliant schools and is called the Ability to comply.

A district's Effort to comply is defined as the difference between the observed, actual RTE compliance rate (current share of pupils in schools that comply with RTE teacher norms) and the theoretical maximum compliance that the district could have achieved:

(1) Effort to comply = Actual compliance - Ability to comply

Since the Ability to comply captures maximum compliance, Actual compliance is never larger. This means that the Effort to comply is a negative number, where zero means that all possibilities to comply with the RTE have been exhausted.

To adhere with the pupil-teacher ratio requirements, districts can respond to the RTE by hiring or re-allocating of teachers. Hiring new teachers will automatically improve the Ability to comply. The effect of new teachers on Actual compliance depends on where the teachers are placed. If they are placed into schools which are already RTE-compliant, Actual compliance doesn't change, leading to reduction in the Effort to comply. If they are placed in schools with teacher deficits, Actual compliance improves along with the Effort to comply. Transfers of existing teachers from overstaffed to understaffed schools improves both the Actual compliance and the Effort to comply without affecting the Ability to comply.

We compute these three measures for all districts and years both before and after the RTE. The first year in our data for which the RTE norms on teachers per pupils are legally applicable is the year 2010, given that the DISE data are recorded in late 2010. Table 1 presents statistics on our indicators of teacher allocation across Indian districts for the whole panel, divided into earlier and later years, corresponding roughly to the RTE legislation. The period was marked by increased hiring of teachers, leading to lower pupil-teacher ratios. Between the two sub-samples (2005-08 and 2009-12), the average PTR improved from about 41 to 32 pupils per teacher. The rate of Actual compliance increased from 32% to 47%. The Ability to comply increased from 68% to 80%, in line with increasing numbers of teachers. These numbers show that the districts have a great capacity to improve their allocation of teachers. With frictionless teacher allocation, districts could reach their calculated Ability to comply. The Effort to comply improved somewhat between the periods because the improvement in the actual rate of compliance (15%) was greater than in the Ability to comply (12%).

+

In principle, teacher reallocation in the form of transfers could also be measured directly. However, an indicator of actual RTE compliant teacher transfers can be imprecise as there is no unique teacher identifier in the DISE database that could be used to trace movements of specific teachers. As such, the inference-based on identity (1) should provide a more precise measure of how well districts are allocating teachers. Nevertheless, we provide a robustness check for our main analysis, where transfers are measured based of exits of teachers from schools' teacher rosters, similarly to an idea in Fagernäs and Pelkonen (2020).

Alongside the indicators for compliance with the RTE PTR requirements, Table 1 also contains statistics on teacher characteristics and a measure of school resources ('Building compliance'), ranging between 0 and 1. The RTE requires schools to have specific physical resources; an all-weather building, at least one classroom per teacher, an extra room, barrier free access, sex-specific toilet, drinking water, playground and a boundary wall.[11] Our "Building compliance" indicator measures the share of these resources held by schools. Compliance with the RTE school resource or building requirements increases from .62 to .69 from the pre- to post-RTE period in the data. While our focus is on the allocation of teachers and not their characteristics, it can be noted that the share of graduate teachers also increased.

In Figure 2, we illustrate how the onset of RTE affected compliance across the years. The plots display the coefficients of an OLS model where the different components of RTE compliance are regressed on year dummies across the panel of districts. The base year (null effect) is set to 2009, right before the onset of the RTE. From top to bottom, and left to right, the dependent variables are: Actual compliance, Ability to comply, Effort to comply, Building compliance, number of schools and the share of para-teachers. From the first four, it is apparent that Actual compliance, Ability to comply and Building compliance all exhibit a growing trend, without a clear discontinuity in 2010, when the law became effective.[12] In contrast, there is a significant increase in the Effort to comply in 2010, with no clear trend prior to the RTE. Neither does there seem to be evidence of significant anticipation effects, that would have led to a jump in the Effort to comply prior to the RTE becoming effective. Therefore, we can conclude that the main observable reaction to the RTE in terms of school resources was the improved allocation of teachers (Effort to comply).

11 We have no data on whether the school has a kitchen, which is one of the RTE requirements. Therefore, we have left this out from the measure.

12 Some of these trends around the implementation of RTE were documented also by Shah and Steinberg (2019).

+

The bottom two graphs in Figure 2 show the time effect of RTE on the number of schools and the share of para-teachers. There is no significant effect on the overall number of primary schools, but we see a negative effect on the share of para-teachers three years after the RTE. This may be due to the aim to phase out para-teachers, but this effect is clearly coming with a lag, as many states were acutely dependent on them to deliver teaching in remote areas. Over the examined period, the share of primary pupils in private schools has been gradually increasing, but there is no obvious breakpoint around the RTE Act in 2009 (Figure A1 in the Appendix).

3.3 Heterogeneity in the response to the RTE with respect to Effort to comply

Figure 2 above indicated that there was a discontinuous jump in Effort to comply around the time of the RTE, which will be the focus of our analysis in the analysis on learning in Sections 4 and 5. This response exhibited a significant degree of heterogeneity across districts, which we describe here.

Figures 3a and 3b show two district-level maps; one for the initial level of Effort to comply prior to the onset of the RTE (2009), and another for the improvement in Effort to comply over a few years after the law became effective. Figure 3a indicates that prior to the RTE, the allocation of teachers was more geared towards the RTE (given resources) in the northernmost states of Uttarakhand, Himachal Pradesh and Jammu and Kashmir, in the coastal strip from Goa to Kerala, and over a broad central belt from Rajasthan to Odisha. The improvements in Effort to comply (Figure 3b) on the other were most notable in southeastern India, around the areas corresponding to Tamil Nadu, Andhra Pradesh and Telangana. There were also large improvements in the areas around Gujarat, Haryana, and the western parts of Maharashtra. These patterns imply that Effort to comply often improved most in the states that were lagging behind on this front prior to the RTE. Therefore, it appears that the RTE induced a degree of catch-up in teacher allocation across Indian districts.

Figure 4 shows the association between the change in Effort to comply and three initial conditions: (1) The pre-RTE Effort to comply at district level, (2) the median distance of schools to district headquarters at the district level and (3) the share of trials completed within 3 years at the state level. In Section 5.3, we present the results of instrumental variables estimations on the association between learning and Effort to comply, which rely on these initial conditions as the source of identifying variation.

The rationale for the three variables is the following. Firstly, a weaker initial allocation implies that a district has more scope to improve its teacher allocation, as was also suggested by the maps in Figures 3a and 3b. Secondly, the reallocation of teachers can be more challenging in districts, where

+

schools are on average more remote. Evidence suggests that Indian teachers are averse to remote schools and may, with means available to them, resist transfers (NUEPA, 2016, Fagernäs and Pelkonen, 2012). Finally, given the possibility of parents to take legal action due to the failure of schools to adhere to the RTE, districts or states with better legal enforcement may react faster to new legal requirements.

The top images in Figure 4 show that districts with a lower pre-RTE Effort to comply saw a larger improvement in Effort to comply, reaching an improvement of about .08, compared to districts with a higher pre-RTE effort, where the improvement is between .025 to .055, depending on whether the change is counted from 2009 or 2008. The figures also indicate that districts with a higher pre-RTE Effort started to react to the RTE a year earlier, between 2008-09. Those with a lower pre-RTE Effort reacted between 2009-10, when the law came into force. Overall, districts that had used their existing resources less efficiently, had more scope to improve their allocation of teachers. In an extreme case, if the Effort to comply is already at the maximum value, there would be no scope to improve it by shuffling existing teachers.

The middle graphs in Figure 4 show that districts with a shorter average distance of schools to district headquarters experience a larger increase in the Effort to comply post-RTE. Again, this would be more pronounced if we would consider that the districts with a shorter distance began to react earlier to the RTE, from 2009 rather than 2010.

The bottom graphs of Figure 4 divide states based on the efficiency of their legal system, as measured by the share of cases completed within 3 years. The areas with lower legal compliance saw improvements of about 0.04 in the Effort to comply by 2012 (left-hand image) whereas in areas with better legal compliance, the Effort to comply improved by about 0.07 on average.

4 Teacher allocation and learning

4.1 Conceptual framework

This section focuses on the association between changes to teacher allocation, captured by the Effort to comply indicator and pupils' learning outcomes. This relationship is not ex ante unambiguous. When teachers are moved from overstaffed to understaffed schools, overstaffed schools lose resources with a potentially detrimental average effect on learning, while understaffed schools should gain. The net impact of these two opposing effects would be positive only in the presence of diminishing returns to teacher inputs.

+

In an individual school, it is reasonable to expect that there is some degree of diminishing returns from teacher inputs to learning outcomes. This is because most of the schools in India are rural schools with 1-3 teachers, and in such circumstances, multi-grade teaching is common. For example, in a single-teacher school, the teacher needs to teach grades 1-5 together, or divide her time between grade levels. In such a case, one additional teacher can make a significant difference to the ability of the school to teach each pupil at the right level. The detrimental effect of multi-grade teaching should diminish rapidly as additional teachers are brought into a school.

The RTE allocation rule, as it is (Appendix Table A3), appears to contain this implicit assumption about the role of PTRs for learning. The discontinuities in these requirements for smaller versus larger schools and the minimum requirement of two teachers per school could be justified by an aim to minimize the negative consequences of multi-grade teaching in India.

4.2 Econometric strategy

Identifying the effect of changes in the Effort to comply on learning is econometrically challenging. The Effort to comply is a decision made by the education authorities. The factors that affect the decision may not be exogenous. Authorities may weigh options for improving compliance; transferring teachers, hiring more teachers, or both. It is also possible that other (unobservable) RTE-induced changes to the school system are correlated with the Effort to comply, given that the RTE Act was a package of measures. On the other hand, despite the bundling of educational changes in the RTE, existing research suggests that teachers and teaching at the right level, rather than physical school resources, are often the dominant factor in the determination of learning outcomes (see eg. Glewwe and Kremer, 2006, Glewwe et al, 2021). Additionally, as shown in Figure 2, Effort to comply was the only resource variable to experience a discontinuous jump around the onset of the RTE.

Despite the empirical challenges, there are good grounds to study the association between teacher allocation and learning. Teacher allocation may well be one of the low-hanging fruits to improve schooling outcomes in developing and emerging economies. Reallocation may not require additional wage costs, but would still lead to more equitable and potentially better aggregate learning outcomes. Transferring teachers can be wrought with challenges, but transfers within more local areas could be possible with relative ease (see eg. Agrawal et al, 2018).

We begin with a cohort-based event study framework to analyze the effect of teacher allocation, or Effort to comply on learning, and control for all other important factors in the educational production function, which in principle could be affected by the RTE. As a robustness check, we estimate

+

instrumental variable models, which rely on the initial conditions prior to the RTE, described in Section 3.3, as the source of identifying variation.

For the estimations, we use a district-cohort level pseudo-panel data set. Teacher allocation commonly takes place at the level of districts (NUEPA, 2016) and the ASER household data has to be aggregated at a relevant level to be able to match it to the DISE school data. The summary statistics for the variables used in the analysis, for the panel of districts over the four cohorts are shown in Table 2. The construction of this data set and the cohort-specific test scores that come from the ASER data will be explained in Section 4.3 below. All other data come from the DISE database and are aggregated at the district-cohort level.

The estimated model takes the following form

(2) $$\Delta Level_{dc}^{k} = \lambda(Effort\ to\ comply_{dc}) + \boldsymbol{X}_{dc}\pi + \phi_c + \psi_d + \omega_{dc}$$

In this model, the dependent variable is defined for cohorts (*c*) of children in each district (*d*) based on the ASER data. More specifically, $\Delta \text{Level}^{k}_{dc}$ represents the cohort-specific change in the share of pupils who exceed level *k* as they age from 6 to 9 in district *d*. The construction of these cohort-specific test scores is discussed in detail in Section 4.2.

The vector of control variables is denoted by X_{dc}. These include teacher characteristics (% female, % graduates and % para-teachers), the average school building compliance index and the Ability to comply, which corresponds to overall teacher resources available to districts. We also control for district (ψ_d) and cohort effects (ϕ_c). A positive coefficient for the Effort to comply (λ) would indicate that an improvement in the allocation of teachers is associated with improved learning in the district-cohort space.

For transparency we provide a range of estimates, for each *k* learning levels, with and without the control variables, and finally with and without state clustering of standard errors. The question on clustering of standard errors is not straightforward. While teacher transfer typically take place at the district level, education policy is directed by the states, and as such this may have implications for the practical implementation of transfers in districts within states.

As the first robustness check, we use an alternative approach, which relies on observed teacher transfers at the school level, instead of the Effort to comply indicator. Teacher transfers cannot be perfectly observed in the DISE data, but it is possible to observe when a teacher disappears from the school's roster of teachers. This allows us to divide such teacher departures into 'pro-RTE' and 'anti-

+

RTE' transfers. Pro-RTE teacher transfers are defined as the share of schools in the district that over-comply and experience a teacher leaving the school. Anti-RTE transfers are defined as the share of schools that are at or below compliance level, but lose a teacher.

The estimated equation takes the following form:

$$(3) \qquad \Delta Level_{dc}^{k} = \alpha_1 ProRTE_d + \alpha_2 AntiRTE_d + \boldsymbol{X}_{dc}\beta + \sigma_c + \theta_d + \varepsilon_{dc}$$

The dependent variables and the control variables are defined as above in equation (2). Again, district effects (θ_d) and cohort effects (σ_c) are included. The parameters of interest are α_1 and α_2. The former is expected to be positive and the latter negative, assuming that district-level changes in allocation conforming to the RTE are associated with improved learning outcomes.

Again, the main threat to identification is that the teacher movements might not be orthogonal to the trends in educational attainment in the districts. We provide a range of estimates using combinations of control variables and clustering of standard errors to enable a transparent assessment of the relationships.

As the final robustness check, we conduct an instrumental variables (IV) estimation. The identification relies on the varied response of districts to the RTE teacher norms, based on the three initial conditions prior to the RTE, described in Section 3.3.

We leverage the fact that the degree of improvement in teacher allocation depends on the three initial pre-RTE characteristics of the district, as discussed above and shown in Figure 4. The framework is similar to that in Acemoglu and Johnson (2007), Bleakley (2010), Ager et al. (2018) and Bhalotra et al. (2023). This corresponds to an instrumental variables estimation, where the Effort to comply is instrumented with three variables, the interaction terms between the dummy variable for RTE and the three initial conditions separately. The first stage model takes the following form

$$(4) \qquad (Effort\ to\ comply)_{dc} = RTE_c \times PreRTE_d\alpha + RTE_c \times PreRTEX_d\beta + \sigma_c + \theta_d + \varepsilon_{dc}.$$

RTE_c is a pre/post dummy variable indicating the cohorts for which the RTE legislation applies. $PreRTE_d$ refers to the set of pre-conditions, calculated for the ultimate pre-RTE cohort. The instrumental variables are the interactions of the preconditions with the RTE event dummy. District effects (θ_d) and cohort effects (σ_c) are included. The main threat to identification is that the three initial conditions might not be orthogonal to the trends in the educational attainment in the districts. In half of the presented specifications, we add interaction terms between control variables that are key inputs to the educational

+

production function ($PreRTEX_d$), and the RTE dummy variable (as in Ager et al, 2018 and Bhalotra et al, 2023). This explicitly controls for the possibility that other key determinants of learning are correlated with the pre-policy levels of the initial conditions.

The second stage model then takes the following form

$$(5) \qquad \Delta Level_{dc}^{k} = \lambda(Effort\ to\ comply)_{dc} + RTE_c \times PreRTEX_d\pi + \phi_c + \psi_d + \omega_{dc}$$

where the parameter of interest is λ, which captures the IV estimate for the effect of Effort to comply on learning.

4.3 Indicators for learning

Our data on learning outcomes come from the ASER survey, which is representative at the level of districts in rural areas. Since the ASER survey is a cross-sectional survey and not a panel, our indicators for learning are based on a set of synthetic cohorts at the district level. For a set of cohorts, we calculate the changes in learning levels between the age of 6 and 9, both pre and post RTE. Figure 5 illustrates how the learning outcome indicators are constructed. For example, 'cohort 05' (c05) refers to children who are 6 years old in 2005, and this cohort would be 9 years in 2008. Similarly, cohort 06 ('c06') is observed in the ASER surveys for 2006 and 2009. Post-RTE cohorts (c09 and c10) are observed at the age of 6 in 2009 and 2010 and at the age of 9 in 2012 and 2013.[13]

The change in achievement level *k* for cohort *c* in district *d* is then computed as the difference in the share of children achieving level *k* between the age of 9 and 6:

$$(6) \qquad \Delta Level_{dc}^{k} = (Level_{dc}^{k}|age = 9) - (Level_{dc}^{k}|age = 6).$$

Due to irregularities in the school starting age and grade repetition, comparing attainment at a particular age captures progress better than comparing attainment in particular grades**.** A similar calculation is carried out for learning levels for both Reading and Mathematics.

The levels for Reading in ASER are the base level, referring to 'nothing', and four increasingly higher levels: 'recognize a letter',' read a word', 'read a paragraph', and 'read a story'. Summary statistics of the levels of learning in the data are in Appendix Table A7. Around 30% of 9-year old children will obtain the highest possible mark in Reading, and this sets a ceiling for the indicator. For

[13] Sample sizes and summary statistics by cohorts and districts are shown in Appendix tables A5 and A6.

+

Mathematics, there are four levels: ‘Nothing’, ‘Recognize a number’, ‘Can subtract’, and ‘Can divide’, but only 13-20% of 9-year olds obtain the highest level.

The share of children achieving a level is based on a sample of children, and as such, there is a degree of uncertainty in the measure at the district level. With respect to the sample-based uncertainty, the resulting problem is that of classical measurement error in the dependent variable. This will reduce the signal-to-noise ratio, making insignificant statistical findings more likely.

In synthetic, or pseudo panels, the definition of the ‘cohort’ needs to remain constant across time. Therefore, the changes in learning levels are computed for all pupils of the correct age in the ASER data, irrespective of whether they are in public, private, or other types of schools. This is in the spirit of the literature on synthetic panels and guarantees that the base sample remains the same throughout the time series (see e.g. Deaton (1985), Verbeek and Nijman (1992), Dang and Lanjouw, (2023)). We therefore need to control for the share of pupils in private schools or in a small ‘other’ category, which in our case means that the pupil is either in a madrassa (Islamic school), not in school or there is no response.

Our explanatory variables are not based on sampling, but the full register data for the schools, aggregated at the district-cohort level. They include the indicators for average teacher characteristics and indicators for physical school resources. All physical and teacher inputs for each cohort are averaged for the academic years that the pupils attended school in each district. For example, for cohort 05, who are tested in the Autumn of 2005 and Autumn of 2008, the values for the control variables are computed from the DISE register data as the means over three academic years 2005-6, 2006-7 and 2007-8.

One observation emerging from the numbers in Table 2 is that the average improvement in learning between the age of 6 and 9 was smaller for the post-RTE cohorts than the pre-RTE cohorts. A closer look at the levels of learning (Appendix Table A7) shows that in the post-RTE cohorts, pupils also start primary schooling (age 6) with a higher level of skills, especially at the bottom end of the ability range, possibly suggesting improving home environments over these cohorts. Despite this, the average skills by age 9 haven’t improved substantially between the pre and the post RTE period, leading to a smaller overall improvement for the post-RTE cohorts. This is not surprising, given that stagnant and even declining levels of learning in the ASER survey have been recognized in India (see e.g. ASER, 2014, Shah and Steinberg, 2019). Alternatively, there may be a systematic change in the rigor in which the ASER test has been carried out from one wave to another. This ought not to be an issue of major

+

significance for the key findings of this study, since we control for cohort-specific effects in all specifications.

5 Results

5.1 Event study results

Table 3 presents a set of results on the effects of Effort to comply on cohort-specific improvement in Reading and Mathematics scores between ages 6 to 9, based on the OLS model (equation 2). As argued above, the sudden jump in the Effort to comply from 2009 onwards, and the set of control variables provide a degree of credibility to this specification**.** In all the estimations, the results are presented separately for Reading and Mathematics, and with and without sets of control variables, and by type of clustering for standard errors.

In general, the coefficients for the Effort to comply are positive and significant, or marginally significant for all learning levels, when standard errors aren't clustered, irrespective of the set of control variables. Once state-level clustering of standard errors is included, the statistical significance is limited to Reading, but still present across the levels: to recognizing letters, reading a word, and reading a level 2 text. Another general observation is that the effects are larger at lower levels of achievement, and larger for Reading than for Mathematics. In total, the evidence here indicates that improvements in the allocation of teachers within districts were associated with increases in learning, particularly at the very lowest levels of elementary literacy.

The size of the coefficients can be gauged by noting that the explanatory variable in the sample has a standard error of .085. As such, a 1 standard deviation improvement in the Effort to comply would imply that the share of pupils reaching level 2 Reading between ages 6-9 would be associated with an increase of .085*.325 = 2.8 percentage points. Similarly, an increase in the share of pupils able to 'read a word' would be higher by .085*.547 = 4.6 percentage points. Such associations are substantial, given that a 1 standard deviation improvement should be attainable for the districts. A more ambitious goal would be to maximize the RTE compliance given the resources of districts, which would imply closing the average post-RTE compliance gap of -.336 entirely. This would translate into an increase by .336*.325 = 10.9 percentage points for 'level 2 Reading' and .336*.547 = 18.4 percentage points for the share of pupils reaching the ability to 'read a word'. Acknowledging that these are extrapolations based on point estimates, such improvements would represent laudable improvements to the current levels of elementary literacy in India.

+

5.2 Results based on actual transfers

The Effort to comply indicator reflects re-allocative efforts to meet the RTE teacher requirements. As an alternative robustness check, we classify teacher exits from schools in the DISE data as pro or anti-RTE, as defined in Section 4.1. This measure of transfers is imprecise as there is no teacher identifier in the DISE database that could be used to track teachers from one school to another. We estimate OLS models on the association between these variables and changes in learning levels, based on equation (3). The results are shown in Table 4. In general, the results show that pro-RTE teacher transfers are associated with improving learning outcomes, and anti-RTE transfers with worsening outcomes. As before, statistical significance falls when state clustering is applied, but even then, we find significant or marginally significant estimates for reading a level 1 story, reading a level 2 story, and subtraction.

5.3 Instrumental variable estimations

The first stage results are shown in Table 5. Models 1 and 3 include only the necessary cohort control, while models 2 and 4 include the set of extended controls, in particular terms $RTE_c \times PreRTEX_d$, or the pre-policy levels of control variables interacted with the RTE. Models 3-4 cluster standard errors at the state level. In all first stage estimations, all instruments have the expected sign and in each specification, at least one of the instruments is statistically significant at the 1% level. The null hypothesis is not rejected in the Sargan test for overidentification in models 2-4, suggesting that the three instruments point to similar results. In model 1, the test is rejected at the 5% level with a p-value of 0.0108.

The IV estimates are shown in Table 6. For most learning levels, Effort to comply is statistically significant and positive without state clustering. It remains statistically significant for the first two Reading levels even with state clustering of standard errors. For the lowest levels of learning outcomes, the estimated effects are about twice as large as in the OLS models (Table 3). This should be considered together with the large standard errors that IV estimates typically suffer from. While they are less precise, the results point to similar conclusions as the OLS estimates; the estimates tend to be larger for lower levels of achievement, and larger for Reading than Mathematics.

6 Are diminishing returns to teachers a realistic assumption?

The finding that reallocation of teachers to adhere to the RTE norms, improves learning outcomes, can be justified under the assumption of diminishing returns to teachers within schools. Improving the

+

allocation of teachers leads to a reduction in teachers in overstaffed schools and an increase in understaffed ones. Under diminishing returns the net effect should be positive, but under linear returns, the net effect would be zero, leading to no improvement in learning.

To examine the presence of diminishing returns, we pool the cross-sectional ASER pupil datasets for the years 2009-2013 and match them to ASER school surveys carried out in the child's village, mentioned in Section 2. We focus on children attending public sector schools. We restrict the sample to villages, where only one public school is included in the school survey sample, which is supposed to be the only public school, or the largest public school in the village. For the period studied here, the ASER household surveys unfortunately do not contain information on which school the child attends. We therefore need to rely on the assumption that children who indicate attending a government school, are attending the surveyed village primary school. We believe this to be reasonable for our purposes, as many villages will have only one public school, and in the case that there is more than one, ASER samples the largest public school. The school survey documents the numbers of pupils and teachers, allowing us to directly measure how the number of teachers in the village school deviates from the RTE norms.

We omit clear outliers by limiting the sample to schools with less than 320 pupils, and to schools with up to 8 teachers according to RTE norms. This covers the great majority of village schools. For each school, we compute whether the school has the required number of teachers, which we treat as the reference group. We then compare the learning outcomes of pupils in the reference group with the learning outcomes of children in schools where the number of teachers is one or two below (shortage) or one or two above (excess) the required number by the RTE. Larger deviations from the RTE norms are excluded from the sample for the sake of simplicity.

The summary statistics for the sample can be found in Appendix Table A8. In a pupil-level model, we regress the Reading and Mathematics scores on the variables for a surplus or shortage of teachers:

$$(7)\qquad Level_{ivdt}^{k} = \alpha_m \sum_{m=1}^{2} Short_{\{m,ivt\}} + \gamma_n \sum_{n=1}^{2} Excess_{\{n,ivt\}} + \beta X_{ivt} + \sigma_t + \theta_d + \varepsilon_{ivdt}$$

where *i* refers to pupil, *v* to village, *t* to time and *d* to district. The sample is limited to schools with a shortage or surplus of at most 2 teachers, with respect to the RTE requirements and these are denoted as $Short_j$ and $Excess_k$. Vector X_{ivt} includes child age dummies, child gender, parental years of education and school size. District effects and survey effects are denoted as θ_d and σ_t. We do not control for grade

+

level, as that is a potential outcome variable; grade repetition is common and could potentially be affected by poor staffing levels in schools. Standard errors are clustered at the village/school level.

The results in Table 7 are presented for selected levels of Reading and Mathematics. They show that in village schools that fall short of the required teachers by one, pupils aged 5-16 are around 1-3 percentage points less likely to reach a learning level. If they fall short by two teachers, the likelihoods are 3-6 percentage points lower, with most of these effects being statistically significant. However, having more teachers than required has no statistically positive effect on learning, apart from 'Recognizing numbers' being marginally significant with two extra teachers.

Overall, these complementary results, while observational and based on cross-sectional estimates, point to diminishing returns to teacher inputs. Schools in Indian villages tend to be small, and losing one teacher can lead to significant difficulties in teaching at the right level, whereas gaining an additional teacher above the recommended numbers yields no corresponding benefits.

7 Discussion and conclusion

In this study, we have examined the compliance of Indian districts with teacher requirements of the Right to Education Act of 2009 (RTE) at the primary level and the implications for learning. By comparing the observed distribution of teachers with a simulated optimal distribution of teachers, we decompose districts' compliance with these norms into Ability to comply and Effort to comply. The former measures the teacher resources that are available to districts, given the characteristics of their schools, and indicates the extent to which the district has sufficient human resources to comply with the RTE. The Effort to comply indicator captures the effort to allocate existing teachers to where they are needed, according to the RTE. We show that the RTE act induced a discrete jump in the districts' Effort to comply, showing that districts reacted to the legislation.

We then study the implications of the improved teacher allocation for learning outcomes. Complying with the RTE norms has the potential to improve learning outcomes under diminishing returns to teachers. In other words, bringing a teacher into an understaffed school should have a larger positive effect than the negative effect coming from removing a teacher from an overstaffed school. To assess the connection with learning, we rely on a synthetic district and child cohort level panel before and after the RTE, and measure the improvement in learning between the ages of 6 and 9, before and after the RTE.

We estimate the effect of the RTE with three complementary techniques. We begin with a cohort-based event study, which utilizes the jump in the compliance effort due to the Act. As a robustness check, we measure the transfers of teachers directly by counting the teachers that disappear from schools' teacher lists from year to another. Here we also find that districts that experience more 'pro-RTE' transfers (teacher departures from over-staffed schools), see larger improvements in learning while 'anti-RTE' transfers (departures from under-staffed schools) are associated with worsening learning. Thirdly, we present instrumental variable estimates, where the change in the Effort to comply is instrumented with initial conditions that are shown to affect post-RTE compliance effort, namely the pre-RTE level of Effort to comply, the median distance of schools to district headquarters and the share of trials completed within 3 years at the state level. This method also indicates that improvements in teacher allocation were associated with an increase in the level of learning, which was larger at lower levels of attainment. The results for Reading are generally more robust to specification than those for Mathematics. Finally, using the ASER village school data, we show that children in understaffed public schools have lower learning outcomes, while children in overstaffed schools do not benefit from extra teachers**,** which is suggestive of diminishing returns to additional teachers.

The event study estimates suggest that if all remaining inefficiencies in the distribution of primary school teachers within districts were eliminated, the test results for the trailing bottom of learners would increase substantially, especially in Reading. The share of children reaching 'level 1' literacy, or the ability to read a paragraph, could increase by up to 10 percentage points. While such calculations are extrapolations and contain uncertainty, one should emphasize that such reorganization should not increase the total wage bill spent on teachers, and as such, would represent potential 'low hanging fruit' for the educational system.

Given that an overwhelming majority of schools in India are small, operating with 1-4 teachers, multigrade teaching will be an omnipresent disadvantage. The presence of multi-grade teaching makes diminishing returns to teacher inputs likely, a priori. One interpretation of the results is that an improved allocation of teachers according to the RTE schedule improves learning by allowing schools to curtail the negative impact of multi-grade teaching.

The Right to Education Act has received critique, in terms of both implementation and effects (see e.g. RTE Forum, 2015). The existing data on learning outcomes also showed stagnating, and even declining levels of learning before and after the RTE (Shah and Steinberg, 2019). However, by decomposing the responses of the districts to the RTE, our study finds that the RTE had implications

+

for the effort to allocate teachers according to the RTE norms, and that according to our estimates, this was associated with non-trivial improvements in learning outcomes.

The literature on misallocation in school systems, especially in emerging economy context is still in its infancy. We believe that further efforts in this line of work are likely to help unravel some of the underpinnings of the 'learning crisis' in emerging economies. Future research in this area would benefit from settings with sufficient variability in country-specific autonomous administrative units, such as states, districts or educational authorities, and policy changes or other quasi-exogenous events that provide variation in responses across administrative units.

An ultimate question for policy is, why do some administrative units maintain a sub-optimal allocation of teachers, and why do some respond to laws and reforms, develop and improve, while others remain stagnant or passive? Our study shows that the responsiveness of administrative educational units to the legal rules and reforms underpins human capital formation. As such, our results are a reflection of the classic determinants of development: governance and institutions.

8 References

Acemoglu, Daron, and Simon Johnson, (2007). Disease and development: the effect of life expectancy on economic growth. *Journal of political Economy*, *115*(6), 925-985.

Ager, Philipp, Casper Worm Hansen and Peter Sandholt Jensen, (2018). Fertility and early-life mortality: Evidence from smallpox vaccination in Sweden. *Journal of the European Economic Association*, *16*(2), 487-521.

Agarwal, Siddhant, Athisii Kayina, Abhiroob Mukhopdhyay and Anugula N. Reddy (2018). Redistributing teachers using local transfers. *World Development*, 110: 333-344.

Angrist, Joshua D., and Victor Lavy (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *Quarterly Journal of Economics*, 114(2): 533–75.

ASER (2014). Annual Status of Education Report (Rural) 2014. ASER Centre, New Delhi.

Banerjee, Abhijit, Rukmini Banerji, James Berry, Esther Duflo, Harini Kannan, Shobhini Mukherji, Marc Shotland and Michael Walton (2016). Mainstreaming an Effective Intervention:

Evidence from Randomized Evaluations of "Teaching at the Right Level" in India. NBER Working Paper 22746, October 2016.

Bhalotra, S., Venkataramani, A., & Walther, S. (2023). Women's Fertility and Labor Market Responses to a Health Innovation. *Journal of the European Economic Association*, jvac072.

Bleakley, Hoyt (2010). Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure. *American Economic Journal: Applied Economics*, *2*(2), 1-45.

Bloom, Nicholas, Renata Lemos, Rafaella Sadun and John Van Reenen (2015). Does Management Matter in Schools? *The Economic Journal*, 125(584): 647-674.

Bloom, Nicholas and John Van Reenen (2011). Human Resource Management and Productivity. *Handbook of Labor Economics*, vol. 4, pp.1697-1767. Elsevier.

Checchi, Daniele and Maria De Paola (2018). The Effect of Multigrade Classes on Cognitive and Noncognitive Skills: Causal Evidence Exploiting Minimum Class Size Rules in Italy. *Economics of Education Review*, 67: 235–253.

Dang, Hai-Anh H., & Lanjouw, Peter F. (2023). Measuring poverty dynamics with synthetic panels based on repeated cross sections. *Oxford Bulletin of Economics and Statistics*, *85*(3), 599-622.

Datta, Sandip and Geeta Kingdon (2021). Teacher Shortage in India: Myth or Reality? The Fiscal Cost of Surplus Teachers, Fake Enrolment and Absences. IZA Disucssion Paper 14251.

Deaton, Angus (1985). Panel Data from Time Series of Cross-Sections. *Journal of Econometrics*, 30(1-2): 109-126.

Duflo, Esther, Pascaline Dupas, and Michael Kremer (2015). School Governance, Teacher Incentives, and Pupil-Teacher Ratios: Experimental Evidence from Kenyan Primary Schools. *Journal of Public Economics*, 123: 92–110

Ehrenberg, Ronald G., Dominic J. Brewer, Adam Gamoran and J. Douglas Willms (2001). Class Size and Student Achievement. *Psychological Science in the Public Interest*, 2(1): 1-30.

Fagernäs, Sonja and Panu Pelkonen (2012). Preferences and Skills of Indian Public Sector Teachers. *IZA Journal of Labor & Development*, 1:3.

+

Fagernäs, Sonja and Panu Pelkonen (2020). Teachers, Electoral Cycles, and Learning in India. *Journal of Human Resources*, *55*(2), 699-732.

Figueiredo Walter, Torsten (2020). Misallocation in the Public Sector? Cross-Country Evidence from Two Million Primary Schools. STICERD working paper, Nr. EOPP 70.

Glewwe, Paul, Eric A. Hanushek, Sarah D. Humpage and Renato Ravina (2011). School Resources and Educational Outcomes in Developing Countries: A Review of the Literature from 1990 to 2010. NBER Working Paper 17554.

Glewwe, Paul and Michael Kremer (2006). Schools, Teachers and Education Outcomes in Developing Countries. *Handbook of the Economics of Education*, Volume 2, pp. 945-1017.

Glewwe, Paul, Celestine Siameh, Bixuan Sun and Suzanne Wisniewski (2021). School resources and educational outcomes in developing countries. *The Routledge Handbook of the Economics of Education*, 218-252.

Glewwe, Paul and Karthik Muralidharan (2016). Improving Education Outcomes in Developing Countries: Evidence, Knowledge Gaps, and Policy Implications. *Handbook of the Economics of Education*, Volume 5, 2016, Pages 653-743.

Gustafsson, Jan-Eric (2003). What Do We Know About Effects of School Resources on Educational Results? *Swedish Economic Policy Review*, 10: 77-110.

Kingdon, Geeta, and Mohammed Muzammil (2009). The Political Economy of Education in India: The Case of Uttar Pradesh. *Oxford Development Studies*, 37(2): 123-144.

Kingdon, Geeta Gandhi and Vandana Sipahimalani-Rao (2010). Para-teachers in India: Status and Impact, *Economic & Political Weekly*, March 20, Vol. XLV, No 12.

KPMG (2016). Assessing the Impact of Right to Education Act. KPMG India, March 2016. Available at https://assets.kpmg/content/dam/kpmg/pdf/2016/03/Assessing-the-impact-of-Right-to-Education-Act.pdf (accessed 11.7.2022).

Lemos, Renata, Karthik Muralidharan and Daniela Scur (2021). Personnel Management and School Productivity: Evidence from India. NBER Working Paper 28663.

Muralidharan, Karthik, and Venkatesh Sundararaman (2013). Contract Teachers: Experimental Evidence from India. NBER Working Paper 19440.

+

NUEPA (2016). Teachers in the Indian Education System. NUEPA Research Reports. Publications Series 001/2016. National University of Educational Planning and Administration, New Delhi.

Pritchett, Lant, Rukmini Banerji and Charles Kenny (2013). Schooling is Not Education! Using Assessment to Change the Politics of Non-learning. A Report of the Center for Global Development Study Group on Measuring Learning Outcomes.

Ramachandran, Vimala, Tara Béteille, Toby Linden, Sangeeta Dey, Sangeeta Goyal, Prerna Goel Chatterjee (2018). *Getting the Right Teachers into the Right Schools: Managing India's Teacher Workforce*. World Bank Studies, Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/28618,

RTE Forum (2015). Status of Implementation of the Right of Children to Free and Compulsory Education Act, 2009: Year Five (2014-15). https://rteforumindia.org/wp-content/uploads/2022/06/Report_2014-15-1.pdf (accessed 11.10.2024).

Shah, Manisha, and Bryce M. Steinberg (2019). The right to education act: Trends in enrollment, test scores, and school quality. *AEA Papers and Proceedings*, 109: 232-238. 2014 Broadway, Suite 305, Nashville, TN 37203: American Economic Association.

Tomaševski, Katarina (2008). The State of the Right to Education Worldwide: Free or Fee? In: Power, Pedagogy and Praxis: Social Justice in the Globalized Classroom. Eds. Shannon Moore and Richard C Mitchell. Chapter 2, pp 19–54. Sense Publishers, Rotterdam, Boston and Taipei.

UNESCO (2015). *Education for All 2000-2015: Achievements and Challenges; EFA Global Monitoring Report*. UNESCO Publishing, 2015.

Urquiola, Miguel (2006). Identifying Class Size Effects in Developing Countries: Evidence from Rural Bolivia. *Review of Economics and Statistics*, 88(1): 171-77.

Urquiola, Miguel, and Eric Verhoogen (2009). Class-Size Caps, Sorting, and the Regression Discontinuity Design. *American Economic Review*, 99(1): 179-215.

Verbeek, Marno and Theo Nijman (1992). Can Cohort Data be Treated as Genuine Panel Data? In: Raj B., Baltagi B.H. (eds) *Panel Data Analysis. Studies in Empirical Economics*. Physica-Verlag HD.

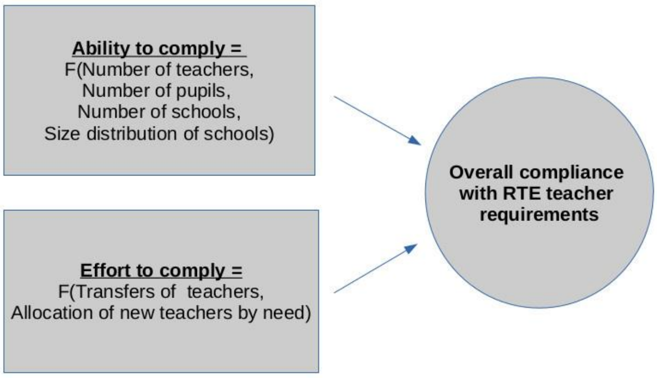
+

World Bank (2018). *World Development Report 2018: Learning to Realize Education's Promise.* Washington, DC: World Bank.

+

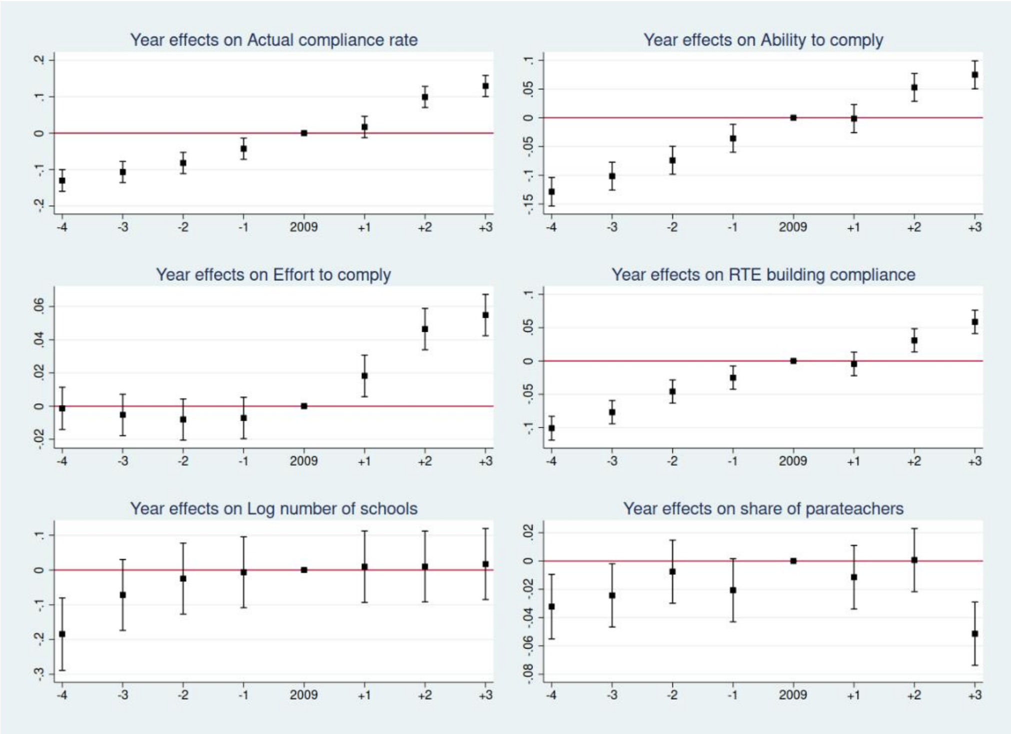
Figures

Figure 1 The two components of RTE teacher compliance at the level of a district



+

Figure 2 Compliance effects of the RTE



Notes: The year effects are estimated in relation to the base year 2009, which is the final year before RTE becomes binding. The RTE Building compliance is a share of eight physical resources required by the RTE, averaged across schools in the district and year: An all-weather building, at least one classroom per teacher, an extra room, barrier free access, sex-specific toilet, drinking water, playground and a boundary wall.

Figure 3a District-level quartiles of Effort to comply in 2009 (pre-RTE), in a histogram and a map.

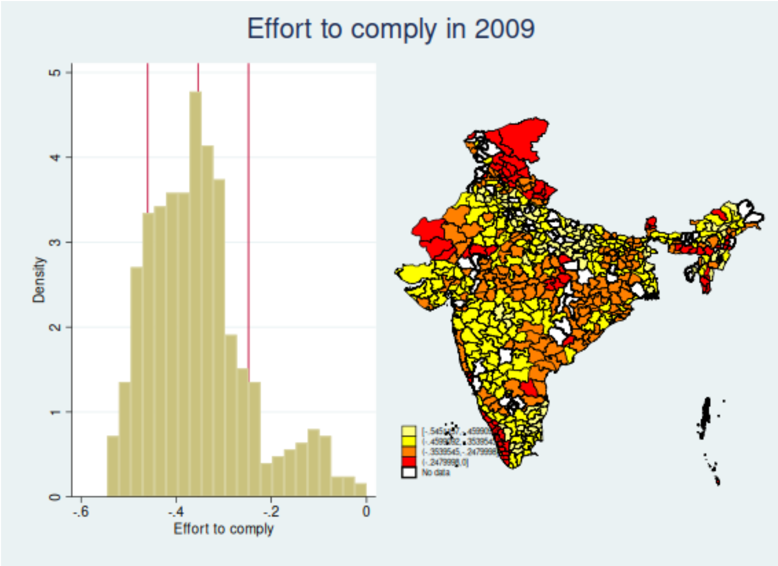


Figure 3b District-level quartiles of change in Effort to comply in 2009-12, in a histogram and a map.

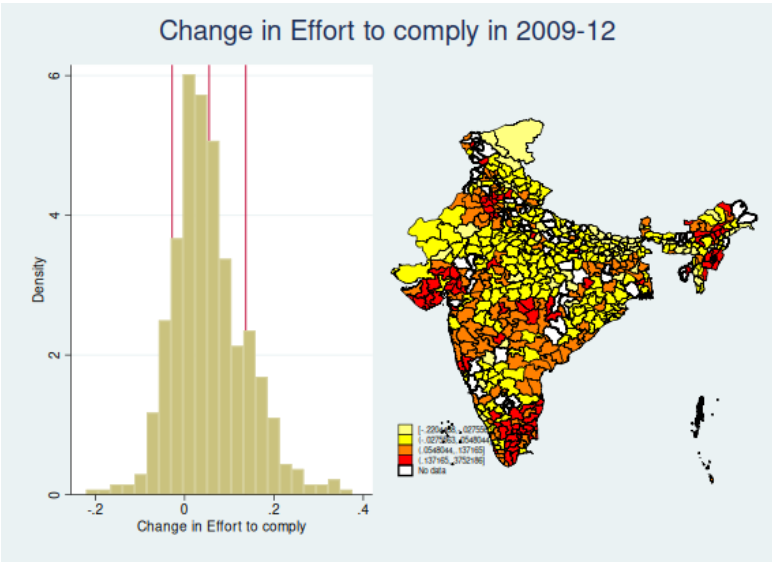
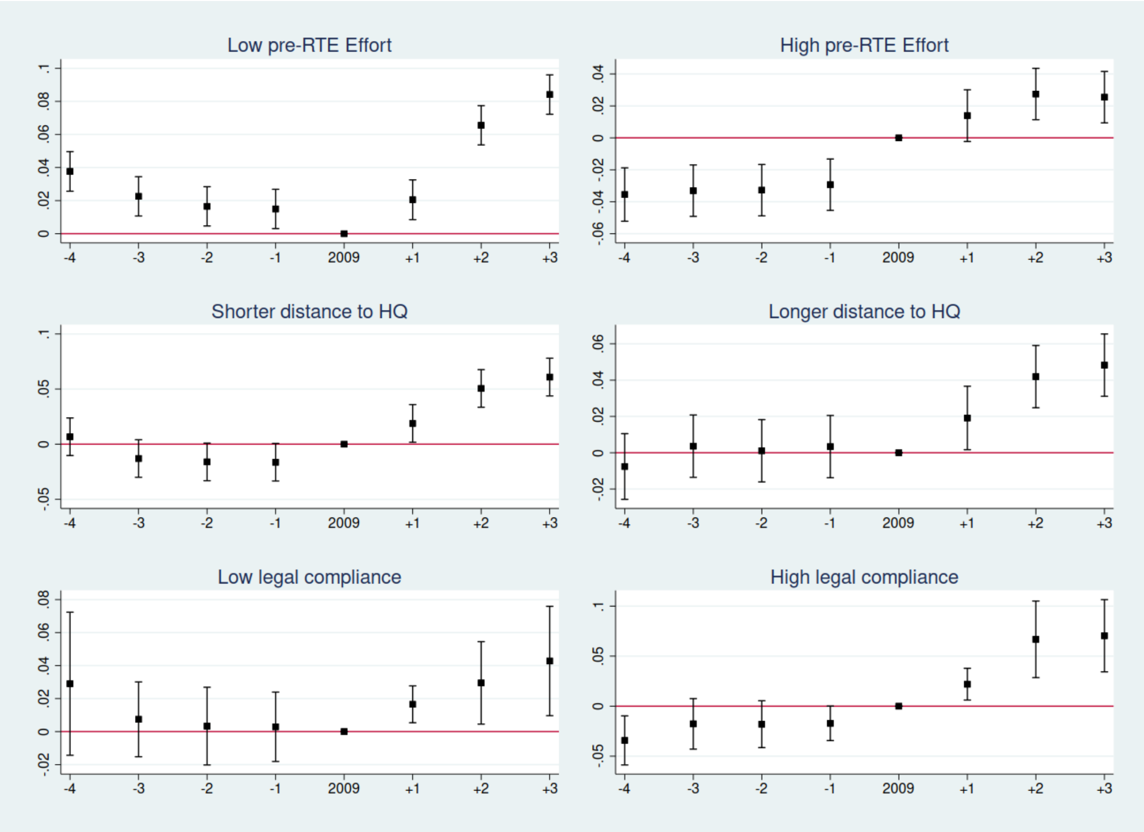


Figure 4 Effect of initial conditions on Effort to comply after the RTE



Notes: Districts are divided into top and bottom halves in terms of the pre-RTE level of the chosen initial conditions. Pre-RTE effort and distance to HQ are determined at the district level, while legal compliance (% of trials completed within 3 years) is determined at the state level.

Figure 5 Evaluated cohorts in ASER surveys 2005-2013.

	Age				
ASER survey	6	7	8	9	
2005	c05				
2006	c06	↘			
2007		↘	↘		
2008			↘	c05	} Pre-RTE
2009	c09			c06	cohorts
2010	c10	↘			
2011		↘	↘		
2012			↘	c09	} Post-RTE
2013				c10	cohorts

+

Tables

Table 1 District level summary statistics, 2005-2012

	Full sample 2005-2012				Pre-RTE 2005-2008		Post-RTE 2009-2012	
	Mean	S.D.	Min	Max	Mean	S.D.	Mean	S.D.
Pupil-Teacher ratio	36.3	15.7	3.3	125.5	40.6	16.3	32.0	14.0
RTE teacher compliance:								
Actual compliance	.399	.255	.001	1	.323	.239	.474	.247
Ability to comply	.740	.210	.139	1	.682	.209	.798	.195
Effort to comply	-.341	.105	-.588	0	-.359	.096	-.324	.110
% Teachers graduates	.420	.206	.009	.887	.384	.192	.455	.213
% Teachers females	.433	.155	.113	.961	.421	.158	.445	.152
% Para-teachers	.132	.184	0	.894	.129	.174	.135	.193
Building compliance	.655	.144	.203	.966	.616	.146	.694	.132
N	4102				2038		2064	

Notes: Individual components of the building compliance index are displayed in Appendix Table A4. Para-teachers refer to short term contract teachers (as opposed to salaried civil servant teachers).

+

Table 2 Summary statistics for the pooled district-cohort observations

	Full sample				Pre-RTE		Post-RTE	
	Mean	S.D.	Min	Max	Mean	S.D.	Mean	S.D.
Δ% Recognize letters	0.225	0.195	-0.294	1	0.291	0.195	0.159	0.173
Δ% Read a word	0.427	0.215	-0.493	0.950	0.489	0.198	0.367	0.213
Δ% Read level 1 text	0.426	0.208	-0.541	0.964	0.474	0.208	0.379	0.198
Δ% Read level 2 text	0.259	0.165	-0.429	0.895	0.267	0.167	0.250	0.163
Δ% Recognize numbers	0.313	0.232	-0.224	1	0.441	0.215	0.186	0.171
Δ% Subtraction	0.301	0.208	-0.738	0.887	0.366	0.215	0.237	0.179
Δ% Division	0.111	0.128	-0.468	0.757	0.141	0.142	0.082	0.105
Pupil-Teacher ratio	39.0	13.7	10.7	90.0	43.3	13.6	34.7	12.5
Pro-RTE transfers	0.036	0.041	0	0.260	0.027	0.034	0.045	0.046
Anti-RTE transfers	0.119	0.057	0	0.327	0.142	0.061	0.096	0.043
RTE teacher compliance:								
Actual compliance	0.356	0.222	0.014	0.972	0.278	0.194	0.434	0.220
Ability to comply	0.712	0.188	0.298	1	0.652	0.176	0.770	0.182
Effort to comply	-0.355	0.085	-0.533	-0.028	-0.374	0.073	-0.336	0.092
Control variables:								
% Private school pupils	0.255	0.202	0	0.907	0.216	0.179	0.294	0.215
% Other school pupils	0.025	0.036	0	0.297	0.030	0.039	0.021	0.033
% Teachers graduates	0.447	0.191	0.044	0.875	0.402	0.179	0.491	0.193
% Teachers female	0.433	0.155	0.119	0.920	0.424	0.157	0.442	0.152
% Para-teachers	0.147	0.184	0	0.867	0.141	0.172	0.153	0.196
Building compliance	0.681	0.128	0.250	0.958	0.646	0.132	0.716	0.113
N	1493				742		751	

Notes: Panel data over districts and four cohorts. Learning outcomes are computed as improvements in the shares reaching a level from age 6 to age 9. % Private school and other school pupils are measured at age 9 for each cohort. 'Other school' pupils include madrassas, out-of-school pupils and non-responses, all of which are small categories. All other variables are computed as 3-year averages over the period that the cohort pupils in question are in school. A breakdown of the items in the building compliance index is shown in Appendix Table A4.

+

Table 3 Effect of RTE-induced compliance on Reading and Mathematics, OLS estimates

Outcome (N = 1493)	Controls	S.E. Clustering	Coef.	S.E.	T-stat.	R-sq.
Recognize letters	Minimal	-	0.456	0.127	3.60	0.517
	Extended	-	0.528	0.136	3.88	0.524
	Minimal	State	0.456	0.230	1.98	0.517
	Extended	State	0.534	0.206	2.59	0.524
Read a word	Minimal	-	0.647	0.145	4.45	0.458
	Extended	-	0.502	0.156	3.21	0.466
	Minimal	State	0.647	0.281	2.30	0.458
	Extended	State	0.547	0.276	1.99	0.463
Read level 1 story	Minimal	-	0.490	0.133	3.69	0.533
	Extended	-	0.455	0.144	3.16	0.534
	Minimal	State	0.490	0.320	1.53	0.533
	Extended	State	0.465	0.306	1.52	0.534
Read Level 2 story	Minimal	-	0.377	0.102	3.69	0.529
	Extended	-	0.325	0.111	2.94	0.531
	Minimal	State	0.377	0.193	1.96	0.529
	Extended	State	0.325	0.181	1.80	0.531
Recognize numbers	Minimal	-	0.237	0.134	1.76	0.620
	Extended	-	0.365	0.144	2.53	0.628
	Minimal	State	0.237	0.296	0.80	0.620
	Extended	State	0.378	0.289	1.31	0.628
Subtraction	Minimal	-	0.254	0.134	1.89	0.518
	Extended	-	0.343	0.145	2.37	0.522
	Minimal	State	0.254	0.466	0.55	0.518
	Extended	State	0.336	0.381	0.88	0.522
Division	Minimal	-	0.140	0.088	1.60	0.469
	Extended	-	0.195	0.095	2.05	0.474
	Minimal	State	0.140	0.201	0.70	0.469
	Extended	State	0.172	0.186	0.92	0.473

Notes: All models include district fixed effects and cohort effects. The ‘Minimal’ controls include the share of pupils in private schools and other schools. The ‘Extended’ control variables further add % teachers graduate, % teachers female, % para-teachers, Building compliance index and District’s Ability to comply.

+

Table 4 Effect of observed teacher transfers on learning

Outcome (N = 1493)	Controls	S.E. Clustering	Pro-RTE transfers Coef.	S.E.	T-stat.	Anti-RTE transfers Coef.	S.E.	T-stat.	R-sq.
Recognize letters	Minimal	-	0.439	0.367	1.20	-0.230	0.158	-1.45	0.513
	Extended	-	0.333	0.417	0.80	-0.109	0.190	-0.57	0.518
	Minimal	State	0.439	0.577	0.76	-0.230	0.326	-0.70	0.513
	Extended	State	0.333	0.530	0.63	-0.109	0.391	-0.28	0.518
Read a word	Minimal	-	1.215	0.420	2.89	-0.414	0.181	-2.29	0.456
	Extended	-	1.258	0.476	2.64	-0.465	0.217	-2.14	0.466
	Minimal	State	1.215	1.010	1.20	-0.414	0.292	-1.42	0.456
	Extended	State	1.258	0.901	1.40	-0.465	0.399	-1.16	0.466
Read level 1 story	Minimal	-	1.630	0.381	4.27	-0.374	0.164	-2.27	0.539
	Extended	-	2.294	0.433	5.30	-0.727	0.198	-3.68	0.545
	Minimal	State	1.630	1.123	1.45	-0.374	0.204	-1.83	0.539
	Extended	State	2.294	1.266	1.81	-0.727	0.267	-2.72	0.545
Read Level 2 story	Minimal	-	1.400	0.294	4.77	-0.134	0.127	-1.06	0.534
	Extended	-	1.724	0.334	5.16	-0.297	0.152	-1.95	0.539
	Minimal	State	1.400	0.563	2.49	-0.134	0.152	-0.88	0.534
	Extended	State	1.724	0.780	2.21	-0.297	0.236	-1.26	0.539
Recognize numbers	Minimal	-	0.512	0.388	1.32	-0.130	0.167	-0.78	0.620
	Extended	-	0.412	0.440	0.93	-0.015	0.201	-0.07	0.626
	Minimal	State	0.512	0.581	0.88	-0.130	0.251	-0.52	0.620
	Extended	State	0.412	0.615	0.67	-0.015	0.345	-0.04	0.626
Subtraction	Minimal	-	1.049	0.384	2.74	-0.638	0.165	-3.86	0.528
	Extended	-	1.465	0.437	3.35	-0.885	0.199	-4.44	0.532
	Minimal	State	1.049	1.224	0.86	-0.638	0.371	-1.72	0.528
	Extended	State	1.465	1.365	1.07	-0.885	0.404	-2.19	0.532
Division	Minimal	-	0.715	0.253	2.82	-0.031	0.109	-0.28	0.472
	Extended	-	0.963	0.288	3.35	-0.167	0.131	-1.27	0.478
	Minimal	State	0.715	0.474	1.51	-0.031	0.210	-0.15	0.472
	Extended	State	0.963	0.664	1.45	-0.167	0.266	-0.63	0.478

Notes: All models include district fixed effects and cohort effects. The 'Minimal' controls include the share of pupils in private schools and other schools. The 'Extended' control variables further add % teachers graduate, % teachers female, % para-teachers, Building compliance index and District's Ability to comply. Pro-RTE teacher transfers are defined as the share of schools that over-comply and experience a teacher leaving the school. Anti-RTE transfers are defined as the share of schools that are at or below compliance, but lose a teacher. Sample means(s.d.) are .036(.041) and .119(.057) respectively.

+

Table 5 Determinants of Effort to comply, first stage 2SLS estimates

	Effort to Comply			
	[1]	[2]	[3]	[4]
Instruments				
RTE ×	-0.126	-0.181	-0.126	-0.181
Pre-RTE Effort to comply	[-4.39]	[-6.61]	[-1.41]	[-2.60]
RTE ×	-0.002	-0.001	-0.002	-0.001
Avg. distance to district HQ	[-5.62]	[-3.82]	[-1.26]	[-1.22]
RTE ×	0.202	0.186	0.202	0.186
% of trials resolved in 3 years	[16.42]	[13.87]	[2.90]	[3.14]
Cohort controls				
% Private school pupils	-0.023	-0.006	-0.023	-0.006
	[-1.57]	[-0.45]	[-0.81]	[-0.35]
% Other school pupils	-0.096	-0.001	-0.096	-0.001
	[-2.52]	[-0.04]	[-1.25]	[-0.04]
Cohort 06	-0.006	-0.007	-0.006	-0.007
	[-2.36]	[-3.29]	[-1.11]	[-1.71]
Cohort 09	-0.115	-0.158	-0.115	-0.158
	[-7.81]	[-9.94]	[-2.35]	[-4.49]
Cohort 10	-0.100	-0.143	-0.100	-0.143
	[-6.73]	[-8.94]	[-2.01]	[-4.05]
Extended controls	No	Yes	No	Yes
State Clustering of SEs	No	No	Yes	Yes
Sargan over-id test (p-value)	0.0108	0.0789	0.3275	0.2325
Observations	1491	1491	1491	1491
Number of districts	389	389	389	389

Notes: All models include district fixed effects and cohort effects. T-statistics in brackets. The 'Minimal' controls include the share of pupils in private schools and other schools. The 'Extended' control variables further add % teachers graduate, % teachers female, % para-teachers, Building compliance index and District's Ability to comply, all interacted with the post-RTE dummy ('RTE').

+

Table 6 Effort to comply and learning outcomes, 2SLS IV estimates

Outcome (N = 1491)	Controls	S.E. Clustering	Coef.	S.E.	T-stat.	R-sq.
Recognize letters	Minimal	-	1.336	0.285	4.69	0.185
	Extended	-	1.176	0.353	3.33	0.210
	Minimal	State	1.336	0.524	2.55	0.185
	Extended	State	1.176	0.550	2.14	0.210
Read a word	Minimal	-	1.437	0.325	4.43	0.144
	Extended	-	0.912	0.395	2.31	0.197
	Minimal	State	1.437	0.661	2.17	0.144
	Extended	State	0.912	0.782	1.17	0.197
Read level 1 story	Minimal	-	0.553	0.293	1.89	0.154
	Extended	-	0.081	0.354	0.23	0.219
	Minimal	State	0.553	0.967	0.57	0.154
	Extended	State	0.081	1.083	0.07	0.219
Read Level 2 story	Minimal	-	0.262	0.226	1.16	0.037
	Extended	-	-0.013	0.276	-0.05	0.085
	Minimal	State	0.262	0.603	0.43	0.037
	Extended	State	-0.013	0.688	-0.02	0.085
Recognize numbers	Minimal	-	0.758	0.298	2.54	0.425
	Extended	-	0.600	0.371	1.62	0.436
	Minimal	State	0.758	0.545	1.39	0.425
	Extended	State	0.600	0.688	0.87	0.436
Subtraction	Minimal	-	0.972	0.300	3.24	0.191
	Extended	-	0.724	0.355	2.04	0.283
	Minimal	State	0.972	1.125	0.86	0.191
	Extended	State	0.724	1.133	0.64	0.283
Division	Minimal	-	0.041	0.194	0.21	0.128
	Extended	-	0.006	0.237	0.02	0.177
	Minimal	State	0.041	0.562	0.07	0.128
	Extended	State	0.006	0.634	0.01	0.177

Notes: All models include district fixed effects and cohort effects. The ‘Minimal’ controls include the share of pupils in private schools and other schools. The ‘Extended’ control variables further add % teachers graduate, % teachers female, % para-teachers, Building compliance index and District’s Ability to comply, all interacted with the post-RTE dummy (‘RTE’).

+

Table 7 The diminishing returns to teachers, ASER pupil data, 2009-2013

	[1]	[2]	[3]	[4]
	Reading		Mathematics	
	Word	Level 1 story	Recog. numbers	Subtraction
2 teachers too few	-.061**	-.0452**	-.0323**	-.0278*
	[.0139]	[.0134]	[.00934]	[.0126]
1 teacher too few	-.0309**	-0.0133	-.0198**	-0.0146
	[.01]	[.0105]	[.00705]	[.00963]
1 teacher too many	0.00421	0.00193	-0.00122	0.00493
	[.00967]	[.0101]	[.00645]	[.0098]
2 teachers too many	0.0074	-0.0138	.012+	-0.00371
	[.0127]	[.0139]	[.0072]	[.0132]
School size 61-90	-.0281*	-.0426**	-.0167*	-.0229*
	[.0112]	[.0121]	[.00768]	[.0114]
School size 91-120	-.0359**	-.0491**	-.0162*	-0.018
	[.0117]	[.0123]	[.00784]	[.0117]
School size 121-200	-.037**	-.053**	-0.00529	-.0227*
	[.0108]	[.0116]	[.00718]	[.0108]
School size 201-240	-.0669**	-.0669**	-.0293**	-0.0213
	[.0157]	[.0172]	[.0107]	[.0163]
School size 241-280	-.0738**	-.0486*	-.0591**	-0.00637
	[.0264]	[.0241]	[.0176]	[.0241]
School size 281-320	-.0442+	-0.0418	0.000428	0.0285
	[.0243]	[.0268]	[.0164]	[.0241]
Father years of education	.00673**	.00919**	.00336**	.00908**
	[.001]	[.00102]	[.000735]	[.000946]
Mother years of education	.0126**	.0122**	.00634**	.0121**
	[.00107]	[.00111]	[.000773]	[.00106]
Female	-.019**	-0.0057	-.0145**	-.0243**
	[.00493]	[.00489]	[.00352]	[.00473]
Age effects	Yes	Yes	Yes	Yes
District effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Observations	30,234	30,234	30169	30169
R-squared	0.304	0.274	0.193	0.241

Notes: ** p<0.01, * p<0.05, + p<0.1. Standard errors (in brackets) are clustered at village/school level. Sample constrained to ASER 2009-2013 public school pupils, who are in a village where only one public primary school with grades 1-4/5 is sampled. The sample includes only villages where the school size is up to 320 pupils, and the baseline schools are ones with up to 60 pupils. The sample is also limited to schools which have at most 2 teachers too many or too few, according to the RTE requirements. Summary statistics of the sample are in Appendix Table A7.

+

Appendices

Appendix Sample selection in the District Information System for Education raw data

The raw DISE data from years 2005-2012 is pooled, and the following restrictions are made:

We use both school level and teacher level data. For the teacher level data, we keep only teachers who teach at the primary level or 'mostly primary' level. This amounts to roughly 27 million teacher observations over 2005-2012 (Table A1). Teacher information is consequently averaged at the school level and further restrictions are applied as described below.

Table A1 Raw data of selected primary school teacher characteristics, 2005-2012

	Obs	Mean	S.D.	Min	Max
Year	27348073	2008.7	2.3	2005	2012
Female	27344712	0.472	0.499	0	1
Graduate	27348073	0.483	0.500	0	1
Age	27073383	37.5	10.3	17	80

Source: DISE 2005-2012

In DISE school-level data, we include only primary schools. For schools that include both primary and secondary levels, we include only primary pupils in grades 1-4 or 1-5, depending on the state. The data set is constrained to non-private schools. The capital city Delhi is excluded, as enrolment data is missing completely for some years.

+

Schools that record zero pupils are excluded, as are schools where the number of pupils or teachers is missing. Schools with a pupil-teacher ratio in the top 0.5% are deemed to be outliers which are removed. This constrains the maximum pupil-teacher ratio in the data to 260. Finally, we exclude districts with less than 30 schools. This leaves us this with the following school level raw data (Table A2).

Table A2 Raw data of selected school characteristics, 2005-2012

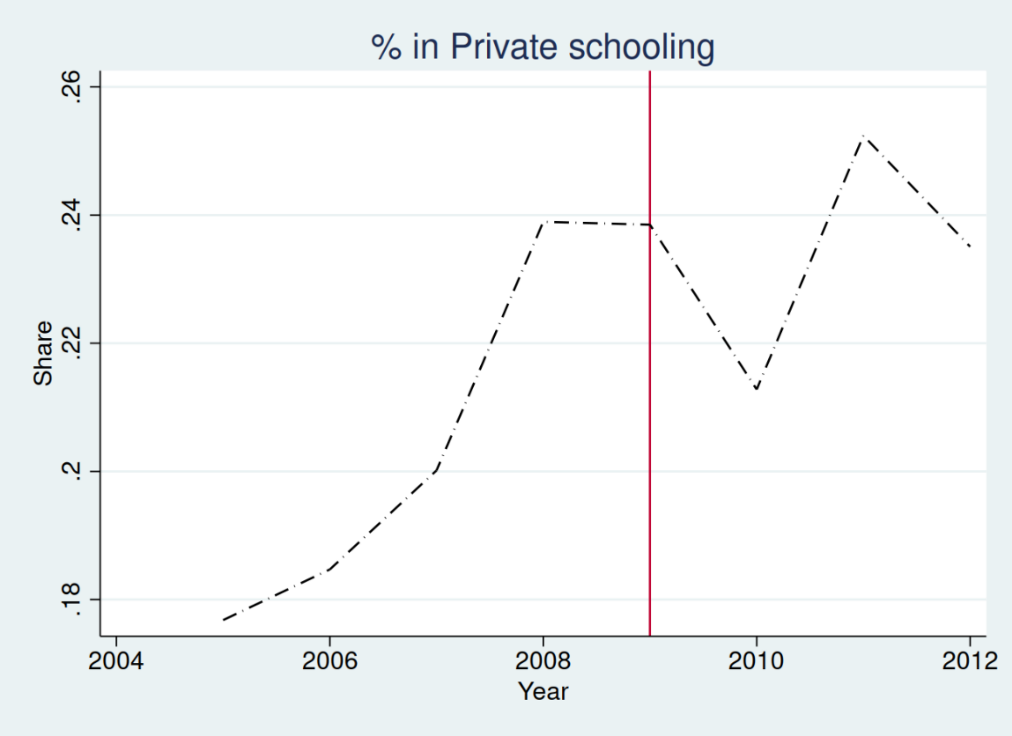
	Obs	Mean	S.D.	Min	Max
Year	6325363	2008.6	2.3	2005	2012
Enrolment	6325363	108.9	100.0	1	3150
Teachers	6325363	2.87	1.82	1	59
PT-ratio	6325363	40.5	32.6	0.1	260
Urban	6324841	0.07	0.25	0	1

Source: DISE 2005-2012

+

Appendix: Further figures and tables

Figure A1 Share of primary aged children in private schooling, based on DISE data



Notes: The line displays the share of primary school pupils in private schools according to the DISE register database (based on pupil numbers reported by schools). The vertical line on 2009 shows corresponds to the onset of the Right to Education Act.

+

Table A3 Pupil-teacher ratio norms under the Right to Education Act.

Admitted children	Number of required teachers
Up to 60	2
61-90	3
91-120	4
121-200	5
Above 200	One per forty children

Notes: Source: RTE Forum (2015)

Table A4 District-cohort summary statistics of the items in the building compliance index

	Full sample				Pre-RTE		Post-RTE	
	Mean	S.D.	Min	Max	Mean	S.D.	Mean	S.D.
Building compliance (index)	0.682	0.128	0.250	0.958	0.647	0.133	0.717	0.113
All-weather building	0.762	0.228	0	0.999	0.772	0.225	0.751	0.231
Enough classrooms	0.734	0.152	0.276	0.980	0.722	0.162	0.746	0.141
Extra room	0.802	0.140	0.227	1	0.788	0.147	0.817	0.131
Barrier-free access	0.565	0.270	0.013	1	0.440	0.262	0.686	0.218
Gendered toilet	0.616	0.256	0.006	0.999	0.514	0.261	0.716	0.207
Drinking water	0.929	0.079	0.319	1	0.900	0.091	0.957	0.051
Playground	0.519	0.195	0.0862	1	0.515	0.190	0.523	0.200
Boundary wall	0.532	0.215	0.078	0.991	0.522	0.221	0.542	0.208
N	1443				714		719	

Notes: The reported values are averaged from pupil weighted district data for cohorts in ages 6-9 over the time they spend in school.

+

Table A5 ASER Pupil-level sample sizes for the examined cohorts

	Cohort 05		Cohort 06	
	Mean	S.D.	Mean	S.D.
Pupil observations	87.9	21.1	83.9	21.1
Reading (age 6)	1.087	0.564	1.177	0.440
Reading (age 9)	2.667	0.535	2.688	0.525
Mathematics (age 6)	0.602	0.352	0.711	0.310
Mathematics (Age 9)	1.598	0.368	1.654	0.371
% Private school	0.228	0.180	0.210	0.175
% Other school	0.029	0.042	0.029	0.037
District observations	375		375	
	Cohort 09		**Cohort 10**	
	Mean	S.D.	Mean	S.D.
Pupil observations	68.8	17.1	66.3	16.5
Reading (age 6)	1.234	0.453	1.160	0.416
Reading (age 9)	2.335	0.593	2.372	0.557
Mathematics (age 6)	0.868	0.251	0.820	0.242
Mathematics (Age 9)	1.345	0.316	1.359	0.282
% Private school	0.292	0.214	0.303	0.212
% Other school	0.024	0.035	0.020	0.031
District observations	375		375	

Source: ASER household surveys 2005-06, 2008-10, 2012-13

+

Table A6 Levels of learning in ASER by cohort and age

Pre-RTE cohorts:	**Cohort 05**		**Cohort 06**	
	Age = 6	Age = 9	Age = 6	Age = 9
	Reading (%)		Reading (%)	
0: Nothing	40.7	5.2	32.9	4.4
1: Letters	30.3	13.6	35.0	14.0
2: Words	16.8	20.4	21.0	22.4
3: Level 1 text	6.3	27.3	6.6	27.7
4: Level 2 text	6.0	33.5	4.5	31.6
Obs.	35140	48960	54099	46762
	Maths (%)		Maths (%)	
0: Nothing	53.7	4.9	46.5	4.5
1: Numbers	35.4	44.8	40.6	43.3
2: Subtraction	7.4	30.6	9.3	32.0
3: Division	3.6	19.7	3.7	20.2
Obs.	34619	48831	53363	46465
Post-RTE cohorts:	**Cohort 09**		**Cohort 10**	
	Age = 6	Age = 9	Age = 6	Age = 9
	Reading (%)		Reading (%)	
0: Nothing	25.2	8.3	27.5	8.5
1: Letters	43.6	19.9	41.0	19.2
2: Words	20.1	20.9	21.0	19.3
3: Level 1 text	7.1	20.0	6.4	21.3
4: Level 2 text	4.0	30.8	4.2	31.8
Obs.	48049	35137	43549	32680
	Maths (%)		Maths (%)	
0: Nothing	25.3	6.4	27.3	6.1
1: Numbers	65.6	55.6	64.5	55.6
2: Subtraction	6.6	25.0	5.6	24.5
3: Division	2.5	13.1	2.6	13.8
Obs.	47499	35067	42994	32597

Notes: Table is based on unweighted data, and includes children irrespective of whether they attend school, or attend public or private school. Changes in sample size from age 6 to 9 within cohort does not imply attrition or selection. Since 2011, ASER has separated number recognition to numbers 0-9 and 10-99, so that Mathematics has a total of five categories. We have made these backward compatible by combining these two to the old 'Recognize a number' -category. This applies to age 9 in cohorts 09 and 10 that come from ASER 2012 and 2013.

Table A7 Summary statistics for ASER 2009-2013 primary pupil sample

	Obs	Mean	S.D.	Min	Max
Year	30,234	2011.3	1.3	2009	2013
Reading: Word	30,234	0.581	0.493	0	1
Reading: Level 1 story	30,234	0.385	0.487	0	1
Math: Recognize numbers	30,116	0.862	0.345	0	1
Math: Subtraction	30,116	0.294	0.456	0	1
Gender (1:M,2:F)	30,234	1.496	0.500	1	2
Father years of education	30,234	8.958	3.144	0	18
Mother years of education	30,234	7.058	2.895	0	18
Pupil class	30,234	2.901	1.430	1	5
Pupil age	30,234	8.093	1.960	5	16
Teachers (at school)	30,234	4.041	1.570	1	10
Pupils (at school)	30,234	117.9	63.3	7	320
Excess teachers (as per RTE)	30,234	0.008	1.179	-2	2
Pupil-teacher ratio	30,234	29.4	12.5	3.5	90

Notes: ASER 2009-2013 household and village samples pooled. Sample is limited to villages with only one reporting public primary school, and to tested pupils in public primary school grades, to schools with less than 320 pupils, and to schools where the number of teachers deviate from the RTE norm at most by two teachers.