Teacher Imbalances and Segregation in India

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Abstract

An important dimension of public service delivery concerns the spatial distribution of staff, but systematic studies on the allocation of teachers in a developing country context are scarce. With the use of an administrative database for India between 2006-2012, we document how the quality of teacher allocation across districts in the country is connected with workplace segregation of teachers by caste and gender. By using the legal school-specific pupil-teacher ratio norms introduced by the Right to Education Act (2009) as an external event, we show that the segregation of teachers, especially by caste, acts as a constraint for improvements in the needs-based allocation of teachers.

Keywords: Teachers, Public service delivery, Gender segregation, Caste segregation, India,

Right to Education Act. JEL Codes: H75, I24, J45, M54

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1 Introduction

The persistence of low levels of learning, despite increases in enrollment and school resources, has led to the need to understand more about the management of school systems and the motivation of teachers in many developing countries (e.g. Pritchett et al., 2013). Recent research, for instance by Bloom et al. (2015) shows that the quality of school management is strongly connected with learning in multiple countries.

This study highlights an overlooked dimension of school management: the spatial distribution of public sector teachers. We study this question in the Indian context. Teachers are a key educational resource and well functioning school systems should be able to distribute teachers in proportion to the students across areas and schools. Large deviations from this aim could be considered evidence of inefficient management of personnel, which is likely to influence the effectiveness of the delivery of education.

While the distribution of health workers has received some attention (see e.g. Lemière et al., 2013 and Munga and Maestad, 2009), quantitative, large-scale studies on imbalances in the distribution of teachers and their correlates are scarce in the context of developing countries.[1] Studies have highlighted inefficiencies driven by high teacher absence rates (e.g. Chaudhury et al., 2006, Kremer et al., 2005, Muralidharan et al., 2014) and the role of incentives in service delivery (e.g. Dal Bó et al., 2003, Muralidharan and Sundararaman, 2011, Ashraf et al., 2016). In developing countries, highly educated teachers and public sector workers are often averse to remote areas (see e.g. Serneels et al., 2010, Fagernäs and Pelkonen, 2012 and Lemière et al., 2013). However, more fundamental societal divisions,

1 See e.g. Zhang and Kanbur (2005) for a more general analysis on spatial inequalities in the provision of health and education in China. Jaramillo (2012) studies the determinants of the location of a teacher's first job in two regions of Peru.

relating to caste and gender roles, may also constrain the allocation of public servants at an aggregate level for instance due to differing individual preferences.

Our study contributes to the gap in the literature by examining imbalances in the distribution of Indian public sector teachers. We rely on a large register database of Indian public sector primary schools, the District Information System for Education (DISE), that covers the entire India. We use a panel data set for the 2006-2012 period. With these data, we construct several indicators to study how equally public sector primary school teachers are allocated within districts, including a novel indicator. In addition, we measure the degree of segregation of teachers by gender and caste across districts. We then test the hypothesis that the need, or desire of formal teachers to segregate can constrain the allocation of formal teachers across schools within districts, and pose a constraint to rules on pupil-teacher ratios.

Regular Indian public primary school teachers are civil servants, who are hired and employed by Indian states on permanent contracts. Pay is relatively inflexible, and the location of employment can be considered an important non-pecuniary aspect of work. In this context, the characteristics of individual teachers are likely to matter for the allocation of teachers, through a combination of factors such as preferences, policy or bargaining power.[2] The actual allocation and transfer of teachers usually takes place at a sub-state level. Typically in larger states, transfers take place either within a district, or sometimes within a block (see e.g. NUEPA, 2016).[3] While there is some variation, a district is the most appropriate unit to study the distribution of teachers.

The period of our study coincides with the implementation of The Right of Children

2 The role of politics in the postings and transfers has also been highlighted for instance by Béteille (2009) and Kingdon and Muzammil (2009). The DISE database does not include indicators on political connections of teachers.

3 A district is an administrative sub-unit of a state and a block an administrative sub-unit of a district.

to Free and Compulsory Education Act (RTE) of 2009, which came into force in April 2010.[4] This is a major education initiative by the Indian government which sets a number of requirements for the provision of schooling, including rules on pupil-teacher ratios in schools.

We begin by analyzing the allocation of teachers and whether the allocation has responded to the RTE Act. In addition to pupil-teacher ratios and the RTE allocation rules, we study the allocation of teachers using a more 'objective' self-constructed index to assess how equally teachers are allocated with respect to pupil numbers at the level of districts. Our analysis reveals fairly significant differences in how pupil-teacher ratios are distributed across schools within districts. While pupil-teacher ratios have improved with the RTE, and the allocation has moved towards meeting the RTE norms, more objectively measured imbalances in teacher allocation have not improved.

We also find evidence of significant and varying segregation of formal teachers with respect to caste and gender. To measure the segregation of formal public sector teachers, we use adjusted dissimilarity indexes, which reflect the similarity of teachers within schools in a district in terms of gender and caste. Segregation can derive from a number of factors such as history, preferences and policy. However, it will at least partly reflect the preferences, or will of specific teachers to work in a particular type of location, or in a particular type of community.[5] Segregation is found to correlate with female progressiveness, urbanization and pupil segregation. It is also geographic to a degree, for instance with the presence of female teachers declining sharply with the remoteness of a school.

Teacher segregation has received rather little attention in the literature, especially in developing countries (see e.g. Frankenberg, 2009). We find that in the period since the

4 See e.g. http://righttoeducation.in/. Last accessed 16th August 2016.
5 Earlier research has shown that location preferences of teachers can vary dramatically by gender or caste of teachers in India (Fagernäs and Pelkonen, 2012).

implementation of RTE, districts with a higher degree of pre-RTE segregation of teachers by caste or gender are less likely to meet the RTE allocation rules on pupil-teacher ratios. Caste segregation is also associated with a higher degree of misallocated teachers in the post-RTE period, according to the more objective measures. At a more general level our results indicate that the effectiveness of policies aiming to improve the allocation of teachers may be hindered by high levels of segregation.

From a broader perspective, our findings on segregation can be connected with the literature on the role that a gender or caste match between pupils and teachers has on learning (see e.g. Dee, 2005, Dee, 2007, Rawal and Kingdon, 2010, Muralidharan and Sheth, 2015, Karachiwalla, 2015). The geographic segregation of teachers is significant enough for urban pupils to be much more likely to be taught by women, and remote rural pupils by men. While the focus is on teachers, the study can also be connected with the literature on the role of social fractionalization in the provision of public goods (see e.g. Banerjee et al., 2005).

We begin with a description of the data (Section 2), which is followed by a description of the indicators used to measure the equality of teacher allocation across districts (Section 3). Section 4 describes the geographic imbalances and Section 5 the segregation of teachers in terms of gender and caste. Finally, we explore the association between the equality of teacher allocation and teacher segregation (Section 6). Section 7 concludes and discusses the broader implications of our findings for policy and related research.

2 Data

The data used in this study come from a register database of all Indian public-sector primary schools, the District Information System for Education (DISE) by the National University of

Education and Planning (NUEPA). We utilize the data for the academic years of 2006/07 to 2012/13. This is an unbalanced panel database 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 resources and management, but it does not include reliable, or comparable data on learning. It covers all public sector schools as well as teachers, and is thus a promising source for studying the composition and distribution of teachers in the Indian primary education sector. A short discussion of the quality of the database can be found in the Appendix. The data are collected in the latter half of a calendar year, around September.

Our main sample covers all regular or para-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.[6] Regular teachers are civil servants, generally with permanent contracts. In addition to regular teachers, many states hire temporary contract (para) teachers to staff schools that lack teachers. Para-teachers tend to be local to the areas, less likely to have teacher training and work on short-term contracts and lower pay (see e.g. Kingdon and Sipahimalani-Rao, 2010). The use of para-teachers itself can be indicative of challenges in the equal allocation of formal teachers. Our indicators on pupil-teacher ratios and the allocation of teachers include both types of teachers. Summary statistics for the main variables of interest for our sample of schools are shown in Table 1.

6 Teachers may be in schools that include classes above lower primary ones, but only teachers who report teaching "primary" or "mostly" lower primary grades are included in the sample. 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"

TABLE 1

3 Measuring the equality of teacher allocation

Teachers are employed by states, that make the core decisions on hiring, but the allocation and transfers of teachers generally take place at the sub-state level. The geographic unit for the allocation and transfer of teachers can vary to some extent by state. It is often the district, but in some cases, it may be sub-district level and in small states, state level. (See e.g. NUEPA, 2016). We study the allocation at the level of districts, which is still arguably the most natural level of focus. The district is often also the level at which the training of teachers takes place in the so called DIETs (District Institute for Education and Training).

Transfers of primary school teachers can take place due to administrative reasons, such as the rationalization of teacher-pupil ratios, upon the request of teachers, in the form of mutually agreed transfers, or on disciplinary grounds, but many states lack clear transfer rules (NUEPA, 2016, Ramachandran et al., 2005 and 2008, and Sharma and Ramachandran, 2009). The recommended pupil-teacher ratio (PTR) under earlier government guidelines (Sarva Shiksha Abhiyan) was set at 40:1. Since the Right to Education Act (or RTE), these norms changed and a legal requirement was established. For smaller schools, the new norm is 30:1 pupils per teacher, and the minimum number of teachers in any school is two. However, 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 the Appendix, Table A2. They have been applicable from April 2010 onwards.

Our first indicator for the allocation of teachers is based on the RTE norms. These

requirements set clearly defined norms on pupil-teacher ratios for which administrators such as the District Education Officers could be held accountable. We measure the compliance of districts with these pupil-teacher ratio norms by computing the proportion of schools in a district that have at least the required number of teachers, for a specific number of pupils.

The RTE norms do not minimize the variance of pupil-teacher ratios across schools, as they do not uniformly require the pupil-teacher ratio to be at 30:1, and can lead to very low pupil teacher ratios in the smallest schools, which are supposed to have two teachers.

A more objective manner of allocating teachers would be to aim to equalize PTRs across schools.[7] We construct an indicator to study the inequality of teacher allocation within districts. It is labeled the 'Share of misallocated teachers'. It describes the share of teachers that could be moved to minimize the variability of PTRs across schools. To our knowledge, this measure has not been used in the education literature before.

We calculate the proportion of teachers that could be transferred *within a district*, so as to minimize the variability in pupil-teacher ratios across schools *within the district.* The deficiency (or surplus) of teachers in each school (s) in a given year (t) is defined as the number of teachers the school would need to gain (or lose if negative), Δ_{st}, in order to have the same pupil-teacher ratio as the district (d) on average:

$$(1) \quad \frac{P_{st}}{T_{st}+\Delta_{st}} = \frac{P_{dt}}{T_{dt}} \Rightarrow \Delta_{st} = \frac{P_{st}T_{dt}}{P_{dt}} - T_{st} \quad ,$$

where P refers to pupils and T to teachers. The sum of deficits across the schools equals the

7 If one assumes that lowering the pupil-teacher (P/T) ratio brings diminishing marginal benefits in terms of learning, the equality of P/T-ratios across schools also implies efficiency in the sense that it maximises total learning. In practice, a more important argument for the equality for P/T ratios across schools is the aim for equality in the quality of public service provision.

sum of surpluses across schools. As such, the potential within-district transfers, or the number of misallocated teachers (M_{dt}) is the sum of the deficits

$$(2) \quad M_{dt} = \sum^{n} \Delta_{st} | \Delta_{st} > 0 \quad ,$$

where the sum is taken over all n schools within district d in year t. This measure is further divided by the total number of teachers in the district to give our measure of the rate, or proportion of teachers that could be moved

$$(3) \quad MR_{dt} = \frac{M_{dt}}{T_{dt}} \quad .$$

This indicator is informative of how teachers are distributed in practice at the district level. It is important to note that this is a measure of imbalance across schools, not of the degree of teacher shortages as such. The assumption is that in a well functioning state, the hiring and distribution of teachers should be needs based: the state should aim to maintain similar pupil-teacher ratios across districts, and districts (or lower levels) aim to distribute teachers across schools in similar proportion to enrollment, so that the pupil-teacher ratios would be roughly equal across schools.[8]

Figure 1 shows the distribution of this measure for cross sections of districts in 2006 and 2012. For comparison, Figure 1 also shows the distribution of corresponding numbers calculated for primary schools of 150 Local Education Authorities (LEA) in England for

8 In this study, we overlook the possibility that the desirable pupil-teacher ratio across schools may vary due to issues such as special educational needs.

2015.

Since pupil-teachers ratios are never precisely similar across schools, districts will, perhaps unfairly, always be labeled by this index as having a certain proportion of misallocated teachers. We therefore carry out a simple simulation exercise with hypothetical districts, where the distribution of pupil numbers across schools is drawn from a Poisson distribution with the means varying between 100-200. We then apply a varying maximum class size cut-off of 30 to 50 pupils per teacher in different simulations.[9] For these 'perfectly managed' cases, the share of 'misallocated' teachers would be between .03-.12, which is in the same range as for England in Figure 1.

FIGURE 1

Figure 1 shows that the overall quality of teacher allocation in India has not changed much from 2006 to 2012. We will return to this observation below. Table 2 summarizes the average pupil-teacher ratios and our indicators for the equality of teacher allocation, the proportion of schools that meet the requirements of the RTE Act on the numbers of teachers per pupils and the share of misallocated teachers. Table 2 shows the averages for pre- and post-RTE years, and show that there is a decline in the PTR from 38 to 31.5 pupils per teacher, and an increase in the proportion of schools that satisfy the PTR norms of the RTE, from 52 to 66 percent.

TABLE 2

9 If the number of pupils is below the cut-off, say 30, the school has one teacher. The next teacher is brought in when the pupil numbers exceed the next threshold in multiples of 30, so that a school with 31 pupils will have two teachers.

Our indicators for teacher allocation include both regular and para-teachers. However, the use of para-teachers can be a reactionary measure to difficulties of filling specific posts with regular teachers. Therefore, the imbalances in the allocation of teachers would be somewhat larger if para-teachers were to be excluded from the figures.

To our knowledge, no systematic descriptions of the quality of teacher allocation are available for India or for most other major developing countries. Given that the DISE database does not include reliable data on learning, we cannot credibly explore the connection between imbalances and learning in detail. However, to provide some indication of the association, we describe the correlation between our indicator for the share of misallocated teachers and the levels of learning.

Figure 2 shows a scatter plot of districts in 2010 with the proportion of misallocated teachers, and the share of rural government school pupils between the age of 9-11, who are able to read a story.[10] The data source for the learning outcomes is the ASER 2010 household survey, which tests children at home.[11] The ASER survey is restricted to rural areas, and therefore the comparison with the misallocation measure is not entirely valid, since it is computed for both rural and urban areas. An unequal distribution of teachers can also potentially benefit many pupils, but overall, Figure 2 suggests a negative average correlation ($r = -0.20$). While the correlation is not very strong, across Indian districts, a more unequal allocation of teachers is associated with lower levels of learning on average.

FIGURE 2

10 Ages 9-11 correspond to the typical ages at the end of the primary school.

11 http://www.asercentre.org/

4 Teacher allocation and the Right to Education Act

Recent assessments of the RTE (for example RTE Forum, 2015) uniformly suggest that pupil-teacher ratios have declined significantly. Less is known about the extent to which the distribution of teachers has improved.

For an indication of developments over time, we estimate an OLS regression model, where the four teacher allocation indicators summarized in Table 1 are explained with year dummies and district fixed effects. The model takes the following form

$$(4) \quad Outcome_{dt} = \lambda_d + \theta_t + e_{dt} \qquad t_{pre-RTE} \in [2006,2009], t_{RTE} \in [2010,2012]$$

The results are shown in Table 3. In all of the models, the years are divided into pre- and post-RTE years. The RTE came into force in April 2010. The first year in our database for which the RTE norms of teachers per pupils are applicable is the year 2010, given that the DISE data are recorded in late 2010. The year 2009 is the reference year and years 2006-2008 are treated as pre-RTE years.

TABLE 3

Column 1 of Table 3 shows that there is a declining trend in pupil-teacher ratios, which is evident in both the pre- and post-RTE period. The dependent variable in column 2 is the proportion of schools that have at least the number of teachers required by the national RTE norms. Again, an improving trend is visible both before and after the RTE, which

logically follows from the increased number of teachers per pupil. The largest improvement takes place between 2010 and 2011, suggesting that the states have started to react to the norms. It is worth noting that satisfying the RTE norms will be more difficult for those states that start with larger PTRs.[12]

Column 3 shows the development in the more 'objective' teacher allocation measure, based on the variability of the school-specific PTRs around the district mean PTRs. Significant improvements in this measure should be possible for most Indian districts even without improvements in the PTRs. However, this indicator show no substantial improvement from the pre-RTE years to 2012; a pattern that is already visually detectable in Figure 1.

There are a few potential reasons why the objective distribution of teachers may not have improved, despite the sensible requirements of the RTE norms. Firstly, the RTE norms do not aim for the minimization of the variability in the PTRs: large and small schools aim for different PTRs (either 40 or 30), and very small schools are still always required to have two teachers.[13] Secondly, it is possible that some administrators aim to maximise the share of complying schools by creating some schools with poor PTRs.

5 Teacher segregation and geographic imbalances of teachers by characteristics

A study of the full array of reasons behind the misallocation of teachers is beyond the scope of this article. In the Sections that follow, we focus on one aspect; the segregation of teachers within schools by gender and schools. Section 5.1 provides some stylized facts on

12 Table A3 in the Appendix describes the indicators for teacher allocation by state for the panel of districts over 2006-2012.

13 The precise teacher norms are in Appendix table A2.

the geographic distribution of teachers and Section 5.2 describes indexes of caste and gender segregation of teachers and their correlates. In Section 6, we show that the ability of states to meet the RTE norms and the equality of teacher allocation are constrained by such segregation of teachers.

5.1 Geography and teacher characteristics

We focus on the spatial distribution of teachers with respect to two characteristics: gender and caste.[14] In the data there are two variables to capture the geographic remoteness of a school: whether the school is in an urban area, and the school's distance to the block headquarters.[15] As Table 1 shows, 6.8% of the schools in the sample are urban schools, and the average distance to the block headquarters is 16 km.

Figure 3 shows the percentage of female teachers by the distance of the school from the block headquarters. It is evident that the presence of women declines steadily with the remoteness of the school. In addition to gender, there is also a geographic pattern in the caste distribution of teachers. We simplify the analysis on caste by focusing on two broader categories; general caste and lower caste (scheduled caste, scheduled tribe and other backward class - SC/ST/OBC[16]) teachers. Lower caste teachers are more likely to be found in remote locations than general caste teachers (Figure 4). This gradient by distance is nearly as steep as that for gender; moving from 0 to 40 km from the block headquarters increases the share of lower caste teachers by about 20 percentage points, and a similar change in Figure 3

14 A further dimension that could be explored is education, but the majority of formal teachers are graduates with teacher training, and the data do not suggest a strong degree of segregation with respect to education.
15 While the DISE database has GIS codes for some schools, the coverage varies by state and is not yet very reliable.
16 Other backward class (OBC) also includes ‘other reserved groups’.

would increase the proportion of male teachers by about 30 percentage points.[17] These facts will be known to educational practitioners in India, but their precise scope is not well documented. The preference of female teachers against remote rural areas in India has been documented experimentally with teacher trainees by Fagernäs and Pelkonen (2012).

FIGURES 3 AND 4

Figures 3 and 4 together show that any segregation of teachers by gender and caste within schools will be at least partly driven by geographic remoteness of schools. Next, we turn to more formal measures of segregation.

5.2 Segregation measures and correlates

In order to calculate measures of teacher segregation, we construct district level indexes for the segregation of teachers across schools by gender and caste, using the DISE teacher level database, annually between 2006-2012.

To measure segregation, we calculate the commonly used Index of Dissimilarity across schools. This index measures degree of similarity of teachers by gender and caste in schools in a district. The higher the degree of similarity, the more segregated are the teachers in the district. The properties of this index, and a number of alternatives in measuring school segregation are discussed for example by Allen and Vignoles (2007). For gender segregation, the index is calculated as

17 The graphs refer to formal teachers, but the distribution of para-teachers by gender and caste and remoteness is similar as for formal teachers.

(5) $$D = \frac{1}{2} \sum_s \left| \frac{f}{F} - \frac{m}{M} \right| \quad ,$$

where *s* and *d* refer to school and district respectively, *f* and *m* refer to the number of female and male teachers in a school respectively, and *F* and *M* refer to the number of female and male teachers in a district respectively. The sum is computed over all schools in the district. The index ranges between [0,1], where zero indicates that all schools have the same proportion of female teachers, and one means that teachers are perfectly segregated by schools.

Since the number of teachers in schools can be small, even a random allocation of teachers by gender or caste will lead to a positive index of segregation. For example, if female teachers account for 50% of teachers and are randomly allocated to two-teacher schools, 50% of the schools will have teachers of both genders {F,M}, and another 50% will be 'perfectly segregated' with combinations {M,M} or {F,F}, leading to an Index of Dissimilarity of 0.5. We therefore adjust the index of dissimilarity as in Carrington and Troske (1997), and compute an adjusted index of dissimilarity (D_a) as follows

(6) $$\begin{aligned} D_a &= (D - D_r) / (1 - D_r) \text{ if } D > D_r \\ &= (D - D_r) / D_r \text{ if } D < D_r , \end{aligned}$$

where D is the observed Index of Dissimilarity and D_r is the randomly occurring dissimilarity. D_r is computed by Monte Carlo simulation taking into account the size distribution of schools.[18] The values for the adjusted index lie between the range of [-1,1], and

18 We take the number of teachers in schools as given. We then draw the gender of each teacher randomly from a binomial distribution, where the likelihood of being female is the same as in the district as a whole in that

the positive figures indicate the share of the possible segregation that takes place over and beyond the randomly occurring segregation. Negative values on the other hand suggest that there is less segregation than expected.

Table 4 shows that in the case of gender segregation, the average simulated value for the index of dissimilarity in the panel of districts is .502.[19] The average value for the actual dissimilarity index is .612. The value for the adjusted index of .223 suggests that 22.3% of possible teacher gender segregation takes place in a typical Indian school district, but this figure ranges from negative segregation (possible attempts to match men with women) to high levels of gender segregation. Gender and caste segregation are not correlated in the panel of districts. For example, for the pooled pre-RTE panel of 2006-2009, the correlation is -0.05.

TABLE 4

To provide some potential explanations for the segregation of teachers, we estimate simple district level OLS regressions with district level explanatory variables and state fixed effects and state trends. Table A4 in the Appendix shows the results. The results show that a lower level of female literacy, which also proxies for the level of development, is associated with a higher degree of segregation by gender and caste. Caste segregation of teachers is associated further with pupil caste segregation, while gender segregation is associated with a higher rate of urbanization and larger use of para-teachers. In the last case, it is likely that large use of para-teachers and gender segregation are both partly driven by presence of

year. We then compute the segregation index for the district-year cell. This is repeated 100 times and the average index over the randomisations is used as the final D_r.

19 The value for the randomly occurring index can be above 0.5 when the proportion of women deviates from 50%.

remote areas in the district that especially formal female teachers are averse of.

6 Does teacher segregation constrain the equality of teacher allocation?

In this Section we test the hypothesis that caste and gender segregation of teachers poses a possible constraint for the allocation of teachers. Teachers are known to have strong preferences with respect to location, and those preferences vary by gender and caste. Teachers may influence their own initial postings and subsequent transfers in both legitimate or illegitimate ways, depending on how the states and districts function in practice. The preferences or constraints of teachers can therefore create a challenge to the administrators attempting to fill schools with a sufficient numbers of teachers.

The Right to Education Act of 2009 (RTE) created requirements for states to comply with specific teacher-pupil ratios. Therefore, the years 2010-2012 in our data set can be considered ones in which more effort was made to rationalize the allocation of teachers, mainly to satisfy the requirements of the RTE. In the estimations that follow, we utilize the onset of the RTE, together with the degree of pre-RTE variation in the degree of gender and caste segregation of teachers to identify whether the allocation of teachers is constrained by teacher segregation. We rely on a district level panel data set, and the dependent variables of interest are the district-level shares of schools that satisfy the minimum requirements of the RTE norms on PTRs and the more objective measures of teacher allocation.

Figure 5 provides a simple graphical association between the levels of caste and gender segregation and the quality of teacher allocation, as measured by the share of misallocated teachers. The scatter plots use the last pre-RTE year, 2009. The correlation of caste segregation with the misallocation is strongly positive, with a correlation coefficient of

0.32. The graph suggests that the uncondiational level of teacher misallocation is minimised at a small positive level of segregation. For gender segregation however, the correlation with misallocation is only -0.03, with no discernible pattern.

FIGURE 5

In the estimation framework, we allow the effect of the RTE policy to vary with respect to the pre-policy levels of teacher segregation. Effectively we study whether districts with a higher degree of segregation have a lower rate of improvement in the PTRs than those with a lower degree of segregation, as the RTE is implemented trhoughout the country. We estimate the following model

$$(7)\quad Outcome_{dt} = \alpha + \beta_1 RTE_t \times PreCSeg_d + \beta_2 RTE_t \times PreGSeg_d + \lambda_d + \theta_t + e_{dt} \quad ,$$

where λ_d refers to district fixed effects, and θ_t to year effects. $PreCSeg_d$ is the adjusted caste segregation index and $PreGSeg_d$ is the adjusted pre-policy gender segregation index for the districts. The values for these indexes are averages for the pre-policy years 2006-2009. RTE_t is a dummy that takes the value of one for the years 2010-12, and zero for 2006-09.

The main coefficient of interest is the one for the interaction term between the RTE policy and the pre-policy levels of gender and caste segregation. This reflects the degree to which the effect of the RTE policy varies depending on the pre-RTE level of segregation. The district-level fixed effects control for all district specific differences in fixed characteristics, such as remoteness, demographic characteristics and the level of development. The year

effects control for all annual shocks, as well as for all general effects of the RTE policy.

We begin by estimating equation 7 for the district level pupil-teacher ratios, and the share of schools that comply with the RTE norms. These results are presented in columns 1 and 2 of Table 5. The first column shows that the impact of the RTE policy on pupil-teacher ratios is not affected by the initial degree of segregation. This implies that for a given level of pupils, *the level of teacher resources* that the districts have at their disposal doesn't vary with level of segregation. On the other hand, the second column shows that the *way in which the resources are used*, does vary by the level of segregation: districts with a higher level of segregation prior to the RTE, especially by caste comply less with the RTE requirements on teachers per pupils.

TABLE 5

To assess the magnitude of the interaction effect in column 2, let us suppose that the adjusted levels of segregation would be zero instead of the average of 0.221 for caste and 0.223 for gender. In such a case, the share of schools satisfying the RTE norms in the post-RTE period, would be up to 10 percentage points higher (-.333*.221 - .151*.223 = -.107). This is a large effect, which, if true, would make a significant difference for the perceived success of the RTE.

In columns 3 and 4 we analyze the robustness of the result. Firstly, in column 3, we interact the RTE policy variable with a pre-RTE (2006-2009) linear trend in the dependent variable. Here we aim to account for the fact that districts may have made progress towards RTE compliance already prior to the RTE due to improving PTRs, and ensure that our

findings in column 2 are not simply explained by pre-RTE trends that may continue and be correlated with levels of segregation. Secondly, we interact the RTE policy variable with the average pre-RTE PTR for the district to account for different levels of initial teacher resources for districts. The main results are robust to these additions, although the negative effect of caste segregation becomes more moderate.

As a final robustness check, we allow the effect of the RTE policy to vary depending on the variables that were found to be associated with segregation within states (Appendix Table A4). The results are shown in column 4 of Table 5. The negative effect of gender segregation, is significantly mitigated, but this doesn't alter the negative effect of caste segregation much.

Figure 1 and Table 2 together suggested that the more objective indicators for the equality of teacher allocation have not changed significantly with the RTE. In Table 6, we study whether pre-RTE teacher segregation influences the degree to which the equality of teacher allocation changes with the RTE. We estimate equation 7 using the measure of the share of misallocated teachers as the dependent variable. The results are shown in Table 6 with similar robustness checks as in Table 5.

TABLE 6

The results in Table 6 show that initial caste segregation is associated with a significantly higher level of misallocated teachers in the post-RTE period. For gender segregation no such effects are present.

Overall, we find robust evidence that the rationalization of teacher resources in the

post-RTE period has been constrained by the initial degree of segregation of teachers, especially by caste. For gender segregation, the evidence points to the same direction, but the effects are weaker. More generally, the results in Tables 2, 5 and 6 indicate that the way in which policy targets are formulated, matters. The proportion of schools that satisfy the allocation requirements increases with the RTE, while the objective measures of allocation do not. Despite this, the objective measures of allocation have improved significantly more in districts with lower level of caste segregation.

7 Discussion

The recent Right to Education bill of 2009 (RTE) set a clear requirement on the number of teachers as a function of school enrolment. The introduction of the bill was an external event that increased the efforts of the Indian states to rationalize the allocation. In this study, we test for the hypothesis that the segregation of teachers prior to the RTE, along caste and gender, poses a constraint on the rationalization of teacher allocation under the RTE. The rationale for such effect is based on assumption of more rigid location preferences of teachers in areas of higher levels of segregation.

We analyze the allocation and segregation of Indian public sector primary teachers and the association between the two factors using a large administrative database. There is little systematic analysis on these questions in the existing literature. The fact that the time period of study coincides with the introduction of an educational policy (RTE) setting requirements on pupil-teacher ratios provides a policy-relevant setting, and allows us to study how allocation responds to such policies. In addition to pupil-teacher ratios and the RTE allocation rules, we have studied the allocation from a more objective perspective, and

constructed a novel indicator for this. There are fairly significant differences in how pupil-teacher ratios are distributed across schools within districts. While pupil-teacher ratios have improved with the RTE, and the allocation has moved towards meeting the RTE norms, allocation has not improved when more objective measure of the inequality of allocation are used.

We document substantial segregation of formal teachers by caste and gender, which is at least partly geographically driven, and varies greatly across districts. We have argued that segregation will at least partly reflect the preferences, or the will of specific teachers to work in a particular type of location, or in a particular type of community. Our results support the hypotheses that the segregation, especially caste segregation can constrain goals to equalize the allocation of pupil-teacher ratios within districts and pose a constraint to the allocation of teachers according to the RTE norms. Districts with a higher degree of pre-RTE segregation of teachers are less likely to meet the RTE allocation rules on pupil-teacher ratios and are likely to have a higher degree of misallocated teachers, according to the more objective measures. At a more general level our results indicate that the effectiveness of policies aiming to improve the allocation of teachers may be hindered by high levels of teacher segregation.

At a broader level, our findings highlight that the equality in the provision of education can be compromised by poor personnel management and lax enforcement of maximum pupil-teacher ratios. These problems are likely to be larger in developing countries with large regional differences in development, deeper segregation by ethnicity or social status, and a weaker institutional framework.

The findings lend support to the interpretation that teacher preferences, and their ability to affect their posting with legitimate or illegitimate means, play a large role in the

allocation of public sector teachers. This is important given that the high prevalence of teacher absences in India (see e.g. Kremer et al., 2005) is at least partly likely to be driven by the preferences of teachers, especially their willingness to be located in a particular school.

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Table 1 Summary statistics on public sector primary schools, panel data for 2006-2012

	Obs.	Mean	SD	Min	Max
Number of teachers	5903148	2.87	1.83	1	239
Number of formal teachers	5903148	2.35	1.88	0	239
Number of parateachers	5903148	.446	.827	0	26
Required RTE teacher norm satisfied	5903148	.466	.499	0	1
Share of SC/ST/OBC caste teachers	5900916	.659	.377	0	1
Share of female teachers	5903090	.375	.363	0	1
Urban school	5903032	.068	.253	0	1
Distance to Block HQ (km)	5872827	16.0	13.3	0	90
Enrolment	5902981	104.3	95.3	0	819
Share of pupils SC/ST/OBC caste	5755188	.770	.308	0	1

Notes: Source DISE 2006-2012. SC/ST/OBC = Scheduled caste, Scheduled tribe, Other backward class (the last category also includes other reserved groups). A block is an administrative sub-unit of a district. HQ refers to Headquarters. Outliers have been removed (see appendix), as well as districts with less than 30 primary schools.

Table 2 Summary Statistics for District level data set, measures of teacher allocation

2006-2012

N = 3441	Pre-RTE (2006-09)				Post-RTE (2010-12)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Measures of teacher allocation								
Pupil / Teacher ratio	38.0	14.8	4.3	99.6	31.5	14.2	2.9	133.9
Share of schools that satisfy RTE norms	.523	.248	0	1	.657	.237	0	1
Share of misallocated teachers	.216	.045	.073	.484	.212	.045	.093	.386

Notes: The measures of imbalances are computed using school level data for each district and year. The share of misallocated teachers refers to equation 3. Sample has been restricted to districts which have not split during the period.

Table 3 Development of teacher allocation in a panel of districts over 2006-2012

	[1] P/T ratio	[2] % Satisfy RTE norms	[3] Share mis-allocated
Year 2006	6.57**	-.118**	.00568**
	[.345]	[.00572]	[.00162]
Year 2007	4.23**	-.0889**	-.00075
	[.329]	[.00563]	[.00113]
Year 2008	2.1**	-.0418**	.00157
	[.29]	[.00521]	[.0011]
Year 2010 (RTE)	-.290	.0134**	-.00124
	[.341]	[.00504]	[.0011]
Year 2011 (RTE)	-4.33**	.0843**	-.0058**
	[.309]	[.00587]	[.0011]
Year 2012 (RTE)	-5.49**	.124**	-.00121
	[.403]	[.00607]	[.00135]
Observations	3441	3441	3441
R-squared	.870	.873	.805

Notes: The reference year is 2009. All models include district fixed effects. 'RTE' refers to years when the Right to Education act is in force. **, *, + refer to p = .01, .05 and .10 statistical significance. Robust standard errors are in parentheses.

Table 4 Summary Statistics for measures of segregation, District level data set, 2006-2012

	Obs.	Mean	SD	Min	Max
Measures of segregation					
Teacher gender segregation	3441	.612	.096	.329	.875
Teacher gender segregation, random	3441	.502	.088	.276	.832
Teacher gender segregation, adjusted	3441	.223	.114	-.251	.661
Teacher caste segregation	3441	.663	.135	.303	1
Teacher caste segregation, random	3441	.568	.159	.301	.997
Teacher caste segregation, adjusted	3441	.221	.139	-.208	1
Pupil caste segregation	3441	.153	.121	.021	.938
Pupil caste segregation, random	3441	.074	.023	.038	.266
Pupil caste segregation, adjusted	3441	.063	.166	-.698	.915

Notes: The segregation indexes are based on the Index of Dissimilarity, equation 6. Sample has been restricted to districts which have not split during the period. Pupil caste segregation is measured similarly to teacher caste segregation, using school-level data.

Table 5 The Effect of the teacher segregation on the allocation of teachers, as required by the RTE act

	[1] P/T ratio	[2] % Satisfy RTE norms	[3] % Satisfy RTE norms	[4] % Satisfy RTE norms
Interactions				
RTE x pre-policy caste segregation	-4.78	-.333**	-.204**	-.191**
	[6.8]	[.0237]	[.0251]	[.0249]
RTE x pre-policy gender segregation	5.9	-.151**	-.146**	-.0496+
	[7.38]	[.0285]	[.0289]	[.0301]
Further controls				
RTE x pre-policy trend in dependent			.524**	.55**
			[.0318]	[.0321]
RTE x pre-policy P/T ratio			-.000266**	.000818**
			[.0000888]	[.000157]
RTE x Female literacy rate				.051
				[.0387]
RTE x Male-female literacy gap				-.106
				[.0732]
RTE x Urbanisation rate				.0703**
				[.0208]
RTE x pre-policy pupil caste segregation				.004
				[.0198]
RTE x Share of teachers parateachers				-.222**
				[.0261]
District fixed effects	Y	Y	Y	Y
Year effects	Y	Y	Y	Y
Observations	3441	3441	3433	3433
R-squared	.652	.881	.900	.904

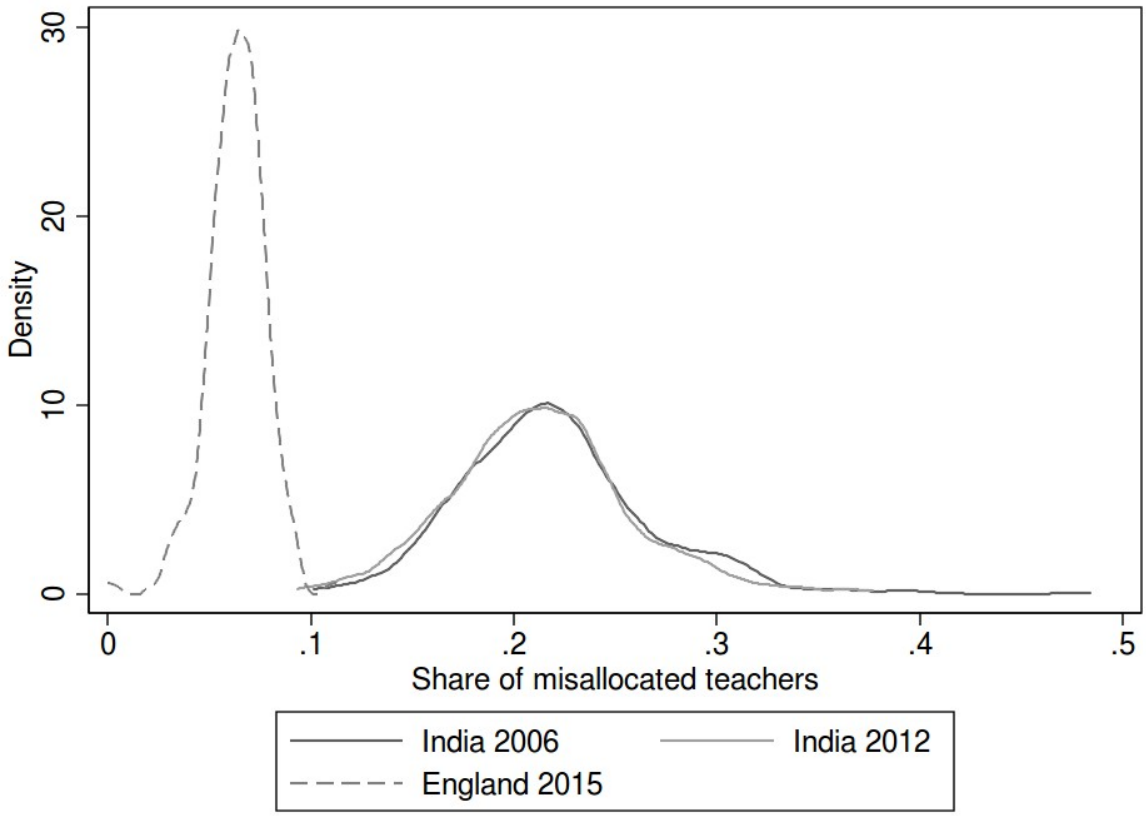
Notes: **, *, + refer to p = .01, .05 and .10 statistical significance. Robust standard errors are in parentheses. The variables for the Female literacy rate, male-female literacy gap and the urbanization rate come from the Indian Census of 2011, and are only available for this year. Summary statistics are shown in the notes to Table A5. The pre-policy trend in the depending variable is calculated for the 2006-09 period and the pre-policy PTR is an average for 2006-09.

Table 6 The Effect of the teacher segregation on the misallocation of teachers since the RTE Act

	[1] Share mis-allocated	[2] Share mis-allocated	[3] Share mis-allocated
Interactions			
RTE x pre-policy caste segregation	.0138*	.0213**	.0188**
	[.00641]	[.00668]	[.00662]
RTE x pre-policy gender segregation	0.0109	0.00952	0.0135
	[.00625]	[.00614]	[.0072]
Further controls			
RTE x pre-policy trend in dependent		.256**	.253**
		[.0352]	[.0361]
RTE x pre-policy P/T ratio		.0000371*	.000
		[.000018]	[.0000321]
RTE x Female literacy rate			.0248*
			[.0101]
RTE x Male-female literacy gap			-.026
			[.0201]
RTE x Urbanisation rate			-.006
			[.00521]
RTE x pre-policy pupil caste segregation			-.002
			[.00644]
RTE x Share of teachers parateachers			.0146*
			[.00593]
District fixed effects	Y	Y	Y
Year effects	Y	Y	Y
Observations	3441	3433	3433
R-squared	.805	.816	.818

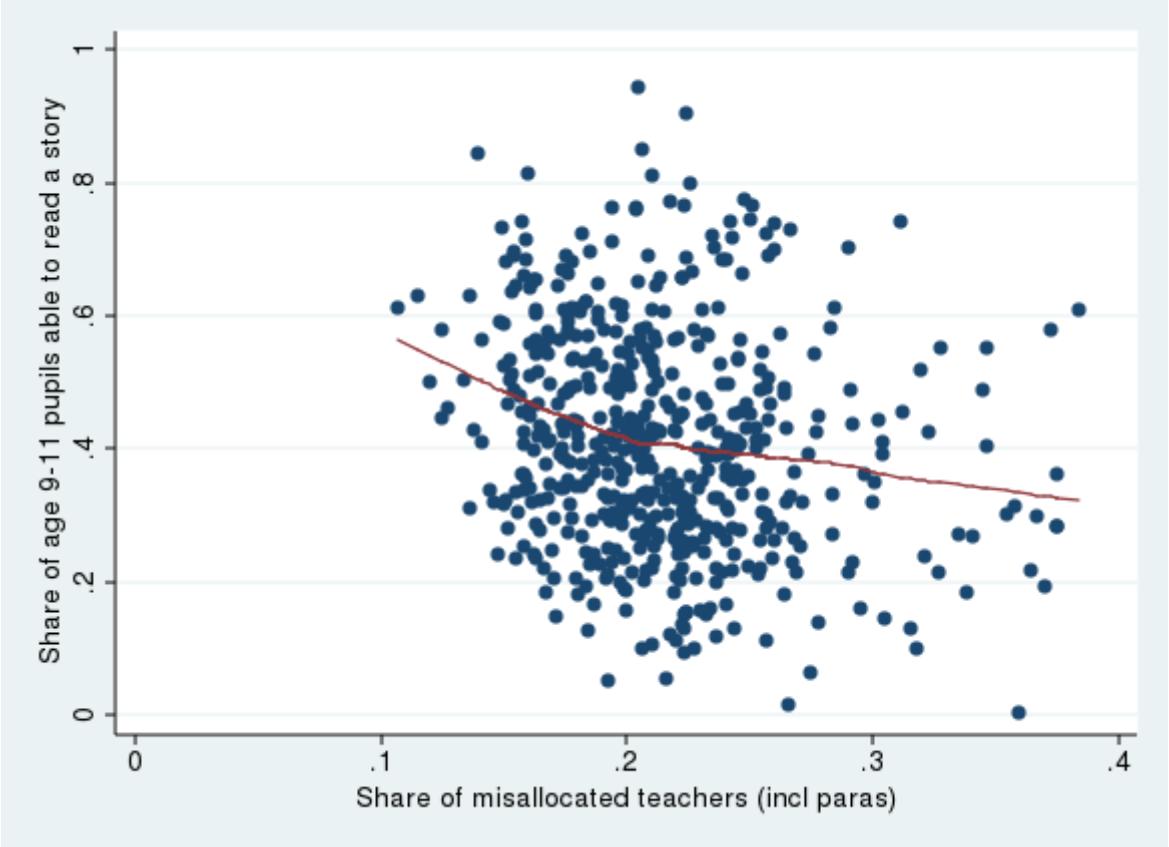
Notes: **, *, + refer to p = .01, .05 and .10 statistical significance. Robust standard errors are in parentheses.

Figure 1 The proportion of teachers that could be transferred within Indian districts in 2006 and 2012 and English Local Education Authorities in 2015.



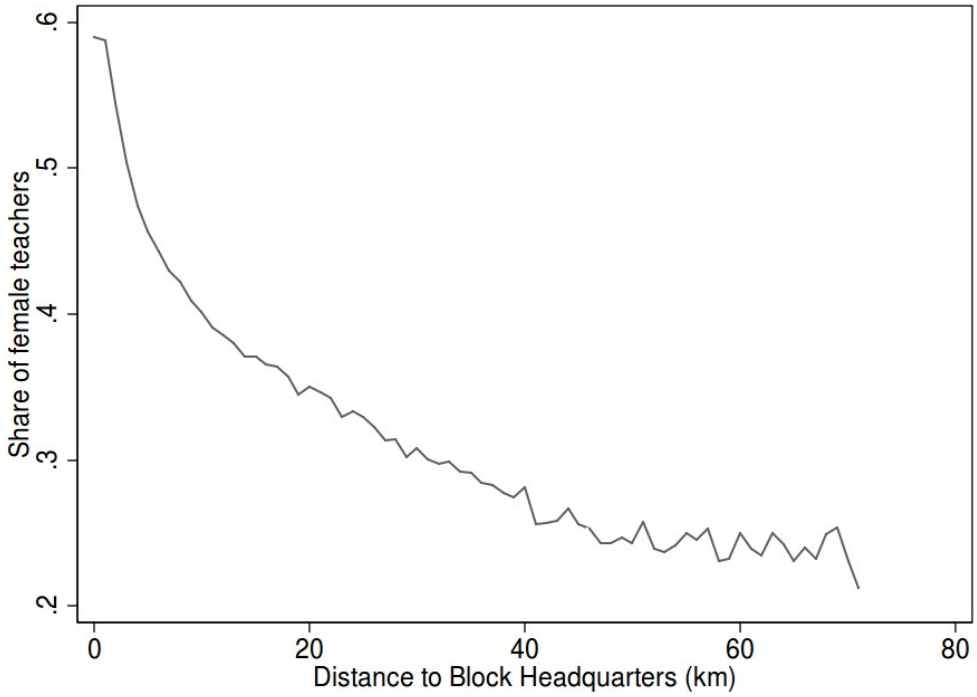
Notes: Figures for England have been calculated for primary schools in 150 Local Education Authorities in 2015, excluding teaching assistants. (Source: Department for Education, UK). Figures for India are based on Indian districts in 2006 and 2012.

Figure 2 Literacy of rural government school pupils between the age of 9-11 and the share of misallocated teachers across districts, 2010



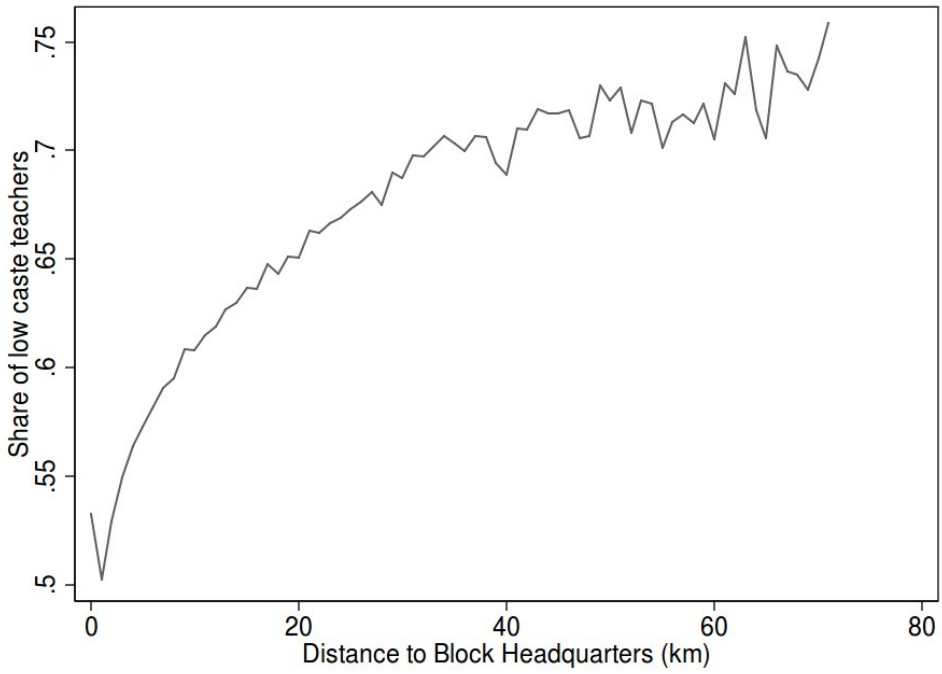
Notes: The data source for literacy is the ASER 2010 survey, restricted to government school pupils aged 9-11. Data includes 527 districts, with on average 200 pupils per district (min:21, max:472). Lowess smoothing line is computed with the defaults of Stata 13.

Figure 3 The share of female teachers by distance to block headquarters, 2011



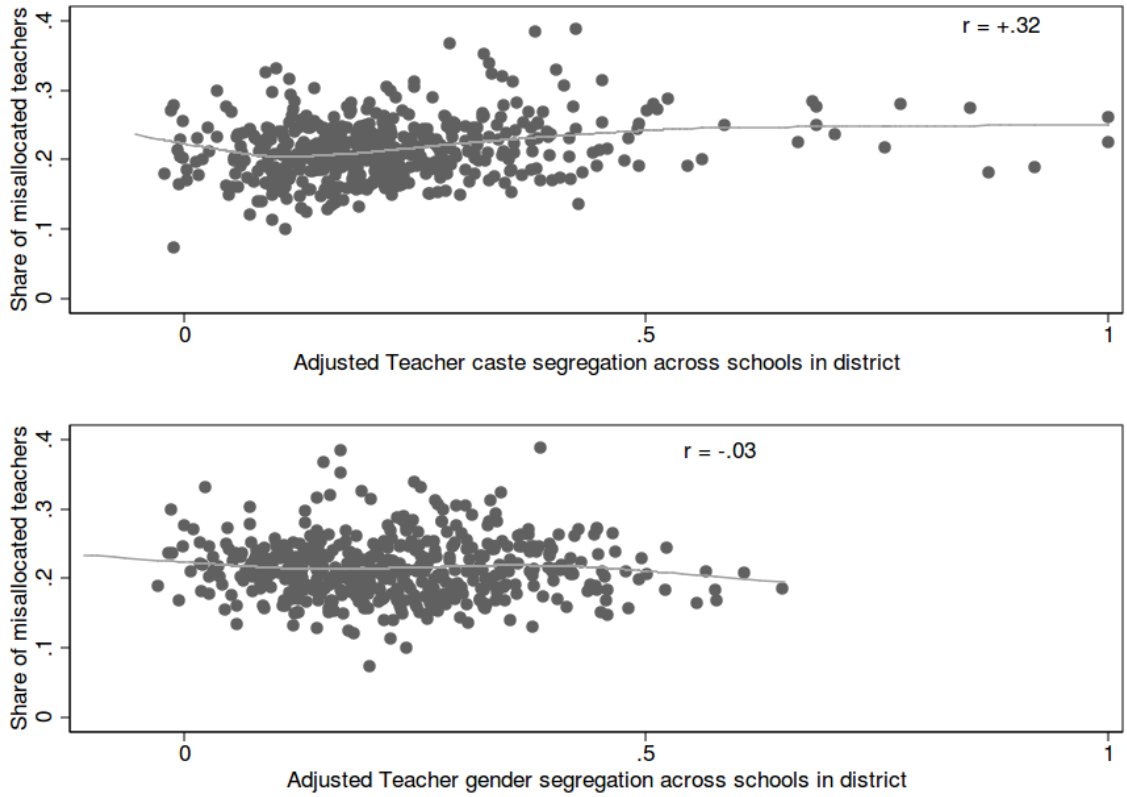
Notes: Graphed using one kilometer bins. Sample: Formal teachers aged 18-55.

Figure 4 The share of lower caste teachers by distance to block headquarters, 2011



Notes: Graphed using one kilometer bins. Sample: Formal teachers aged 18-55.

Figure 5 Scatter plots of gender and caste segregation with the share of misallocated teachers, 2009



Appendix

Cleaning of the DISE data

The sample of districts includes only districts that have not split over the time period, to guarantee comparability over time.

The DISE database was originally introduced for the purpose of planning and monitoring of national education programs in India, as such information systems were not available. The responsibility of reporting lies with the schools. The consistency of the DISE data is checked annually at the state level with 5% re-sampling, and should involve independent monitors. There are no other comparable large, or accurate data sources on Indian schools.[20]

For this study we constrain the data to non-private lower primary schools (grades 1-4 or 1-5 depending on the state). Some schools also have higher grades, but in such cases we have included in our sample only teachers who report that they teach 'Primary' or 'Mostly Primary' grades, and primary level enrollment numbers. With such restrictions, our raw data contains a panel of 7198460 teacher observations over 2006-12 (Table A1).

Some of the school characteristics in DISE include outliers. We have categorized observations as outliers for each year as follows: largest 0.5% of enrollment numbers for each elementary school, largest 0.5% of values for the distance to the block headquarters, and largest 0.5% of the values for the pupil-teacher ratio. If a school has outlier values for any of these variables, it is excluded from the analysis and summary statistics. We also set as outliers the schools that are in districts with less than 30 schools, or for which the number of pupils, or formal teachers is missing. Overall, outliers lead to the exclusion of about 1% of the observations, which are more likely to be urban schools (Table A1).

20 http://www.dise.in/

Table A1 Sample selection due to data cleaning, teacher level data 2006-2012

	Raw data	Outliers	Final sample
Observations	7198460	71808	5903148
Year	2009.1	2009.4	2009.0
Share women	.376	.472	.375
Share SC/ST/OBC	.66	.72	.66
Urban school	.072	.166	.068

Notes: The 'Raw data' is restricted to formal lower primary schools and teachers who report that they teach in such schools.

Table A2 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 A3 Descriptive statistics of teacher allocation by state, district averages, 2006-2012.

State	P/T	RTE norms	MR
Andaman and Nicobar	13	.985	.208
Andhra Pradesh	33	.648	.198
Arunachal Pradesh	21	.818	.291
Assam	31	.665	.299
Bihar	63	.189	.224
Chandigarh	42	.491	.124
Chattisgarh	29	.679	.224
Dadra Nagar	35	.499	.163
Daman & Diu	17	.968	.186
Gujarat	29	.697	.176
Haryana	34	.559	.168
Himachal Pradeh	16	.958	.190
Jammu and Kashmir	12	.961	.260
Jharkand	47	.335	.215
Karnataka	42	.484	.244
Kerala	20	.909	.214
Madhya Pradesh	41	.438	.208
Maharashtra	29	.667	.200
Manipur	18	.874	.275
Meghalaya	18	.882	.232
Mizoram	16	.869	.237
Orissa	31	.646	.213
Pondicherry	23	.847	.223
Punjab	33	.604	.156
Rajasthan	32	.610	.235
Sikkim	13	.968	.226
Tamil Nadu	41	.461	.188
Tripura	25	.726	.254
Uttar Pradesh	25	.762	.246
Uttarakhand	45	.437	.221
West Bengal	35	.522	.176

Notes: All figures are means of district-level values over 2006-2012. MR refers to the share of misallocated teachers. All numbers include both formal and parateachers. 'RTE Norms' refers to the share of schools that satisfy the minimum number of teachers as required by RTE norms. The sample has been restricted to districts that have not split over 2006-2012.

Table A4 Associations between the misallocation of teachers and gender and caste segregation, panel data set 2006-2012, OLS

	[1]	[2]
	Adjusted caste segregation	Adjusted gender segregation
Female literacy rate	-.116*	-.137*
	[.0491]	[.0581]
Male-female literacy gap	-.1130	.17+
	[.13]	[.10]
Urbanisation rate	.0459	.107**
	[.029]	[.0234]
Adjusted pupil caste segregation	.11*	.0405+
	[.0444]	[.0226]
Share of teachers parateachers	.0091	.141**
	[.0299]	[.0307]
Year effects	Y	Y
State effects	Y	Y
Observations	3441	3441
R-squared	.526	.554

Notes: **, *, + refer to p = .01, .05 and .10 statistical significance. Standard errors (in parentheses) are clustered by district. The summary statistics for the variables can be found in Table A5.

Table A5 Summary statistics of additional fixed control variables, district panel data, 2006-2012

	Obs.	Mean	SD	Min	Max
Female literacy	3441	.634	.122	.303	.977
Male-female literacy gap	3441	.172	.062	-.069	.340
Rate of urbanisation	3441	.246	.183	0	1
Share of para-teachers	3441	.140	.189	0	.892

Notes: The source for Literacy rates and the Rate of urbanization is the Indian Census of 2011 and the values are fixed over time. Sample has been restricted to districts which have not split during the period. The share of para-teachers is calculated at the teacher-level using the DISE database.