Impact of Private Secondary Schooling on Cognitive Skills: Evidence from India

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Abstract

We examine the effect of attending private secondary school on educational achievement, as measured by scores in a comprehensive standardize math test, in two Indian states: Orissa and Rajasthan. We use propensity score matching (PSM) to control for any systematic differences between students attending private secondary schools and public secondary schools, and assess the sensitivity of our estimates with respect to unobservables using the Rosenbaum bounds. We find that students in private schools in rural (urban) Rajasthan scored about 1.3 (0.4) standard deviation (SD) higher than their counterparts in the public schools. Importantly, the positive private school impact in rural (urban) Rajasthan survives a large (moderate) amount of positive selection on unobservables. We do not find statistically significant difference in urban Orissa, while a positive impact of 0.3 SD in rural Orissa is susceptible to small amount of positive selection on unobservables.

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1. Introduction

Recent research on education quality and economic growth (Hanushek and Woessmann, 2008) presents strong evidence that cognitive skills, as opposed to mere school enrollment or years of schooling completed, are powerfully related to individual earnings, income distribution, and economic growth. If learning outcomes are critical for success, then understanding how these outcomes are affected is the key to effective policy making. One of the important sources of differential learning outcomes is type of schooling.

The relative performance of students from different type of schooling has been subject to considerable debate in both developed and developing countries. For example in the United States, there exists a large literature on the relative performance of public and Catholic school students. For instance, Evans and Schwab (1995), Neal (1997), and Altonji, Elder and Taber (2005a) compared the effects of school type on outcomes such as standardized cognitive achievement tests, the probability of completing high school and the probability of starting college. The results from these studies are mixed. In Australia, Vella (1999) found that attendance to Catholic schools is linked to better performance in the labor market and achievements. Using the 2000 Programme for International Student Assessment (PISA) data for 22 countries, Vandenberghe and Robin (2004) examined the gap between public and private schools' students using three different estimation methods. They found that private education did not generate systematic benefits. Jimenez, Lockheed, and Paqueo (1991) in a study considering data from Colombia, Dominican Republic, Philippines, Tanzania, and Thailand concluded that, even controlling for student background, private schools performed better than their public counterparts. Newhouse and Beegle (2006) found that Indonesian public junior secondary schools were more effective than their private counterparts at imparting cognitive skills, as measured by students' scores on the national test administered upon completion of junior secondary school.

The education systems in the States and Union Territories of India generally follow the 8+2+2+3 pattern, which provides for eight years of elementary education (five years of primary and three years of middle education), two years each of secondary and senior secondary schooling, and three years of university education. There are four types of schools in India: government schools, established by central and state governments; local body schools, established by local government; private schools that receive government grants-in aid (known as aided schools), and private unaided schools. Government and local body schools are entirely financed and managed by the public sector, and hence collectively called as "government schools." From the early 1970s onward, teachers of private-aided schools have been paid directly from the state government treasury and are recruited by a government-appointed Education Service Commission rather than by the school (Kingdon 2008). Thus, government and aided schools are now quite similar in their mode of operation. In contrast, private unaided schools are run entirely on fee revenues and have virtually no government involvement in matters such as teacher recruitment. Thus private unaided schools are the genuine private schools and we refer to these as private schools.

India has witnessed a considerable growth of private schooling in recent past, even in the rural areas.[2] However, there exists limited understanding of the effectiveness of different type of schools in India especially at the secondary and higher secondary level. Analysis of education in India in general and of private and public schools in particular is hampered by the lack of available data. Despite recent improvements, there is a serious dearth of reliable educational data in India.

[2]Several recent papers point out that private schools are increasingly catering a substantial fraction of primary school going children in India (Kingdon, 2008; Muralidharan and Kremer, 2008; Tooley and Dixon, 2005). According to National Sample Survey, 29.7, 22.8, and 25.5 (20.3, 17.3, and 18.4) percent students at the primary, middle, and secondary school levels attended private unaided schools in 2014 (2007-08) (National Sample Survey Organization, 2015, 2010).

No national-, state-, or district-level data are collected on student learning achievement in primary and junior education in private and public schools; while exam boards do have achievement data for the secondary school level, these are not publicly available to researchers and, in any case, they are not linked to student, teacher, and school characteristics (Kingdon, 2008).

The one strand of the debate on public and private schools in India has focused on the cost and accountability of those schools, while the other strand has examined achievement differentials. For example, Chaudhury et al. (2006) found one in four teachers absent at a typical government-run primary school, and the absence rate ranged from 15% in Maharashtra to 42% in Jharkhand. They also found only 45% of teachers actively engaged in teaching at the time of the random visit. Muralidharan and Kremer (2008) found that private school teachers are 2-8 percentage points less likely to be absent than teachers in public schools and 6-9 percentage points more likely to be engaged in teaching activity at any given point in time.

Although the literature on the public-private achievement differential has been growing with increasing availability of data, most of the studies focus at the primary level of schooling. The evidence from these studies in general suggests a private school advantage. For example, a nationwide survey of rural children's reading and arithmetic skills conducted by Pratham found that 60% of the rural children enrolled in grade 5 in government schools can read a simple paragraph compared to 70% for those in private schools (Pratham 2005). Desai et al. (2008) found modest but statistically significant improvements in reading and arithmetic skills of students in age group 8-11 in private school. Desai et al. also found a large inter-state variation: controlling for parental characteristics, government school students in states as diverse as Kerala, Himachal Pradesh, Chhattisgarh and West Bengal performed at a higher level than private school students in many other states; within states, the performance of private school students was not consistently higher than government school students and in some states government school students did better than private school students. They used data from India Human Survey (IHDS) conducted in 2004-05. Short assessments of reading, writing, and arithmetic skills for children aged 8-11 were included in IHDS, and the objective of these assessments were to measure whether a child is not able to read at all, or is able to read letters, words, sentences, paragraphs or stories. Thus these assessments are not best-suited to capture variation in achievement. Positive impact of private school is also shown by a study in Delhi slums (Tooley and Dixon, 2005).

Using the same IHDS data and assessment of reading, writing, and arithmetic skills as used by Desai et al., Chudgar and Quin (2012) using a propensity score matching method found no unequivocal evidence of superiority of private schools. Goyal (2009) examined the achievement differential between private and public school students in grade 4 based on a comprehensive test in the eastern state of Orissa in India. She finds that students from private school scored 16 percentage points more in mathematics test and 15.4 percentage points more in language test. French and Kingdon (2010) used ASER individual level survey data for age group 6-14. Their achievement data was based on basic test measures. Using household fixed-effects, they found that private school effect on child achievement is about 0.17 standard deviation. Muralidharan and Sundararaman (2013) provided experimental evidence of private school effect based on a random evaluation carried out in the rural areas of the Indian state of Andhra Pradesh. They offered school vouchers through random assignment to children in the last year of the pre-school and grade 1 for the entire duration of the primary schooling till grade 5, which can be used to attend any private school in the village. They examined the impact of school choice after two and four years of the school choice program. They found that the children in private school performed better in Hindi, however no difference in Telugu (native language of Andhra Pradesh) and math. They also found a small positive impact in English. Averaging across subjects, they reported that students who attended private school scored 0.23 SD higher. Using longitudinal data from Young Lives Study in the Indian state of Andhra Pradesh, Singh (2015) found that private school had a positive impact in English and no impact in mathematics between the ages of 8 and 10 years in rural Andhra Pradesh.

In comparison to primary schools where information on the learning outcomes is getting increasingly available, there exists limited information on the effectiveness of private and public schools at the secondary level. The short version of an analysis of secondary educational quality in India is, we don't really know, but relatively small-scale assessments suggest it is very low (World Bank, 2009). Using a survey of public and private secondary schools carried out in urban areas of one of the district in the Indian state of Uttar Pradesh, Kingdon (1996) examined the private and public school achievement differential. She also controlled for potential endogenous selection into different school types on the basis of unobserved characteristics using the Heckman procedure. She found that even after controlling for student background and selection effects, private schools were significantly more effective in teaching mathematics and were marginally more effective in teaching language. Singh (2015) found children in private school in rural Andhra Pradesh score 0.2 SD higher compared to government school children in mathematics at the age of 15 (secondary school age). He also found statistically insignificant positive impact in Telugu language. He did not find any impact of private school on math and Telugu scores at the age 15 in urban Andhra Pradesh though his sample size was small for urban Andhra Pradesh.

In this paper, we provide additional evidence of private-public schools achievement gaps at the secondary level from two Indian states: Orissa and Rajasthan. We use a comprehensive achievement data from two Indian states---Orissa and Rajasthan---collected in 2005 as a part of a larger World Bank Study. The survey administered 90-minute mathematics tests for grade 9 students in both the states. As has been widely recognized in literature, private school is an endogenous variable. Given the non-experimental nature of data, the main option is to find a non-experimental source of variation in private school attendance that is exogenous with respect to the outcome under study. The problem, however, is that valid instruments are difficult to find, and often infeasible in the developing country context because even where official (exogenous) rules exist in law, they are rarely adhered in practice (Kingdon and Teal, 2010). In the absence of an instrument variable, we rely primarily on richness of the data to address these concerns. In addition to parametric Ordinary Least Squares (OLS), we also use semi-parametric Propensity Score Matching (PSM) to control for confounding factors. PSM is arguably an improvement over OLS because it is not constrained by the assumption that the treatment effect is linearly related to the outcome, and explicitly avoids extrapolation into areas of the causal effect distribution which is not on the common support. We also assess the sensitivity of the PSM estimates with respect to the unobservables using, now widely used, Rosenbaum bounds.

We find that private-public schools achievement gaps vary by urban/rural areas and states. We find that students in private schools in rural Rajasthan scored 1.3 standard deviation (SD) higher than their peers in the public schools, whereas in urban Rajasthan this advantage is only 0.4 SD. Importantly, the advantage of private schools in rural Rajasthan survives even if we allow for a large amount of selection on unobservables, whereas the positive impact in urban areas survives only a moderate amount of selection on unobservables. In contrast to Rajasthan, we do not find statistically different impact of private schools in urban Orissa. Although, in rural Orissa private school students scored 0.3 SD higher, this positive advantage is wiped out at small amount of positive selection on unobservables.

There is a general consensus in the literature in India that private schools are superior to public schools (at the primary level), however, our findings at the secondary level suggest that might not hold at the secondary level. There is a large inter-state (urban/rural) variation in the effectiveness of private school. This suggests there is no “one size fits mantra” as far as effectiveness of private school is concerned.

The paper is organized as follows. Section 2 describes the data, Section 3 details the empirical strategy followed in the paper, Section 4 presents the results, and Section 5 concludes.

2. Data

We use data collected in 2005 as part of a larger World Bank study designed and led by Kin Bing Wu, and conducted by the Social and Rural Research Institute (SRI) unit of IMRB International.[3] The survey was conducted in January and February 2005—which is close to the end of the school year in India—in two Indian states of Rajasthan (in the West) and Orissa (in the East). Both Rajasthan and Orissa are poor states with a significantly lower per capita GPD than national per capita GDP.[4] According to Census 2011, the literacy rate (age 7 and above) in Rajasthan and Orissa was 67.1 and 73.5 percent compared with the national literacy rate of 74 percent. Both the states follow 8+2+2+3 education system. In 2007-07, 18.4 (26.8 urban and 14.5 rural) percent of students at secondary and higher secondary level attended private unaided schools at the national level (National Sample Survey, 2010). The percentage of students at secondary and higher secondary level attending private unaided schools are considerably larger (smaller) in Rajasthan (Orissa) compared to national average. In 2007-08, 36.7 (8.9) percent of secondary and higher

[3]For further details on the survey design, see Wu et al. (2006 and 2007). The same data has been used in Wu et al. (2006, 2007, 2009), World Bank (2009), and Das and Zajonc (2010).
[4]In 2014, the per capita GDP of Rajasthan and Orissa was $1443 and $1150, respectively, while national per capita GDP was $1627 (source: Ministry of Statistics and Programme Implementation, India).

secondary students in Rajasthan (Orissa) attended private unaided schools. In urban Rajasthan (Orissa), 51.7 (15.1) percent of secondary and higher secondary students attended private unaided school in 2007-08, whereas in rural Rajasthan (Orissa) 29.5 (7.5) percent of students attended private unaided schools.

The sample was designed by first selecting districts using population proportional to size (PPS) sampling, where, in the absence of data on school-by-school enrollment, the PPS methodology was applied to the population of schools across districts. Following the selection of districts, the total number of schools to be selected in each district was arrived at and schools were surveyed in both urban and rural areas, as well as across institutional affiliation. A maximum of 30 students were selected randomly from various classes in the ninth grade in each school.

The survey administered two separate 90-minute mathematics tests to 3418 and 2856 ninth-grade students in Rajasthan and Orissa, respectively.[5] In addition, the survey also administered student and school questionnaires. The student questionnaire collected data on student characteristics (gender and social composition, age, disability), family background (parental educational level, home resources), schooling experience (pre-primary and primary school enrollment, repetition and dropout, absence, private tutoring, school resources), parental expectations, the opportunity to learn (new lessons, questions, homework, and tests), and work outside school.[6] The school questionnaire collected information about the school from the administrative records.

[5]The test comprises 36 items which assess general mathematic content, knowledge of data representation and analysis, fraction and number sense, algebra, geometry, probability, and statistics (see Appendix Table 1). The items were selected from a sample of published items from the Third International Mathematics and Science Study (TIMSS) for grade 8. Although the original TIMSS populations were the eighth grade, in both the Indian states, test was implemented to students of grade 9. However, more difficult items from the TIMSS tests were chosen to adjust for the grade difference. The tests were shown to teachers, students, and state-level officials to ensure that they were within the curriculum.

[6]Since, the survey asked questions to the students, it does not have information on household income.

We dropped the students attending private aided schools, and concentrate on private unaided and government schools (called private and public schools in this paper).[7] Thus, our final sample consists 3226 (1892 public and 1334 private) students in Rajasthan, and 2460 (1330 public and 1130 private) students in Orissa. We do our analysis separately for urban and rural areas. The score obtained in the math test is our measure of cognitive skills. Math score is a good indicator of school effectiveness because it is a subject learned primarily in school, as compared with other subjects, such as language, which tend to be more heavily influenced by students' experiences at home. We standardize the scores in each states by urban/rural areas, i.e. we use the z-score of achievement as our dependent variable. The normalization implies that the estimated coefficient can be interpreted as fraction of the standard deviation (SD).

Figure 1 shows the kernel density of the scores achieved by the public and private school students in both states. The private school score distribution lies to right of public school score distribution in both urban and rural Rajasthan. In contrast, the score distributions of private and public schools seem similar in Orissa. Table 1 provides the descriptive statistics of the sample used in this paper. Students in private secondary schools in urban Rajasthan scored about 0.50 SD more on average compared to students in public secondary schools in urban Rajasthan. Moreover, the raw advantage of private school students in rural Rajasthan is more than twice compared to the advantage in urban Rajasthan: the students in private schools in rural Rajasthan scored 1.28 SD more than their counterparts in public school, which is a huge advantage. In contrast, Orissa presents a very different picture. The students in private schools in urban Orissa scored marginally lower than their counterparts in the public school, though in rural Orissa private school students scored 0.29 SD more on average. The difference in observed characteristics of private and public

[7] 185 and 396 students attending private aided schools in Rajasthan and Orissa, respectively, were dropped from the sample. 7 students were further dropped from Rajasthan sample as they did not respond to any of the 36 questions.

school students are statistically significant for many characteristics in Rajasthan, while difference is statistically significant only for few characteristics in Orissa.

3. Empirics

3.1. Parametric estimation

We begin by specifying the following regression model to estimate the effect of private school

$$y_i = \alpha P_i + x_i' \gamma + \epsilon_i \qquad (1)$$

where the dependent variable y_i is the normalized test score in mathematics, P_i is a dummy variable for school type being private, x_i is a vector of controls, α and γ are parameters to be estimated, with α being the parameter of interest, and ϵ_i is a error term.

For the OLS estimation of Equation (1) to yield a consistent estimate of α, participation in private school must be independent, conditional on x, of the unobservables that impact student achievement. Even if the distributional assumption concerning ϵ is correct, attendance in the private school will not be independent with the error term conditional on x if selection into private school is influenced by unobservables attributes. This problem is widely recognized in literature and most wrestle with it in one way or another. In the absence of experimental data, the main option is to find a non-experimental source of variation Z_i in private school attendance that is exogenous with respect to the outcome under study. The problem, however, is that most student background characteristics that influence schooling decisions, are likely to influence outcomes independently of the school since they are likely to be related to other parental inputs. Valid instruments are difficult to find, and often infeasible in the developing country context because even where official (exogenous) rules exist in law, they are rarely adhered in practice (Kingdon and Teal, 2010). Altonji, Elder, and Taber (2005b) show that attempts to correct for selection bias face severe problems since most family background characteristics, for example, that influence school choice are also likely to influence educational outcomes independently of the school attended and do not therefore qualify as appropriate instruments.[8]

As we do not believe that we have access to good and credible instrument for private schooling; we rely on richness of data to address some of the concerns about selectivity and present our OLS estimates of private school advantage.

3.2. Semi-Nonparametric Estimation

The parametric estimator requires one to specify a functional form for the outcome equation, as well as distributions for the error terms; we turn to semi-nonparametric Propensity Score Method (PSM) to relax these assumptions. PSM is arguably an improvement over OLS because it is not constrained by the assumption that the private school effect is linearly related to the outcome, and explicitly avoids extrapolation into areas of the causal effect distribution which is not on the common support. A further important advantage of the PSM estimator relative to other methods is that, ceteris paribus, by reducing sample heterogeneity (observed differences) it can lead to a reduction in both sample variability and to the sensitivity of the estimated treatment effect to potential omitted variable bias (Rosenbaum, 2005).

Analyses based on PSM rely on the assumption of *selection on observables*: conditional on observable characteristics, students in private and public schools do not systematically differ along unobservable dimensions. This approach compares students in private and public school who have similar estimated propensities to attend private schools, matching each private school student with at least one public school student based on the propensity score.

[8]Altoji, Elder, and Taber (2005b) evaluate the instrument used in two influential papers---Evans and Schwab (1995) and Neal (1997) --- on the effect of Catholic school in the US, and conclude that none of the candidate instruments is a useful source of the Catholic school effect, at least in the NELS:88 data set.

For PSM estimation, first a model of school choice (private versus public) is estimated using a probit model:

$$Prob(P_i = 1) = \Phi(Z'\beta) \tag{2}$$

Then this propensity score is used to find a match between the treated individuals (private secondary school students) and a set of non-treated individuals who are observationally similar and who are attending public secondary school. Although propensity scores are widely used in the matching literature, no single method has dominated, so we employ three commonly-used matching methods: kernel density, nearest neighbor, and caliper.[9]

3.2.1 Rosenbaum Bounds

Although PSM controls for observable differences, it does rule out the possibility of selection bias due to unobserved differences between private secondary students and even a well-matched comparison group from public secondary school students. This limitation has been mitigated by the Rosenbaum bounds (Rosenbaum 2002) method, which enables a statistical assessment to be made of the likelihood that an unobserved confounding covariate will neutralize the propensity score matched estimated treatment effect. We use Rosenbaum bounds to assess the sensitivity of our results to the selection on unobservables.

To understand the Rosenbaum bounds, let Π_i represent the odds of student i receiving the treatment (i.e. attending private school), $\frac{\Pi_i}{1-\Pi_i}$ is the odds ratio. Assume the log odds ratio can be expressed as a generalized function of observables x_i and a binary unobserved term ξ_i. Formally,

$$\ln\left(\frac{\Pi_i}{1-\Pi_i}\right) = \kappa(x_i) + \delta\xi_i \tag{3}$$

Thus the relative odds ratio of two observationally identical students is given by

[9]We used psmatch2 (Leuven and Sianesi 2003) in STATA to get PSM estimate.

$$\frac{\frac{\Pi_i}{1-\Pi_i}}{\frac{\Pi_j}{1-\Pi_j}} = \frac{\exp(\kappa(x_i) + \delta\xi_i)}{\exp(\kappa(x_j) + \delta\xi_j)} \tag{4}$$

which differ from unity if δ and $(\xi_i - \xi_j)$ is non-zero. Since ξ_i is binary, $(\xi_i - \xi_j) \in (-1,0,1)$, and

$$\frac{1}{\exp(\delta)} \leq \frac{\Pi_i(1-\Pi_j)}{\Pi_j(1-\Pi_i)} \leq \exp(\delta) \tag{5}$$

If $\Gamma = \exp(\delta) = 1$, as it would be in a randomized experiment or in non-experimental data free of bias from selection on unobservables, the model is said to be free of hidden bias; controlling for selection on observables would yield an unbiased estimate of the treatment effect. Higher values of Γ would imply an increasingly important role of unobservables in the treatment selection process. For example, $\Gamma = 2$ implies that observationally identical students differ in their relative odds of treatment by a factor of two. Rosenbaum bounds use bounds on the distribution of Wilcoxen's signed rank statistic under the null of zero treatment effect using different values of Γ. This leads to bounds on the significance level of a one-sided test for no treatment effect. Specifically, we report upper bounds on the *p*-value of the null of zero average treatment effect for different values of Γ, where Γ reflects the relative odds ratio of two observationally identical student attending private school.

4. Results

4.1. Basic Results

Table 2 presents the results of OLS regression estimates of Equation (1). Column (1) of the Table 2 shows the raw difference in achievement. The students who attend private secondary schools scored 0.50 and 1.28 SD higher in urban and rural Rajasthan.[10] The difference is not statistically significant in urban Orissa, whereas in rural Orissa, the students at private school scored 0.29 SD higher. The difference is statistically significant only at 10% significance level in rural Orissa. Singh (2015) reports a raw difference of 0.49 (0.34) SD in mathematics score in rural (urban) Andhra Pradesh for the 15 year olds in 2011.

Previous studies have identified many personal and family-related factors that are closely associated with educational outcomes and our survey collected information on many of these. In the next column, Column (2) of Table 2, we control for students characteristics such as, age, gender, any disability, student live in hostel, and time taken to reach school and family level characteristics, such as education and occupation of parents, Caste, number of brothers and sisters, asset index for household assets.[11] Controlling for individual and household characteristics reduces the impact of the private school in urban Rajasthan by 0.1 SD; however, it marginally increases the negative coefficient in urban Orissa. In rural areas, the inclusion of observed characteristics increases the private school coefficients in both Rajasthan and Orissa. In addition, after controlling for observed characteristics, the coefficient of private school becomes statistically significant at 5% significance level in rural Orissa.

Although we believe that controlling for family and individual characteristics addresses the main sources of selection bias, nonetheless it is impossible to rule out that we have left out some relevant variable. However, it should be noted that in order to change our results materially, it would have to be a variable that, conditional on all the explanatory variables mentioned above, has

[10] Standard errors are clustered at the school level to allow for correlation among students attending the same school.
[11] We also estimated the equation with additional controls such as attended pre-primary, hours spent doing math's homework, started grade at less than 5 years age, hours spent on household chores, works outside, individual private tutoring, group private tutoring, and hours per week private tutoring. However, all these variables were insignificant. Hence, we do not include those in our final model.

a strong relationship with attendance in private school and achievement. As the effect of private school does not change substantially when we control observables characteristics usually identified as closely associated with educational outcomes, this suggests that the effect of private should not be affected substantially by the unobservables also (Altonji, Elder, and Taber 2005a).[12] Hence, we conclude that after controlling for individual and family characteristics, the students in private secondary schools in rural Rajasthan scored 1.34 SD higher while the students in private schools in urban Rajasthan only score 0.40 SD higher. In contrast, there is no difference in achievement in urban Orissa, whereas in rural Orissa, students in private schools scored 0.31 SD higher. The effectiveness of private schools in rural Orissa is much less compared to Rajasthan.

Next we move to PSM estimation. For this, we estimate probit model of school choice for urban and rural areas separately for both the states, and use that for propensity score calibration in both states (reported in appendix Table A2). The probit model include household level characteristics which are supposedly invariant to the choice of schooling such as gender, age, education and occupation of parents, Caste of the household, number of brothers and sisters, and household assets. In the second step, the propensity score generated from the probit model is used to find a match between students who are attending private school and a set of public school students who are observationally similar. We find considerable overlap in support between the students attending private schools (treated group) and students attending public schools (Figure 2 and Figure 3). Appendix Table A3 explores whether the matching has balanced all the variables

[12]Altonji, Elder, and Taber (2005a) also provide an informal way to use information about selection on the observables as a guide to selection on the unobservables, applicable to continuous case. The idea is to assess how much selection on unobservables there must be, relative to the amount of selection on observables, to fully account for the positive association between private school attendance and achievement. Under the hypothesis of equality of selection (normalized) on observables and unobservables, Altonji, Elder, and Taber (2005a) derive an implied ratio. However, in our case the $var(\varepsilon)$ is very large, and as discussed in Altonji, Elder, and Taber (2005a), in case of very large $var(\varepsilon)$, the implied ratio is not very informative.

which affect the choice of schooling. Column (4) and Column (8) of appendix Table A3 report the p-values of t-test of equality between treatment and matched control group for each conditioning variable. We find that matching does a good job, and there are no statistically significant differences in all the conditioning variables in the matched sample. Matching balances the differences observed in the raw data. Matching also significantly reduces standardized bias (SB). In most empirical studies, a SB below three percent, or five percent after matching, is acceptable (Caliendo and Kopeinig 2008). In our case, the SB (Column [3 and 7] of appendix Table A3) is below five percent for majority of covariates. Following Sianesi (2004), we re-estimated the propensity score on the matched sample, i.e., only on private school students and matched public school students, and compare the *pseudo*-R^2 before and after matching (reported in appendix Table A4). After matching, no systematic differences should exist in the covariate distribution between the two groups, therefore the *pseudo*-R^2 should be low. In our case, the $pseudo - R^2$ approaches to 0.002/0.003 in in both the states. Furthermore, the likelihood ratio test on the joint significance of all regressors in the probit model which rejected the null of jointly insignificant before matching, no more rejects the null after matching (Appendix Table A4).

Table 3 presents PSM estimates for the impact of private school on mathematics achievement in grade 9. The reported results are the differences in means between the students who were enrolled in private secondary schools and the matched public school students (known as average treatment effect on treated or ATT in program evaluation literature). The kernel matching estimator (column (2) of Table 5) compares each student in the treatment group (i.e. students attending private secondary schools) to a weighted average of all comparison group observations (i.e. students attending public secondary schools) with the weight for each observation in the comparison group inversely proportional to the difference between that observation's estimated propensity score and the propensity score of the treatment student.[13] We prefer this estimator as one major advantage of kernel matching is the lower variance, which is achieved because more information is used. However, the results are close even if we use other PSM estimators. In the nearest neighbor (4-nearest neighbor)---column (3) and column (4)---matching, each treatment student is matched with the one (four) students in public schooling who have the most similar propensity scores.[14] In the caliper matching, we match each treatment student with all students in public schools who have propensity scores within a predetermined distance (or "radius"). The kernel matching estimator suggests that students in urban (rural) Rajasthan private school scored 04 (1.3) SD higher than the observationally similar students in public school. In contrast, there is no difference in achievement in urban Orissa. However, students in private schools in rural Orissa scored about 0.3 SD higher than the observationally similar students in public school.

4.2. Sensitivity to Unobservables

As discussed earlier, although PSM controls for observable differences, it does rule out the possibility of selection bias due to unobserved differences between private secondary students and even a well-matched comparison group from public secondary school students. We assess the sensitivity of PSM estimates with respect to unobservables using the bounding approach proposed by Rosenbaum (2002). The basic idea is to determine how strongly an unmeasured variable must influence the selection process to undermine the implications of the matching analysis. If we have a positive (unobserved) selection i.e. those most likely to go to private school also are more likely to score higher, then the estimated treatment effects overestimate the true treatment effect. Table

[13] We used kernel weighting with the epanechnikov kernel and a fixed bandwidth of 0.10. Confidence intervals are obtained using 100 bootstrap repetitions.

[14] The matching is done with replacement. Abadie and Imbens (2006) imply that the use of four neighbors minimizes mean-squared error, although our results are largely insensitive to including between one and five nearest neighbors.

4 reports the upper bound on the *p-value* of the null of zero average treatment effect for different values of Γ. If the upper bound on the *p-value* is less than, say, 0.10 for reasonably large values of Γ, then the treatment effect is said to be robust to hidden bias.

The results suggest we can reject the null of no private school effect in rural Rajasthan even in the presence of large hidden bias. For example, if we allow for a significant amount of selection on unobservables---such that observationally identical students differ in their relative odds of attending private school by a factor of 3, we reject the null of zero private school effect at 5% significance level in rural Rajasthan. However, positive private school impact in urban Rajasthan survives only a moderate positive selection (upto $\Gamma < 2.0$). The results for urban Orissa was statistically insignificant to start with, while for rural Orissa, we find that the positive effect of private school vanishes even under a small amount of selection on unobservables---such that observationally identical students differing in their relative odds of attending private school by a factor of 1.4, we fail to reject the null that the private schools have no effect on score. In the PSM literature, $\Gamma = 1.4$ is usually interpreted as small, implying that our PSM estimates of the private school effect in Orissa is not free from hidden bias. Overall, the results of Rosenbaum bounds suggests that the positive private school effect in rural Rajasthan will withstand even in the presence of significant amount of selection on unobservables, while the positive effect of private school in rural Orissa is susceptible to a small amount of selection on unobservables. While the Rosenbaum bounds do not yield point estimates of the treatment effects once hidden bias is taken into account, they increase confidence in the positive impact of private schools in rural Rajasthan.

To explore further about the reasons for the advantage of private schools in Rajasthan, we control for various facilities available at school, student-teacher ratio, availability of parent teacher association, and the characteristics of the principal. The magnitude of private school advantage decrease in rural Rajasthan from 1.30 to 1.18, while in urban Rajasthan it increases marginally. Importantly, the observed school and principal characteristics are unable to explain the differences.

5. Conclusion

In recent past, there has been a growing body of research that has investigated effects of private schools at the primary stage in India. Although not unequivocal, the research concentrating on the primary school stage suggests a positive effect of private schools on the achievement. However, there exists limited information about achievement gaps between private and public schools at the higher levels of schooling (such as middle or secondary). In this paper, we examine the effects of private school on achievement at the secondary school level. We use a unique achievement survey data collected in two Indian states. The survey administered two separate 90-minute mathematics tests to 3418 students in Rajasthan and 2856 students in Orissa, both in the ninth grade. This dataset contain a very rich set of variables allowing estimation of achievement production functions, and information on a number of variables typically not observed in other data sets.

In the absence of access to credible instrument, we rely on the richness of dataset to reduce some of the biases. We also use semi-parametric propensity score matching (PSM) to estimate the effect of private secondary school on mathematics score. We find heterogeneous effects of private school in two states. Students in private schools in rural Rajasthan scored 1.30 SD higher than their counterparts in public school, and this positive impact withstand a large amount of selection on unobservables. In contrast, students in private schools in rural Orissa only scored 0.3 SD higher. Moreover, this small positive effect is wiped out if we allow small selection on unobservables. Similarly, there is no difference in Urban Orissa, while in urban Rajasthan, the students in private school scored 0.4 SD higher. However, this positive effect survives only a moderate amount of selection on unobservables. The study suggests inter-state variation in effectiveness of private secondary schools, and collaborate the findings of Desai et al. (2008) who finds a large inter-state variation in effectiveness of private school at the primary school level.

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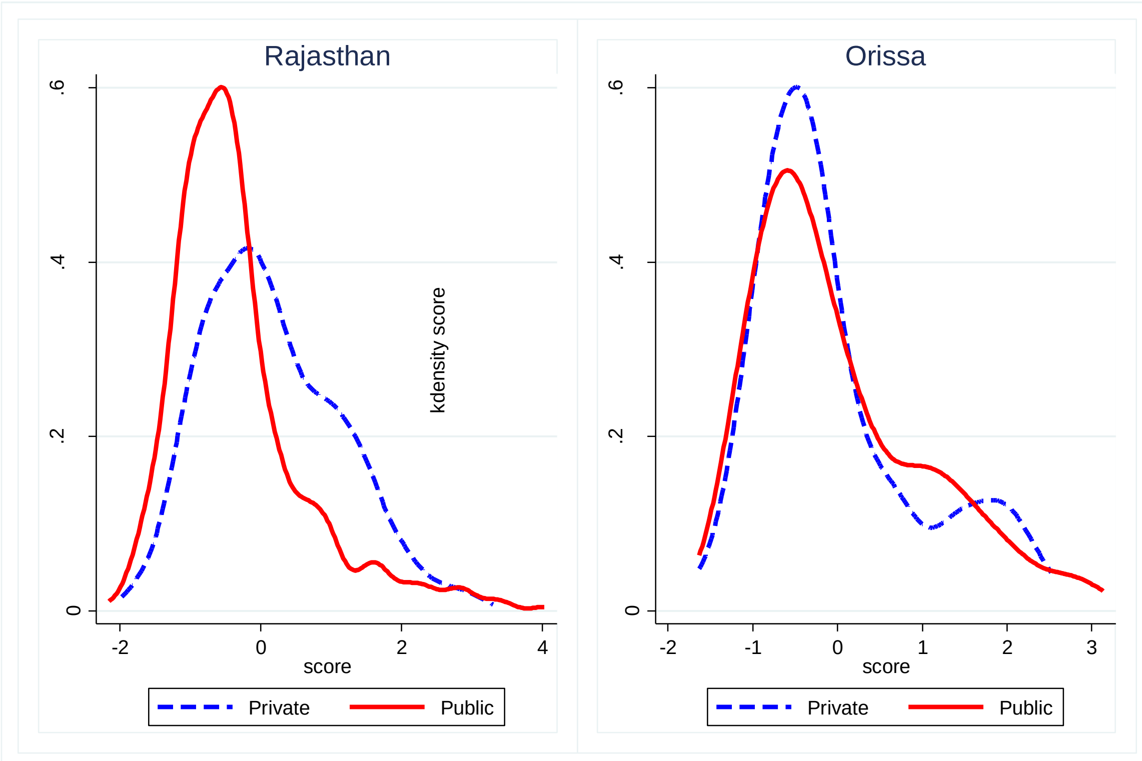
Figure 1: Distribution of mathematics score, Grade 9

a. Urban areas



b. Rural areas

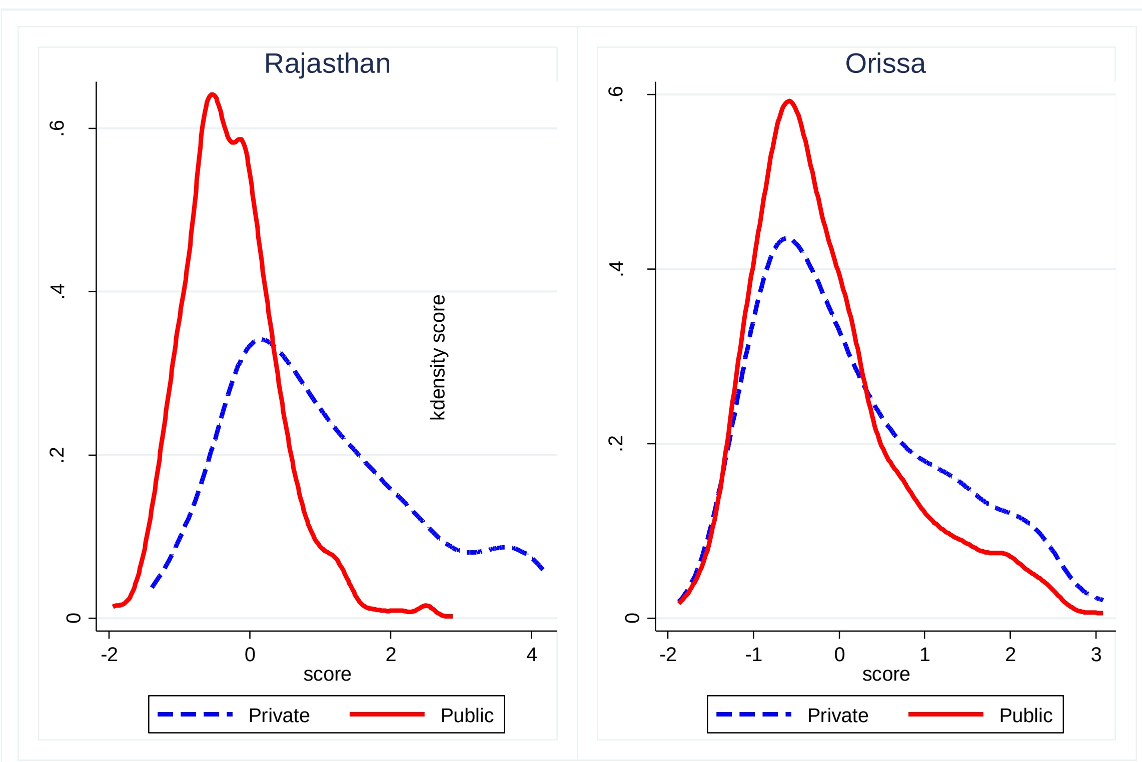
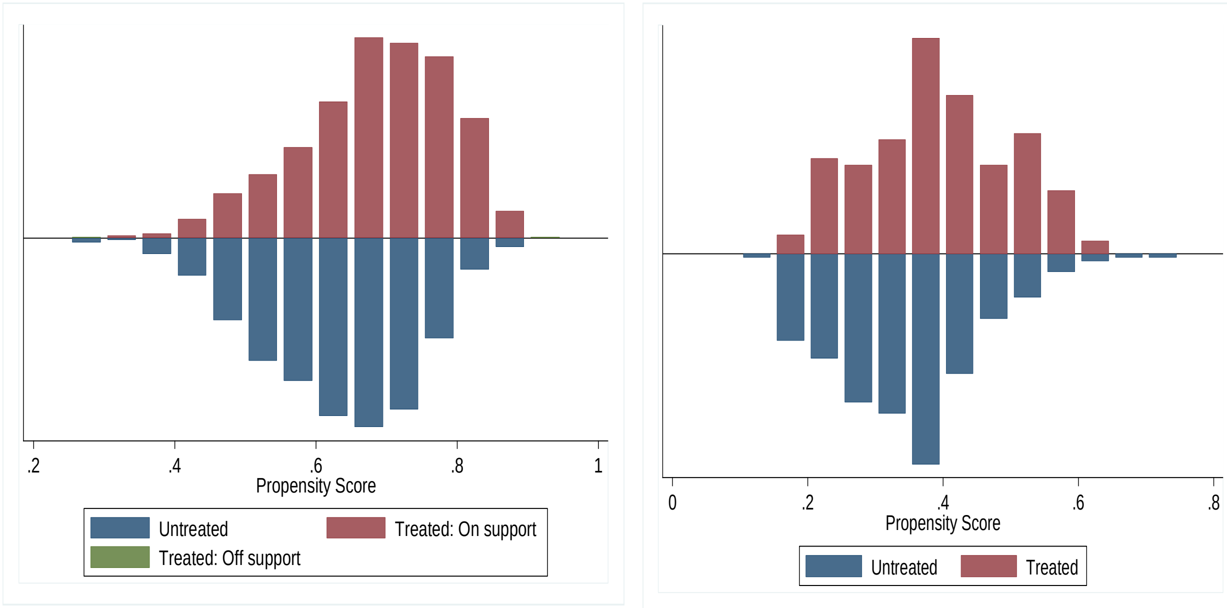


Figure 2: Overlapping support in the distribution of the propensity score, urban areas

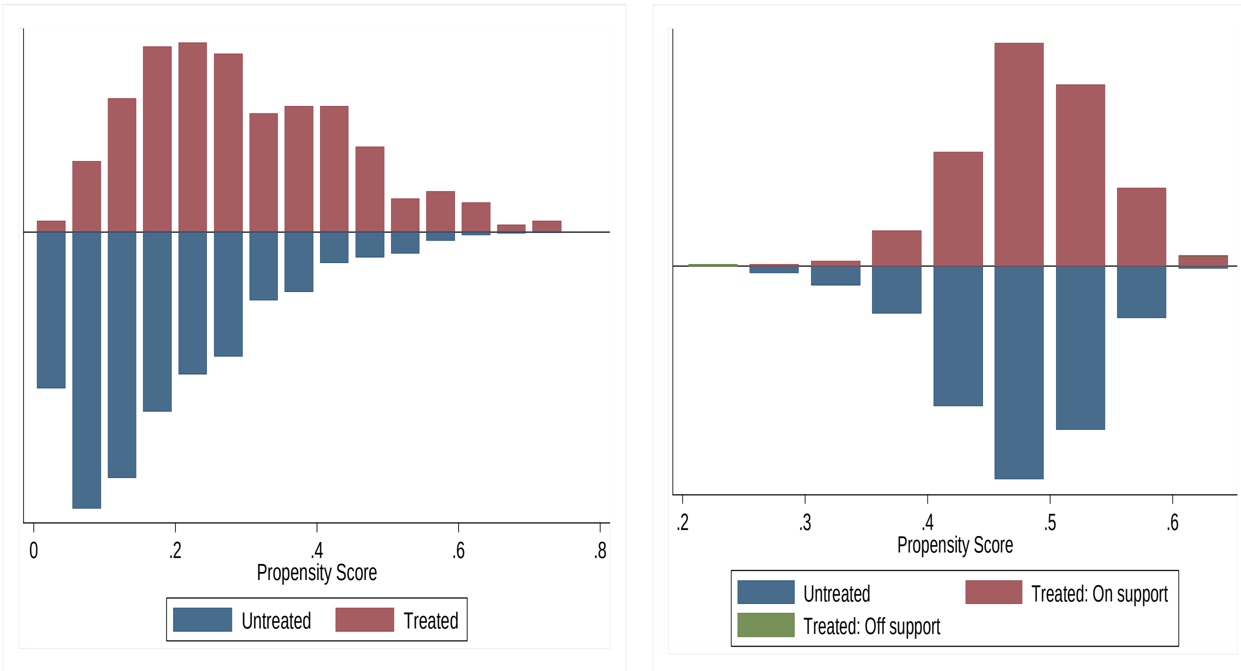
Rajasthan-Urban **Orissa-Urban**



Note: Histogram of propensity score distribution for private and public school students. 2 private school students in Rajasthan were off the common support.

Figure 3: Overlapping support in the distribution of the propensity score, rural areas

Rajasthan-Rural **Orissa-Rural**



Note: Histogram of propensity score distribution for private and public school students. 3 of the private school students in Orissa were off the common support.

Table 1: Descriptive Statistics

	Urban						Rural					
	Rajasthan			Orissa			Rajasthan			Orissa		
	Private	Public	Diff	Private	Public	Diff	Private	Public	Diff	Private	Public	Diff
Score	0.17	-0.33	0.50***	-0.04	0.02	-0.06	1.02	-0.26	1.28***	0.15	-0.14	0.29***
Disadvantaged Caste	0.52	0.66	-0.14***	0.60	0.61	-0.01	0.77	0.78	-0.01	0.79	0.76	0.03
Age	13.78	13.99	-0.21***	13.76	13.57	0.19**	13.53	14.17	-0.63***	13.78	13.70	0.08*
Gender-female	0.40	0.31	0.10***	0.29	0.43	-0.15***	0.22	0.31	-0.08***	0.51	0.46	0.05**
Have some disability	0.11	0.14	-0.03	0.13	0.12	0.01	0.10	0.09	0.01	0.06	0.07	-0.01
Live in hostel	0.02	0.02	0.00	0.09	0.10	-0.01	0.03	0.01	0.02***	0.06	0.04	0.02**
Time taken to reach school	15.46	17.63	-2.17***	8.90	12.98	-4.08***	21.64	25.11	-3.47***	16.22	15.72	0.50
Number of brother	1.28	1.47	-0.19***	1.25	1.14	0.11	1.38	1.66	-0.28***	1.34	1.25	0.08*
Number of sister	1.26	1.50	-0.24***	1.05	1.19	-0.15	1.45	1.70	-0.24***	1.38	1.27	0.10**
Father-secondary and higher secondary	0.40	0.39	0.01	0.35	0.31	0.04	0.42	0.33	0.09***	0.29	0.33	-0.03
Father-graduate and above	0.22	0.14	0.09***	0.18	0.20	-0.03	0.09	0.07	0.02	0.09	0.10	-0.01
Mother-secondary or higher secondary	0.21	0.15	0.06***	0.29	0.25	0.04	0.04	0.04	-0.01	0.15	0.20	-0.05***
Mother-graduate and above	0.09	0.07	0.02	0.08	0.08	0.01	0.01	0.01	0.00	0.02	0.03	-0.01
Father is in salaried occupation	0.37	0.32	0.05*	0.36	0.41	-0.05	0.31	0.19	0.12***	0.24	0.24	-0.01
Mother is in salaried occupation	0.06	0.05	0.01	0.09	0.10	-0.01	0.02	0.02	0.01	0.03	0.05	-0.02**
Asset index	0.28	0.02	0.26***	-0.60	-0.69	0.09	0.68	0.16	0.51***	-0.23	-0.24	0.01
Parents check HW regularly	0.43	0.46	-0.03	0.52	0.54	-0.02	0.41	0.36	0.05*	0.64	0.59	0.05**
Parent expectation-Senior secondary	0.32	0.44	-0.12***	0.47	0.46	0.01	0.55	0.50	0.06*	0.48	0.43	0.05**
Parent expectation-Graduate	0.63	0.47	0.16***	0.48	0.37	0.11**	0.40	0.28	0.13***	0.30	0.31	-0.01
Student have all required books	0.88	0.87	0.01	0.71	0.84	-0.14***	0.90	0.87	0.03	0.54	0.58	-0.04*
Language of instruction is English	0.15	0.01	0.14***	0.00	0.09	-0.09***	0.00	0.00	0.00	0.03	0.00	0.03***
Number of days math's teacher was absent	1.46	1.43	0.03	0.86	3.88	-3.01***	1.04	1.69	-0.65***	0.90	1.25	-0.35***
Observations	971	488		154	269		363	1404		976	1061	

Table 2: Impact of private secondary school on grade 9 mathematics achievement, OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Urban				**Rural**			
	Rajasthan		**Orissa**		**Rajasthan**		**Orissa**	
Attend Private school	**0.496****	**0.396****	**-0.059**	**-0.084**	**1.284*****	**1.344*****	**0.290***	**0.311****
	(0.208)	(0.181)	(0.349)	(0.251)	(0.302)	(0.296)	(0.170)	(0.154)
Disadvantaged Caste		-0.113		-0.171		0.141**		-0.218*
		(0.095)		(0.103)		(0.060)		(0.114)
Age		-0.039		0.093		-0.003		-0.046
		(0.032)		(0.110)		(0.019)		(0.039)
Gender-female		-0.173*		0.111		0.111		-0.107
		(0.096)		(0.148)		(0.091)		(0.095)
Have some disability		-0.041		0.151		0.176		0.035
		(0.112)		(0.144)		(0.122)		(0.108)
Live in hostel		0.061		0.207		-0.420*		0.247
		(0.177)		(0.155)		(0.221)		(0.255)
Time taken to reach school		-0.006**		-0.004		-0.003**		0.000
		(0.003)		(0.005)		(0.001)		(0.003)
Number of brother		-0.051		-0.135***		0.001		-0.009
		(0.031)		(0.042)		(0.020)		(0.024)
Number of sister		-0.090***		-0.060		-0.009		-0.035
		(0.023)		(0.037)		(0.014)		(0.022)
Father-secondary and higher secondary		-0.079		0.010		0.110*		0.003
		(0.075)		(0.103)		(0.063)		(0.070)
Father-graduate and above		0.069		0.390***		0.195**		0.458***
		(0.092)		(0.128)		(0.093)		(0.116)
Mother-secondary or higher secondary		0.063		0.223*		0.043		0.013
		(0.105)		(0.126)		(0.108)		(0.080)
Mother-graduate and above		0.642***		0.900***		0.393		0.090
		(0.164)		(0.271)		(0.236)		(0.185)
Father is in salaried occupation		0.145		-0.038		-0.283***		0.020
		(0.093)		(0.083)		(0.074)		(0.070)
Mother is in salaried occupation		-0.090		0.033		-0.255		0.025
		(0.096)		(0.205)		(0.180)		(0.118)
Asset index		0.061		0.078		-0.071**		0.144***
		(0.048)		(0.068)		(0.034)		(0.046)
Constant	-0.330*	0.591	0.021	-1.095	-0.264***	-0.260	-0.139	0.719
	(0.179)	(0.424)	(0.215)	(1.430)	(0.048)	(0.285)	(0.087)	(0.587)
Observations	1,459	1,459	423	423	1,767	1,767	2,037	2,037
R-squared	0.055	0.167	0.001	0.242	0.269	0.301	0.021	0.119

Note: Standard errors are clustered at school level and reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Impact of private secondary school on grade 9 mathematics achievement

		Propensity Score Estimates: ATT				
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS*	Kernel Matching	Nearest Neighbour Matching	4- Nearest Neighbour Matching	Caliper matching (б=0.001)	Caliper matching (б=0.01)
Urban						
Rajasthan	0.396***	0.410***	0.489***	0.394***	0.398***	0.418***
	(0.181)	(0.061)	(0.070)	(0.762)	(0.067)	(0.063)
Orissa	-0.083	-0.054	-0.015	-0.110	-0.008	-0.120
	(0.251)	(0.108)	(0.141)	(0.136)	(0.150)	(0.120)
Rural						
Rajasthan	1.343***	1.289***	1.291***	1.308***	1.330***	1.309***
	(0.296)	(0.085)	(0.091)	(0.081)	(0.096)	(0..067)
Orissa	0.310**	0.305***	0.368***	0.354***	0.327***	0.311***
	(0.154)	(0.048)	(0.059)	(0.051)	(0.046)	(0.052)

Note: For kernel matching, the epanechnikov kernel and a fixed bandwidth of 0.10 are used. Confidence intervals are obtained using 100 bootstrap repetitions.

Table 4: Sensitivity of PSM estimates, Rosenbaum Bounds

	Urban	**Rural**	
	Rajasthan	Rajasthan	Orissa
Γ=1.0	0.000	0.000	0.000
Γ=1.2	0.000	0.000	0.000
Γ=1.4	0.000	0.000	0.083
Γ=1.6	0.000	0.000	0.646
Γ=1.8	0.000	0.000	0.973
Γ=2.0	0.010	0.000	1.000
Γ=2.2	0.127	0.000	1.000
Γ=2.4	0.472	0.000	1.000
Γ=2.6	0.819	0.000	1.000
Γ=2.8	0.966	0.000	1.000
Γ=3.0	0.996	0.000	1.000

Note: Rosenbaum critical p-values for test of the null of zero average treatment effect on treated (ATT).

Appendix

Table A1: Public Private Differential in Achievement (Raw Score)

Q No.	Content Category	Performance Expectation	Rajasthan			Orissa		
			Private School	Public School	Difference	Private School	Public School	Difference
1	Data Representation, Analysis and Probability	Using Complex Procedures	39.6	26.8	12.7***	33.5	29.8	3.7*
2	Fractions and Number Sense	Knowing	18.5	6.3	12.2***	21.1	16.9	4.1***
3	Geometry	Using Complex Procedures	30.7	22.3	8.5***	33.8	28.8	5.0***
4	Algebra	Knowing	65.2	35.2	30.0***	49.7	41.5	8.2***
5	Geometry	Investigating and Solving Problems	46.5	34.1	12.3***	47	45.9	1.1
6	Algebra	Knowing	35.4	29.6	5.8***	33.9	27.1	6.8***
7	Fractions and Number Sense	Investigating and Solving Problems	30.6	18.5	12.1***	37.5	28	9.5***
8	Data Representation, Analysis and Probability	Knowing	46.9	38	8.9***	20.9	25.9	-5.0***
9	Measurement	Knowing	34.9	29.1	5.8***	23.4	18.1	5.2***
10	Algebra	Investigating and Solving Problems	48.1	26.2	21.9***	37.7	33.4	4.3**
11	Fractions and Number Sense	Knowing	33.1	27.2	6.0***	19.6	22.3	-2.7
12	Data Representation	Analysis and Probability	62.1	48.1	14.0***	44.8	46.9	-2.1
13	Algebra	Knowing	28.2	21.1	7.1***	43.5	36.2	7.3***
14	Measurement	Investigating and Solving Problems	36.7	24.9	11.8***	41.2	31.3	10.0***
15	Geometry	Knowing	46.2	32	14.2***	49.9	47.1	2.8
16	Fractions and Number Sense	Using Routine Procedures	25.5	8.1	17.3***	23.7	26.2	-2.4
17	Geometry	Using Routine Procedures	44.1	29.9	14.2***	38	34.4	3.5*
18	Algebra	Using Routine Procedures	42.9	34.4	8.5***	50.1	52	-1.9
19	Fractions and Number Sense	Using Complex Procedures	65.8	46.8	19.0***	54.2	52.4	1.8
20	Data Representation, Analysis and Probability	Using Complex Procedures	47.2	38.6	8.6***	39.7	36.2	3.5*
21	Algebra	Communicating and Reasoning	36.9	21.8	15.1***	43.6	36.6	7.0***
22	Algebra	Using Routine Procedures	39.3	25.7	13.5***	37.7	35.4	2.3
23	Geometry	Investigating and Solving Problems	30.1	18.5	11.6***	34.7	27.2	7.5***
24	Fractions and Number Sense	Using Routine Procedures	51.1	33.4	17.7***	36.5	34.5	1.9
25	Fractions and Number Sense	Knowing	55.5	41.4	14.0***	52.6	44.9	7.7***
26	Measurement	Knowing	62.2	42.9	19.3***	53.8	46.5	7.3***
27	Fractions and Number Sense	Investigating and Solving Problems	32.2	32	0.1	38.8	34.6	4.3**
28	Measurement	Investigating and Solving Problems	20.5	17.4	3.0**	33.4	29.7	3.7*
29	Algebra	Knowing	66.6	52.6	14.0***	66.8	65.3	1.5
30	Geometry	Using Routine Procedures	28.5	22.5	6.0***	24.9	21.6	3.3*

31	Algebra	Knowing	44	25.1	18.9***	47.5	39.2	8.3***
32	Fractions and Number Sense	Investigating and Solving Problems	44.1	27.5	16.6***	41.5	37.4	4.1**
33	Data Representation, Analysis and Probability	Using Complex Procedures	35.5	27.9	7.6***	34.9	25.3	9.5***
34	Algebra	Knowing	21	15.4	5.6***	32	27.7	4.3**
35	Geometry	Using Complex Procedures	26.2	24.6	1.5	32.2	26.1	6.1***
36	Algebra	Knowing	41.8	25.8	16.0***	42.4	37.7	4.7**

Note: The numbers are percentage of student who responded correctly on each question. The difference is the difference between private and public school. Difference is significant at * significant at 10%; ** significant at 5%; *** significant at 1%

Table A2: Probit for calibrating propensity score

	Urban		Rural	
VARIABLES	Rajasthan	Orissa	Rajasthan	Orissa
Disadvantaged Caste	-0.085***	0.007	0.017	0.028
	(0.027)	(0.054)	(0.022)	(0.028)
Age	-0.022**	0.065**	-0.059***	0.017
	(0.011)	(0.029)	(0.008)	(0.012)
Gender-female	0.073***	-0.156***	-0.107***	0.050**
	(0.026)	(0.049)	(0.020)	(0.023)
Have some disability	-0.065*	0.020	0.021	-0.030
	(0.039)	(0.074)	(0.032)	(0.046)
Number of brother	-0.034**	0.031	-0.020**	0.013
	(0.013)	(0.026)	(0.009)	(0.011)
Number of sister	-0.034***	-0.018	-0.013*	0.015
	(0.011)	(0.021)	(0.007)	(0.010)
Father-secondary and higher secondary	0.006	0.005	0.013	-0.031
	(0.029)	(0.058)	(0.021)	(0.027)
Father-graduate and above	0.070*	-0.078	-0.031	0.011
	(0.041)	(0.084)	(0.037)	(0.049)
Mother-secondary or higher secondary	-0.003	0.065	-0.096**	-0.070**
	(0.037)	(0.064)	(0.041)	(0.033)
Mother-graduate and above	-0.090	0.143	-0.009	-0.080
	(0.060)	(0.120)	(0.100)	(0.078)
Father is in salaried occupation	-0.012	-0.035	0.085***	0.008
	(0.028)	(0.054)	(0.025)	(0.030)
Mother is in salaried occupation	-0.025	-0.039	0.062	-0.099*
	(0.059)	(0.088)	(0.077)	(0.060)
Asset index	0.049***	0.031	0.085***	0.026*
	(0.016)	(0.026)	(0.011)	(0.014)
Observations	1,459	423	1,767	2,037
Pseudo R-squared	0.0436	0.0395	0.115	0.0105

Note: Marginal impact is reported. Standard errors are clustered at school level and reported in parenthesis.

Table A3: Balancing tests for covariates after matching

	Rural Areas							
	Rajasthan				Orissa			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Treated	**Control**	**% SB**	**P-Value (T=C)**	**Treated**	**Control**	**% SB**	**P-Value (T=C)**
Disadvantaged Caste	0.77	0.77	0.00	1.00	0.79	0.79	0.00	1.00
Age	13.53	13.62	-6.70	0.34	13.78	13.73	5.20	0.25
Gender-female	0.22	0.23	-2.40	0.74	0.51	0.49	5.20	0.25
Have some disability	0.10	0.12	-4.40	0.57	0.06	0.06	0.00	1.00
Number of brother	1.38	1.41	-2.80	0.68	1.34	1.28	5.90	0.20
Number of sister	1.45	1.50	-3.20	0.65	1.37	1.32	4.30	0.34
Father-secondary and higher secondary	0.42	0.41	3.50	0.65	0.29	0.30	-1.10	0.81
Father-graduate and above	0.09	0.09	-2.80	0.73	0.09	0.09	1.10	0.81
Mother-secondary or higher secondary	0.04	0.03	0.40	0.95	0.15	0.15	0.30	0.95
Mother-graduate and above	0.01	0.01	-0.10	0.99	0.02	0.02	3.10	0.43
Father is in salaried occupation	0.31	0.29	4.20	0.60	0.24	0.23	0.90	0.84
Mother is in salaried occupation	0.02	0.02	2.00	0.80	0.03	0.02	3.00	0.41
Asset index	0.68	0.66	2.20	0.76	-0.23	-0.27	4.70	0.30
	Urban Areas							
Disadvantaged Caste	0.52	0.54	-4.60	0.33	0.60	0.60	0.10	0.99
Age	13.78	13.75	2.10	0.64	13.76	13.73	3.40	0.77
Gender-female	0.40	0.38	4.50	0.33	0.29	0.30	-2.00	0.86
Have some disability	0.11	0.12	-2.40	0.59	0.13	0.11	5.40	0.63
Number of brother	1.28	1.29	-0.40	0.92	1.25	1.20	6.10	0.60
Number of sister	1.26	1.35	-8.30	0.06	1.05	1.08	-2.70	0.80
Father-secondary and higher secondary	0.40	0.40	-0.40	0.93	0.35	0.35	-0.50	0.97
Father-graduate and above	0.22	0.21	4.20	0.39	0.18	0.18	-2.00	0.86
Mother-secondary or higher secondary	0.21	0.20	3.80	0.43	0.29	0.27	3.60	0.76
Mother-graduate and above	0.09	0.09	0.00	1.00	0.08	0.09	-0.50	0.97
Father is in salaried occupation	0.37	0.38	-1.50	0.75	0.36	0.37	-2.30	0.84
Mother is in salaried occupation	0.06	0.06	-2.10	0.65	0.09	0.09	1.40	0.90
Asset index	0.28	0.24	4.50	0.29	-0.60	-0.61	1.10	0.92

Note: Standardized bias (SB) for each variable is defined as the difference of sample means in the treated and control subsamples as a percentage of the square root of the average of sample variances in both groups. Reduction in bias refers to the percentage reduction in bias after matching.

Table A4: Indicators of covariate balancing, before and after matching

		Urban		Rural	
		Rajasthan	Orissa	Rajasthan	Orissa
Before Matching	Pseudo R^2	0.044	0.040	0.115	0.011
	Prob > χ^2	0.000	0.056	0.000	0.005
After Matching	Pseudo R^2	0.003	0.002	0.002	0.003
	Prob > χ^2	0.826	1.000	0.999	0.819