THE IMPACT OF SCHOOL LUNCHES ON PRIMARY SCHOOL ENROLLMENT: EVIDENCE FROM INDIA'S MIDDAY MEAL SCHEME♮

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Abstract. At the end of 2001, the Indian Supreme Court issued a directive ordering states to institute a warm school lunch – known locally as a "midday meal" – in government primary schools. This paper provides a large-scale assessment of the enrollment effects of India's midday meal scheme, which offers warm lunches to 120 million primary school children across India and is the largest school feeding program in the world. To isolate the causal effect of the policy, we make use of staggered implementation across Indian states in government but not private schools. Using a panel data set of over 500,000 schools observed annually from 2002 to 2004, we find that midday meals result in substantial increases in primary school enrollment, driven by early primary school responses to the program.

Key words and phrases. Primary school enrollment, School lunches, Natural experiment, ITT.
♮ We thank Arun Metha and Naveen Bhatia for kindly sharing their DISE data and gratefully acknowledge funding from DFG Grant JA 1675/2-1.
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1. Introduction

Education is thought to be central to economic development. Beneficial in and of itself, it is also viewed as a major contributor to human capital, leading to higher productivity and living standards. Primary education is thought to be associated with especially high returns.[1] Its importance is enshrined in the Millennium Development Goals (MDGs), which call for universal primary education by 2015.

In fact, primary education is far from universal and this MDG remains elusive. UNICEF (2008), the agency responsible for tracking progress on this MDG, estimates a net primary school enrollment rate in developing countries of 84 per cent; this is also its estimated average for India. In view of this, governments across the developing world have instituted a wide range of policies aimed at encouraging school enrollment.

School lunches are one such policy. They are thought to increase enrollment through two main channels.[2] First, they lower the cost of schooling, thereby providing an implicit subsidy to parents. Second, by improving child nutrition school lunches are thought to foster learning, thereby increasing the returns to education. School feeding programs are popular in the developing world and beyond, not only because of their educational but also for their nutritional benefits. Despite a large empirical literature on the relationship between feeding programs and educational attainment, reviewed in Bundy et al. (2009), there have, to the best of our knowledge, been no large-scale assessments of their causal impact on enrollment (Adelman et al. 2007).

This paper fills this gap by providing a large-scale impact assessment of India's warm school lunch program – known locally as the "midday meal" scheme – on primary school enrollment. India's midday meal scheme is the largest school nutrition program in the world. In 2006, it provided lunch to 120 million children in government primary schools every school day (Kingdon 2007). We exploit a quasi-natural experiment in order to identify the causal impact of midday meals on primary school enrollment using a large school-level panel data set, the District Information System for Education (DISE). Our sample contains over 500,000 primary schools in 15 major states across India, observed annually in academic years 2002/3, 2003/4 and 2004/5 (referred to hereafter as 2002, 2003 and 2004).

Identification of a causal effect comes from state-level variation in the implementation of a 2001 Indian Supreme Court directive, which was instigated by public interest

[1]Psacharopoulos and Patrinos (2002) estimate private returns to primary education of over 25%.

[2]These are widely documented. See, for example, PROBE (1999), Drèze and Goyal (2003) and Kremer and Vermeersch (2004).

litigation aimed at redressing starvation. The directive ordered states to institute midday meals in government primary schools (referred to hereafter as public schools). Prior to 2001, only two states had universal public primary school midday meal provision.[3] Over the subsequent three years, however, state governments across India introduced midday meals.

Two main sources of variation are used in assessing the impact of midday meals: the date on which states introduced midday meals in primary schools, and the fact that (in accordance with the Supreme Court directive) they were introduced in public, but not private primary schools. Since the directive was addressed nation-wide, concerns regarding program placement bias are alleviated. Moreover, staggered implementation at the state level in public but not private schools allows us to treat all private schools as well as public schools in states not yet implementing the program, as a quasi-control group for public schools in states which introduced midday meals.

We find that midday meals lead to large and statistically significant increases in primary school enrollment. Our main triple difference intent to treat (ITT) estimates point to a statistically significant 6.6% increase in primary school enrollment, amounting to almost 19 additional students in primary school. The enrollment response to midday meals, although positive across all grades, is driven by large and statistically significant responses in early primary school, namely grades 1, 2 and (in our matched sample) grade 3. In grade 1, enrollment increases by approximately 18%; in grade 2, this increase is about half as large (approximately 9%); and in grade 3 the increase is typically two percentage points lower than that in grade 2. The response remains positive, with smaller point estimates and statistically insignificant coefficients across all specifications in grades 4 and 5.

These results are robust to a wide range of specification tests. We demonstrate that the program timing is not associated with different initial schooling input levels, or trends in enrollment outcomes. We further provide robustness checks which indicate that our results are not driven by the timing of implementation. Our main results are virtually unchanged for a matched sample of public and private schools; and we show that enrollment in private schools did not respond to midday meal introduction, suggesting that private schools are a legitimate control group. Neither were there contemporaneous changes in relative inputs in public versus private schools, and this alleviates concerns regarding confounding policy changes.

In an extension, using cross-sectional household and school survey data from the Indian Human Development Survey (IHDS) 2005, we provide some suggestive evidence

[3]These two states were Tamil Nadu and Gujarat. A third state, Kerala, had an opt-in program.

that the positive enrollment response associated with midday meal provision is not accompanied by improved learning, as measured by test scores for reading, writing and mathematics among 8 to 11 year-olds. This indicates that the positive enrollment we observe in our quasi-experimental setting may be driven by the implicit subsidy channel rather than nutrition-induced improvements in learning.

This paper contributes to a growing literature which relies on natural experiments to assess the impact of schooling policies on schooling outcomes.[4] Within the natural experiments literature, this paper most closely follows Duflo (2001), who examines the effect of a large school building program in Indonesia on educational attainment and wages, and Chin (2005) who assesses India's Operation Blackboard (which introduced additional teachers), in that the natural experiment here *directly* concerns variation in the policy variable.

Our paper also complements a recent literature, which uses randomized trials to evaluate the effect of school feeding programs on school participation. Powell et al. (1998), Jacoby E. and E. (1996) and Kremer and Vermeersch (2004) each find increased participation resulting from school breakfasts in Jamaica, Peru and Kenya, respectively. And Kazianga et al. (2009) find that school lunches as well as take home rations increase new enrollment for girls by 5 to 6 percentage points. Identification in our quasi-experimental setting is unlikely to be as clean as it is in these carefully conducted randomized trials. Nevertheless, there are two strengths to our approach. First, it enables an impact assessment of the world's largest nutrition program in a country which has the largest number of out-of-school children in the world. Second, its large-scale nature allays concerns about generalizability, to which smaller-scale studies are sometimes prey.

Finally, our findings generally corroborate the positive enrollment effect documented in smaller-scale non-experimental survey-based assessments of midday meal provision in India. In particular, Khera (2002) finds a 23% increase in enrollment following the introduction of school lunches in her 63 Rajasthan schools. Drèze and Goyal (2003) find an 18%, 11%, and 14% increase in enrollment in their Rajasthan, Chhattisgarh and Karnataka villages, respectively. The 6.6% primary school enrollment response we find in our DISE data, although substantial, is considerably smaller than these estimates. Since previous studies have measured the effect of midday meal provision – which is likely to be an endogenous outcome at the local level – often in relatively

[4]See Kremer and Glewwe (2005) for a review of this literature and Hanushek (1995) for a critique of earlier studies.

under-developed villages, our results suggest that the problem of purposive placement may have resulted in an upward bias of these estimates.[5]

The paper proceeds as follows. Section 2 provides background regarding the Supreme Court directive and the midday meal scheme, together with a discussion of its implementation and content. Section 3 describes the DISE data, and Section 4 presents our empirical strategy. Our empirical results using DISE data, including specification tests, are presented in Section 5. Section 6 presents an extension regarding learning associated with midday meal provision using IHDS data, and Section 7 concludes.

2. Midday Meals

2.1. **Background.** In India, primary school education typically covers grades 1-5, and is the joint responsibility of central and state governments. The central government generally issues guidelines and provides funding, but policy implementation is a state-level decision. The central government has a long-standing commitment to the provision of midday meals. As early as August, 1995, The National Program of Nutritional Support to Primary Education mandated cooked meals in all public primary schools. Not a single state responded to this universal mandate. (Kerala responded, but only by offering an opt-in program which resulted in partial coverage in public primary schools.) Two states had, by this time, long established universal midday meal provision in public primary schools. Tamil Nadu, a state in the Southeast, was a pioneer. Its midday meal program was launched in 1982 at the personal behest of its then-Chief Minister M.G. Ramachandran, who cited as his motivation early childhood experiences with hunger (Harriss 1991, p.10). Gujarat, a state in Central-west India, followed suit in 1984.[6]

Between 2002 and 2004, however, most Indian states instituted universal midday meals in public primary schools. This wave was precipitated by public interest litigation following reports of drought-instigated starvation deaths in the press.[7] In April, 2001 the People's Union for Civil Liberties (PUCL), Rajasthan, submitted a writ petition to

[5]In this sense, our results corroborate Afridi (2007), who exploits staggered implementation using a double difference strategy in 41 Madhya Pradesh villages, and finds a similarly muted response in enrollment and attendance.

[6]Most other states provided "dry rations" to enrolled children, which typically comprised 3 kg. per month of raw wheat or rice grains (depending on local consumption habits). By many accounts, the distribution of these dry rations was sporadic and of low quality (see for example, PROBE (1999)). Moreover, there is evidence of extensive leakage in this dry rations program, in the sense that children enrolled in private schools also received dry rations (see, for example Muralidharan (2006)).

[7]There were 7 drought-affected states in 2001: Gujarat, Rajasthan, Maharashtra, Orissa, Madhya Pradesh, Chhattisgarh, and Andhra Pradesh (Down to Earth, Vol. 10, Issue 20010615, June 2001.) They include both early and late implementers of midday meals.

the Supreme Court pointing out that "while on the one hand the stocks of food grains in the country are more than the capacity of storage facilities, on the other there are reports from various states alleging starvation deaths."[8] The PUCL documented that, despite their protests to the contrary, states could in fact afford to widen a number of statutory food and nutrition programs, including the midday meal scheme in schools. The writ urged the court to instruct the Government to release public food stocks, arguing that the right to life under Article 21 of the Indian Constitution included the right to food.[9] The petition has culminated in protracted public interest litigation which is yet to be concluded.[10]

Nevertheless, on November 28, 2001 the Supreme Court issued an interim order directing states to introduce cooked midday meals, i.e. a warm school lunch, in all public schools, but *not* in private schools. More specifically, the directive said, "Every child in every government and government-assisted school should be given a prepared midday meal".

2.2. **Implementation.** Implementation of this and other Supreme Court directives are left to the relevant executive branch of government (Desai and Muralidhar 2000). In this case, state governments were responsible for introducing midday meals.[11] To examine the effects of this policy change on schooling outcomes, we gathered information on the policy implementation in public schools from state documents and then cross-checked this information at least two (and usually, more) independent sources (see Appendix A for meal contents by state and list of state documents, independent monitors, auditors, field surveys and news articles).[12]

The result of this exercise is described in Table 1. Column 1 lists the 15 states which are covered in the data for our school-level analysis, and Column 2 indicates the month

[8]Rajasthan PUCL Writ in Supreme Court on Famine Deaths, PUCL Bulletin, November 2001.

[9]Article 21 of the Constitution of India is entitled "Protection of life and personal liberty". It states, in its entirety, "No person shall be deprived of his life or personal liberty except according to procedure established by law."

[10]PUCL vs Union of India and Others, Writ Petition [Civil] 196 of 2001. The Right To Food Campaign has been closely monitoring the developments associated with this case and maintains an extremely informative website at www.righttofoodindia.org.

[11]As Gauri (2009, p.2) notes, "courts do not and cannot enforce many of their broad directives". For this reason, estimating the Intent to Treat by using the Supreme Court directive as a source of exogenous variation at the national level is not particularly meaningful.

[12]In only one case, namely Andhra Pradesh, was there a discrepancy between independent sources and state documents. The Comptroller and Auditor General of India claimed November 2003 implementation and a best practice report of NUEPA put the date at 2001. We chose January 2003, as this was the date provided by the state documents, 6 reports of the Commissioner of India and numerous press reports. Dropping Andhra Pradesh from the sample or changing its implementation year to 2001 or 2004, has no qualitative bearing on our estimates.

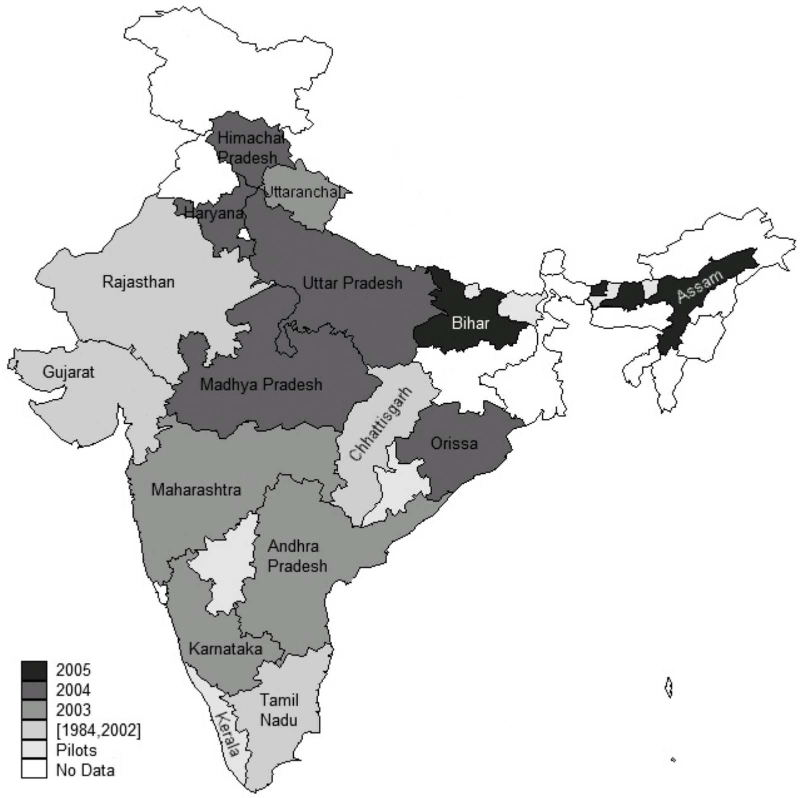
and year in which the corresponding state is documented to have introduced a midday meal. Note that this does not necessarily mean that midday meals were in fact on the ground in every public school in the state.[13] Since, as we elaborate in Section 3, enrollment figures are recorded as on September 30th of any given year, we regard a state as having instituted a midday meal policy if its implementation took place before September 30th in the corresponding year. The last column of the table documents the year of initial treatment according to this criterion.

Data from three additional states – Jharkhand, Kerala and West Bengal – were available from DISE but are not used in our main analysis due to poor documentation of partial implementation and potential purposive placement.[14] Finally, also due to worries of purposive placement, we dropped from our main sample 28 districts (in 2001 India had 593 districts) from Assam, Bihar, Karnataka and Orissa where the midday meal scheme was implemented earlier on a pilot basis. Nevertheless, as we show in our specification checks, the addition of these pilot districts and Kerala does not change the results.

The wide geographic coverage of our data and state-level variation in the date of implementation, evident in Table 1, are graphically displayed in Figure 1. Together, the states covered in our data house over 80% of the Indian population according to the 2001 Census of India. Pertinently, the geographic pattern in terms of timing of implementation is mixed. For example, pioneers (Tamil Nadu and Gujarat) come from South and Central India. Early implementers include not only the "usual suspects" in Southern India, Andra Pradesh and Karnataka, but also surprising candidates like Rajasthan and Chhattisgarh. The so-called "BIMARU" set of states, include late

[13]Data limitations make it difficult to verify the proportion of public schools which actually provided midday meals during our observation period. Household surveys are not conducted annually and rarely pose a midday meal consumption question. Deaton and Drèze (2006) assert, moreover, that at least in the National Sample Surveys (NSS), midday meal consumption is underreported. The school survey data from IHDS 2005 (which we describe in Section 6) indicate, however, that in states which we classify as having been treated by 2005, 84% of public schools in the IHDS public school survey are reported as providing midday meals in the IHDS 2005. This suggests that the vast majority of schools which we consider as treated in our ITT framework are, in fact, treated.

[14]Jharkhand instituted midday meals in November 2003 as a pilot project, but we are unable to ascertain where these pilots were implemented. We could also not verify when full coverage was announced as having been achieved. West Bengal started a midday meal roll out in January 2003. We could not find documentation for the placement, and full coverage is yet to be achieved. Kerala, as mentioned earlier, allows schools to opt-in to the midday meal scheme, and this raises concerns of selection bias.



Note: This map depicts the states and pilot regions of India covered in DISE 2002-2004. States are shaded according to the timing of midday meal implementation.

FIGURE 1. DISE Data Coverage and Midday Meal Implementation

implementers (BIhar), middle implementers (MAdhya Pradesh and Uttar Pradesh) and early implementers (Rajasthan).[15]

Idiosyncratic timing in implementation has been attributed to successful pressure applied by civil society. In particular, the initial 6-month deadline set by the Supreme

[15]The acronym comes from its resemblance to the Hindi word, "bimar" meaning sick. These 4 states have among the lowest domestic products in the country. The fact that Bihar and Assam, two "late" implementers in our sample, also have rather poor economic educational characteristics does not obviously detract from our claim of idiosyncratic timing in light of the fact that Punjab and West Bengal – two states which are not in our sample but which have reasonably advanced economic and educational outcomes – are also late implementers.

Court was without exception breached, with states complaining that they did not have sufficient funding to implement the policy. This excuse was widely dismissed by the media, two Supreme Court commissioners, and the activist community, who instead blamed the "lack of political, bureaucratic and societal will" for state governments' recalcitrance (Parikh and Yasmeen (2004); Drèze and Goyal (2003) and Zaidi (2005) make similar claims.) State government inaction spurred grassroots activists, coordinated by India's Right to Food Campaign which had grown out of the PUCL's Supreme Court litigation efforts, to start public mobilization efforts. It was these efforts, supported by continued monitoring and chastisement on the part of two commissioners as well as media, which compelled states to comply with the Supreme Court directive (see Sharma et al. (2006) and Khera (2006)).

2.3. **Financing and Content.** The midday meal scheme is a joint undertaking of central and state governments. During our observation period, the central government provided financial assistance to cover the cost of food grains and their transport. In particular, The Food Corporation of India (FCI), an institution set up in 1964 to support the operation of the central government's food policies, provided states free supply of food grains from the nearest of its godowns. Provision for each student with 100 grams of wheat or rice per day cost the central government approximately Rs. 1.11 (NPNSPE 2004). In principle, fair average quality of the grains was also guaranteed, with the FCI being responsible for replacing the grains otherwise. The transport subsidy to carry the grains from the nearest FCI godown to the primary school was set at a maximum of Rs. 50 per quintal, amounting to an average transport subsidy of Rs. 0.05 per child per school day.[16] The total value of the central government subsidy between 2002-2004 therefore amounted to Rs. 1.16 per child per school day.

The Supreme Court's 2001 directive mandated that midday meals have "a minimum content of 300 calories and 8-12 grams of protein each day of school; for a minimum of 200 days a year." The overall responsibility for implementation of this directive lies with state governments, who supplement the central government's contributions to varying degrees.[17] Day-to-day operations lie in the hands of local government bodies,

[16]This figure is calculated from NPNSPE (2004, Section 3.4) which states that at the end of 2004, i.e. after our period of observation, the transport subsidy grew by one third, namely to Rs. 75 per quintal, which amounted to an average of Rs. 0.08 per child per school day. Following our observation period, an additional Rs. 1 per child per school day was contributed by the central government towards cooking costs, comprising cost of ingredients other than grains, including vegetables, cooking oil, and condiments, as well as the cost of fuel and wages for personnel.

[17]These supplements are non-transparent and poorly documented, but available evidence suggests that there is no obvious correlation between supplements and timing of midday meal implementation. For example, Tamil Nadu (an early implementer) and Andra Pradesh (which implemented in 2003)

typically village governments (panchayats), who sometimes delegate implementation to local Parent Teacher Associations (PTAs) or NGOs.

In practice, the meal itself tends to be a simple affair. At around midday children sit at their plates, which are typically set on the ground, where they are served a cooked meal prepared on site, usually by a cook who is hired for this purpose. The meal comprises cooked rice or wheat (depending on the local staple), typically mixed with lentils or jaggery, and sometimes supplemented with oil, vegetables, fruits, nuts, eggs or dessert at the local level (see Appendix A for details on meal content by state). Eye-witness accounts suggest that, although the quality and variety of the meal varies from district to district or even school to school, children seem to enjoy their lunch (see, for example, Drèze and Goyal (2003)).

3. Data

In order to execute a large-scale evaluation of the midday meal program we use the District Information System for Education (DISE), which is the "most comprehensive information system in the education sector" in India (Ward 2007, p. 291). DISE is a school-level data set covering government-recognized elementary institutions. It is a joint initiative of the Government of India, UNICEF and the National University of Educational Planning and Administration (NUEPA), and came into being explicitly because of a lack of reliable statistical databases for education in India (Mehta 2007). Initiated on a pilot basis in 1995 to monitor schooling inputs and enrollment outcomes for those districts covered by the District Primary School Education Programme (DPEP), DISE was gradually rolled out to cover non-DPEP districts. Starting from 2002, DISE achieved coverage of all districts of the 18 states mentioned in Section 2, where it was initially launched (DISE 2008).

Data is collected annually, and reflects school characteristics (such as infrastructure and staff) as well as student enrollment as on September 30th of the respective year. School headmasters answer a nationally standardized school survey questionnaire. The data is verified and manually checked at various stages from lower to higher levels of administration. At the cluster level, responses are verified for completeness and accuracy. The data is then aggregated at the district level, where it is checked for computational and consistency errors. Further consistency checks take place at the state level. In addition to these measures, the NUEPA has commissioned post-enumeration audits

both contributed Rs. 1 per child per day towards cooking costs in 2005, whereas Rajasthan and Chattisghar, which implemented earlier than Andra Pradesh, contributed little towards cooking costs (Secretariat of the Right to Food Campaign 2005).

through external agencies, so as to verify the accuracy of the data provided by the school headmasters. In these audits, 5% of schools chosen randomly from at least 10% of districts from each state were thus cross-checked with site visits (Kaushal 2009). The major findings of these surveys is that the total enrollment figures for primary school are overwhelmingly accurate. Systematic errors were, however, found in responses to questions which were either unclear, or open to subjective interpretation. Hence, we refrain from using variables which capture qualitative assessments. For example, rather than construct a variable capturing the quality of classroom infrastructure, we use total number of classrooms.

We exploit a three year balanced panel of 506,125 schools over the academic years 2002/03 to 2004/05.[18] We consider public and private primary schools. Private schools in Indian school system parlance are, in the context of our data, "unaided schools". What we call public schools in our sample are government owned and operated schools; they are not so-called "government aided" schools. Government aided schools were dropped since the documentation is opaque as to when and whether these schools were covered by the midday meal program at the state level. They constituted 4.80% of the full 2002-2004 data set, and including them in the analysis as either part of the treatment or quasi-control groups does not alter the results.

Private schools constitute 6.81% of our sample. The distribution of public and private schools among states in our sample can be seen in Table 2. The former closely follows the state population distribution.

We estimate enrollment responses separately for grades 1 to 5, as well as for primary school as a whole. DISE also reports enrollment separately by gender. We exploit this in an extension to our basic results to investigate whether midday meals serve to narrow the gender gap in enrollment.

Table 3 furnishes means of enrollment and of schooling inputs, which we use in our specification tests. It indicates that average enrollment in primary schools is just below 125 students, starting with about 33 students in 1st grade and declining steadily until, in 5th grade, enrollment is just over half of that in 1st grade. On average, a primary school has about 3 classrooms, 1 additional room, 2 teachers, 0.5 non-teaching staff (including para-teachers), 5 blackboards and 2 "trunks" of teaching materials. Just half of the schools have a playground, roughly one quarter have electricity, about 83% of schools have water, and the majority does not have toilets; 96% teach in the

[18]These are the only years for which data for all DISE districts were made available to us. Prior data would, however, not have been representative at the state level, since survey coverage in previous years was substantially more limited, and restricted overwhelmingly to educationally underdeveloped districts within each state vis à vis education.

vernacular. In our estimations, we control for these inputs and also create a matched sample based on these observable schooling characteristics.

4. Empirical Strategy

4.1. **Approach.** To study the impact of the midday meal policy on primary school enrollment, we exploit the variation created by its staggered introduction in public primary schools throughout India.[19] We employ an intent-to-treat (ITT) analysis throughout (see for example, Imbens and Rubin (1997)). In particular, all public schools located in a state which has been documented as having implemented the Supreme Court directive at time t and thereafter (see Table 1) are considered as treated.

This approach has three related merits. First, it is a natural way to analyze a policy which may be characterized by non-random compliance at the school or village level. Second, it is useful from a policy perspective since state governments' budgetary allocations to midday meals are typically associated with their decision to introduce the policy even if these allotments are not spent at the local level by non-compliers. Finally, since DISE does not include information on midday meal implementation at the school level, we are unable to verify compliance. (In Section 6, we exploit household survey data containing information on schools' midday meal compliance.)

Our aim is to identify the effect of midday meals instituted in public schools (treatment group) by certain states (experimental states). (This exposition follows the description in Gruber (1994), who uses a similar triple difference strategy.) In order to accomplish this, we need to control for systematic shocks in enrollment outcomes of the treatment group in experimental states that are correlated with, but not due to, the institution of midday meals. We accomplish this by estimating the following triple difference equation, which uses private schools as a control group:

$$Y_{ist} = \gamma_t + \lambda_s + \alpha Pub_i + \delta_1(Pub_i \cdot \lambda_s) + \delta_2(Pub_i \cdot \gamma_t) + \delta_3(\lambda_s \cdot \gamma_t) + \beta(m_{st} \cdot Pub_i) + \epsilon_i \tag{4.1}$$

where Y_{ist} is the log of enrollment, for school i, in state s, at time $t = 2002, 2003, 2004$. In various specifications it pertains to enrollment in grades 1-5 separately, as well as to total primary school enrollment.

National trends in enrollment are captured through year fixed effects, γ_t. State fixed effects, λ_s, account for enrollment differences across states. The dummy variable Pub_i,

[19]Broadly speaking, our use of staggered implementation as an identification strategy follows Gruber and Hungerman (2008), who assess the impact on religious participation of the repeal of "Blue Laws" in U.S. states, and Field (2007) who studies a nation-wide titling program in Peru.

which is equal to 1 if school i is a public school and 0 if it is a private school, allows for different average enrollments in public relative to private schools. The interaction term $Pub_i \cdot \lambda_s$ permits this average to vary by state, and $Pub_i \cdot \gamma_t$ captures a national trend in public school enrollment.

The key advantage of this triple difference approach is that it allows us to account for state specific shocks over the observation period through state-by-year effects, $\lambda_s \cdot \gamma_t$. This is important in a federal country such as India, where schooling policy is largely governed by states and trends in economic development (including population growth), which vary across states.[20]

The variable m_{st} in Equation (4.1) is equal to 1 if the midday meal program was in place in state s prior to the September 30th enrollment deadline in year t, as described in Table 1. The coefficient β on the interaction term $m_{st} \cdot Pub_i$ (which we label MDM in our results tables) is our triple difference estimate. It captures changes in enrollment in public schools following the institution of a midday meal program in the state, compared to analogous changes in enrollment in private schools in the same state.

4.2. **Identification.** The main identifying assumption in this triple difference specification is that there were no contemporaneous shocks in states at the time of midday meal introduction, which impacted relative outcomes of the treatment group. At the state level, such a change may occur in public schools if there is a contemporaneous change in state school policy, and in Section 5.2.2 we provide a detailed discussion of possible candidates. Additionally, private schools may have responded to the introduction of a midday meal in public schools by strategically improving school quality in the hope of attracting or retaining students. Such confounding changes are likely to be reflected in relative changes in schooling inputs (including teachers, teaching aids and physical infrastructure). We test this by putting them on the left hand side of our triple difference equation (4.1). Our results indicate that there were no contemporaneous changes in the relative inputs between treatment and control groups at the time of midday meal introduction.

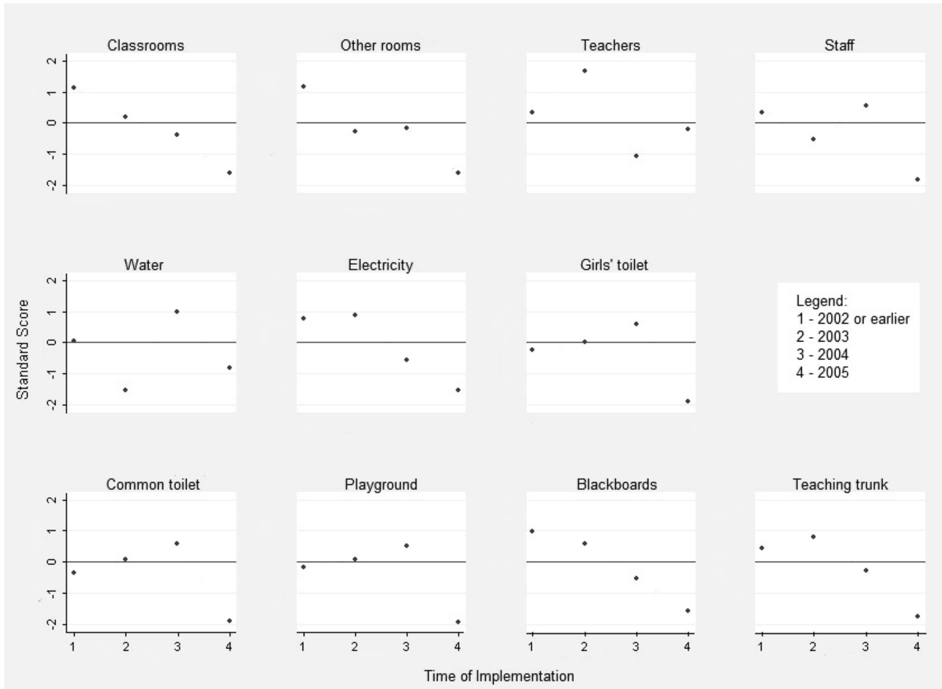
[20]The three year window of observation essentially precludes the use of a time trend trend, and a double difference strategy would not allow us to distinguish state-by-year effects from the midday meal effect. Given the state-time heterogeneity in India, this is likely to result in biased treatment effect estimates, and it is for this reason that we eschew a double difference in favor of the triple difference strategy. Double difference estimates in these data (not reported) are never statistically significant. Inconsistent with extant statistical as well as anecdotal evidence, this is likely to be a reflection of confounding state-by-year effects.

There are two pre-conditions for the validity of our quasi-experimental approach. The first is that control group outcomes are unaffected by treatment. In our specification tests, we try to verify this by showing that private school enrollment did not change in response to the introduction of midday meals. The second pre-condition is that there was no purposive placement of the midday meal policy. As discussed in section 2, the timing of midday meal introduction was idiosyncratic. This is broadly supported in Figure 2, which depicts standard scores of various initial (2002) schooling inputs, in states which grouped by timing of implementation. The data confirm that, at least states in our data which implemented in 2004 or earlier, there is no evidence that later implementers have systematically better or worse school quality than early implementers. At the same time, the 2005 implementers, Bihar and Assam, are generally characterized by poor schooling quality. Although standard score would, no doubt be higher if we had data from say, Punjab and West Bengal, who are also late implementers, we may still be concerned about bias introduced by potentially non-random late implementation in these data. We deal with this in our specification tests by showing that our results are robust to the exclusion of late (as well as early) implementers.

There may also be lingering concern that the timing of midday meal adoption is related to state policies or preferences which are correlated with state-level trends in educational outcomes. Figure 3, which presents literacy data from India's decennial censuses, suggests that this is not the case. It shows that literacy rates, in states from the sample grouped by timing of implementation over our period of observation, have developed in a largely parallel fashion over the last twenty years.

However, there do exist observable differences in schooling inputs between public and private schools, as documented recently in Muralidharan and Kremer (2006) and Kingdon (2007).[21] As the first two columns of Table 4 indicate, private schools have

[21] Muralidharan and Kremer (2006) and Kingdon (2007) have also noted a growth in private school enrollment, driven primarily by the entry of private unrecognized schools. Since DISE only surveys recognized schools and our sample constitutes a balanced panel, our results are not directly driven by births in the sample. There may, however, be an indirect effect if new entrants draw enrollment away from extant public or private schools. To the extent that new private entrants (whether recognized or unrecognized) draw proportionately from enrollment in extant public and private schools at the state level over the period of observation, this should not compromise the identification strategy in our balanced panel. If, on the other hand, private unrecognized schools enter strategically where there has been a failure in public schools, then our treatment effect estimates may be biased downward. This seems unlikely for two reasons. First, there is no reason to believe that private entry is correlated with idiosyncratic midday meal introduction. Second, in a narrow, high-frequency window of observation, parallel trends between private and public school enrollment within a state seems like a reasonable assumption even with entry.

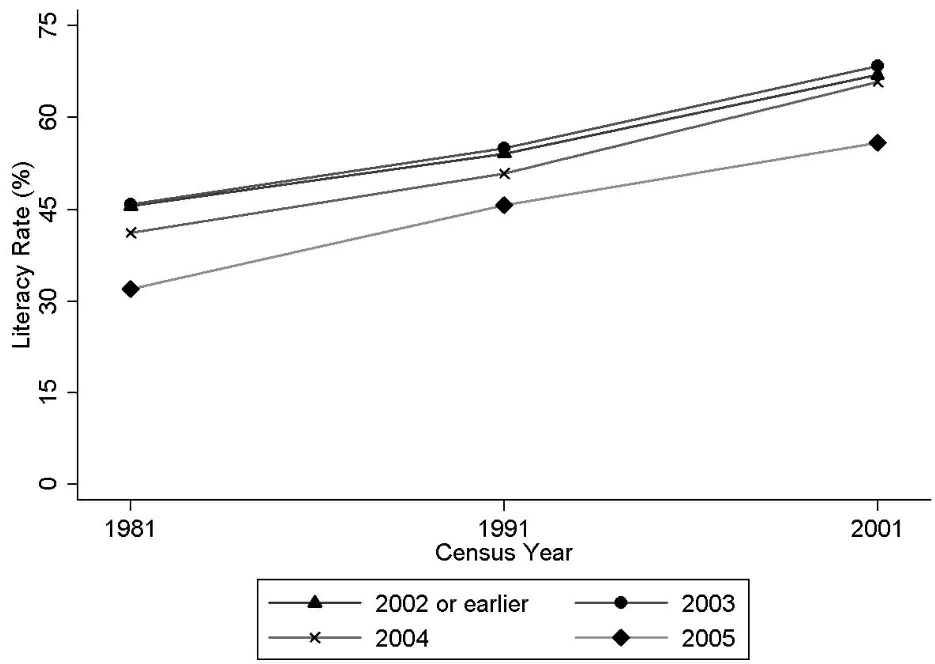


Note: This figure depicts 2002 schooling inputs from DISE, grouped by timing of midday meal implementation. The groups pertain to: Chhattisgarh, Gujarat, Tamil Nadu and Rajasthan in 2002 or earlier (group 1); Andhra Pradesh, Karnataka, Maharashtra and Uttaranchal in 2003 (group 2); Haryana, Himachal Pradesh, Madhya Pradesh, Orissa and Uttar Pradesh in 2004 (group 3); and Assam and Bihar in 2005 (group 4). The data points represent standard scores, which are calculated as the group mean minus the sample mean, divided by the sample standard deviation.

Figure 2. 2002 School Inputs by Timing of Midday Meal Implementation

larger student bodies; have more rooms, staff and equipment; better schooling infrastructure; and are less likely to teach in the vernacular (likely, reflecting more English language instruction).

The main concern arising from these observed differences is that characteristics which differentiate private and public schools may be associated with different trends in enrollment between the two groups within a given state. We account for these concerns by applying our simple triple difference estimation described in Equation (4.1) to a



Note: This figure depicts trends in literacy rates in states, which are grouped according to the timing of midday meal implementation. The groups pertain to: Gujarat, Tamil Nadu and Rajasthan in 2002 or earlier; Andhra Pradesh, Karnataka, and Maharashtra in 2003; Haryana, Himachal Pradesh, Madhya Pradesh, Orissa and Uttar Pradesh in 2004; and Assam and Bihar in 2005. Chhattisgarh and Uttaranchal are not separately included since they became states only in 2000. Source: Census of India.

FIGURE 3. Literacy Rates by Timing of Midday Meal Implementation

matched sample of public and private schools. Remaining concerns pertaining to standard omitted variable bias are accounted for by extending the empirical model to include a vector of potentially time-varying school-level inputs $\mathbf{X}_{it}$.

The goal of the matching exercise is to find a group of private schools that is as observationally similar as possible to the public schools in our sample. To achieve this, we first estimate for each school the propensity score with a standard probit regression model in which the independent variables are from the base year 2002. We match on basic infrastructure (classrooms, other rooms, toilets, water, electricity, playgrounds), staff (teachers and other staff), teaching learning materials (blackboards, and trunks that contain learning materials), language of instruction (vernacular) and on primary school size. In the common support region, for each public school we find a comparable private school located in the same state with the closest propensity score. The propensity score matching is done to the first nearest neighbor without replacement so as to obtain a sample of public schools as similar as possible to that of private schools. Unmatched schools are discarded and not used in estimating the treatment impact.[22]

As the last two columns of Table 4 indicate, the matched sample of public and private schools are indistinguishable in terms of observable characteristics. The residual differences in average school characteristics after matching are close to zero and therefore economically trivial.

5. Results

5.1. **Main Results.** We begin by estimating Equation (4.1) using pooled OLS. Table 5 presents our main result: the triple difference estimate β, which captures the effect of midday meals (MDM=$m_{st} \cdot Pub_i$) on school enrollment. Each column represents a different regression. In this and all other triple difference estimations, we control for state, time, and public school dummies as well as their pair-wise interactions as presented in Equation 4.1 (although, in the interest of space, coefficient estimates are not reported). In columns 1-5, the dependent variable is log of enrollment in grades 1-5, respectively, and in column 6 the dependent variable is the log of total primary school enrollment.[23] Following Bertrand et al. (2004), in this and all subsequent tables, standard errors clustered at the state level are presented in parentheses.

The positive coefficients for β in row 1 indicate that midday meals increase primary school enrollment. The response is largest in grade 1 (column 1), where enrollment increases by a large and statistically significant 18.2%.[24] The point estimate for β in grade 2, although economically and statistically significant, is half as large, corresponding to a 9.4% increase. It continues to fall and is statistically insignificant in grades 3, 4 and 5. This is likely to reflect the fact that the relative value of the implicit

[22]Matching with replacement does not eliminate the differences in observable average characteristics between private and public schools. Our analysis was performed using the user-written Stata program 'psmatch2' (described in Leuven and Sianesi http://ideas.repec.org/c/boc/bocode/s432001.html).
[23]The different number of observations in each column, despite having a balanced panel of schools, follows from the fact that in some years, enrollment numbers are missing.
[24]This and other percentage increases in enrollment following from the binary explanatory variable, MDM, are calculated in the following manner: $0.182 = exp(0.167) - 1$.

subsidy contained in midday meals is declining in higher grades, since the direct and opportunity costs of schooling typically increase with grade.

Overall, midday meals engender a statistically significant 6.6% increase in primary school enrollment (column 6). The level results (not reported) underscore the economic significance of this percentage increase: it corresponds to around 19 additional students in primary school, over 10 of whom join grades 1 and 2. The fact that the level results closely resemble the log results in table 5 suggests, moreover, that this main result is not sensitive to functional form.

5.2. **Specification Tests & Extensions.** In this section we run a number of specification checks in an effort to ascertain the robustness of our main results and validity of our empirical strategy.

5.2.1. *School-level Heterogeneity.* Our research design allows for different average enrollments at the state level between public and private schools. However, we may still be concerned that secular differences in school characteristics are correlated with different trends in enrollment between public and private schools at the state level. We account for this possibility in Table 6, which presents triple difference estimates analogous to those in Table 5 using the matched sample of public and private schools described earlier.

The results described in the top half of the Table 6 closely resemble our main results. The 6.4% increase in primary school enrollment, significant at the 10.5% level, presented in column 6 is strikingly similar to the 6.6% increase estimated for the full sample. Although there is a one to three percentage point difference in the point estimates at the individual grade level (columns 1-5), and the enrollment increase is statistically significant in grade 3 as well as grades 1 and 2, the magnitudes as well as the pattern of the point estimates are qualitatively identical to those presented in Table 5. In particular, the overall increase in primary school is driven by statistically significant increases in early primary school enrollment; enrollment responses are positive throughout; and decrease monotonically with grade.

The bottom half of Table 6 extends this exercise to account for omitted variable bias by including a vector of potentially time-varying schooling inputs $\mathbf{X}_{it}$, summarized in Table 3. The coefficient estimates on the schooling inputs (not reported) are consistent with our priors: more classrooms, teachers, other staff, blackboards, and physical infrastructure are associated with higher enrollment. The triple difference point estimates in this specification are approximately 3 percentage points larger than those in the top half of the table, suggesting that our simple triple difference estimates may represent a lower bound on the enrollment effect of midday meals. However this interpretation needs to be treated with caution since, to the extent that schooling inputs are endogenous, all the coefficients in this table will be biased. In general, however, the magnitude of the point estimates are not significantly different and the overall pattern of the estimates is qualitatively identical to the triple difference estimates in both the full and the matched sample.

Together these robustness checks alleviate concerns that unobserved heterogeneity across (private and public) schools is driving our main results. Given the loss in sample size entailed in this matching exercise, we conduct further specification tests on the full sample, although the results are qualitatively similar when using the matched sample.

5.2.2. *Confounding Changes.* State governments have discretion over the implementation of school policies. This could be problematic for our triple difference model if there were confounding policy changes at the state level contemporaneous to the institution of midday meals, which affected treatment and control groups differentially. In this respect, there are two serious public policy contenders: the District Primary Education Programme (DPEP) and the Sarva Shiksha Abhiyan (SSA).

The DPEP was conceptualized in the early 1990s in response to India's low literacy rates. Its stated aims were to provide primary school access for all children, reduce dropout rates, increase learning achievements, and reduce gender and caste gaps in educational attainment (DOE 1995).[25] In 2002 all the states in our sample were covered by the DPEP. To this extent, the observed effect of the introduction of school lunches cannot be confounded with any effect associated with cross state-time differences in the introduction (or withdrawal) of the DPEP per se. In 2001-02 the Government of India launched the SSA, merging into it all previous investments in elementary education from the state or from the central government (SSA 2008). Therefore, as of 2002, DPEP was integrated into the SSA framework.

Targeted at the 6-14 age group, the SSA's stated aims were to achieve universal enrollment and retention, bridge gender and caste gaps, and improve education quality. Under this framework, new schools were opened in habitations with no schooling facilities and the basic infrastructure of existing schools was strengthened. New teachers were hired and grants were given for the development of teaching learning materials.

The interventions for out of school children focused mainly on alternative schooling models (Alternative and Innovative Education (AIE) schools, residential bridge

[25]See World Bank (2003) for a review of the evidence regarding the impact of this program.

courses, tent schools, mobile schooling or home based education) and on the building of Education Guarantee Scheme (EGS) schools. These types of schools are not included in our panel of schools. Therefore, as long as there is no differential impact of these interventions on our treatment and control groups, they should not affect our estimates.

Still, the concern remains that changes in schooling inputs introduced under the auspices of the SSA may have coincided with midday meal implementation. We examine this possibility by estimating a triple difference with different schooling inputs (instead of enrollment) on the left hand side of Equation (4.1), focusing on the set of schooling inputs that could have been changed under the SSA: basic infrastructure of the schools (classrooms, other rooms, toilets, water, electricity, playgrounds), staff (teachers and other staff) and teaching learning materials (blackboards and trunks that contain learning materials).

Table 7 furnishes the results of this exercise. Each column has, as a dependent variable, a different schooling input on the left hand side. The statistically insignificant triple difference estimates in the top third of the table indicate that schooling inputs in public versus private schools within each state did not change differentially at the same time of midday meal introduction.

The lower two sections of Table 7 report the double difference (DD) coefficient estimate, ϕ, from the following model:

$$Q_{ist} = \lambda_s + \gamma_t + \phi m_{st} + \epsilon_i, \quad (5.1)$$

where λ_s, γ_t, and m_{st} are defined as in Equation (4.1), and Q_{ist} is (in different regressions) one of the 10 different schooling inputs listed in the column headings.

The sample in the middle section is restricted to the treatment schools, so the point estimate captures whether there were contemporaneous changes in public school inputs at the time of midday meal introduction. The statistically insignificant coefficients suggest that, across the board, there were no such changes. The sample for the double difference estimates presented in the bottom section of Table 7 is restricted to private schools. The results indicate that private schools did not respond to the introduction of midday meals in the state by significantly altering their inputs either. This provides some validity for using private schools as a control group.

In general, the results in Table 7 are likely to be a reflection of the fact that there was little change in schooling inputs over time during our three-year observation period, whether contemporaneous to midday meal introduction or otherwise; this is immediately evident from a cursory glance at descriptive statistics of schooling inputs by academic year (not shown). This feature further alleviates worries regarding potentially confounding changes.

5.2.3. *Contamination.* In principal the increased enrollment in public schools can come from two potential sources: children who would not have otherwise been in school (new enrollments), or children who would otherwise be enrolled in private schools and may be switching from private to public schools. In the latter case, our control group would be contaminated and the triple difference estimates presented in Table 5 would be upward bias estimates of the general equilibrium enrollment effects of midday meals.

We explore this possibility by estimating a DD model analogous to that in Equation (5.1), but with enrollment on the left hand side, for our sample of private schools. If increased public school enrollment reflected transfers, then we should expect to see a statistically significant negative coefficient for our estimate of ϕ.

Table 8 provides suggestive evidence that this is not the case. It is reassuring that the estimates are not only statistically insignificant but also close to 0 for all grades. This allays fears of contamination and provides some validation for the use of private schools as a control group in the triple difference model.

5.2.4. *Timing of Implementation.* Our empirical strategy relies on the staggered timing of implementation of the midday meal scheme. We argued earlier that the timing of implementation during our observation period is idiosyncratic. But there may still be concern that early or late implementers have policies and preferences which are correlated with trends in enrollment that are different from others in our sample. One way of addressing this concern is to examine whether our results are being driven by these states.

In Table 9 we estimate the triple difference model in Equation (4.1) on four different samples of public and private schools, depending upon early or late implementation. The point estimates are virtually identical when we drop laggards Assam and Bihar (first quarter of Table 9), which is especially comforting in light of the concerns raised in Section 4.2. They fall by 2-3 percentage points when we drop pioneers Tamil Nadu and Gujarat (second and third quarters of Table 9), and we lose some variation in the data. But even here, the results are qualitatively similar, with a statistically significant increase in primary school enrollment, driven by early primary school responses. Finally, when we exclude one state at a time from the sample our results are also unchanged (not reported).

As related in Section 2, we did not include pilot districts or Kerala in our sample, because of both poor documentation regarding implementation and worries of bias introduced by purposive placement. In the bottom quarter of Table 9, we include schools in Kerala as well as schools covered in these pilot districts, treating each set of pilot districts in a given state as a "new" state, with the m_{st} variable defined accordingly. The bottom quarter of Table 9 reports our triple difference estimates for this extended sample. The picture remains the same.

Together, these robustness checks indicate that our results are not driven by potentially non-random timing of implementation.

5.2.5. *Gender.* The results presented heretofore pertain to aggregate enrollment of both boys and girls. An important policy concern in the Indian context is, of course, the gender gap in enrollment (see, for example, Kingdon (2007)). In Table 10, we examine gender disaggregated responses in enrollment. The patterns of responses for boys and girls are similar and mirror that of our aggregate results in Table 5. Interestingly, the point estimates for girls is larger than that for boys in grade 1, but this inequality is reversed in grades 2-5. However, none of these differences are statistically significant, indicating that the midday meal scheme may not alter the gender gap in primary school enrollment.

6. Learning Effect: Suggestive Evidence from Household Data

The positive enrollment response to midday meals documented in Section 5 reflects the sum of two effects, alluded to in the introduction. The first is the implicit subsidy effect, which is thought to be positive as school lunches lower the cost of schooling. The second is the learning effect whose sign is, in general, ambiguous.[26] On the one hand, there is a positive direct effect, as improved nutrition from midday meal consumption leads to improved nutrition, more learning, and commensurately higher returns to education, and thereby higher enrollment. But there is also a negative indirect learning effect. This arises from the possibility that limited resources in terms of personnel, learning tools, and infrastructure may have to be stretched over a larger number of enrolled children; or from the prospect of teachers being distracted from teaching due to meal-related administration.

Whether midday meals promote academic performance is, of course, very important from a policy perspective. Unfortunately, data limitations preclude the empirical identification of a causal relationship between midday meals and academic achievement.

[26]Kremer and Vermeersch (2004) and Kazianga et al. (2009) provide detailed discussions of this.

Nevertheless, in this section, we use a recent household and school-level survey from the Indian Human Development Survey (IHDS) 2005 to explore whether there is some corroborative evidence for the presence and direction of a net learning effect.

6.1. **Data.** IHDS 2005 is a nationally representative survey conducted in 41,554 households during 2004-2005 across all states and union territories of India with the exception of the Andaman & Nicobar and Lakshadweep islands. The survey covers 1,504 villages and 970 urban neighborhoods. In addition to a standard household survey, the IHDS has two unique features which are attractive for our purpose. (See Desai et al. (2008) for a more complete description.)

First, it includes a primary school survey which covered at least one public and (where present) one private school in each village or urban block, the primary sampling units (PSU).[27] Importantly, this school survey included a question regarding whether a midday meal was offered in the school. The second unique feature of IHDS is that it includes assessments of reading, writing and arithmetic skills for children aged 8-11, developed in conjunction with Pratham, an NGO with extensive knowledge in this area.[28]

Our sample comprises children between 8 and 11 years of age who are either out of school or are currently enrolled in a public primary school. We use the response to the midday meal question in the school survey to construct a variable which captures whether or not at least one public school in the PSU provided midday meals.

Table 11 presents summary statistics for the 9,224 observations in our sample of 8-11 year-olds. It indicates that 77% of children in this age group have access to a midday meal offered at a local public school. On average, 88% are currently enrolled; 36% are either Scheduled Castes or Scheduled Tribes (SC\ST); 49% belong to an upper caste (i.e. non-SC\ST); and the remainder belong to minority religions. The vast majority of children come from households where parents have completed only 5 years of schooling or fewer.

Three dummy variables, *Reading*, *Math* and *Writing*, are constructed to capture learning. Of the children who were administered learning tests, 72% can read at least words; 40% of the children that took the math test can solve at least a simple addition problem; and 61% can write a simple sentence with at most one mistake.

[27]The choice of school was non-random: where more than one of either facility was present, interviewers were asked to select the facility which was predominantly used by residents.

[28]Although all 8-11 year-olds in the sample households were supposed to take the test, only about 72% of them actually did so, and we cannot rule out the possibility that missing scores are non-random.

6.2. **Empirical Model & Results.** In contrast to our empirical strategy using DISE's panel data structure, we cannot use an ITT strategy exploiting staggered implementation of the policy. The simple reason for this is that by 2005 when the IHDS was conducted, the vast majority of the Indian states had introduced the midday meal scheme. Furthermore, because IHDS is a cross-section, and midday meals are only offered in public schools, we cannot use private schools as a control group since this would not permit us to distinguish the midday meal effect from secular differences in enrollment between private and public schools.

We therefore estimate the following individual linear probability model:[29]

$$l_{ihj} = \lambda MDM_j + \nu Z_{ih} + \epsilon \tag{6.1}$$

where l_{ihj} is the binary learning test result of child i in household h from PSU j. It indicates, in three separate specifications, whether the child can read, write or do math. In an additional specification, we estimate results for the dependent variable s_{ihj}, the binary decision of household h from PSU j to send child i to school or not. The dummy variable MDM_j indicates whether midday meals are served in the public primary school surveyed in PSU j ($MDM_j = 1$) or not ($MDM_j = 0$). Since compliance to the midday meal mandate is likely to be endogenous at the local level, we cannot rule out bias in our estimate of λ. It is merely indicative of a potential correlation between midday meal implementation and public school enrollment or academic achievement. The vector Z_{ih} contains individual characteristics such as gender and age, and household characteristics including caste and parents' education.

Table 12 presents results pertaining to enrollment and learning associated with midday meals. The sample in column 1 pertains to all children between the ages of 8 and 11 who are either non-enrolled or currently enrolled in public primary school. The point estimate in row 1 indicates that midday meals are associated with 10.8% higher enrollment in this age group. This estimate is twice the size of our DISE estimates for both primary school and even larger relative to the responses in grades 3-5 (where 8-11 year-olds are typically enrolled) The coefficient, though likely to be upward biased, is similar in magnitude to estimates from smaller non-experimental studies reviewed in Section 1.

The dependent variable in Columns 2-4 are dummy variables indicating children's ability to read, solve math problems, and write, respectively. Row 1 in columns 2-4 indicates that midday meals are not associated with *any* learning effect: the coefficient

[29]Probit estimations produce qualitatively identical results.

estimates are statistically insignificant and close to zero in each of the three categories. This is consistent with evidence from studies in other geographies, reviewed in Kazianga et al. (2009), that school feeding programs are often ineffectual at raising academic achievement.

This finding, while troubling, is not necessarily surprising. If anything, based on the evidence from DISE, it seems surprising that the negative indirect learning effect does not dominate given the magnitude of the enrollment response to the programme and the absence of any concomitant increase in staff or infrastructure. In sum, since midday meals are associated with higher enrollment but not increased learning, these data seem to suggest that the implicit subsidy channel is driving the positive enrollment response to midday meals.

7. Discussion

This paper provides evidence that India's midday meal scheme has led to large increases in primary school enrollment. Our main triple difference estimates indicate that primary school enrollment increased by 6.6%, with the largest and most robust increase coming from grades 1 and 2, where enrollment, rose by 18% and 9%, respectively. Enrollment in grades 4 and 5 are, by contrast, considerably less responsive to this policy. This suggests that midday meals, although effective at encouraging early school enrollment, may be less effective at retaining students or encouraging re-enrollment in upper primary school.

Our estimates suggest that midday meals may be a cost-effective means of increasing enrollment. The overall primary school enrollment response associated with midday meals in our matched sample is, for instance, comparable to that of having 1.5 additional teachers.[30] If the value of the central and state government subsidies for the midday meal program at the beginning of 2005 was Rs. 3.21, this means that the lunch program at an average public primary school which meets the Supreme Court's minimum directive of providing lunch for 200 days, would cost roughly Rs. 6,400 per

[30]The triple difference point estimate is 0.09 (see Table 6) and the coefficient on the number of teachers (not reported, but included in the bottom half of the table) is 0.058.

month.[31] This amounts to approximately 85% of the typical public school teacher's salary of approximately Rs. 7,500 (and 57% of the cost of 1.5 teachers.)[32]

While the enrollment effects are encouraging, the learning effects are less so. Here, our results are only suggestive. However, it does seem to corroborate anecdotal evidence that the administration of midday meals distracts from teaching, and that the enrollment response to the program has stretched limited resources, both of which compromise learning. The scheme's success in encouraging enrollment would seem to require complementary investments in staff, materials and infrastructure if it is to also promote learning.

Given the wide coverage of the data we exploited in this paper, we believe the results we present here to be representative for India. This is policy relevant given both the scale of the midday meal program, and the fact that India houses the largest number of out-of-school children in the world (UNICEF 2008). It seems fair to speculate that the magnitude of the response that we document here is larger than it would be, were a similar school feeding program to be instituted in Latin America or East Asia, where primary school enrollment is already considerably advanced. Quite apart from enrollment effects, however, there may be important nutritional or school attendance benefits which may still speak for the introduction of similar school feeding programs in these regions. At the same time the enrollment effect we document in this paper may be generalizable to parts of Sub-Saharan Africa, where primary school enrollment rates are comparable to those of India, and decentralized government institutions have the capacity to implement this logistically demanding policy.

[31]The Rs. 3.21 is likely to be an upper bound for the average cost in most states. This figure comes from the Secretariat of the Right to Food Campaign (2005). It is a little more than Rs. 2 higher than the Rs. 1.16 subsidy allotted during our observation period since the transport subsidy was increased, the central government contributed an additional Rs. 1 towards cooking costs, and several state governments contributed an additional Rs. 1; $6400 \approx [(120 \text{ students}) \text{ X } (\text{Rs. } 3.21 \text{ per student}) \text{ X } (200 \text{ days})]/12$

[32]This salary estimate is from Muralidharan and Kremer (2006). Pritchett and Pande (2006) put the average Indian public school teacher monthly base pay between Rs. 5,000 – 8,000, plus perks.

TABLE 1. Sample of states and time of implementation

State Name	**Implementation**	**Treatment Year**
Andhra Pradesh	January 2003	2003
Assam*	January 2005	2005
Bihar*	January 2005	2005
Chhattisgarh	April 2002	2002
Gujarat	November 1984	1986
Haryana	August 2004	2004
Himachal Pradesh	September 2004	2004
Karnataka*	July 2003	2003
Madhya Pradesh	July 2004	2004
Maharashtra	January 2003	2003
Orissa*	September 2004	2004
Rajasthan	July 2002	2002
Tamil Nadu	July 1982	1982
Uttar Pradesh	September 2004	2004
Uttaranchal	July 2003	2003

Note. a. The second column contains the month and year when the midday meal scheme was implemented with full coverage throughout the state; these dates were collected from state midday meal scheme audit and budget reports. The third column contains the academic year starting from which a state is considered to have implemented the midday meal scheme; an academic year is considered to start on the 30th of September. States marked with * implemented first the midday meal scheme in pilot districts as follows: Assam Pilot in December 2004 (treatment year 2005), Bihar Pilot in September 2004 (treatment year 2004), Karnataka Pilot in June 2002 (treatment year 2002) and Orissa Pilot in June 2001 (treatment year 2001).

b. States or districts were excluded from the main DISE sample due to partial implementation, lack of information regarding where the scheme was implemented or due to potential purposive placement: Jharkhand, Kerala, West Bengal, Assam Pilot, Bihar Pilot, Karnataka Pilot and Orissa Pilot. The main regressions in the paper are similar if these districts are included (see text). All other states are not covered by DISE.

Table 2. School Distribution among States in Sample

		Schools	
State Name	**Population**	**Public**	**Private**
Andhra Pradesh	9.24	7.86	1.98
Assam	3.23	5.69	0.09
Bihar	10.06	6.35	0.06
Chhattisgarh	2.53	5.20	3.07
Gujarat	6.14	2.16	1.47
Haryana	2.56	0.62	0.02
Himachal Pradesh	0.74	2.56	1.47
Karnataka	6.41	4.97	5.11
Madhya Pradesh	7.31	12.98	20.98
Maharashtra	11.74	7.71	3.59
Orissa	4.46	4.46	1.28
Rajasthan	6.85	10.55	16.57
Tamil Nadu	7.56	5.62	8.02
Uttar Pradesh	20.14	20.94	33.47
Uttaranchal	1.03	2.36	2.82
Total	100.00	100.00	100.00

Note. In percentages. The second column figures are calculated from Census of India 2001 data. The figures in the third column are calculated from our main sample of public schools. The figures in the fourth column are calculated from our main sample of private schools.

TABLE 3. Means of variables

Enrollment[a]	
Grade 1	33.21
	(37.94)
Grade 2	26.39
	(30.04)
Grade 3	24.21
	(27.90)
Grade 4	21.32
	(25.48)
Grade 5	19.18
	(26.07)
Primary school	124.31
	(130.77)
Schooling Inputs[b]	
Number of classrooms	3.39
	(3.13)
Number of other rooms	1.02
	(1.75)
Number of teachers	1.91
	(1.99)
Number of other staff	0.45
	(1.16)
Dummy for water	0.83
	(0.37)
Dummy for electricity	0.23
	(0.42)
Dummy for girls' toilet	0.29
	(0.45)
Dummy for common toilet	0.43
	(0.49)
Dummy for playground	0.53
	(0.50)
Number of blackboards	4.63
	(4.22)
Number of teaching trunks	1.65
	(2.59)
Dummy for teaching in vernacular	0.96
	(0.19)

Note. Standard deviation in parentheses. All regressions omit observations in 3 states and 28 pilot districts due to partial implementation, lack of information regarding where the scheme was implemented or due to potential purposive placement. Data are from DISE 2002 - 2004. Observations: *a*: 1,601,778 *b*: 1,451,028.

Table 4. Means of 2002 Variables: Before and After Matching

	Before[a]		After[b]	
	Public	Private	Public	Private
School size	121.26	164.38	150.89	162.90
	(111.70)	(192.52)	(170.04)	(186.04)
Number of classrooms	3.00	6.98	5.79	6.91
	(2.39)	(5.73)	(4.42)	(5.48)
Number of other rooms	0.89	1.87	1.64	1.86
	(1.60)	(2.54)	(2.38)	(2.52)
Number of teachers	1.87	2.94	2.52	2.90
	(1.73)	(3.74)	(2.91)	(3.44)
Number of other staff	0.35	0.75	0.55	0.74
	(0.95)	(2.06)	(1.46)	(2.00)
Number of blackboards	4.14	7.53	6.43	7.47
	(3.47)	(6.61)	(5.61)	(6.44)
Dummy for playground	0.49	0.81	0.82	0.81
	(0.50)	(0.40)	(0.38)	(0.40)
Dummy for electricity	0.17	0.66	0.62	0.66
	(0.37)	(0.47)	(0.49)	(0.47)
Dummy for water	0.79	0.96	0.96	0.96
	(0.41)	(0.19)	(0.19)	(0.19)
Dummy for girls' toilet	0.20	0.67	0.64	0.67
	(0.40)	(0.47)	(0.48)	(0.47)
Dummy for common toilet	0.32	0.73	0.71	0.73
	(0.47)	(0.44)	(0.45)	(0.44)
Dummy for vernacular	0.98	0.84	0.94	0.84
	(0.15)	(0.37)	(0.24)	(0.37)

Note. Standard deviation in parentheses. Means are calculated on the basis of 2002 values for *a*. full sample comprising 442,676 observations and *b* matched sample comprising 55,336 observations. Propensity score matching uses the nearest neighbor without replacement.

Table 5. Triple Difference: Primary School Enrollment

	(1) Grade 1	(2) Grade 2	(3) Grade 3	(4) Grade 4	(5) Grade 5	(6) Primary
MDM (β)	0.167***	0.090**	0.072	0.069	0.037	0.064**
	(0.050)	(0.037)	(0.044)	(0.045)	(0.046)	(0.027)
Obs.	1,347,123	1,337,121	1,325,522	1,303,973	1,163,526	1,365,694
Adj. R^2	0.28	0.23	0.19	0.14	0.13	0.23

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies, year dummies, a public school dummy PUB, and state x time, state x PUB, time x PUB interaction terms. The dependent variables are log of yearly primary school enrollment, total and disaggregated by grade. The MDM dummy is set to unity for public schools once a state implements the midday meal scheme. Sample: All regressions include public primary schools and private primary schools. All regressions omit observations in 3 states and 28 pilot districts due to partial implementation, lack of information regarding where the scheme was implemented or due to potential purposive placement. Data are from DISE 2002 - 2004.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Primary School Enrollment on Matched Sample

	(1) Grade 1	(2) Grade 2	(3) Grade 3	(4) Grade 4	(5) Grade 5	(6) Primary
	Triple Difference[a]					
MDM (β)	0.134**	0.094*	0.069*	0.035	0.018	0.062
	(0.053)	(0.044)	(0.037)	(0.047)	(0.046)	(0.036)
Obs.	126,448	125,563	124,828	123,672	120,035	128,172
Adj. R^2	0.16	0.17	0.14	0.12	0.10	0.15
	Triple Difference with Covariates[b]					
MDM (β)	0.163**	0.121**	0.100*	0.065	0.054	0.090*
	(0.057)	(0.052)	(0.055)	(0.070)	(0.070)	(0.046)
Schooling Inputs	YES	YES	YES	YES	YES	YES
Obs.	122,249	121,412	120,709	119,593	116,096	123,932
Adj. R^2	0.30	0.32	0.31	0.30	0.28	0.34

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies, year dummies, a public school dummy PUB, and state x time, state x PUB, time x PUB interaction terms. Regressions *b* include as covariates the schooling inputs listed in part *b* of Table 3. The dependent variables are log of yearly primary school enrollment, total and disaggregated by grade. The MDM dummy is set to unity for public schools once a state implements the midday meal scheme. From the sample in Table 5 a sub-sample was created through a propensity score first nearest neighbor match with replacement on the common support, based on the 2002 values of the schooling inputs described in Table 4, by state between public and private schools.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7. Schooling Inputs

	(1) Classrooms	(2) Otherrooms	(3) Teachers	(4) Staff	(5) Water	(6) Electricity	(7) Gtoilet	(8) Ctoilet	(9) Playground	(10) Blackboard	(11) Trunk
Triple Difference[a]											
MDM (β)	-0.350	-0.180	-0.227	-0.051	-0.014	0.001	-0.012	-0.029	-0.009	0.034	-0.078
	(0.379)	(0.229)	(0.220)	(0.175)	(0.015)	(0.013)	(0.017)	(0.023)	(0.013)	(0.375)	(0.057)
Obs.	1,524,967	1,524,967	1,509,543	1,509,523	1,469,257	1,486,757	1,477,564	1,480,326	1,482,037	1,524,967	1,524,967
Adj. R^2	0.19	0.05	0.10	0.10	0.09	0.29	0.17	0.15	0.08	0.17	0.03
Double Difference: Public School Inputs[b]											
MDM (ϕ)	0.060	0.023	0.041	0.016	-0.002	0.001	0.015	0.018	-0.007	-0.064	-0.068
	(0.059)	(0.017)	(0.037)	(0.059)	(0.019)	(0.009)	(0.015)	(0.018)	(0.007)	(0.066)	(0.052)
Obs.	1,421,182	1,421,182	1,408,537	1,408,520	1,368,955	1,385,616	1,377,468	1,379,866	1,382,550	1,421,182	1,421,182
Adj. R^2	0.07	0.03	0.08	0.08	0.07	0.22	0.12	0.12	0.06	0.13	0.03
Double Difference: Private School Inputs[c]											
MDMstate (ϕ)	0.478	0.180	0.277	0.137	-0.010	-0.001	0.006	0.033	-0.007	-0.124	-0.028
	(0.415)	(0.236)	(0.220)	(0.216)	(0.009)	(0.007)	(0.013)	(0.039)	(0.013)	(0.420)	(0.118)
Obs.	103,785	103,785	101,006	101,003	100,302	101,141	100,096	100,460	99,487	103,785	103,785
Adj. R^2	0.18	0.07	0.07	0.13	0.05	0.13	0.05	0.03	0.03	0.18	0.01

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies, year dummies. Regressions a also include a public school dummy PUB, state x time, state x PUB, time x PUB interaction terms. The dependent variables are various schooling inputs as noted in the column title. The MDM dummy is set to unity for public schools only once a state implements the midday meal scheme. The MDMstate dummy is set to unity for all schools once a state implements the midday meal scheme in public schools. Sample in regressions a is as in Table 5. Regressions b are run on the sub-sample from a which includes only public schools. Regressions c are run on the sub-sample from a which includes only private schools.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8. Double Difference: Private School Enrollment

	(1) Grade 1	(2) Grade 2	(3) Grade 3	(4) Grade 4	(5) Grade 5	(6) Primary
MDMstate (ϕ)	0.014	-0.014	-0.015	-0.014	-0.044	-0.001
	(0.049)	(0.030)	(0.035)	(0.031)	(0.030)	(0.034)
Obs.	88,525	88,038	87,315	86,153	82,793	89,686
Adj. R^2	0.13	0.15	0.14	0.12	0.10	0.15

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies and year dummies. The dependent variables are log of yearly primary school enrollment, total and disaggregated by grade. The MDMstate dummy is set to unity once a state implements the midday meal scheme in public schools. All regressions include private unaided primary schools only. All regressions omit observations in 3 states and 28 pilot districts due to partial implementation, lack of information regarding where the scheme was implemented or due to potential purposive placement. Data are from DISE 2002-2004.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE 9. Triple Difference: Primary School Enrollment, Various Samples

	(1) Grade 1	(2) Grade 2	(3) Grade 3	(4) Grade 4	(5) Grade 5	(6) Primary
			Without Late Implementers[a]			
MDM (β)	0.167***	0.090**	0.072	0.070	0.037	0.064**
	(0.050)	(0.037)	(0.044)	(0.045)	(0.046)	(0.027)
Obs.	1,200,155	1,190,538	1,179,416	1,158,904	1,065,042	1,207,646
Adj. R^2	0.26	0.22	0.19	0.14	0.13	0.21
			Without Early Implementers[b]			
MDM (β)	0.164**	0.071	0.044	0.041	0.005	0.045*
	(0.061)	(0.046)	(0.034)	(0.036)	(0.033)	(0.021)
Obs.	1,235,670	1,225,920	1,214,528	1,193,572	1,057,011	1,253,614
Adj. R^2	0.30	0.24	0.20	0.15	0.14	0.25
			Without Early or Late Implementers[c]			
MDM (β)	0.164**	0.071	0.045	0.042	0.005	0.044*
	(0.061)	(0.046)	(0.035)	(0.037)	(0.033)	(0.021)
Obs.	1,088,702	1,079,337	1,068,422	1,048,503	958,527	1,095,566
Adj. R^2	0.28	0.24	0.20	0.15	0.14	0.23
			With Pilots and Kerala[d]			
MDM (β)	0.164***	0.089**	0.071	0.065	0.037	0.068**
	(0.049)	(0.035)	(0.043)	(0.044)	(0.044)	(0.026)
Obs.	1,447,537	1,437,104	1,425,036	1,402,736	1,249,587	1,469,019
Adj. R^2	0.28	0.23	0.19	0.15	0.14	0.23

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies, year dummies, a public school dummy PUB, and state x time, state x PUB, time x PUB interaction terms. The dependent variables are log of yearly primary school enrollment, total and disaggregated by grade. The MDM dummy is set to unity once a state implements the midday meal scheme. All regressions include public primary schools and private unaided primary schools only. From the sample in Table 5 new samples are created in the following way: In regressions *a* Assam and Bihar are excluded; In regressions *b* Tamil Nadu and Gujarat are excluded; In regressions *c* Tamil Nadu, Gujarat, Assam and Bihar are excluded; In regressions *d* the pilot districts Assam Pilot, Bihar Pilot, Karnataka Pilot and Orissa Pilot are included as well as Kerala.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10. Triple Difference: Primary School Enrollment, by Gender

	(1) Grade 1	(2) Grade 2	(3) Grade 3	(4) Grade 4	(5) Grade 5	(6) Primary
			Girls[a]			
MDM (β)	0.188***	0.087**	0.057	0.059	0.033	0.072**
	(0.058)	(0.036)	(0.050)	(0.043)	(0.046)	(0.024)
Obs.	1,312,472	1,299,075	1,283,611	1,253,892	1,106,844	1,342,812
Adj. R^2	0.24	0.19	0.16	0.12	0.11	0.21
			Boys[b]			
MDM (β)	0.149***	0.097**	0.089**	0.091*	0.050	0.063**
	(0.045)	(0.039)	(0.038)	(0.042)	(0.035)	(0.028)
Obs.	1,312,227	1,299,524	1,285,859	1,261,157	1,122,467	1,340,545
Adj. R^2	0.27	0.21	0.18	0.14	0.12	0.24

Note. Robust standard errors in parentheses clustered at the state level. All regressions include state dummies, year dummies, a public school dummy PUB, and state x time, state x PUB, time x PUB interaction terms. The dependent variables are in regressions a log of yearly primary school enrollment of girls, total and disaggregated by grade, and in regressions b log of yearly primary school enrollment of boys, total and disaggregated by grade. The MDM dummy is set to unity for public schools once a state implements the midday meal scheme. Sample is as in Table 5.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11. IHDS: Means of Selected Variables

MDM	0.77
	(0.42)
Dependent Variables	
Currently enrolled	0.88
	(0.33)
Reading	0.72
	(0.45)
Math	0.40
	(0.49)
Writing	0.61
	(0.49)
Individual Characteristics	
Male	0.50
	(0.50)
Age	9.37
	(1.04)
Household Characteristics	
Upper castes	0.49
	(0.50)
SC\ST	0.36
	(0.48)
Muslim\Christian	0.15
	(0.36)
Mother no education	0.64
	(0.48)
Mother completed primary school	0.19
	(0.39)
Mother completed more than 5 years of schooling	0.05
	(0.22)
Father no education	0.36
	(0.48)
Father completed primary school	0.30
	(0.46)
Father completed more than 5 years of schooling	0.14
	(0.35)

Note. Standard errors in parentheses. Sample: children between 8 and 11 years of age, either out of school or enrolled in public primary schools. 9,224 observations. Means for reading, math and writing are calculated on a 78% sub-sample of children that took a learning test.

Table 12. OLS: Learning and Enrollment

	(1) Enrollment	(2) Reading	(3) Math	(4) Writing
MDM (λ)	0.108***	0.005	0.014	0.008
	(0.03)	(0.04)	(0.04)	(0.05)
Male	0.040*	0.059*	0.076**	0.042*
	(0.02)	(0.02)	(0.03)	(0.02)
Age	0.368*	0.076	0.325	0.247
	(0.14)	(0.13)	(0.17)	(0.15)
Age^2	-0.020**	-0.001	-0.013	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
SC\ST	0.008	-0.047*	-0.036*	-0.033
	(0.01)	(0.02)	(0.02)	(0.02)
Muslim\Christian	-0.078*	-0.006	-0.000	-0.006
	(0.04)	(0.03)	(0.02)	(0.04)
Parents' Education	YES	YES	YES	YES
Income	YES	YES	YES	YES
Obs.	9,224	6,644	6,631	6,594
Adj. R^2	0.11	0.08	0.11	0.09

Note. Robust standard errors in parentheses clustered at the state level. *Parents' Education* refers to a set of dummy variables for mother and father alike with the exclusion being no education: less than 5 years of schooling, completed only primary school, more than primary and missing parent. The regression in column 1 is calculated on the sample of 8-11 year-olds that are either out of school or enrolled in a public primary school. The regressions in columns 2-4 are calculated on the sub-sample from column 1 that took the learning test.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Appendix A. Midday Meal Implementation in Public Primary Schools

State	Implementation Date	Midday Meal Content
Andhra Pradesh	January 2003	Rice, sambhar, egg/banana twice a week
Assam	January 2005	Rice, dal, vegetables
Bihar	September 2004(Pilot) January 2005	Rice with sabji, dal, pulao, karhi or khichri
Chhattisgarh	April 2002	Rice with dal or vegetables
Gujarat	November 1984	Wheat, rice, pulses, oil, spices
Haryana	August 2004	Mitha rice, vegetbale pulao, dalia, paushtic khichri or bakli by rotation
Himachal Pradesh	September 2004	Grains, seasonal vegetables, fruit, eggs
Karnataka	July 2002(Pilot) June 2003	Rice, pulses, oil, salt, vegetables
Madhya Pradesh	July 2004	Dal-roti/dal-sabji (in wheat predominant areas) or dal-rice/dal-rice-sabji (in rice predominant areas)
Maharashtra	January 2003	Rice, dal, vegetables, spices, oil, banana/egg at least once a week
Orissa	June 2001(Pilot) September 2004	Rice, dal, egg/soya twice a week
Rajasthan	July 2002	Ghooghari (mixture of gur/jaggery and boiled wheat), dalia
Tamil Nadu	July 1982	Rice, eggs, boiled potatoes, cooked black bengal, vegetables with variation
Uttar Pradesh	September 2004	Food grains, pulses, oil, salt, spices

Uttaranchal	November 2002 - July 2003	Rice, dal, kheer, fruits and eggs alternately

The information provided in this table was drawn from state government documents listed in *a*, and then verified and cross-checked using more than one independent source listed in *b*-*e*). *Sources of information are: a.* state government documents: The National Programme of Midday Meal in Schools, Annual Work Plan and Budget, 2009-10'; *b.* planning commission: Program Evaluation Organization (2010): 'Performance Evaluation of Cooked Mid-Day Meal', Planning Commission; independent monitors: the 6 reports of the Commissioner of India on the Writ Petition 196 of 2001 (PUCL vs. Union of India and Others); *c.* independent auditors: Civil Performance Audit Reports from 2007 and 2008 of the Comptroller and Auditor General of India (for Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Kerala, Madhya Pradesh, Orissa, Uttar Pradesh, Uttaranchal); National University of Educational Planning and Administration, New Delhi, Study of best practices in: Andhra Pradesh by Y.Josephine, Assam by VPRS. Raju, Haryana by M. Narula, Karnataka by K. Srinivas, Maharashtra by S. Chugh, Orissa by S.K. Malik, Rajasthan by S. Kaushal, Uttar Pradesh by K. Wizarat; *d.* field surveys: Kumar P. and Sood T. (2005): 'Bihar: Mid-day Meal Survey Report'. Right to food campaign , Afridi F. (2005): 'Mid-day Meals: A Comparison of the Financial and Institutional Organization of the Program in Two States (Madhya Pradesh and Karnataka). Economic and Political Weekly, Robinson F. (2007) 'The Mid-Day Meal Scheme In Four Districts of Madhya Pradesh'. Jawaharlal Nehru University The Hunger Project, CUTS Center for Consumer Action, Research & Training (CART) and World Bank (2007): 'An assessment of the Mid-Day Meal Scheme in Chittorgarh District (Rajasthan)'; *e.* selected news articles and reports: Chettiparambil-Rajan A. (2007): 'India: A desk review of the Midday Meal Programme' World Food Programme, Khera R. (2006): 'Mid-Day Meals in Primary Schools: Achievements and Challenges' Economic and Political Weekly, Parikh K. and Yasmeen S. (2004): 'Groundswell for mid-day meal scheme' India Together, Dreze J. and Goyal A. (2003): 'The Future of Mid-day Meals' Economic and Political Weekly, R. Anuradha (2003): 'Nutrition Schemes in Tamil Nadu' UNDP, Khera R. (2002): 'Mid-day Meals in Rajasthan' The Hindu.