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# 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 2002-2004, we find that midday meals result in substantial increases in primary school and especially grade 1 enrollment.

*Key words and phrases.* Primary school enrollment, School lunches, Natural experiment, ITT.
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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.

This paper examines the enrollment effects of one such policy: the provision in India of a warm school lunch, or "midday meal", in government primary schools. India's midday meal scheme is the largest such program in the world. In 2006, it provided lunch to 120 million children every school day (Kingdon 2007). This paper offers, what to the best of our knowledge is, the first large-scale assessment of the enrollment effect of midday meals.

The effect of school lunches on enrollment is thought to operate through two main channels. First, school lunches lower the implicit cost of schooling. Second, by improving child nutrition, school lunches are thought to foster educational achievement. Since these channels have not previously been formalized, our first step is to do so in a very general theoretical framework. The main prediction of the model is that school lunches promote school enrollment. The objective of this paper is to empirically test this theoretical prediction. To these ends, we use a large school-level panel data set, the District Information System for Education (DISE). Our sample comprises over 500,000 primary schools in 15 major states across India, observed annually from 2002 to 2004.

Identification of a causal effect of midday meals on enrollment comes from state-level variation in the implementation of a 2001 Indian Supreme Court directive, which was instigated by public interest 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.[2] Over the subsequent three years, however, state governments across India introduced midday meals.

[1]Psacharopoulos and Patrinos (2002) estimate private returns to primary education of over 25%.
[2]A third state, Kerala, had an opt-in program.

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.

Our empirical results confirm the theoretical predictions of the model. We find that midday meals lead to large and statistically significant increases in primary school enrollment, particularly in grade 1. Our main triple difference intent to treat (ITT) estimates point to a statistically significant 5.7% increase in primary school enrollment following the introduction of midday meals, amounting to just over 17 additional students in primary school. The increase is largest in grade 1, where enrollment grows by a large and statistically significant 17.7%. For grade 2 the enrollment increase, although statistically significant in most specifications, is only half as large. The response remains positive, but is statistically insignificant and declines steadily from grades 3 to 5. (In the appendix, we provide evidence which suggests that the positive enrollment effect is driven by the implicit subsidy rather than the learning channel.)

These results are robust to a wide range of specification tests. We argue that the program timing is unlikely to be correlated with trends in enrollment outcomes, and provide robustness checks which indicate that our results are not driven by the timing of implementation. Our main results are also qualitatively similar 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.

This paper contributes to a growing literature which relies on natural experiments to assess the impact of schooling policies on schooling outcomes. (See Kremer and Glewwe (2005) for a review of this literature and Hanushek (1995) for a critique of earlier studies.) Within this 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 the variation in the policy variable.

Our paper complements a recent literature, reviewed in Bundy et al. (2009), which uses randomized trials to evaluate the effect of school feeding programs – overwhelmingly breakfasts – 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.

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 (2006) 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 5.7% primary school enrollment response we find in our data, although substantial, is considerably smaller than these estimates. Since previous studies have measured the effect of midday meal policy provision – which is likely to be an endogenous outcome at the local level – often in relatively under-developed villages, our results suggest that the problem of purposive placement may have resulted in an upward bias of these estimates.[3]

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 presents the theoretical predictions which this paper sets out to test. Section 4 describes the DISE data, and Section 5 presents our empirical strategy. Our empirical results, including specification tests and extensions are presented in Section 6, and Section 7 concludes.

## 2. Midday Meals

2.1. **Background.** In India, primary school education covers grades 1-5, and is the joint responsibility of central and state governments. The central government typically 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

[3]Our enrollment results are not directly comparable with Afridi (2007) who studies the effect of midday meal provision on attendance rather than enrollment using an empirical strategy which is similar to ours for 41 Madhya Pradesh villages. Interestingly, however, her estimates provide a similarly muted assessment of the impact of midday meals on school attendance.

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. Most other states provided "dry rations" of raw wheat or rice grains (depending on local consumption habits) to enrolled children.

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.[4] In April, 2001 the People's Union for Civil Liberties (PUCL), Rajasthan, submitted a writ petition to 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."[5] 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.[6] The petition has culminated in protracted public interest litigation which is yet to be concluded.[7]

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).

[4]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.

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

[6]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."

[7]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.

In this case, state governments were responsible for introducing midday meals.[8] To examine the effects of this policy change on schooling outcomes, we gathered information from press reports, Supreme Court commissioner reports, and state government documents regarding when states introduced universal midday meals in public schools.

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 and year in which the corresponding state is documented to have introduced a midday meal. Note that this captures the reported time of midday meal scheme implementation, and not whether midday meals were in fact on the ground in every public school in the state. Since, as we elaborate in Section 4, enrollment figures are recorded as on 30th September of any given year, we regard a state as having instituted a midday meal policy if (reported) 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.[9] 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, there is no obvious geographic pattern to the implementation of the midday meal scheme. As the initial 6-month deadline set by the Supreme Court was without exception breached, Supreme Court commissioners, the media and activists (most notably the Right to Food Campaign) started putting

[8]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.

[9]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.

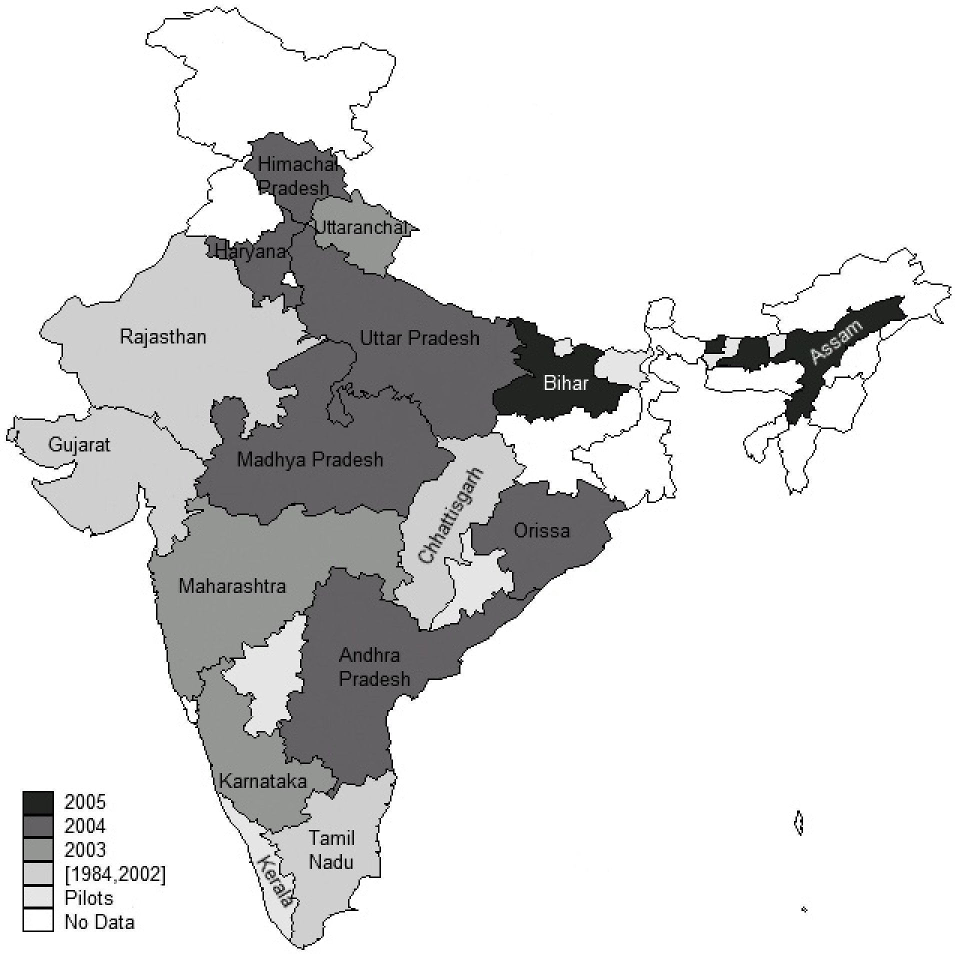


FIGURE 1. Map of Covered States and Pilot Regions, India

pressure on state governments and it was this pressure which compelled states to comply with the Supreme Court directive (Sharma et al. 2006). Hence the reasons for, and the timing of, states' introduction of midday meals over our observation period (2002-2004) were idiosyncratic.

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.[10] 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.[11] Day-to-day operations lie in the hands of local government bodies, 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 whom 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. 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 Drèze and Goyal (2003) and PROBE (1999)).

## 3. Enrollment Effect of Midday Meals: Theory

School lunches are thought to promote primary school enrollment through two main channels (see PROBE (1999), Drèze and Goyal (2003) and Kremer and Vermeersch (2004)). First, they act as an implicit subsidy to families: a meal provided at school relieves families of the need to provide this food to their child. Second, by alleviating classroom hunger and improving child nutrition, school lunches are thought to improve

[10]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.

[11]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 2004) both contributed Rs. 1 per child per day towards cooking costs in 2005, whereas Uttar Pradesh, which implemented at the same time as Andra Pradesh, contributed little towards cooking costs (Secretariat of the Right to Food Campaign 2005).

learning. This translates into a more engaging classroom experience for children, and potentially higher returns to schooling.

In the following, we present a general formalization of these channels to derive a theoretical prediction of the midday meal effect on enrollment. This exercise also reveals that an additional sufficiency condition is needed for the intuition provided above to go through.

Consider an economy with $N$ households, each of which comprises one primary-school-aged child. There is a unique consumption good $c \in \Re^+$, whose price is set to one. Parents in each household make a school enrollment decision $s \in \{0, 1\}$, where $s = 1$ when the child is enrolled in school and $s = 0$ when not. The enrollment decision is conditional on midday meal provision $m \in \{0, 1\}$, where $m = 1$ indicates that a midday meal is provided in the local public school and $m = 0$ indicates that it is not. Both $m$ as well as child, household and local characteristics $\mathbf{Z}$ are taken as exogenous.

Denote household income net of child food expenditure by $I(s\,; m, \mathbf{Z})$ and let parental utility be denoted by $U(c, s\,; m, \mathbf{Z})$. We place weak assumptions on this utility function, assuming only that:

**C1:** $U(c, s\,; m, \mathbf{Z})$ is non-decreasing in $c$.

The parents' problem is to maximize utility subject to a budget constraint:

$$
\begin{aligned}
\max_{c,s} \quad & U(c, 1\,; m, \mathbf{Z}) \\
\text{s.t.} \quad & c \leq I(s\,; m, \mathbf{Z})
\end{aligned}
\tag{3.1}
$$

Our core assumptions, which capture the two channels through which school lunches are thought to promote enrollment, are codified in the following two conditions:

**IS:** $I(1; 1, \mathbf{Z}) \geq I(1; 0, \mathbf{Z})$
**LE:** $U(c, 1\,; m, \mathbf{Z})$ is non-decreasing in $m$.

The Implicit Subsidy (IS) condition states that for a household whose child is enrolled in school, the introduction of a midday meal cannot lower income net of child food expenditure. This condition is easily satisfied if school lunches even partially crowd out household spending on food for an enrolled child.[12] The Learning Effect (LE) condition states that the introduction of a midday meal cannot make a child who is enrolled in school worse off. It captures the idea that increased learning associated

[12]Afridi (2010) provides corroborative evidence that this condition is likely to be satisfied in a sample of Madhya Pradesh households.

with lunches consumed at school may enhance the child's joy of school and/or future earnings.

Assumptions (IS) and (LE) formalize, in a rather general way, the two main channels the literature has advanced so far to characterize the effect of midday meals on enrollment. However, these assumptions are not sufficient to explain the direction of the midday meal effect. If school policies targeted at enrolled children have strong positive externalities for non-enrolled children, this may induce parents of enrolled children to withdraw their children from school. For school feeding programs, it seems reasonable to assume that there are No Positive Externalities (NPE) associated with midday meals for out-of-school children,[13] at least in the short-run, and this is codified in our final assumption:

**NPE:** $U(c, 0\,;\, m, \mathbf{Z})$ and $I(0\,;\, m, \mathbf{Z})$ are non-increasing in $m$.

In the following we establish that, under assumptions (C1), (IS), (LE) and (NPE), enrollment increases with the introduction of midday meals. We show this result at the household and then at the school level.

Note first that since the utility is non-decreasing in consumption, Equation (3.1) is equivalent to

$$\max_s V(s\,;\, m, \mathbf{Z}) \tag{3.2}$$

where,

$$V(s\,;\, m, \mathbf{Z}) \equiv U(I(s\,;\, m, \mathbf{Z}), s\,;\, m, \mathbf{Z}). \tag{3.3}$$

Denote then by $s^*(s\,;\, m, \mathbf{Z})$ the optimal enrollment decision which maximizes (3.3), such that

$$s^*(m, \mathbf{Z}) = 1 \Leftrightarrow V(1\,;\, m, \mathbf{Z}) \geq V(0\,;\, m, \mathbf{Z}). \tag{3.4}$$

The following theorem states that midday meals give households an incentive to enroll their child in school.

**Proposition 3.1.** $s^*(m, \mathbf{Z})$ *is non-decreasing in* $m$.

**Proof:** Without loss of generality we drop notation $\mathbf{Z}$ and consider $I(s\,;\, m)$, $U(c, s\,;\, m)$, $V(s\,;\, m)$ and $s^*(m)$.

---

[13]This rules out second order effects of midday meals, such as improved health of non-enrolled children as a result of interactions with now-healthier enrolled children, or higher wages of non-enrolled children due to a contraction in the supply of child labor.

From Equation (3.4), $s^*(m)$ is non-decreasing in $m$ if $V(s\,;\,m)$ is supermodular[14] in $s$ and $m$, that is

$$V(1;1) - V(0;1) \geq V(1;0) - V(0;0) \tag{3.5}$$

We first show that $-V(0;1) \geq -V(0;0)$. From (NPE), we have $I(0;1) \leq I(0;0)$ so that,

$$\begin{aligned} I(0;1) \leq I(0;0) \quad &\Rightarrow \quad U(I(0;1),0;1) \leq U(I(0;0),0\,;\,1) \\ &\Rightarrow \quad U(I(0;1),0;1) \leq U(I(0;0),0\,;\,0) \\ &\Leftrightarrow \quad V(0;1) \leq V(0;0) \end{aligned} \tag{3.6}$$

where the first equation holds from the monotonicity of $U(c,0\,;\,1)$ in $c$ from (C1), the second equation from (NPE) and the last one by definition of $V(s;m)$.

On the other hand, we have

$$V(1;1) \geq V(1;0) \quad \Leftrightarrow \quad U(I(1;1),1;1) \geq U(I(1;0),1\,;\,0) \tag{3.7}$$

Equation (3.6) holds since $U(c,1\,;\,m)$ is non-decreasing in $c$ from (C1), and in $m$ from (LE), where $I(1,1) \geq I(1,0)$ from (IS). Finally, Equations (3.6) and (3.7) imply (3.5). ■

Since this result is rather general, the model can be directly applied to numerous potentially discrete school policy variables, such as school uniforms or books, which satisfy the NPE, IS, and LE conditions. Proposition 3.1 is, however, less likely to be readily applicable to schooling interventions such as vaccination or other infectious-disease prevention programs, which may be characterized by large positive externalities thereby violating the NPE condition.[15]

It is worth noting that (IS), (LE) and (NPE) are sufficient conditions for the result to hold; enrollment may still increase if the positive externalities are not too large compared to the implicit subsidy and learning effects. On the other hand, in the absence of externalities, school enrollment does not increase when neither (IS) nor (LE) are satisfied.

[14]See Topkis (1998) for a general treatment of supermodular functions. To see why (3.5) is sufficient to show the result in our context, note that $s^*(0,\mathbf{Z}) = 1 \Leftrightarrow V(1\,;\,0,\mathbf{Z}) - V(0\,;\,0,\mathbf{Z}) \geq 0$ which implies, if (3.5)) holds, that $V(1\,;\,1,\mathbf{Z}) - V(0\,;\,1,\mathbf{Z}) \geq 0 \Leftrightarrow s^*(1,\mathbf{Z}) = 1$.

[15]The presence of treatment externalities with school health interventions is well recognized in the literature. See Miguel and Kremer (2004) for a recent example.

As we discuss in more detail in Section 4, our main results exploit a primary school-level data set. In order to test the theoretical predictions of our household decision model using these aggregate enrollment data, consider the probability distribution of $\mathbf{Z}$ and the corresponding expectation operator $\mathbb{E}(\cdot)$. We referred to $N(1)$, the total number of children enrolled in school, such that $N(1) = \mathbb{E}(s(1;\mathbf{Z}))$. The number of non-enrolled children, $N(0)$, is therefore equal to $N(0) = \mathbb{E}(s(0;\mathbf{Z}))$ where $N(0) + N(1) = N$.

The next result establishes that enrollment at the school-level increases with midday meals,

**Theorem 3.2.** $N(1) \geq N(0)$

**Proof:** The result comes from Theorem 3.1 and the fact that operator $\mathbb{E}(\cdot)$ preserves monotonicity.■

The primary objective of the paper is to empirically verify Theorem 3.2.

## 4. 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 that came into being particularly 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).

Variable definitions are nationally standardized as DISE is used at the national and state level for education policy management. Data reliability is achieved through consistency and validation checks at the district level. The school headmaster answers the school survey questionnaire, which includes questions on enrollment figures in each grade and on schooling inputs (such as physical infrastructure and staff). The data is collected annually and reflects enrollment as on September 30th of the respective year.

We exploit a three year balanced panel of 506,125 schools over the academic years 2002/03 to 2004/05 (referred to hereafter as 2002 - 2004).[16] 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 distribution of public schools in our sample closely follows the state population distribution; Using a t-test, we are unable to reject the null hypothesis of 0 difference in means.

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 (documented, among others, in PROBE (1999)).

Table 3 furnishes means of enrollment and of schooling inputs, which are also surveyed annually in DISE and 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), and 5 blackboards. 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. In our estimations, we control for these inputs and also create a matched sample based on these observable schooling characteristics.

[16]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.

## 5. Empirical Strategy

5.1. **Approach.** To study the impact of the midday meal policy on primary school enrollment, we exploit the variation created by their staggered introduction in public primary schools throughout India.[17] 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 the appendix, 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).[18] 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:

$$Y_{ist} = \gamma_t + \lambda_s + \alpha Pub_i + \delta_1(Pub_i \cdot \lambda_s) + \delta_2(Pub_i \cdot \gamma_t) + \delta_3(\lambda_s \cdot \gamma_t) + \beta(m_{st} \cdot Pub_i) + \epsilon_i, \quad (5.1)$$

where $Y_{ist}$ is the log of enrollment, for school $i$, in state $s$, at time $t = 2002, 2003, 2004$. It corresponds to $log(N)$ in Theorem 3.2, and in different specifications it pertains to enrollment in grades 1-5 separately, as well as total primary school enrollment.

National trends in enrollment are captured through year fixed effects, $\gamma_t$. State fixed effects, $\lambda_s$, account for enrollment differences across states. The dummy variable $Pub_i$, 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

[17]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.

[18]This exposition follows the description in Gruber (1994).

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 permits 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 trends in economic development (including population growth) across states are varied.

The variable $m_{st}$ in Equation (5.1) corresponds to the variable $m$ in the theory model. It 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 $\beta$ 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.

5.2. **Identifying Assumptions.** 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 6.2.2 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 hopes 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 (5.1). 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. Two additional difference-in-differences, estimated separately for public and private schools, indicates such confounding changes were absent in both the treatment and control groups.

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. In Section 2 we argued that the timing of midday meal introduction was idiosyncratic. However, there may 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.

Literacy Rates by Year of Implementation, Census of India

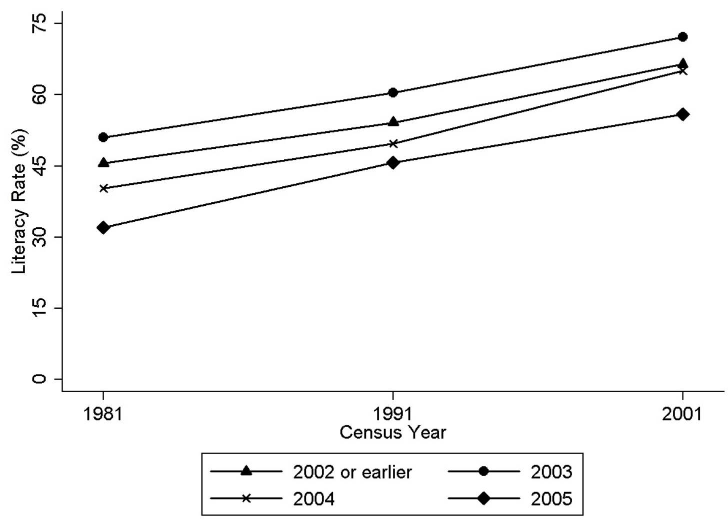


FIGURE 2. *Note.* States are grouped according to timing of implementation. "2002 or earlier" refers to Chhattisgarh, Gujarat, Tamil Nadu and Rajasthan; "2003" refers to Karnataka, Maharasthra and Uttaranchal; "2004" refers to Andhra Pradesh, Haryana, Himachal Pradesh, Mahdya Pradesh, Orissa and Uttar Pradesh; "2005" refers to Assam and Bihar. However, it is important to note that Chhattisgarh and Uttaranchal gained statehood only in 2000; before they were part of Madhya Pradesh and Uttar Pradesh, respectively, and therefore their literacy results for 1981 and 1991 are included in the "2004" group.

Figure 5.2, 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. Our specification tests show, moreover, that the main results are robust to the exclusion of early and/or late implementers.

It is important to acknowledge that there exist observable differences in schooling inputs between public and private schools (see for example Muralidharan and Kremer (2006) and Kingdon (2007)).[19] We account for this in two ways. First, we extend

[19]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

the empirical model described in Equation (5.1) to include a vector of potentially time-varying school-level inputs $\mathbf{X}_{it}$. This alleviates concerns of omitted variable bias. However, it may not be enough in the context of our identification strategy, if the characteristics which differentiate private and public schools are also associated with different trends in enrollment between the two groups within a given state.

We account for this possibility through a second specification test wherein our triple difference estimation is applied to a matched sample of public and private schools, obtained through propensity score matching.[20] The goal is to find a group of private schools that is as 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 schooling inputs, listed in Table 3, from the base year 2002. In the common support region, for each public school we find a comparison private school located in the same state with the closest propensity score. The propensity score matching is done to the first nearest neighbor with replacement (private schools can be used as matches multiple times), which has been shown to reduce bias relative to matching without replacement (Dehejia and Wahba 2002). Unmatched schools are discarded and not used in estimating the treatment impact.[21]

## 6. Results

### 6.1. **Main Results.**

We begin by estimating Equation (5.1) using pooled OLS. Table 4 presents our main result: the triple difference estimate $\beta$, which captures the effect of midday meals (MDM=$m_{st} \cdot Pub_i$) on school enrollment. Each column represents a different regression, and in each case controls for all the variables mentioned in Equation (5.1) are included (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.[22] Following Bertrand, Duflo, and Mullainathan (2004), in

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.

[20]The matching method that we use follows the recommendations of Dehejia and Wahba (2002).

[21]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).

[22]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.

this and all subsequent tables, standard errors clustered at the state level are presented in parentheses.

The positive coefficients for $\beta$ in row 1 confirm the theoretical prediction of the model: midday meals increase primary school enrollment. The response is largest in grade 1 (column 1), where enrollment increases by a large and statistically significant 17.7%.[23] The point estimate for $\beta$ for grade 2, although economically and statistically significant, is half as large. 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 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 5.7% increase in primary school enrollment (column 6). The level results (not reported) underscore the economic significance of this percentage increase: it corresponds to 17.6 additional students in primary school, just over 10 of whom join grades 1 and 2.[24]

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

6.2.1. *School-level Heterogeneity.* We begin by extending the model presented in Equation (5.1) to account for omitted variable bias, by including a vector of potentially time-varying schooling inputs $\mathbf{X}_{it}$, summarized in Table 3. Table 5 presents the results for the extended model. The coefficient estimates on the schooling inputs are consistent with our priors: more classrooms, teachers, other staff, blackboards, and physical infrastructure are associated with higher enrollment.

The pattern of the triple difference estimates closely resemble our main results described in Section 6.1. Enrollment effects are statistically significant and largest in grades 1 and 2. They remain positive but are statistically insignificant and declining steadily from grades 3 to 5. The estimates for $\beta$ in row 1 of Table 5 suggest, moreover, that our basic triple difference estimates in Table 4 may represent a lower bound on the true effect of midday meals. However, these results need to be treated with caution since, to the extent that schooling inputs are endogenous, all the coefficients in this table will be biased.

[23]This and other percentage increases in enrollment following from the binary explanatory variable, MDM, are calculated in the following manner: $0.177 = exp(0.163) - 1$.

[24]The level results closely resemble the log results in table 6.1, suggesting that this main result is not sensitive to functional form.

Although our results are robust to the inclusion of schooling inputs and our research design allows for different enrollments at the state level between public and private schools, 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 runs the triple difference estimation on the matched sample of public and private schools described earlier. Unsurprisingly, doing so leads to less variation in the data so, with the exception of grade 1, the coefficient estimates are statistically insignificant. (Grade 2 enrollment responses are significant at the 12% level.) However, the pattern of the triple difference effects across different grades in this table is strikingly similar to that in Table 4. The point estimates are only slightly lower for grades 1 and 2 and primary school as a whole, but none of these differences are statistically significant.

Together these robustness checks alleviate concerns that unobserved heterogeneity across (private and public) schools is driving our main results.

6.2.2. *Confounding Changes.* As mentioned in Section 2, 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 public and private schools 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 primary aims were to provide primary school access for all children, reduce dropout rates, increase learning achievements, and reduce gender and caste gaps (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.

The SSA, aimed at the 6-14 age group, has the similar aim of achieving universal enrollment, bridging gender and caste gaps, achieving universal retention and improving education quality.[26] To the extent that it was launched in 2001, at the same time in all states, any difference in enrollment outcomes in the treatment group cannot be attributed to the introduction of the scheme as a whole.

[25]See World Bank (2003) for a review of the evidence regarding the impact of this program.
[26]see http://ssa.nic.in/

Nevertheless, these programs may have induced changes in some schooling inputs at the state level, thereby violating our main identifying assumption outlined in Section 5.2. We examine this possibility by estimating a triple difference with different schooling inputs (instead of enrollment) on the left hand side of Equation ((5.1)).

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, $\phi$, from the following model:

$$Q_{ist} = \lambda_s + \gamma_t + \phi m_{st} + \epsilon_i, \tag{6.1}$$

where $\lambda_s$, $\gamma_t$, and $m_{st}$ are defined as in Equation (5.1), 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 indicate 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.

6.2.3. *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 4 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 (6.1), 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 $\phi$.

Table 8 indicates that this is not the case. The double difference estimate is always statistically insignificant and, pertinently, close to 0. This allays fears of contamination and provides further validation for the use of private schools as a control group in the triple difference model.

6.2.4. *Alternative Samples.* 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 which 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 (5.1) on four different samples of public and private schools: without the early implementers Tamil Nadu and Gujarat (top quarter), without the late implementers Assam and Bihar (second quarter) and without either of these states (third quarter). In each case, the results are qualitatively similar to those in Table 4, although the point estimate for total enrollment is lower and we lose some variation in the data when early implementers are omitted from our sample. In general, this table suggests that our main results – particularly the substantial statistically significant increase in grade 1 enrollment – are not being driven by differential trends in enrollment associated with the timing of implementation.

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 of the 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.

Finally, when we exclude one state at a time from the sample, our results are also unchanged (results not reported). Together, these robustness checks suggest that our results are not driven by any one state, or by a correlation between the timing of implementation and trends in enrollment.

6.2.5. *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 4. 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.

## 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 5.7%, with the largest and most robust increase coming from grade 1 enrollment, which rose by 17.7%. Enrollment in grades 3 to 5 is, 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 in upper primary school.

Our estimates suggest that midday meals may be a cost-effective means of increasing enrollment. The enrollment response associated with midday meals is, for instance, comparable to that of having one additional teacher. 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 month.[27] This amounts to approximately 85% of the typical public school teacher's salary of approximately Rs. 7,500.[28]

Our theoretical model formalized two main channels through which midday meals promoted enrollment – the implicit subsidy effect and the learning effect. Unfortunately, the DISE data do not allow us to distinguish between which of these channels is at work. In Appendix A, we analyze data from a household survey, the Indian Human Development Survey (IHDS), which in addition to demographic and enrollment data, has information regarding the provision of midday meals at local public schools, as well as test scores for reading, math, and writing for 8- to 11-year-olds in the sample.

[27]The Rs. 3.21 is likely to be an upper bound for the average cost in most states. This figure comes from 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; $6400 \approx [(120 \text{ students}) \text{ X } (\text{Rs. } 3.21 \text{ per student}) \text{ X } (200 \text{ days})]/12$

[28]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.

The IHDS data corroborate our main findings from DISE, namely that the provision of a midday meal is positively associated with enrollment. At the same time, there is no evidence of a positive learning effect. Since midday meals are associated with higher enrollment but not increased learning, the theory suggests that the implicit subsidy channel is driving the former result.

Given the wide coverage of the data we exploited in this paper, we believe that the results we present here are 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 enrollment rates – particularly in early primary school where the effects we observe in our data are largest – are already close to 100%. 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.

Table 1. Sample of states and time of implementation

| **State Name** | **Implementation** | **Treatment Year** |
|---|---|---|
| Andhra Pradesh | November 2003 | 2004 |
| Assam* | April 2005 | 2005 |
| Bihar* | January 2005 | 2005 |
| Chhattisgarh | April 2002 | 2002 |
| Gujarat | November 1985 | 1986 |
| Haryana | April 2004 | 2004 |
| Himachal Pradesh | September 2004 | 2004 |
| Karnataka* | June 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. t-test fails to reject the null hypothesis of 0 difference in means between the population and the public school distribution.

TABLE 3. Means of variables

| | |
|---|---|
| *Enrollment*[a] | |
| Grade 1 | 33.27 |
| | (38.12) |
| Grade 2 | 26.40 |
| | (30.05) |
| Grade 3 | 24.19 |
| | (27.87) |
| Grade 4 | 21.27 |
| | (25.42) |
| Grade 5 | 19.12 |
| | (26.10) |
| Primary school | 124.25 |
| | (130.61) |
| *Schooling Inputs*[b] | |
| Number of classrooms | 3.38 |
| | (3.12) |
| Number of other rooms | 1.01 |
| | (1.74) |
| Number of teachers | 1.91 |
| | (1.99) |
| Number of other staff | 0.45 |
| | (1.16) |
| Number of blackboards | 4.62 |
| | (4.21) |
| Dummy for playground | 0.53 |
| | (0.50) |
| Dummy for electricity | 0.23 |
| | (0.42) |
| Dummy for water | 0.83 |
| | (0.37) |
| Dummy for girls' toilet | 0.29 |
| | (0.45) |
| Dummy for common toilet | 0.42 |
| | (0.49) |

*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*: 1,524,967 *b*: 1,400,743.

Table 4. Triple Difference: Primary School Enrollment

| | (1) Grade 1 | (2) Grade 2 | (3) Grade 3 | (4) Grade 4 | (5) Grade 5 | (6) Primary |
|---|---|---|---|---|---|---|
| MDM ($\beta$) | 0.163*** | 0.081* | 0.065 | 0.055 | 0.028 | 0.055* |
| | (0.053) | (0.041) | (0.046) | (0.048) | (0.047) | (0.029) |
| 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 brackets 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 unaided 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 5. Triple Difference: Primary School Enrollment with Covariates

| | (1) Grade 1 | (2) Grade 2 | (3) Grade 3 | (4) Grade 4 | (5) Grade 5 | (6) Primary |
|---|---|---|---|---|---|---|
| MDM ($\beta$) | 0.234*** | 0.147** | 0.127 | 0.108 | 0.084 | 0.136* |
| | (0.043) | (0.060) | (0.097) | (0.103) | (0.106) | (0.064) |
| Classrooms | 0.077*** | 0.077*** | 0.080*** | 0.084*** | 0.085*** | 0.081*** |
| | (0.011) | (0.011) | (0.012) | (0.012) | (0.011) | (0.011) |
| Other rooms | 0.003 | 0.004 | 0.005 | 0.007* | 0.009*** | 0.001 |
| | (0.004) | (0.004) | (0.003) | (0.003) | (0.003) | (0.003) |
| Teachers | 0.094*** | 0.100*** | 0.102*** | 0.103*** | 0.095*** | 0.107*** |
| | (0.015) | (0.014) | (0.014) | (0.013) | (0.010) | (0.014) |
| Other staff | 0.049** | 0.048** | 0.051** | 0.049** | 0.045** | 0.044* |
| | (0.020) | (0.020) | (0.021) | (0.021) | (0.020) | (0.021) |
| Blackboards | 0.018*** | 0.020*** | 0.022*** | 0.023*** | 0.023*** | 0.023*** |
| | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) |
| Playground | 0.040 | 0.040* | 0.041* | 0.040* | 0.031* | 0.041* |
| | (0.023) | (0.021) | (0.021) | (0.020) | (0.016) | (0.020) |
| Electricity | 0.109*** | 0.128*** | 0.140*** | 0.155*** | 0.150*** | 0.133*** |
| | (0.024) | (0.026) | (0.029) | (0.029) | (0.033) | (0.033) |
| Water | 0.042* | 0.049** | 0.059** | 0.069** | 0.086*** | 0.072*** |
| | (0.021) | (0.021) | (0.024) | (0.026) | (0.028) | (0.024) |
| Girls' toilet | 0.033** | 0.043** | 0.044** | 0.048** | 0.045** | 0.038** |
| | (0.014) | (0.016) | (0.016) | (0.016) | (0.019) | (0.016) |
| Common toilet | 0.042*** | 0.067*** | 0.073*** | 0.079*** | 0.088*** | 0.072*** |
| | (0.010) | (0.010) | (0.011) | (0.013) | (0.018) | (0.010) |
| Obs. | 1,239,682 | 1,231,836 | 1,223,360 | 1,205,921 | 1,077,901 | 1,256,317 |
| Adj. $R^2$ | 0.42 | 0.40 | 0.38 | 0.36 | 0.33 | 0.45 |

*Note.* Robust standard errors in brackets 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 is as in Table 4.

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

Table 6. Triple Difference: Primary School Enrollment on Matched Sample

| | (1) Grade 1 | (2) Grade 2 | (3) Grade 3 | (4) Grade 4 | (5) Grade 5 | (6) Primary |
|---|---|---|---|---|---|---|
| MDM ($\beta$) | 0.159*** | 0.067 | 0.055 | 0.038 | 0.006 | 0.042 |
| | (0.048) | (0.041) | (0.048) | (0.049) | (0.054) | (0.033) |
| Obs. | 1,155,818 | 1,148,624 | 1,140,614 | 1,124,415 | 1,004,894 | 1,170,605 |
| Adj. $R^2$ | 0.28 | 0.23 | 0.19 | 0.14 | 0.13 | 0.23 |

*Note.* Robust standard errors in brackets 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. From the sample in Table 4 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 used in Table 5, 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) Otherstaff | (5) Electricity | (6) Water | (7) Girls'toilet | (8) Ctoilet | (9) Blackboards | (10) Playground |
|---|---|---|---|---|---|---|---|---|---|---|
| **Triple Difference[a]** | | | | | | | | | | |
| MDM ($\beta$) | -0.375 | -0.176 | -0.265 | -0.055 | -0.001 | -0.014 | -0.013 | -0.023 | 0.036 | -0.010 |
| | (0.398) | (0.240) | (0.220) | (0.181) | (0.014) | (0.015) | (0.017) | (0.025) | (0.388) | (0.014) |
| Obs. | 1,524,967 | 1,524,967 | 1,509,543 | 1,509,523 | 1,486,757 | 1,469,257 | 1,477,564 | 1,480,326 | 1,524,967 | 1,482,037 |
| Adj. $R^2$ | 0.19 | 0.05 | 0.10 | 0.10 | 0.29 | 0.09 | 0.17 | 0.15 | 0.17 | 0.08 |
| **Double Difference: Public School Inputs[b]** | | | | | | | | | | |
| MDM ($\phi$) | 0.065 | -0.010 | 0.057 | 0.069 | 0.004 | 0.001 | 0.014 | 0.028 | -0.091 | -0.010 |
| | (0.061) | (0.025) | (0.036) | (0.063) | (0.008) | (0.022) | (0.016) | (0.025) | (0.072) | (0.008) |
| Obs. | 1,421,182 | 1,421,182 | 1,408,537 | 1,408,520 | 1,385,616 | 1,368,955 | 1,377,468 | 1,379,866 | 1,421,182 | 1,382,550 |
| Adj. $R^2$ | 0.07 | 0.03 | 0.08 | 0.08 | 0.22 | 0.07 | 0.12 | 0.12 | 0.13 | 0.06 |
| **Double Difference: Private School Inputs[c]** | | | | | | | | | | |
| MDMstate ($\phi$) | 0.503 | 0.165 | 0.316 | 0.156 | 0.001 | -0.009 | 0.007 | 0.032 | -0.137 | -0.007 |
| | (0.434) | (0.247) | (0.221) | (0.224) | (0.007) | (0.009) | (0.013) | (0.041) | (0.437) | (0.013) |
| Obs. | 103,785 | 103,785 | 101,006 | 101,003 | 101,141 | 100,302 | 100,096 | 100,460 | 103,785 | 99,487 |
| Adj. $R^2$ | 0.18 | 0.07 | 0.07 | 0.13 | 0.13 | 0.05 | 0.05 | 0.03 | 0.18 | 0.03 |

*Note.* Robust standard errors in brackets 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 4. Regressions *b* are run on the sub-sample from *a* which includes only public schools. Regressions *c* are run on the sub-sample from *b* 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 ($\phi$) | 0.018 | -0.007 | -0.009 | -0.006 | -0.037 | 0.006 |
| | (0.049) | (0.029) | (0.035) | (0.030) | (0.030) | (0.033) |
| 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 brackets 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 Early Implementers[a] | | | | | | |
| MDM ($\beta$) | 0.161** | 0.060 | 0.036 | 0.023 | -0.007 | 0.033 |
| | (0.064) | (0.051) | (0.037) | (0.040) | (0.032) | (0.024) |
| 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 Late Implementers[b] | | | | | | |
| MDM ($\beta$) | 0.163*** | 0.081* | 0.066 | 0.056 | 0.028 | 0.054* |
| | (0.053) | (0.041) | (0.046) | (0.048) | (0.048) | (0.029) |
| 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 or Late Implementers[c] | | | | | | |
| MDM ($\beta$) | 0.161** | 0.060 | 0.037 | 0.024 | -0.008 | 0.033 |
| | (0.065) | (0.052) | (0.037) | (0.040) | (0.032) | (0.024) |
| 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 ($\beta$) | 0.160*** | 0.080* | 0.065 | 0.051 | 0.028 | 0.059* |
| | (0.051) | (0.039) | (0.045) | (0.047) | (0.045) | (0.029) |
| 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 brackets 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 4 new samples are created in the following way: In regressions *a* Tamil Nadu and Gujarat are excluded; In regressions *b* Assam and Bihar 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 ($\beta$) | 0.187*** | 0.080* | 0.051 | 0.045 | 0.024 | 0.063** |
| | (0.060) | (0.039) | (0.052) | (0.045) | (0.047) | (0.027) |
| 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 ($\beta$) | 0.145*** | 0.086* | 0.082* | 0.075 | 0.041 | 0.051 |
| | (0.048) | (0.043) | (0.041) | (0.046) | (0.037) | (0.031) |
| 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 brackets 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 4.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

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## Appendix A. Learning Effects Using Household Data

The theory model presented in Section 3 suggests two main channels through which midday meals promote enrollment. It is difficult to empirically disentangle which of these channels is at work. We are unable to directly test the implicit subsidy (IS) channel due to data limitations. However, data from the Indian Human Development Survey (IHDS) 2005 give us an opportunity to explore whether there is some corroborative evidence for the presence of a learning effect (LE).

IHDS 2005 is a nationally representative survey conducted in 41,554 households 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. Detailed questions are asked about education, household and individual characteristics. In each village and urban neighborhood up to two randomly selected primary schools are asked if midday meals are being served. Moreover, reading, writing and arithmetic skills of currently enrolled children aged 8 - 11 are evaluated.

Our sample comprises children between 8 and 11 years of age who are either out of school or currently enrolled in a public primary school. Table 11 presents summary statistics. The variable labeled MDM captures whether (MDM=1) or not (MDM=0) a midday meal is provided in a local public school in the primary sampling unit (PSU, which is typically the village, or the neighborhood in the case of urban areas). The table indicates that 77% of children in this age group have access to a midday meal offered at a local public school. On average, 88% of the children are currently enrolled; 49% belong to an upper caste (i.e. non-SC ST) and 36% are either Scheduled Castes or Scheduled Tribes (SC ST). The vast majority of children come from households where parents have completed 5 years of schooling or less.

Three dummy variables, *Reading*, *Math* and *Writing*, are constructed to capture learning. Of the children who were administered learning tests, 73% can read at least words. 41% of the children that took the math test can solve at least a simple addition problem and 62% can write a simple sentence with at most one mistake.

We use these data to estimate the following individual linear probability model:[29]

$$l_{ihj} = \lambda m_j + \nu Z_{ih} + \epsilon \tag{A.1}$$

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.

[29]Probit estimations produce qualitatively identical results.

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 $m_j$ indicates whether midday meals are served in public primary schools from PSU $j$ ($m_j = 1$) or not ($m_j = 0$); $Z_{ih}$, contains a vector of individual characteristics such as gender and age, and household characteristics including caste and parents' education; $Z_{ih}$ corresponds to $\mathbf{Z}$ from the theory model presented in Section 3.

In contrast to our empirical strategy using DISE's panel data structure, here 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, 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. Instead, we exploit the variation created by compliance at the PSU level. This means that causality cannot be attributed, so the following estimation results should be viewed as correlations.

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 88 who either non-enrolled or are 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. Almost twice the size of our estimates for primary school as a whole using DISE data, this coefficient is similar in magnitude to the results obtained in other midday meal studies reviewed in Section 1.

The dependent variable in Columns 2-4 are dummy variables indicating the 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 estimates are statistically insignificant and close to zero in each of the three categories. Since midday meals are associated with higher enrollment but not increased learning, the theory suggests that the implicit subsidy channel is driving the result.

TABLE 11. IHDS: Means of Selected Variables

| | |
|---|---|
| MDM | 0.77 |
| | (0.42) |
| *Dependent Variables* | |
| Currently enrolled | 0.88 |
| | (0.33) |
| Reading | 0.73 |
| | (0.44) |
| Math | 0.41 |
| | (0.49) |
| Writing | 0.62 |
| | (0.48) |
| *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. 9,228 observations. Only children enrolled in school were administered the learning tests, therefore the means for reading, math and writing are calculated on a sample of 6,917 observations.

TABLE 12. OLS: Learning and Enrollment

| | (1) Enrollment | (2) Reading | (3) Math | (4) Writing |
|---|---|---|---|---|
| MDM ($\lambda$) | 0.108*** | -0.004 | 0.009 | 0.001 |
| | (0.03) | (0.04) | (0.04) | (0.05) |
| Male | 0.040* | 0.053* | 0.072** | 0.039* |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Age | 0.368* | 0.058 | 0.311 | 0.258 |
| | (0.14) | (0.13) | (0.17) | (0.14) |
| Age$^2$ | -0.020** | 0.000 | -0.012 | -0.011 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| SC\ST | 0.008 | -0.042 | -0.034 | -0.031 |
| | (0.01) | (0.02) | (0.02) | (0.02) |
| Muslim\Christian | -0.078* | -0.006 | 0.002 | -0.005 |
| | (0.04) | (0.03) | (0.02) | (0.04) |
| Parents' Education | YES | YES | YES | YES |
| Income | YES | YES | YES | YES |
| Obs. | 9224 | 6457 | 6444 | 6407 |
| Adj. $R^2$ | 0.11 | 0.08 | 0.11 | 0.08 |

*Note.*Robust standard errors in brackets clustered at the state level. $Parent'sEducation$ 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. *Income* includes the income figure in Rupees divided by 10,000 as well as the square of this figure. The regressions in columns 2-4 are calculated on the sample of 8-11 year-olds enrolled in public schools that took the learning test. 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.

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