Ramadan School Holidays as a Natural Experiment: Impacts of Seasonality on School Enrollment in Bangladesh

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ABSTRACT School academic calendar not accommodating the agricultural cycles may hamper the educational outcomes and may leads to dropouts for agrarian economies. In Bangladesh, the *Aman* paddy harvesting season typically coincides with the annual final exam schedules of schools in December. However, in the year 1999, Ramadan school vacation was in December which forced schools to pre-pone their final exam schedules in November, which was the month before the harvest begins. "Ramadan in the year 1999" is a natural experiment that reduced the labour demand for children during the exam period. Using household level panel data of 1999 and 2002, and after controlling for various unobservable variations including individual fixed effects, aggregate year effects, and subdistrict-level year effects, this paper finds evidence of statistically significant impacts of seasonal labour demand on school dropout in Bangladesh among the children from agricultural households. The results shown in this paper can provide foundation for reconsidering the school calendar that is consistent with agrarian calendar and seasonal local labor market conditions.
KEYWORDS: Dropout, child labor, seasonal labor demand, school calendar, Ramadan
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1 Introduction

Bangladesh is aiming to achieve the two Millennium Development Goals (MDGs) related to education by 2015, one of which is to ensure the primary education for all school-aged children (6-10 years). The Government of Bangladesh has taken a few initiatives which have reportedly increased the net enrollment rates (NER) for the primary school-age children. For instance, the net enrolment rate of primary school was about 60% in 1990, which has gradually increased by an additional 20% points within a decade (BBS and UNICEF, 2000; Chowdhury et al., 2002) and the latest statistics shows that the NER has reached 88.4% in 2008 (UN, 2011). However, base line survey conducted by the Department of Primary Education (DPE) of Bangladesh reveals that the primary education dropout rates in both Government Primary Schools (GPS) as well as Registered Non-Government Primary Schools (RNGPS) have increased from 33% in 2002 to 47.2% in 2006 and an alarming 50.5% in 2007 (DPE, 2008, 2009). This means that almost half of the students who enrolled in class 1 will not be able to finish their primary education, indicating a loss of resources which is termed as a 'colossal waste' (pg. 59) by an independent watch dog group of MDGs in Bangladesh (PFM, 2008).

Previous literature focused on dropout has identified many potential factors which is crucial in triggering the process of school dropout in developing countries. These factors could be broadly classified as individual, household, school and government specific along with natural disasters driven elements. Individual specific issues that affect dropout are mainly ill-health, under-nutrition (Glewwe and Jacoby, 1995; Glewwe et al., 2010; Alderman et al., 2001) and lack of motivation (Hunt, 2008). Household levels factors are mainly poverty (Hunter and May, 2003), child labor (Sabates et al., 2010), migration (Hunt, 2008) and parental illiteracy, attitude and death (UNESCO, 1984; Case and Ardington, 2006). A notable number of papers have reported negative impacts of traditional beliefs and religiosity as well as adolescent marriage and pregnancy on girls education and dropout (Colclough et al., 2000; Dunne et al., 2005; Cardoso and Verner, 2006; Bandyopadhyay and Subrahmanian, 2008; Grant and Hallman, 2008; Hossain, 2010, to name a few). Other discussed factors are teacher absenteeism (Banerjee and Duflo, 2006), school location and distance, poor quality educational provision (Harbison and Hanushek, 1992), natural disaster and rehabilitation (DPE, 2009).

One rarely studied cause of dropout is the seasonal labor demand in the agricultural sector. Previous studies examined the role of technological and price changes on schooling, but not necessarily related to seasonality. Some find negative estimates of child schooling on child wage and yield variations (Rosenzweig and Evenson, 1977), while other studies found persistent change in productivity increases schooling (Rosenzweig, 1990; Foster and Rosenzweig, 1996, 2004). Poor rural children from agricultural households are often needed by their families for labor purposes, especially during the peak harvesting seasons. Seasonal labor demand by definition creates variations of short term, and is expected to decrease enrollment. Indeed, seasonal increase in labor demand is known to lead to high dropout rates in rural areas (Hadley, 2010). The situation gets even critical when the peak harvesting season coincides with school exam schedules.

Since independence, schooling system in Bangladesh follows the English calender year as the academic calender without accommodating the agrarian calender. As a consequence, seasonal agricultural labor demand regularly hampers poor agricultural household children which leads to extended absenteeism from school. This absenteeism becomes crucial when it affects the final exam preparation, because progression to the next class is usually given on the basis of satisfactory results of the annual examination held at the end of each academic year (BANBEIS, 2007).

Unfortunately, the typical exam period in primary and secondary schools usually coincides with the peak harvesting of wet season paddy called *Aman*. *Aman* has the largest coverage in terms of area and has the second highest yield in Bangladesh. *Aman* is usually harvested during the period of late November to early January, and the labor demand for the harvesting reaches its peak during December. During the harvesting season poor households can not afford to hire external labor to help them with the harvesting procedure. As a result, children from agricultural households get engaged in harvesting and spend less time in preparing for the final exams, which might result in failing and eventually dropping out of the schools. Moreover, there are several other impediments in exam preparations when children are involved in harvesting procedure: they face frequent injuries, fatigue from work may affect learning intensity, and they have to study at night under inadequate rural electrification.

With publication of a handful of anecdotal papers (Ardt et al., 2005; CAMPE, 2004, 2008; DPE, 2009), importance of seasonal labor impacts on dropout is widely acknowledged by practitioners.[*1] However, academic literature, with an exception of Sabates et al. (2010), has paid a relatively sparse attention, and such impacts are rarely examined. This is partly due to difficulty in finding valid instrumental variables to be used in rigorous assessment, because local seasonal labor demand or local productivity shocks are not readily observable.

[*1] In a recent comprehensive study to find the reasons for rising dropout in Bangladesh, (DPE, 2009) reports that after poverty, child labor is the second most frequently cited cause of dropout. Since poverty and child labor go simultaneously in Bangladesh, academic calender not facilitating the seasonal labor demand may also has contributed to the rising rate of dropout.

The aim of this paper is to rigorously identify the impacts of seasonal labor demand on school enrollment choices. Our assessment takes an advantage of the overlap between peak seasonal labor demand period and exam period. An ideal way to conduct such impact evaluation research is to employ a randomized control trial (RCT). However, implementing a RCT in this context, assigning different exam schedules to different individuals, will be difficult and costly, as it must randomize at school levels which necessitates a large scale operation. Instead of a RCT, this paper utilizes Ramadan holidays as a natural experiment that shifted the exam period ahead of peak seasonal labor demand period.

Bangladesh is predominantly a muslim country and during the time of Ramadan, schools are closed for holidays to accommodate Ramadan activities for children. Since Islamic months follow the lunar calendar, the schedule of Ramadan drifts each solar year by 11 to 12 days. Interestingly, in the year of 1999, Ramadan was celebrated during the month of December, as a result schools had to pre-pone their final exam schedules in November which did not overlap with the peak seasonal labor demand period for *Aman* paddy. Three years later, due to shifting Ramadan period, Ramadan in 2002 was celebrated during November. Schools were closed in November, all the final exams were scheduled in December which entirely overlapped with the Aman harvesting season. This makes year 2002 as an ideal candidate for counterfactual of Ramadan in 1999, and data from both years will provide outcomes of a natural experiment that reduced the labor demand for children during the exam period. This paper uses 1999-2002 (collected in 2000 and 2003) longitudinal data set to estimate the impact of such overlapping seasonal labor demand and academic calender on school dropout in Bangladesh.

Consistent with our assumption that children from agricultural households are more affected than children from non-agricultural households by increased agricultural labor demand in 2002, we find evidence that more children from agricultural households have dropped out by 2002 than children from non-agricultural households. Enrollment rates also decrease between 1999 and 2002 as one progresses through school, but they decrease more for agricultural households. This tendency remains unchanged after we control for variations at various levels. Our estimates confirmed our hypothesis that rescheduling exam period off the peak seasonal labor demand period decreases dropouts (increases enrollment).[*2]

In the next section, we will show how we can systematically consider about enrollmemt/dropout decisions using a simple dynamic model. In Section 3, we present identification strategy, discuss potential confounding factors and our ideas on how

[*2] We will use enrollment and dropout interchangeably throughout our text, because majority of dropouts in Bangladesh do not come back to schools (CAMPE, 2008).

we can separate them in the estimation. In Section 4, we use descriptive statistics to examine data and explain about how we select samples. Section 5 gives estimated results and Section 6 concludes our analysis.

2 Model

It is a simple task to describe impacts of reduced seasonal labor demand, as a consequence of Ramadan coinciding with exam period in 1999, in a theoretical model. Consider an individual living for 2 periods. In the first period, she faces a trade-off in choosing the optimal hours l in schooling over work $1-l$. If she chooses to go to school for l hours, she receives an income according to production function $h(1-l)$, and her second period income y increases at rate $e(l) > 0$ with $e(0) = 1$. We let a multiplicative term $1 + aD$ with $a > 0$ which measures the productivity change to enter production, where in harvest seasons D takes the value of 1, and 0 otherwise. Rewriting $1 + aD = m$, individual's problem is:

$$\begin{aligned} \max_{\{c_1, c_2, l\}} \quad & u(c_1) + \beta u(c_2) \\ \text{s.t.} \quad & mh(1-l) = c_1 + s \\ & e(l)y + Rs = c_2 \end{aligned} \tag{1}$$

where we denoted c_t as period t consumption, $\beta \in (0, 1]$ as a discount factor, s as saving, y as second period base income, and $R > 0$ as an interest rate factor. Upon substitution, this is equivalent to:

$$\max_{\{s,l\}} \; u[mh(1-l) - s] + \beta u[e(l)y + Rs]$$

First order conditions (FOCs) are, assuming positive saving:

$$\begin{aligned} -u'(c_1) + \beta R u'(c_2) &= 0, \\ -mh'(1-l)u'(c_1) + \beta e'(l) y u'(c_2) &= 0. \end{aligned}$$

The second FOC shows that individuals equate marginal utility loss of income in the period 1 due to schooling to marginal utility gain due to increased income in the second period. Substituting the first FOC into the second FOC, we have[*3]:

$$e'(l) = \frac{R}{y} mh'(1-l). \tag{2}$$

[*3] We can alternatively rewrite (2) as:

$$g(l) = \frac{R}{y} m, \qquad g(l) \stackrel{\text{def}}{=} \frac{e'(l)}{h'(1-l)}, \; g' < 0.$$

Taking an inverse function will show that l^* is a nonlinear function in arguments of RHS functions to which later approximate by log-linearization. In the case of (3), this is equivalent to a wage rate decrease. Log-linearization of this gives

$$l \simeq= l^* + a_1(R - R^*) + a_2(y - y^*) + (m - m^*),$$

which gives the basis for the estimation equation.

If there is a uniform market wage rate w, then at the equilibrium without any factor market imperfection, we must have $w = mh'(1-l)$. Then the above becomes

$$e'(l) = \frac{R}{y}w. \tag{3}$$

Let us assume that the return to schooling e and production h are strictly concave functions. Assume also that regularity conditions $\lim_{l \to 0} e'(l) = \infty$ and $\lim_{l \to 0} h'(1-l) = \bar{h} > 0$ hold.[*4] Then, we know that there exists $l^* > 0$ that satisfy FOCs, because LHS of (2) is increasing while RHS is decreasing in l. When $D = 1$ and $m > 1$, the marginal productivity of labor gets larger and l^* becomes smaller.

The impact of having Ramadan during the harvest season is equivalent to a decrease in productivity or wage rates in this model. Harvest season coincides with year-end exam period 2002. In 1999, however, Ramadan holiday was during the harvest season. This led schools to pre-pone the exams to before the harvest begins. Hence the individuals faced a lower marginal labor productivity/wage during the exam period in 1999 than in 2002. This can be expressed as having lower values for m. If we compare between agricultural and non-agricultural households, we will be able to identify Ramadan impact on enrollment if $\Delta m_{ag} \geqslant \Delta m_{nonag}$ where $\Delta m \equiv m_{2002} - m_{1999}$.

Noting that passing the exam is critical to the future increase in incomes, individuals' future incomes crucially depend on the hours spent for the exam before and during the exam period. As the individuals face lower wage rates, it allowed them to concentrate their efforts in exam preparation, or to choose a larger l^*.

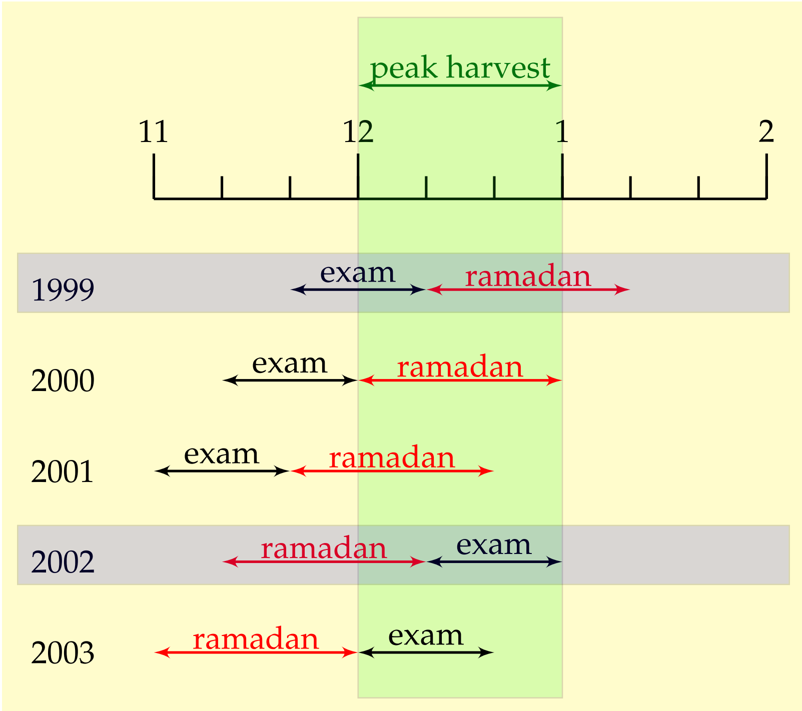
3 Identification Strategy

As noted, Ramadan driven school holidays in 1999 forced schools to prepone the exam to November, when *Aman* harvest has not begun. In Figure 1, schematic explanation of timing is given. In 1999, exam period and harvest period did not overlap completely. In 2002, Ramadan and school holidays came first and the exams and harvest took place concurrently. For the students (and their parents) who were preparing for the exams, this implies that they were facing lower wage rates or smaller seasonal labor demand during the exam period of 1999 than in 2002. It is this variation we utilize to identify the impacts of smaller labor demand during the exam period.

By taking log-linear approximation of (2), the base estimation equation can be

[*4] These assure $l^* > 0$ to exist. Given that almost everyone goes to school to some extent, and Government of Bangladesh introduced compulsory primary education in 1991, these conditions are not a bad description of reality.

Figure 1: Sequence of Events



Notes: 1. Timing of exams, Ramadan, and peak harvest period for *Aman* paddy.

2. Ramadan shifts by about 10 days in each year:
1999: December, 9.
2000: November, 27.
2001: November, 16.
2002: November, 6.
2003: October, 27.

written as:

$$y_{i,t} = \boldsymbol{\beta}'\mathbf{x}_{it} + \gamma r_{i,t}D_i + \delta r_{i,t} + v_i + e_{i,t}, \quad (4)$$

where $y_{i,t} = 0, 1$ is a binary variable indicating enrollment for an individual i at period t, $\mathbf{x}_{i,t}$ is a set of exogenous covariates, $r_{i,1} = 1$, $r_{i,2} = 0$ is a dummy variable for Ramadan coinciding with harvest seasons, $D_i = 0, 1$ is now a dummy variable for agricultural households, v_i is an individual effect, and $e_{i,t}$ is an error term.

In (4) we are approximating l^* with enrollment continuation binary variable $y_{i,t}$. As we do not observe production function h nor wage rate w during exam period, we take $r_{i,t}D_i$ as a proxy of decreased labor productivity or decreased agricultural wage rates during exam period that agricultural households faced in 1999. The coefficient δ of year 1999 dummy $r_{i,t}$ picks up all other effects in 1999 and γ measures enrollment differential in 1999 of agricultural households relative to non-agricultural households.

$\mathbf{x}_{i,t}$ includes all other relevant variables that affect second period base incomes y and effective interest rate R that an individual faces. These are in general functions of parental characteristics and wealth levels. So we will incoporate variables such as head education levels and land holding. These variates may also enter home production processes h, so the interpretation of estimates on them can be either or all of future income, effective interest rate, and current production inputs. As it is not our main focus, we will not try to derive structural interpretation of these estimates.

In general $\mathcal{E}[\mathbf{x}_{i,t}v_i] \neq \mathbf{0}$ or $\mathcal{E}[D_i v_i] \neq 0$, so we demean both sides to eliminate individual effects v_i:

$$\begin{aligned} y_{i,t} - \bar{y}_i &= \boldsymbol{\beta}' \left(\mathbf{x}_{it} - \bar{\mathbf{x}}_{it}\right) + \gamma r_{i,t} D_i + \delta r_{i,t} + e_{i,t} - \bar{e}_{i,t}, \\ &\text{or,} \\ \tilde{y}_{i,1} &= \boldsymbol{\beta}' \tilde{\mathbf{x}}_{i1} + \gamma D_i + \delta + \tilde{e}_{i,1}, \\ \tilde{y}_{i,2} &= \boldsymbol{\beta}' \tilde{\mathbf{x}}_{i2} + \tilde{e}_{i,2}, . \end{aligned} \tag{5}$$

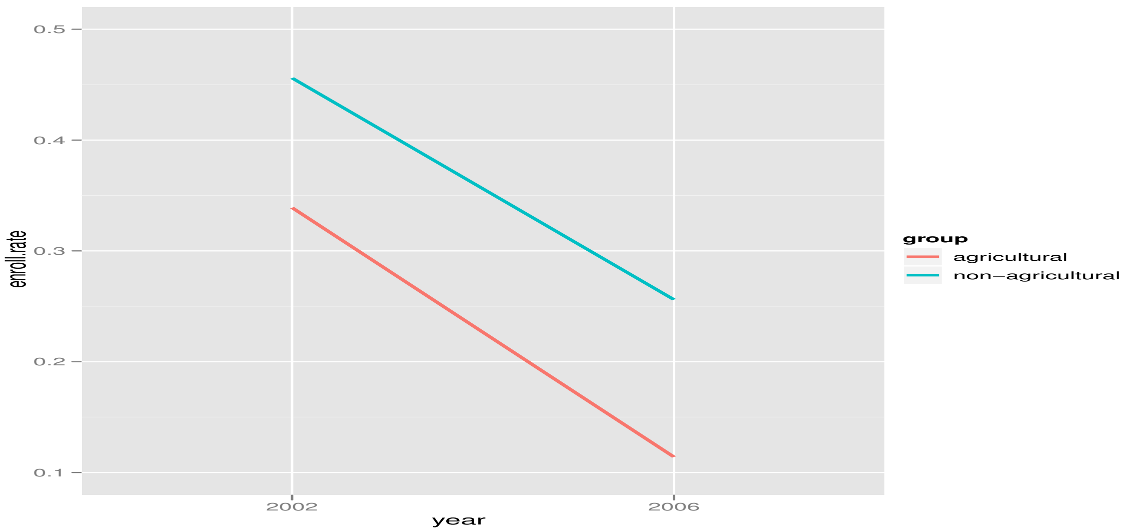
where we denoted $\tilde{A}_{i,t} = A_{i,t} - \bar{A}_i$.

As we are interested in the impacts of off-harvest exam period, or lowered wage rates, on enrollment, we need to compare individual's outcome with credible counterfactual. With the panel data in the absence of any random variations affecting the magnitude of labor demand that individuals face, the most credible strategy is to use the difference-in-differences (DID) estimator by assuming a group of individuals faced smaller labor demand than the others. We assume children from agricular households faced relatively larger reduction in labor demand in 1999 than children from non-agricultural households. This is based on a presumption that children of agricultural households have stronger ties with agricultural community and have more unignorable experiences in agricultural production. From employers' perspectives, children from agricultural households tend to have better expertise in agricultural production and thus are more employable during the harvesting season. In addition, we note that non-agricultural households face peak labor demand, if any, different than harvesting season (for example during the time of new year celebration).

The basic idea of our identification strategy is to use DID and compare enrollment status between individuals, who are otherwise similar in their observed characteristics, of agricultural and non-agricultural households, and between 2002 and 1999. By taking deviations from individual means, we can control for any time-invariant traits of individuals that may affect school enrollment.

DID estimators require the common trend assumption in enrollment rates between agricultural and non-agricultural households. This cannot be shown with same data, but we can indicate suggestive evidence that it may hold. Our data set comes with three rounds, with the final round collected in 2006. Because there are seven years between the first and the third rounds, many children finish schooling by 2006. So the third round has many missing observations for ages 10 and older which makes the triple difference estimator infeasible. Nevertheless, we can still measure enrollment rates of agricultural and non-agricultural households, and compare them. Figure 2

Figure 2: Common Trends in Enrollment Rate Changes in 2002 and 2006 (%)



Notes: 1. A common trend is examined on family members who were first interviewed in 1999 and are aged 10 - 22 in 1999 (17 - 29 in 2006).

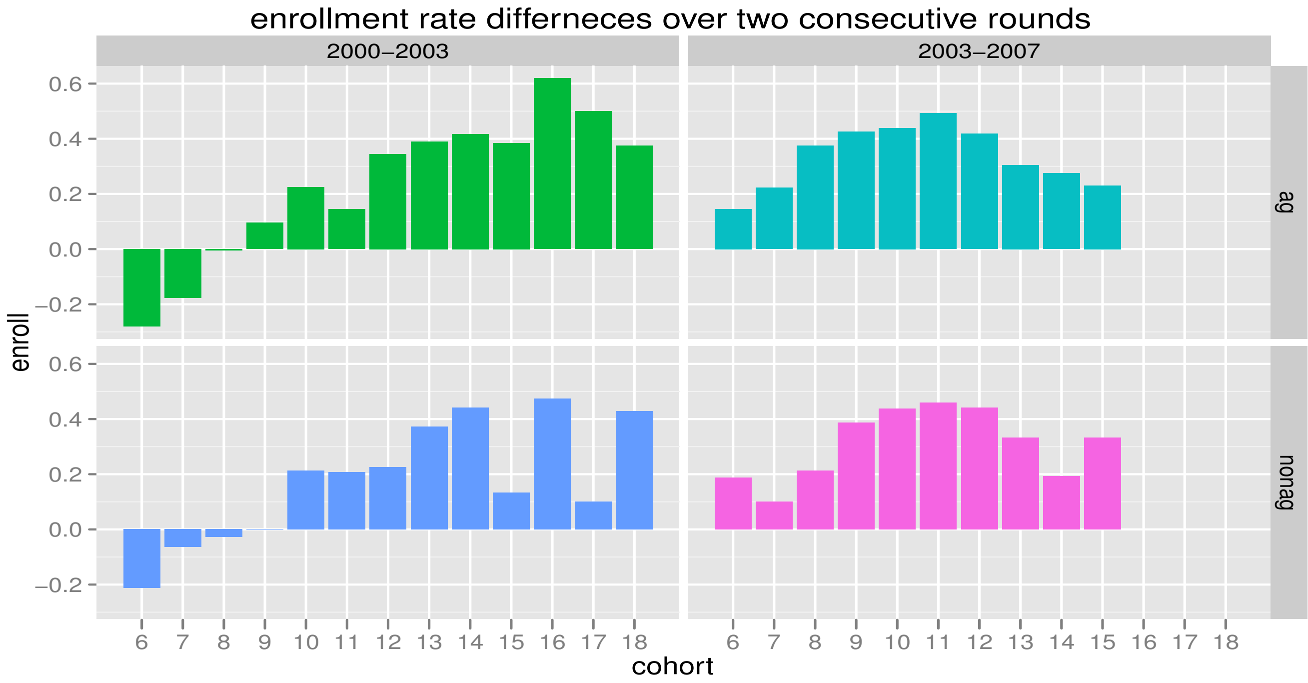
2. All attrited family members in 2006 are assumed to have left school.

3. Δ enrollment rates: agricultural 22.5, non-agricultural 20.0. Difference is not significantly different from zero, p-value = .48.

plots mean enrollment rates for agricultural and non-agricultural households in 2002 and 2006 for children aged between 10 and 22 in 1999. We have assumed that attrited individuals are not going to school. A proportions test for the null of equal change in enrollment rates, 22.5% for agricultural households and 20.0% for non-agricultural households, could not be rejected ($p-$value .48). Barring year effects, this exercise indicates that common trend assumption may hold in our sample. In figure 3, we construct a cohort panel and plotted the difference in enrollment rates by cohort. We have constructed a cohort panel, not an individual panel, for three rounds of surveys because attrition rates become high in the third round. One can see that, in the right panels of 2002-2006 differences, the patterns are similar between agricultural and non-agricultural households. In the left panels where we plot 1999-2002 differences, the pattern seems to differ, which we attribute to Ramadan.

There are a few other issues to consider in validating DID identification strategy. The first issue is our key identification assumption that individuals from agricultural households are more strongly affected by the agricultural labor demand than individuals from non-agricultural households. Even if γ is statistically significant, it can be that agricultural households share unobservable chracteristics that result in higher dropout rates in 2002 than non-agricultural households. However, one must note that we are controlling for individual fixed-effects. Thus the remaining unobservable characteristics we have to worry about are time-varying ones. The most likely candidate is plausibility of particularly large agricultural labor demand in 2002. It is possible that, even if there was no impact of Ramadan 1999 on enrollment, the good harvest in 2002 induced higher dropout rates for agricultural households relative to

FIGURE 3: DIFFERENCES IN ENROLLMENT RATES BY COHORTS OF 1999



Notes: 1. As attrition rates become high for individuals who are school aged in 1999, a cohort panel is constructed to retain as many observations as possible to compare three rounds of data.

2. Left panels show difference in enrollment rates between 1999 and 2002 for each cohort. Right panels show difference in enrollment rates between 2002 and 2006 for each cohort.

3. Top panels show differences for agricultural households. Bottom panels show differences for non-agricultural households.

non-agricultural households, making 1999 enrollment large relative to 2002.

To test this idea, it is ideal to use paddy productivity in the regressor. However, the data set focuses on schooling and puts sparse attenion on production-related information. As a proxy to paddy productivity variability, we include year 2002 dummy and interaction terms of location (thana[*5]) dummies and year 2002 dummy, although these variable capture all other time-variant causes that affect enrollment. While an imperfect measure, we note that national production of *Aman* does not differ much between these two seasons, 11249 thousand metric tons in 1999 and 11520.5 thousand metric tons in 2002, a 2.4 per cent change.

Second, it is arguable that our identification strategy cannot separately identify Ramadan impacts from any event peculiar to 2002 that is unrelated to productivity shocks. An example is having a holiday season before the exam period. This happened in 2002 but not in 1999. This can harm learning for children whose home learning environment is disadvantageous. So it is possible that it is not Ramadan impact that our interaction term between agricultural household and year 2002 dummies are picking up, but the impacts of having holidays before the exams that are

[*5] A thana is an administrative unit for subdistricts.

specific to agricultural households. The latter impact may penalize enrollment of children in agricultural households, because their learning environment is expected to be poorer due to many reasons, like, their house has livestock whose sounds become annoyance for study, even after we control for observable wealth measures such as land holding, nonland assets, and official poverty status.

To examine if such interpretation holds, we will add parental education variables to regressors. If home learning environment differs and affects enrollment, it should also affect how the children spend their holidays before the exam in 2002. So children from more learning-conducive home, which is supposedly positively correlated with parental education, should increase the chance of enrollment. As maternal education can play a key role in home learning (Behrman et al., 1999), we include both parents' education variables in our regressions. In doing so, we had to reduce the sample size as we needed to exclude single-parent households.

Third involves the subtlties on how ages affect enrollment status. As a general trend in the low income areas, enrollment rates decrease as one progresses in school. So we will need to control for baseline dropout rates for each cohort. One way to achieve this is to use individual deviation from cohort mean. Assuming individuals in the same cohort faces the same dropout distribution, then taking deviation from the cohort mean will control for baseline dropout rates for the cohort. So the base model changes to

$$y_{i,c,t} = \boldsymbol{\beta}'\mathbf{x}_{i,c,t} + \gamma r_{i,c,t} D_{i,c} + v_{i,c} + e_{i,c,t}, \tag{6}$$

where a suffix $_c$ is an index for cohort c. This gives cohort means by year as:

$$\begin{aligned}\bar{y}_{c,1} &= \boldsymbol{\beta}'\bar{\mathbf{x}}_{c,1} + \gamma \bar{D}_c + \bar{v}_c + \bar{e}_{c,1},\\ \bar{y}_{c,2} &= \boldsymbol{\beta}'\bar{\mathbf{x}}_{c,2} + \bar{v}_c + \bar{e}_{c,2},\end{aligned}$$

Using the original FE model, cohort demeaned estimation equations are:

$$\begin{aligned}y_{i,c,1} - \bar{y}_{c,1} &= \boldsymbol{\beta}'\left(\mathbf{x}_{i,c,1} - \bar{\mathbf{x}}_{c,1}\right) + \gamma\left(D_{i,c} - \bar{D}_c\right) + (v_{i,c} - \bar{v}_c + e_{i,c,1} - \bar{e}_{c,1}),\\ y_{i,c,2} - \bar{y}_{c,2} &= \boldsymbol{\beta}'\left(\mathbf{x}_{i,c,2} - \bar{\mathbf{x}}_{c,2}\right) + (v_{i,c} - \bar{v}_c + e_{i,c,2} - \bar{e}_{c,2}).\end{aligned}$$

Individual mean for these is:

$$\bar{y}_{i,c} - \bar{y}_c = \boldsymbol{\beta}'\left(\bar{\mathbf{x}}_{i,c} - \bar{\mathbf{x}}_c\right) + \gamma\tfrac{1}{2}\left(D_{i,c} - \bar{D}_c\right) + (v_{i,c} - \bar{v}_c + \bar{e}_{i,c} - \bar{e}_c),$$

or

$$\tilde{y}_{i,c} = \boldsymbol{\beta}'\tilde{\mathbf{x}}_{i,c} + \gamma\tfrac{1}{2}\tilde{D}_{i,c} + (\tilde{v}_{i,c} + \tilde{e}_{i,c}),$$

where we denoted $\tilde{A}_{i,c} = \bar{A}_{i,c} - \bar{A}_c$ with slight abuse of notation. Demeaning individual means will give:

$$\begin{aligned}y_{i,c,1} - \bar{y}_{c,1} - \tilde{y}_{i,c} &= \boldsymbol{\beta}'\left[\mathbf{x}_{i,c,1} - \bar{\mathbf{x}}_{i,c} - (\bar{\mathbf{x}}_{c,1} - \bar{\mathbf{x}}_c)\right] + \gamma\tfrac{1}{2}\left(D_{i,c} - \bar{D}_c\right) + (e_{i,c,1} - \bar{e}_{i,c} - (\bar{e}_{c,1} - \bar{e}_c)),\\ y_{i,c,2} - \bar{y}_{c,2} - \tilde{y}_{i,c} &= \boldsymbol{\beta}'\left[\mathbf{x}_{i,c,2} - \bar{\mathbf{x}}_{i,c} - (\bar{\mathbf{x}}_{c,2} - \bar{\mathbf{x}}_c)\right] + \gamma\tfrac{1}{2}\left(-(D_{i,c} - \bar{D}_c)\right) + (e_{i,c,2} - \bar{e}_{i,c} - (\bar{e}_{c,2} - \bar{e}_c)).\end{aligned}$$

Note:

$$\overline{r_{i,t}D_{i,c}}\Big|_{\text{over } t} = \tfrac{1}{2}D_{i,c}, \quad \overline{r_{i,1}D_{i,c}}\Big|_{\text{over } i \text{given } c} = \bar{D}_c,$$
$$\overline{r_{i,2}D_{i,c}}\Big|_{\text{over } i \text{given } c} = 0, \qquad \overline{r_{i,t}D_{i,c}}\Big|_{\text{over } i \text{given } c} = \tfrac{1}{2}\bar{D}_c,$$

we have

$$\ddot{y}_{i,c,t} = \boldsymbol{\beta}'\ddot{\mathbf{x}}_{i,c,t} + \gamma\ddot{d}_{i,c,t} + \ddot{e}_{i,c,t},$$

where we denoted $\ddot{A}_{i,c,t} = A_{i,c,t} - \bar{A}_{i,c} - (\bar{A}_{c,t} - \bar{A}_c)$ and $d_{i,c,t} = r_{i,t}D_{i,c}$. Note that we have got rid of all fixed effects from our estimation equation.

In sum, under the full set of controls, we control for time-invariant individual characteristics, time-variant aggregate unobservables, time-variant thana-level unobservables, and cohort effects. We also confirmed that national paddy production does not show a significant increase in 2002 relative to 1999. If there is anything else that systematically prompted individuals to drop out only from agricultural households at individual level in 2002, such as household-level productivity shocks that are uncorrelated with aggregate productivity shocks, we are not controlling them. This is the extent of credibility that our analysis conveys.

4 Data, Definitions, and Descriptive Statistics

Data set we use is a panel collected in 1999 and 2002 in rural Bangladesh as FFE-CEF by International Food Policy Research Institute (IFPRI). It surveyed 469 households from 47 villages to investigate the impacts of Food-For-Education (FFE) programs on school enrollment. From these households, the total of 2597 individuals were surveyed.

In our analysis, we will compare agricultural households against non-agricultural households in their enrollment trends. An agricultural household is defined as a household whose household head reports his/her main income source or self-reported occupation as agriculture. We also use a broader definition that a household is agricultural if at least one member reporting its main income source or main occupation as agriculture or if a household owns agricultural plots. Different definitions are highly correlated with each other and estimated results turned out to be similar. So we will use the narrower definition. We will interact the agricultural household dummy with the year 2002 dummy to see if we observe a negative impacts on enrollment rate changes which indicate higher enrollment rates in 1999 for agricultural households.

In Table 1, three-year trends in enrollment rates for each cohort using individual panel data are reported.[*6] Per cohort differences show two things: First, children are

[*6] Note that this data is different from what is used in figure 3. While Table 1 is based on individual panel, figure 3 uses cohort panel to keep as many observations as possible.

Table 1: Enrollment Rates per Cohort of 1999

year		5	6	7	8	9	10	11	12	13	14	15	16	17	all
2000	all	12.70	63.00	80.36	84.82	83.33	92.00	89.58	84.91	71.43	67.09	52.38	60.87	38.10	72.78
	a	7.69	61.40	75.93	83.82	83.61	91.55	84.75	82.46	68.25	65.91	54.55	54.17	50.00	70.55
	n	20.83	65.12	84.48	86.36	82.98	92.59	97.30	87.76	77.14	68.57	47.37	68.18	14.29	75.88
2003	all	87.30	84.31	92.79	83.33	75.93	69.77	71.11	55.14	34.02	26.25	25.40	13.04	2.44	61.77
	a	82.50	80.70	96.23	80.00	75.41	70.67	64.15	47.37	30.16	26.67	20.45	4.17	0.00	57.85
	n	95.65	88.89	89.66	88.64	76.60	68.52	81.08	64.00	41.18	25.71	36.84	22.73	7.14	67.22
change	all	74.60***	21.31***	12.43***	−1.49	−7.40	−22.23***	−18.47***	−29.77***	−37.41***	−40.84***	−26.98***	−47.83***	−35.66***	−11.01***
	a	74.81***	19.30**	20.30***	−3.82	−8.20	−20.88***	−20.60**	−35.09***	−38.09***	−39.24***	−34.10***	−50.00***	−50.00***	−12.71***
	n	74.82***	23.77***	5.18	2.28	−6.38	−24.07***	−16.22**	−23.76***	−35.96***	−42.86***	−10.53	−45.45***	−7.15	−8.66***

Source: Compiled from IFPRI individual panel data before dropping observations.
Notes: 1. Numbers in first parenthesis are number of observations of each cell.
2. *, **, * * * indicate significance levels at 10%, 5%, 1%, respectively.
3. Column under "All" indicates simple group means.
4. Rows headed by 'a' indicates agricultural households, 'n' indicates non-agricultural households.

more likely to stop enrollment within three years as they become older. Second, it is generally the agricultural households who report larger drops in enrollment rates. The overall reduction in enrollment rates between 1999 and 2002 is 12.71% points for agricultural households while it is 8.66% points for non-agricultural households. This seemingly small difference between two groups of households can be greater than they may look, because we are dealing with limited dependent variables whose values are less likely to decrease from lower levels.[*7] These two findings give some vindication to our supposition that children from agricultural households may have been affected more strongly by reduced labor demand in 1999. While this is all suggestive, we need to employ a more elaborate estimation technique than descriptive statistics to rigorously identify the impacts of Ramadan in 1999.

Given our focus on primary and secondary schooling, we will set age limits on the sample we use in our empirical analysis. In Bangladesh, school age officially starts from six. However, some parents choose to start earlier.[*8] Considering the small chance of working as a harvest laborer, and the fact shown in Table 1 that most individuals younger than age 10 cohort in 1999 do not drop out by 2002, we will use only age 11 and older. We have used other cut off ages (10 and 12) and the results are similar and follows a statistically predicted pattern (See page 17).

Setting the upper-bound age for our sample is not as simple as the lower-bound. High schools officially end at the age of sixteen, but due to late start and repetition, many children stay in high schools at ages older than sixteen. As the public primary schools accept up to age ten for class 1, and the fact that many children start enrolling

[*7] For example, for age 13 cohort, a decrease from 68.25% to 30.16% is a 38.09 point or a 55.81% reduction, while 77.14% to 41.18% is a 35.96 point or 46.62% reduction.

[*8] At the same time, judging from discrepancy of information between two rounds of data, there is a good chance that parents may say "yes" to enrollment without understanding the question was asking about primary school, not preschool.

at schools late, there are many children who may be considered as "adults" if judged only with their age, still going to school nonetheless. Thus we will have many individuals included in our sample who have already finished schooling if we set a uniform upper-bound for age at twenty three, say.

Fortunately, the data has information on the year of first enrollment. We will use the expected year of finishing high school as our primary criteria to exclude adults from our sample. We will allow for a three year margin to factor in class repetition. So any individual whose expected year of graduation is 1999 or later will be included in our sample. At the same time, it is unrealistic to assume a twenty eight year old individual to be in class 10. So we will combine another cutoff at age twenty five in round 1 (1999). So the upper-bound of age is set by the interaction of two conditions: an individual with expected year of graduation is no earlier than 1999, and ages below twenty five in 2002.

Under these conditions, it turns out that the eldest individual in our sample is twenty one in 1999. There are originally 2597 individuals in the original panel data, of which 881 individuals fit into age limits (between 7 and 25) and expected graduation after 1999. We have excluded individuals whose highest education level in round 2 (2002) is Play-School, Madrasa, Bachelor or higher degrees, in which we dropped 24, 1, and 18 individuals, respectively. This leaves us with 838 individuals, and after imposing lower age limit of 10 years and older, we drop 388 individuals and total number of individuals in our sample becomes 450. Age limit of 11 years and older leaves 361 individuals, and age limit of 12 years and older leaves 263 individuals..

The data set reports reasons for stop going to school, which are given in Table 2. As the data also have household consumption information, we summarized the reported reasons for dropping out by per household member consumption quartiles in the top table. In the bottom table, we have summarized the reported reasons by household type: agricultural or non-agricultural households. In the top table, drop out rates are higher for lower per member consumption quartiles, and their reasons for dropping out are more concentrated in financial difficulty while upper quartile individuals give non financial reasons such as not fitting well or marriage. This suggests that we need to control for household wealth in analyzing school enrollment decisions.

In the bottom table of Table 2, there is no significant difference in terms of reported reasons by agricultural and non-agricultural households. This is because, in essence, bottom table can be considered as derived by computing weighted averages with similar weights for both type of households. The proportions of quartiles 1, 2, and 4 which report similar reasons within each group do not differ much for agricultural and non-agricultural households, and consumption quartiles do not seem to differ be-

Table 2: Reported Reasons for Stop Going to School by Consumption Quartiles and by Household Type

quartile	group	financial	not accepted	school environ	not want to, others	distance	sickness	marriage	NA	total
1	non-goers 2000	0.68	0.02	0.27	0.00	0.00	0.00	0.00	0.02	41
1	non-goers 2003	0.55	0.00	0.01	0.10	0.00	0.00	0.01	0.33	114
1	drop outs 2003	0.60	0.00	0.01	0.09	0.00	0.00	0.01	0.28	75
2	non-goers 2000	0.57	0.00	0.23	0.09	0.09	0.00	0.00	0.03	35
2	non-goers 2003	0.36	0.00	0.04	0.19	0.01	0.00	0.00	0.41	81
2	drop outs 2003	0.44	0.00	0.04	0.12	0.02	0.00	0.00	0.38	50
3	non-goers 2000	0.57	0.00	0.26	0.04	0.00	0.09	0.00	0.04	23
3	non-goers 2003	0.28	0.00	0.00	0.24	0.00	0.01	0.04	0.42	78
3	drop outs 2003	0.25	0.00	0.00	0.26	0.00	0.02	0.04	0.44	57
4	non-goers 2000	0.22	0.11	0.44	0.00	0.11	0.00	0.00	0.11	9
4	non-goers 2003	0.10	0.03	0.03	0.20	0.00	0.03	0.02	0.58	60
4	drop outs 2003	0.12	0.04	0.02	0.19	0.00	0.04	0.02	0.58	52

ag HH	group	financial	not accepted	school environ	not want to, others	distance	sickness	marriage	NA	total
yes	non-goers 2000	0.60	0.02	0.24	0.06	0.06	0.00	0.00	0.02	63
yes	non-goers 2003	0.33	0.00	0.02	0.17	0.00	0.01	0.02	0.44	204
yes	drop outs 2003	0.31	0.01	0.02	0.19	0.01	0.01	0.03	0.43	145
no	non-goers 2000	0.62	0.02	0.33	0.00	0.00	0.00	0.00	0.02	42
no	non-goers 2003	0.42	0.01	0.01	0.19	0.00	0.01	0.01	0.36	123
no	drop outs 2003	0.49	0.01	0.01	0.13	0.00	0.01	0.00	0.35	86

Source: Compiled from IFPRI data.
Notes: 1. Numbers are all ratios except totals.
2. "ag HH" indicates agricultural households. See main text for definition of agricultural households.
3. Non-goers are individuals who were not enrolled in respective period.
4. Drop outs are individuals who were enrolled in 1999 but not in 2002.

Table 3: Tabulation of Agricultural vs. Consumption Quartiles (%)

ag HH/quartile	1	2	3	4	NA	rowtotal (persons)
yes	23.68	23.4	20.06	32.87	0	718
no	25.47	24.84	30.27	18.37	1.04	958

Source: Compiled from IFPRI data.
Notes: 1. Consumption quartiles are based on households, not individuals.
2. "ag HH" indicates agricultural households. See main text for definition of agricultural households.

Table 4: Tabulation of Enrollment against Program Membership (1999)

enrollment	A non-member	FFW	IFS-FFA	Primary stipend	RMP	Secondary stipend	VGD
yes	7	180	5	190	164	187	109
no	329	2	0	1	0	0	0

Source: Compiled from IFPRI individual panel data.
Notes: 1. Compiled from ages 6 - 21 in 1999.
2. Apprebiations for prorgams are: FFW (Food-For-Work), IFS-FFA (Integrated Food Security - Food For Asset Creation), RMP (Rural Maintainance Program) , VGD (Vulnerable Group Development).

tween them. This is seen in Table 3 where we tabulated agricultural/non-agricultural households against consumption quartiles.

As Bangladesh is known for proactive education policies, one needs to take education support programs into account when analyzing enrollment behavior. It turns out that most of non-enrollers do not have membership to any of the listed support programs. Table 4 shows tabulation for education support program membership against enrollment status in 1999 for children between six and twenty one years old. The table shows a clear correlation between membership and enrollment. It is difficult to assess causality as we cannot control for actual targeting rules being used by various institutions, but it suggests it is essential to control for program membership in the estimation.

To conclude this section, we summarize relative advantages of our identification strategy over a more conventional, more structural approach. In theory, the investigation we undertake can be done with oft used exogenous random variation, rainfall recorded at closest weather stations, possibly interacted with household characteristics, in instrumenting the observed productivity. However, this approach has some drawbacks.First, the estimated parameter under the structural approach is labor supply elasticity of school going children in response to seasonal labor demand variations. However, this is not the question policy makers are asking. Rather, they ask, "does rescheduling of exam period away from harvesting seasons increase enrollment?" Our identification strategy gives a straight answer as it has internal validity for the question being asked, while the estimation of labor supply elasiticity requires further assumptions to do the same. Knowledge of labor supply elasticity can provide external validity, but it comes with a cost that we must use additional assumptions when we translate it to the projected impacts of exam period rescheduling. Second, in the absence of explict randomization, researchers often lack valid and strong enough instruments for productivity. Rainfall, a candidate instrument under a more structual approach, can be a weak instrument. This is because rainfall is often recorded at weather stations covering spatially wide areas. There is an inherent "basis risk" in the use of recorded rainfall for instruments for productivity, if geographical information is not provided additionally. In addition, even under the same rainfall, impacts on yield may differ across plots by alteration in elevation and drainage availability, even after controlling for observable differences in farmer characteristics.

5 Estimation Results

In Table 5, estimated results for age cutoff at 11 are shown. First column (1) is the most basic specification where we use only the year 2002 dummy and its interaction term with the agricultural household dummy. Result shows that the impact is to decrease 10.8% points in enrollment rates. In column (2), we introduce individual characteristics (age, sex). As we estimate fixed-effect models, sex is interacted with year 2002 dummy. Results do not change the estimates significantly. In (3) we add household characteristics and we control for individual characteristics, participation to various support programs including cash transfer programs.[*9] As we have seen

[*9] Other household characteristics, agricultural household dummy, per member land holding, and non-land asset values, are also interacted with year 2002 dummy. We have also used other covariates suggested by the theoretical model, such as poverty status, GPS-measured distance to schools,

in Table 4, beneficiaries of programs are mostly enrollers. So we need to control for program participation as it will inflate the enrollment rates. As expected, the estimated standard error of $\hat{\gamma}$ decreases. Further addition of household wealth variables in (4) do not change the point estimates. In (5), we incporporate head's spouse characteristics. As there are fewer observations that report them, sample size decreases. With a reduction in sample size, estimated standard errors increase. In (6), we use thana × year 2002 interaction terms to control for thana specific changes in enrollment rates. $\hat{\gamma}$ is unaffected by this. From Table 5, we see that estimates on agricultural household dummy has negative impacts on enrollment rate changes, indicating that enrollment probabilities of children from agricultural households dipped more severely in 2002 than children from non-agricultural households. Point estimates range from 10% points to 11% points, and all estimates are statistically significant at 5 or 1% level.

Looking at other covariates, program membership to support programs have large impacts on enrollment. Estimates show that girls have lower enrollment prospects in rural Bangladesh, because, firstly, back in 1999 and 2002, employment opportunities which require higher education were limited except in a narrowly defined garment industry (Paul-Majumder and Begum, 2000; World-Bank, 2008), and secondly, in a patrilineal society like rural Bangladesh, parents may find it financially unrewarding to invest on girls as they will marry off and will not provide as much old age supports as boys (Chowdhury and Bairag, 1990; Fraser, 2010). Per member land holding shows positive estimates, indicating that any deterring impacts of family labor demand, due to imperfect substitutability between family and hired labor, if any, are overturned by wealth effects on enrollment. Estimates on non-land assets are positive, also indicating wealth effects. None of spousal characteristics is statistically significant.

As discussed in the section 3, there are two lingering issues in identification. First, we may be picking up impacts of time-varying productivity shocks that may have increased labor demand in 2002. Although the aggregate production of *Aman* is not very different between two waves of data, it is possible that regional variation may still exist. To best control the productivity differences, we used year 2002 dummy for aggregate productivity shocks, and thana*2002 interaction terms for time-variant thana-level productivity shocks. Year 2002 dummy is negative in the base specification but it turns to positive and statistically significant in the later specifications. This is partly due to aggregate shocks on labor demand, but it may also capture the general trend in schooling advances in rural Bangladesh. Thana-level control is included in specification (6) in both Tables 5, 6, and all point estimates

anthropometric measures, but none of them turned out to be statistically significant and have been dropped from estimation for Table 5 and Table 6.

stay the same and statistically significant.

Second, our identification strategy cannot separately estimate seasonal labor demand impacts from any event peculiar to 2002 that is unrelated to productivity shocks, such as having holidays prior to exam period. To control for possible differences in home learning environment, we added to regressors parental education variables. Column (5) shows the estimated results. Surprisingly, heads' secondary education reduces enrollment. This may be because more educated fathers, after controlling for household wealth, may have stronger ties with potential employers, or own more agricultural machinery which increases per area marginal labor productivity. Spousal secondary education has positive impacts on enrollment, but it is statistically insignificant and does not affect point estimates of γ. Most estimates of γ stay statistically significant and show the expected signs.

As a part of robustness checks, in Table 6, we restrict our sample to sons and daughters of household heads ("nuclear family households"). Sample size is reduced, but the qualitative results stay the same as Table 5, only that some of point estimates are larger in magnitude. Impacts of per member land holding is larger, possibly due to smaller household size. In Tables 9, 11, we have further estimated the same specifications with extended and nuclear family member data after subtracting cohort means. Figure 4 gives an overview of these estimates. In all figures, points and bars indicate point estimates and their 95% confidence intervals, respectively.

The differences between each figure are that, first, change in the mean levels of point estimates (but not individual deviations from mean), and second, widths of confidence intervals. One advantage of an overview like Figure 4 is that it gives an idea what factors are changing the estimates. From comparison of each figure, we note a systematic change of point estimate means in response to specifications. It can also be seen that widths of confidence intervals as a function of sample size; wider confidence intervals for "mother" and "thana" due to much smaller sample size of 384 where we have 450 in "base" in Table 5.

Figure 7 and Figure 8 in the Appendix give estimates using a broader definition for agricultural households, where we base occupation of all adult members and ownership of agricultural plots. Estimated results do not change significantly, both qualitatively and quantitatively, except that estimate of γ become smaller in absolute values in some cases.

If we use a lower age cut off, it will leave more younger children in the sample. Then it is reasonable to expect a smaller proportion of individuals to be distracted with their schooling by harvest labor, leading to attenuated estimates of γ. Increased sample size may improve standard errors, so the changes in significance levels can go either way. This is indeed the case in Tables 13, 14 where we show estimated results

Table 5: Linear Enrollment Probability Fixed-Effect Model, All Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age		−0.037	0.106	0.052	0.051	0.033
		(0.147)	(0.104)	(0.099)	(0.109)	(0.113)
age2		−0.006***	−0.009***	−0.010***	−0.009***	−0.009***
		(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
year 2003	−0.299***	0.372	0.719**	0.875***	0.749**	0.747**
	(0.033)	(0.406)	(0.300)	(0.279)	(0.338)	(0.353)
program membership			0.656***	0.655***	0.679***	0.686***
			(0.031)	(0.031)	(0.034)	(0.033)
interaction with 2003						
agricultural household	−0.108**	−0.105**	−0.104***	−0.109***	−0.100***	−0.100**
	(0.046)	(0.045)	(0.035)	(0.035)	(0.038)	(0.040)
sex (female = 1)		−0.008	−0.169***	−0.170***	−0.182***	−0.189***
		(0.046)	(0.037)	(0.037)	(0.040)	(0.040)
head primary			−0.012	−0.003	−0.031	−0.026
			(0.040)	(0.039)	(0.043)	(0.043)
head secondary			−0.097**	−0.095**	−0.129***	−0.147***
			(0.047)	(0.047)	(0.050)	(0.051)
head spouse primary					−0.024	−0.023
					(0.045)	(0.044)
head spouse secondary					0.007	0.011
					(0.045)	(0.045)
spouse sex (female = 1)					0.095	0.171
					(0.136)	(0.144)
per member land holding				5.803***	6.150***	7.006***
				(1.553)	(1.770)	(2.212)
nonland asset (1,000,000 Tk)				5.277***	5.730***	6.081***
				(1.925)	(1.977)	(1.939)
thana dummies * 2003						yes
n	450	450	450	446	384	384

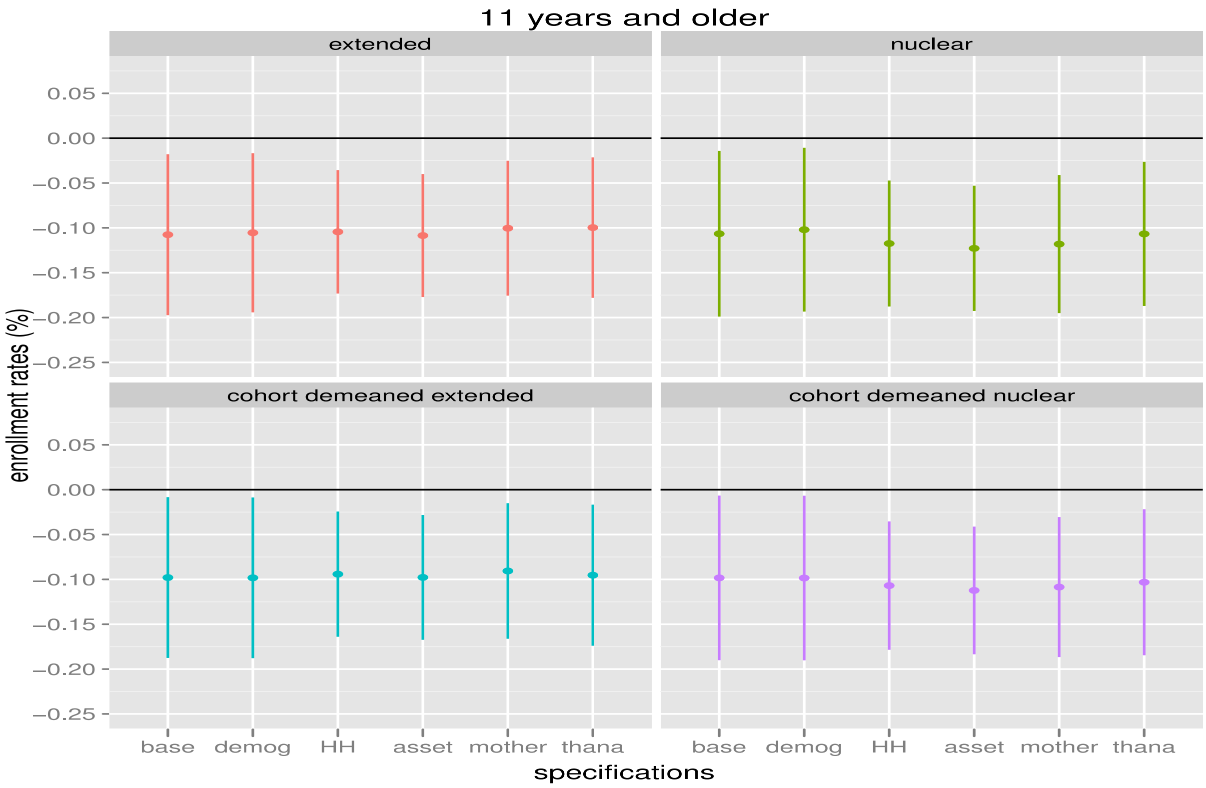
Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. ∗, ∗∗, ∗ ∗ ∗ indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 6: Linear Enrollment Probability Fixed-Effect Model, Nuclear Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age		−0.025	0.100	0.049	0.053	0.032
		(0.147)	(0.106)	(0.101)	(0.111)	(0.115)
age2		−0.007***	−0.009***	−0.009***	−0.009***	−0.009***
		(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
year 2003	−0.293***	0.369	0.721**	0.874***	0.736**	0.703*
	(0.033)	(0.404)	(0.302)	(0.286)	(0.341)	(0.359)
program membership			0.656***	0.656***	0.674***	0.683***
			(0.032)	(0.032)	(0.035)	(0.034)
interaction with 2003						
agricultural household	−0.107**	−0.102**	−0.117***	−0.123***	−0.118***	−0.107***
	(0.047)	(0.047)	(0.036)	(0.036)	(0.039)	(0.041)
sex (female = 1)		−0.004	−0.169***	−0.169***	−0.174***	−0.179***
		(0.047)	(0.038)	(0.038)	(0.042)	(0.041)
head primary			−0.023	−0.014	−0.039	−0.033
			(0.040)	(0.040)	(0.044)	(0.043)
head secondary			−0.089*	−0.087*	−0.113**	−0.125**
			(0.049)	(0.049)	(0.052)	(0.052)
head spouse primary					−0.022	−0.027
					(0.046)	(0.045)
head spouse secondary					0.014	0.011
					(0.046)	(0.046)
spouse sex (female = 1)					0.094	0.188
					(0.131)	(0.143)
per member land holding				6.473***	6.827***	6.916***
				(1.588)	(1.771)	(2.250)
nonland asset (1,000,000 Tk)				5.511***	5.841***	6.101***
				(1.931)	(2.002)	(1.963)
thana dummies * 2003						yes
n	421	421	421	417	361	361

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. ∗, ∗∗, ∗ ∗ ∗ indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Figure 4: Robustness Check on $\hat{\gamma}$



Source: Estimated by authors using IFPRI data.

Notes: 1. Fixed effect linear probability models. All regressands are enrollment.

2. Regression specifications "base", "demog", "HH", "asset", "mother", and "thana" correspond to (1) - (6) in the result tables, respectively.

using a new age cut off at ten or older. All point estimates become smaller for 10 and older, but estimates remain statistically significant, because standard errors are smaller. In contrast, if we set the cut off at twelve and older, the contrary should occur. This is what we observe in , and Tables 15, 16. We have greater point estimates than 10 years and older case, but also greater standard errors, consistent with expectation.

6 Conclusion

The issue of seasonality is quite important and needs to be addressed properly to have effective public policies. Adjustments in institutional design are necessary for developing countries which are predominantly agrarian economies and are frequently affected by seasonality. To our surprise, seasonally adjusted policies outside the context of food security and disaster management are rare. This paper seeks to address the impact of seasonal labor demand on school enrollment and drop out in Bangladesh. The school calender for both primary and high schools in Bangladesh is not seasonally adjusted to local agriculture. This can increase drop out by forcing children to trade-off between education and work, especially during the peak harvesting season. To identify the impacts of seasonal labor demand on dropout, we employed Ramadan vacation in the year of 1999 as a natural experiment. In 1999, Ramadan driven school vacation coincided with the original annual exam period of December. This forced schools to pre-pone their final exam schedules in November, which was the month before the harvest begins. As a consequence, labor demand during the annual examination period in year 1999 was smaller. Comparing this phenomenon with year 2002, by employing longitudinal data, we found positive and significant impacts of seasonal labor demand on drop out for the rural agricultural households in Bangladesh.

There are arguably ample factors other than seasonality that are limiting educational attainment and increasing the dropout in Bangladesh. However, adjusting the school calendars with local agrarian calendars will at least reduce the dilemma faced by the children from the agricultural households and implementing such adjustment is almost costless for Bangladesh. Countries like Japan, Brazil, Colombia and The Gambia have implemented seasonally adjusted education policies in the past, and their impacts are told favorably, if anecdotally. Even in Bangladesh, non-formal education providers, which are mainly Non Government Organizations (NGOs), have also taken steps to adjust school calendars with seasonality. For instance, schools run by BRAC, a leading NGO for example, has already undertook seasonally-adjusted school calendar in Bangladesh.

We have used household level panel data to rigorously assess the impacts of having the exams in off-harvesting seasons. Our identification strategy using DID estimators relied on several assumptions: First, differential impacts exist between agricultural and non-agricultural households. This is likely to hold, as non-agricultural households face peak labor demand, if any, different than harvesting season (for example during the time of new year celebration). Second, from employers' perspectives, children from agricultural households tend to have better expertise in agricultural production and thus are more employable during the harvesting season. Third, impacts of having holidays immediately before the exam period can be partly captured by parental education that are assumed to proxy the home learning environment. While these proxies are never perfect, they will control certain aspects of learning environment at the home. Given these considerations, we expect the results of our empirical analysis to have high credibility.

We have shown that estimated results robustly point that schooling of children from agricultural households have benefitted from Ramadan holidays in 1999 relative to children from non-agricultural households. Results survived after extensive specification search, where we used various wealth, locational measures, official program membership variables, and we have also controlled for cohort effects. The results shown in this paper can provide foundation for reconsidering the school calendar that is consistent with seasonal local labor market conditions.

Table 7: Alternative Agricultural Household Definition

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
age		−0.040 (0.146)	0.102 (0.104)	0.049 (0.099)	0.045 (0.110)	0.027 (0.114)
age2		−0.006*** (0.002)	−0.009*** (0.001)	−0.010*** (0.001)	−0.009*** (0.002)	−0.008*** (0.002)
year 2003	−0.304*** (0.034)	0.362 (0.404)	0.732** (0.300)	0.886*** (0.280)	0.764** (0.338)	0.760** (0.354)
program membership			0.662*** (0.030)	0.662*** (0.031)	0.683*** (0.033)	0.691*** (0.033)
interaction with 2003						
agricultural household	−0.094** (0.046)	−0.086* (0.046)	−0.117*** (0.036)	−0.120*** (0.036)	−0.114*** (0.040)	−0.116*** (0.041)
sex (female = 1)		−0.008 (0.046)	−0.173*** (0.037)	−0.174*** (0.037)	−0.184*** (0.040)	−0.191*** (0.039)
head primary			−0.011 (0.039)	−0.003 (0.039)	−0.030 (0.043)	−0.026 (0.042)
head secondary			−0.096** (0.047)	−0.094** (0.047)	−0.130*** (0.050)	−0.148*** (0.050)
head spouse primary					−0.024 (0.045)	−0.023 (0.044)
head spouse secondary					0.004 (0.045)	0.008 (0.044)
spouse sex (female = 1)					0.097 (0.134)	0.176 (0.143)
per member land holding				5.793*** (1.555)	6.100*** (1.760)	6.872*** (2.155)
nonland asset (1,000,000 Tk)				5.217*** (1.927)	5.637*** (1.981)	6.000*** (1.932)
thana dummies * 2003						yes
n	450	450	450	446	384	384

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 8: Alternative Agricultural Household Definition, Nuclear Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
age		−0.027 (0.147)	0.095 (0.105)	0.044 (0.102)	0.045 (0.111)	0.025 (0.115)
age2		−0.007*** (0.002)	−0.009*** (0.001)	−0.009*** (0.002)	−0.009*** (0.002)	−0.008*** (0.002)
year 2003	−0.299*** (0.035)	0.356 (0.403)	0.731** (0.302)	0.882*** (0.286)	0.747** (0.340)	0.713** (0.360)
program membership			0.662*** (0.032)	0.663*** (0.032)	0.680*** (0.035)	0.689*** (0.034)
interaction with 2003						
agricultural household	−0.090* (0.047)	−0.079* (0.047)	−0.126*** (0.037)	−0.130*** (0.036)	−0.127*** (0.041)	−0.120*** (0.042)
sex (female = 1)		−0.004 (0.047)	−0.173*** (0.038)	−0.173*** (0.038)	−0.176*** (0.042)	−0.181*** (0.041)
head primary			−0.022 (0.040)	−0.013 (0.040)	−0.038 (0.043)	−0.034 (0.043)
head secondary			−0.086* (0.048)	−0.084* (0.049)	−0.112** (0.052)	−0.125** (0.052)
head spouse primary					−0.024 (0.046)	−0.028 (0.045)
head spouse secondary					0.011 (0.046)	0.008 (0.046)
spouse sex (female = 1)					0.099 (0.130)	0.194 (0.141)
per member land holding				6.393*** (1.603)	6.729*** (1.772)	6.776*** (2.220)
nonland asset (1,000,000 Tk)				5.422*** (1.934)	5.709*** (2.004)	5.988*** (1.953)
thana dummies * 2003						yes
n	421	421	421	417	361	361

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 9: Cohort Demeaned

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000***	0.000***	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
program membership			0.651***	0.651***	0.680***	0.687***
			(0.034)	(0.034)	(0.037)	(0.036)
interaction with 2003						
agricultural household	−0.098**	−0.098**	−0.094***	−0.098***	−0.091**	−0.095**
	(0.046)	(0.046)	(0.036)	(0.035)	(0.038)	(0.040)
sex (female = 1)		−0.010	−0.171***	−0.168***	−0.185***	−0.190***
		(0.046)	(0.037)	(0.037)	(0.040)	(0.040)
head primary			−0.010	−0.003	−0.031	−0.027
			(0.040)	(0.040)	(0.044)	(0.043)
head secondary			−0.090*	−0.086*	−0.122**	−0.142***
			(0.048)	(0.048)	(0.051)	(0.052)
head spouse primary					−0.022	−0.020
					(0.044)	(0.044)
head spouse secondary					0.004	0.011
					(0.046)	(0.045)
spouse sex (female = 1)					0.127	0.210
					(0.147)	(0.155)
per member land holding				4.568**	4.693**	5.953**
				(2.067)	(2.094)	(2.411)
nonland asset (1,000,000 Tk)				5.259***	5.741***	6.044***
				(1.954)	(2.008)	(1.957)
thana dummies * 2003						yes
n	441	441	441	438	378	378

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Cohort demeaning eliminates cohort common trends, including age and year dummy.
3. *, **, * * * indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 10: Cohort Demeaned, Alternative Definitions

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000***	0.000***	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
program membership			0.656***	0.656***	0.682***	0.689***
			(0.034)	(0.034)	(0.037)	(0.036)
interaction with 2003						
agricultural household	−0.087*	−0.087*	−0.108***	−0.111***	−0.105***	−0.110***
	(0.046)	(0.046)	(0.036)	(0.036)	(0.039)	(0.041)
sex (female = 1)		−0.010	−0.174***	−0.171***	−0.186***	−0.191***
		(0.046)	(0.037)	(0.037)	(0.040)	(0.040)
head primary			−0.009	−0.002	−0.030	−0.026
			(0.040)	(0.040)	(0.043)	(0.043)
head secondary			−0.088*	−0.084*	−0.123**	−0.142***
			(0.047)	(0.048)	(0.051)	(0.052)
head spouse primary					−0.022	−0.020
					(0.044)	(0.044)
head spouse secondary					0.000	0.008
					(0.046)	(0.045)
spouse sex (female = 1)					0.129	0.212
					(0.144)	(0.152)
per member land holding				4.427**	4.550**	5.702**
				(2.082)	(2.083)	(2.360)
nonland asset (1,000,000 Tk)				5.251***	5.707***	6.016***
				(1.958)	(2.013)	(1.952)
thana dummies * 2003						yes
n	441	441	441	438	378	378

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Cohort demeaning eliminates cohort common trends, including age and year dummy.
3. *, **, * * * indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 11: Cohort Demeaned, Nuclear Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000***	0.000***	0.000	0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
program membership			0.649***	0.651***	0.673***	0.684***
			(0.035)	(0.035)	(0.038)	(0.037)
interaction with 2003						
agricultural household	−0.098**	−0.098**	−0.107***	−0.112***	−0.109***	−0.103**
	(0.047)	(0.047)	(0.036)	(0.036)	(0.040)	(0.041)
sex (female = 1)		−0.009	−0.172***	−0.168***	−0.177***	−0.181***
		(0.047)	(0.038)	(0.038)	(0.042)	(0.041)
head primary			−0.021	−0.013	−0.039	−0.034
			(0.041)	(0.041)	(0.045)	(0.044)
head secondary			−0.082*	−0.078	−0.106**	−0.120**
			(0.049)	(0.049)	(0.053)	(0.054)
head spouse primary					−0.018	−0.021
					(0.046)	(0.045)
head spouse secondary					0.012	0.013
					(0.048)	(0.047)
spouse sex (female = 1)					0.119	0.219
					(0.141)	(0.152)
per member land holding				5.283**	5.640**	6.119**
				(2.165)	(2.242)	(2.602)
nonland asset (1,000,000 Tk)				5.503***	5.903***	6.148***
				(1.966)	(2.043)	(1.992)
thana dummies * 2003						yes
n	413	413	413	410	355	355

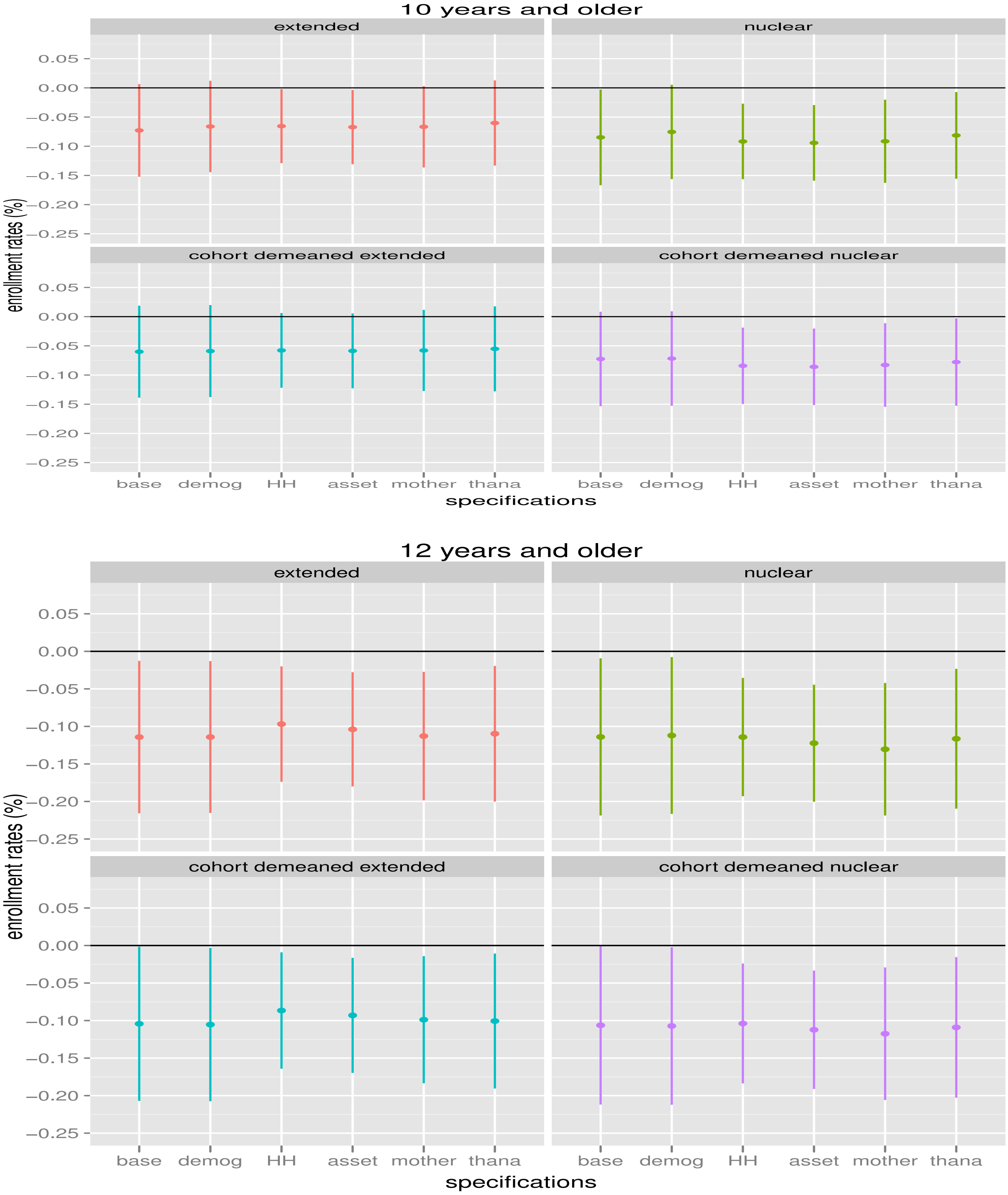
Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Cohort demeaning eliminates cohort common trends, including age and year dummy.
3. *, **, * * * indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 12: Cohort Demeaned, Nuclear Members, Alternative Definitions

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000***	0.000**	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
program membership			0.654***	0.656***	0.677***	0.688***
			(0.035)	(0.035)	(0.038)	(0.037)
interaction with 2003						
agricultural household	−0.082*	−0.083*	−0.116***	−0.120***	−0.118***	−0.114***
	(0.047)	(0.047)	(0.037)	(0.037)	(0.041)	(0.042)
sex (female = 1)		−0.010	−0.175***	−0.172***	−0.178***	−0.182***
		(0.048)	(0.038)	(0.038)	(0.042)	(0.041)
head primary			−0.019	−0.011	−0.037	−0.033
			(0.041)	(0.041)	(0.044)	(0.044)
head secondary			−0.078	−0.074	−0.105**	−0.119**
			(0.049)	(0.049)	(0.053)	(0.054)
head spouse primary					−0.020	−0.023
					(0.046)	(0.045)
head spouse secondary					0.008	0.009
					(0.047)	(0.047)
spouse sex (female = 1)					0.123	0.223
					(0.139)	(0.149)
per member land holding				5.085**	5.419**	5.842**
				(2.215)	(2.259)	(2.595)
nonland asset (1,000,000 Tk)				5.468***	5.837***	6.090***
				(1.972)	(2.048)	(1.985)
thana dummies * 2003						yes
n	413	413	413	410	355	355

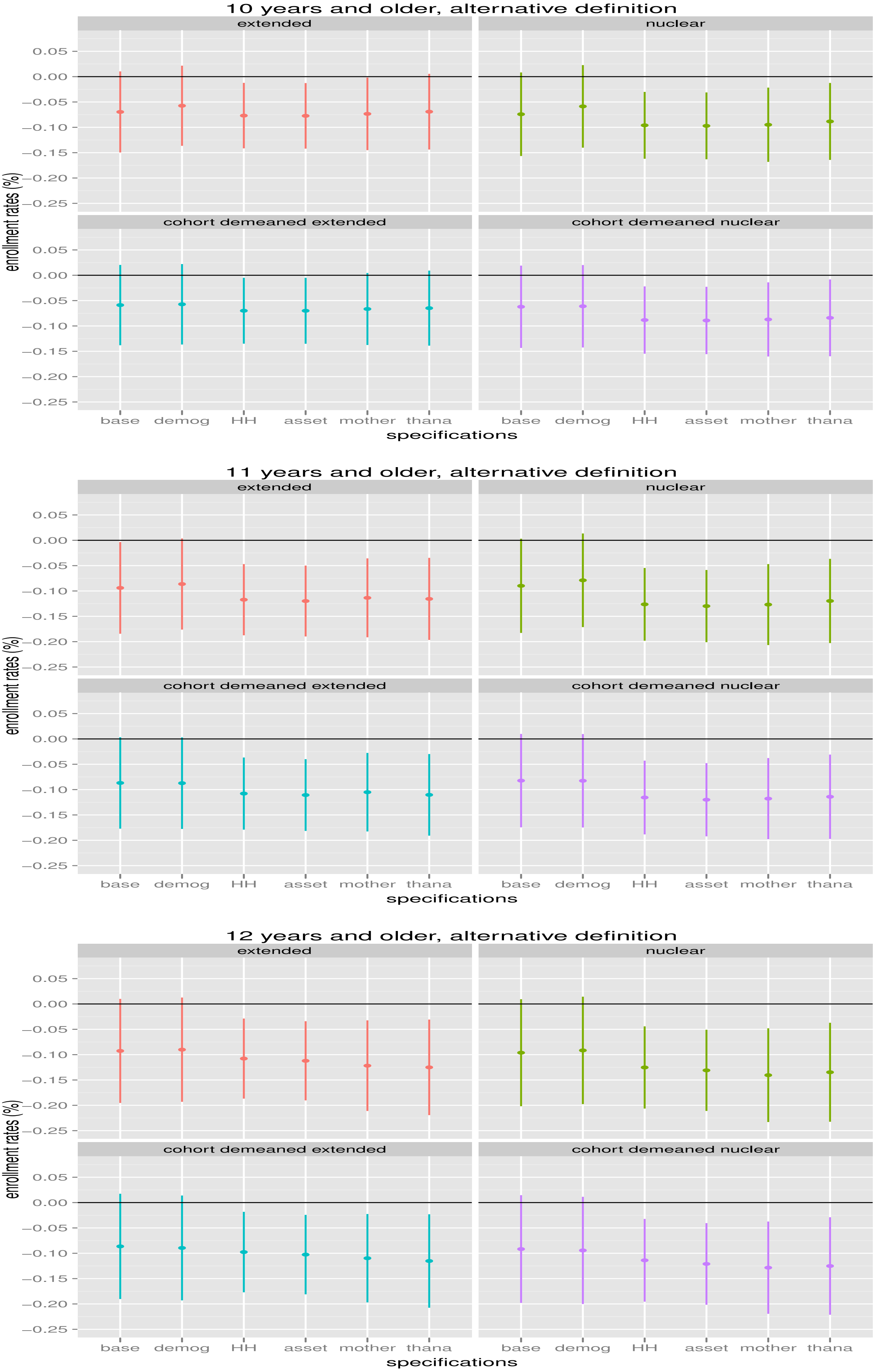
Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Cohort demeaning eliminates cohort common trends, including age and year dummy.
3. *, **, * * * indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Figure 5: Robustness Check on $\hat{\gamma}$



Source: Estimated by authors using IFPRI data.
Notes: 1. Fixed effect linear probability models. All regressands are enrollment.
2 Regression specifications are are of (1) - (6) in estimation results table.

Figure 6: Robustness Check on $\hat{\gamma}$, Alternative Definition



Source: Estimated by authors using IFPRI data.
Notes: 1. Fixed effect linear probability models. All regressands are enrollment.
2 Regression specifications are are of (1) - (6) in estimation results table.

Table 13: Ages 10 and Older

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
age		−0.043 (0.131)	0.055 (0.098)	0.001 (0.091)	0.018 (0.100)	−0.008 (0.104)
age2		−0.006*** (0.002)	−0.008*** (0.001)	−0.009*** (0.001)	−0.009*** (0.001)	−0.008*** (0.001)
year 2003	−0.292*** (0.029)	0.357 (0.368)	0.700** (0.280)	0.849*** (0.256)	0.777*** (0.301)	0.781** (0.314)
program membership			0.612*** (0.028)	0.607*** (0.029)	0.620*** (0.031)	0.626*** (0.031)
interaction with 2003						
agricultural household	−0.073* (0.040)	−0.066* (0.040)	−0.066** (0.032)	−0.067** (0.032)	−0.067* (0.036)	−0.060 (0.037)
sex (female = 1)		0.036 (0.040)	−0.141*** (0.034)	−0.139*** (0.034)	−0.154*** (0.037)	−0.155*** (0.037)
head primary			0.008 (0.036)	0.015 (0.036)	−0.015 (0.039)	−0.009 (0.039)
head secondary			−0.051 (0.043)	−0.048 (0.043)	−0.087* (0.046)	−0.101** (0.046)
head spouse primary					0.003 (0.041)	0.007 (0.041)
head spouse secondary					−0.005 (0.042)	−0.001 (0.042)
spouse sex (female = 1)					0.072 (0.105)	0.130 (0.111)
per member land holding				5.543*** (1.637)	5.609*** (1.758)	6.787*** (2.084)
nonland asset (1,000,000 Tk)				3.193* (1.937)	2.871 (2.080)	2.704 (2.173)
thana dummies * 2003						yes
n	565	565	565	560	482	482

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Minimum age is set to 10.
3. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 14: Ages 10 and Older, Nuclear Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
age		−0.027 (0.147)	0.095 (0.105)	0.044 (0.102)	0.045 (0.111)	0.025 (0.115)
age2		−0.007*** (0.002)	−0.009*** (0.001)	−0.009*** (0.002)	−0.009*** (0.002)	−0.008*** (0.002)
year 2003	−0.299*** (0.035)	0.356 (0.403)	0.731** (0.302)	0.882*** (0.286)	0.747** (0.340)	0.713** (0.360)
program membership			0.662*** (0.032)	0.663*** (0.032)	0.680*** (0.035)	0.689*** (0.034)
interaction with 2003						
agricultural household	−0.090* (0.047)	−0.079* (0.047)	−0.126*** (0.037)	−0.130*** (0.036)	−0.127*** (0.041)	−0.120*** (0.042)
sex (female = 1)		−0.004 (0.047)	−0.173*** (0.038)	−0.173*** (0.038)	−0.176*** (0.042)	−0.181*** (0.041)
head primary			−0.022 (0.040)	−0.013 (0.040)	−0.038 (0.043)	−0.034 (0.043)
head secondary			−0.086* (0.048)	−0.084* (0.049)	−0.112** (0.052)	−0.125** (0.052)
head spouse primary					−0.024 (0.046)	−0.028 (0.045)
head spouse secondary					0.011 (0.046)	0.008 (0.046)
spouse sex (female = 1)					0.099 (0.130)	0.194 (0.141)
per member land holding				6.393*** (1.603)	6.729*** (1.772)	6.776*** (2.220)
nonland asset (1,000,000 Tk)				5.422*** (1.934)	5.709*** (2.004)	5.988*** (1.953)
thana dummies * 2003						yes
n	421	421	421	417	361	361

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Minimum age is set to 10.
3. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 15: Ages 12 and Older

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age		0.186	0.166	0.168	0.365***	0.375***
		(0.216)	(0.144)	(0.152)	(0.069)	(0.096)
age2		−0.005*	−0.010***	−0.010***	−0.009***	−0.009***
		(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
year 2003	−0.329***	−0.419	0.578	0.568	−0.177	−0.268
	(0.037)	(0.604)	(0.404)	(0.427)	(0.192)	(0.294)
program membership			0.689***	0.695***	0.709***	0.712***
			(0.033)	(0.033)	(0.036)	(0.036)
interaction with 2003						
agricultural household	−0.114**	−0.114**	−0.097**	−0.104***	−0.113***	−0.110**
	(0.052)	(0.052)	(0.039)	(0.039)	(0.044)	(0.046)
sex (female = 1)		−0.063	−0.170***	−0.166***	−0.160***	−0.167***
		(0.052)	(0.040)	(0.040)	(0.044)	(0.044)
head primary			−0.040	−0.023	−0.056	−0.049
			(0.044)	(0.043)	(0.047)	(0.047)
head secondary			−0.100*	−0.096*	−0.127**	−0.141**
			(0.053)	(0.052)	(0.058)	(0.058)
head spouse primary					0.014	0.011
					(0.050)	(0.050)
head spouse secondary					0.011	0.012
					(0.051)	(0.051)
spouse sex (female = 1)					0.109	0.174
					(0.127)	(0.136)
per member land holding				5.643***	5.545***	5.811**
				(1.586)	(1.860)	(2.357)
nonland asset (1,000,000 Tk)				7.013***	7.249***	7.669***
				(2.010)	(2.090)	(2.131)
thana dummies * 2003						yes
n	361	361	361	359	309	309

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Minimum age is set to 12.
3. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

Table 16: Ages 12 and Older, Nuclear Members

variables	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age		0.175	0.155	0.158	0.358***	0.383***
		(0.212)	(0.153)	(0.160)	(0.069)	(0.094)
age2		−0.005*	−0.009***	−0.009***	−0.009***	−0.008***
		(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
year 2003	−0.331***	−0.406	0.571	0.563	−0.198	−0.371
	(0.040)	(0.586)	(0.432)	(0.454)	(0.187)	(0.286)
program membership			0.694***	0.702***	0.712***	0.716***
			(0.034)	(0.034)	(0.037)	(0.036)
interaction with 2003						
agricultural household	−0.096*	−0.092*	−0.125***	−0.131***	−0.140***	−0.135***
	(0.054)	(0.054)	(0.041)	(0.041)	(0.047)	(0.050)
sex (female = 1)		−0.061	−0.174***	−0.170***	−0.158***	−0.160***
		(0.053)	(0.041)	(0.041)	(0.045)	(0.045)
head primary			−0.049	−0.032	−0.066	−0.062
			(0.045)	(0.044)	(0.048)	(0.048)
head secondary			−0.094*	−0.089*	−0.110*	−0.123**
			(0.054)	(0.054)	(0.062)	(0.061)
head spouse primary					0.002	−0.006
					(0.051)	(0.051)
head spouse secondary					0.009	0.003
					(0.053)	(0.053)
spouse sex (female = 1)					0.114	0.196
					(0.120)	(0.131)
per member land holding				6.237***	6.320***	5.703**
				(1.644)	(1.877)	(2.384)
nonland asset (1,000,000 Tk)				6.784***	6.911***	7.244***
				(2.020)	(2.112)	(2.123)
thana dummies * 2003						yes
n	338	338	338	336	291	291

Source: Compiled from IFPRI data.
Notes: 1. Location dummies are omitted from the table for brevity.
2. Minimum age is set to 12.
3. *, **, *** indicate significance levels at 10%, 5%, 1%, respectively, using cluster robust standard errors.

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