The Winter's Tale: Season of Birth Impacts on Children in China*

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Abstract

This paper examines the effect of season of birth on height, cognitive ability, and non-cognitive ability of Chinese children. We find that season of birth has a significant impact on the height of girls aged less than five years in agricultural households. In particular, girls born in winter have lower height as compared to those born in other seasons, consistent with son preference in deciding the allocation of resources in early childhood. We find, however, that this relative height differential does not translate to deficits in cognitive and non-cognitive skills when girls are older. We argue that compensating investments by parents, manifested through greater parental expectations on educational attainment for poorly endowed girls born in the winter, may explain this catch-up.

Key Words: Child Health, Cognitive and Non Cognitive Skills, Compensating Investments, Season of Birth, China

JEL Codes: O15, I15, J13

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1 Introduction

This paper examines the effect of season of birth on long-term health, and on cognitive and non-cognitive ability of Chinese children. There is now a growing literature that examines the effects of initial or early childhood conditions on outcomes later in life. Specifically, it is argued that the time of the year when a child is born matters. This is because there are periods in the year when food and other resources are plentiful. There are also other times annually when households might be severely resource-constrained. The medical literature has now documented that time of birth during the year can affect the outcomes of very young children including infant mortality (Breschi and Livi-Bacci, 1997), their health as adults (Weber, Prossinger, and Seidler, 1998), susceptibility to diseases and disabilities (Muhuri, 1996), their life span (Doblhammer and Vaupel, 2001), and cognitive ability (McGrath, Saha, Lieberman, and Buka, 2006, Venkataramani, 2012). The economics literature from both developed and developing countries also suggests that the time of the year the child is born impacts human capital development. For example the education literature starting from Angrist and Kruger (1991) finds that in the US, children born during the first quarter of the year have lower average level of education than children born later in the year. Turning to developing countries, Almond and Mazumder (2011) finds that in-utero exposure to Ramadan (the Islamic month of fasting) results in lower birth weight and long term disability. Using data from India, Lokshin and Radyakin (2012) finds that children born during the monsoon months have lower anthropometric scores compared to children born in the post-monsoon and winter months.

We examine the impact of season of birth on children born in agricultural and non-agricultural households in China, after ensuring that there is no selection into season of birth (i.e., the timing of birth is not endogenous). We investigate specifically whether the effect of birth season varies by gender and developmental stages. In China, as in many other developing countries where agriculture is an important source of livelihood, the monsoon season is crucially important. The monsoon can affect child health and skills in multiple ways. By influencing agricultural production, the timing of the monsoon is correlated with resource availability within the household, which can positively influence the health and cognitive ability of children (Maccini and Yang, 2009, Tiwari, Jacoby, and Skoufias, 2017, Shah and Steinberg, 2017). However, the monsoon is also associated with an enhanced disease environment, which can have a negative effect on the health of children in agricultural households (Muhuri, 1996). Which effect dominates in a specific context is ultimately an empirical question. Conversely, births in other seasons of the year might also have adverse implications for children. For example, winter, is also often viewed as a season of shortages. Agricultural activity is rather limited during winter and this clearly has implications for household resources, particularly for agricultural households. Additionally, Brown, Bulte, and Zhang (2011) argue that during specific events and festivals, poor households in China tend to increase their spending on socially observable goods as a channel of status seeking. The Lunar New Year, which is typically in winter, is one such event that promotes status seeking consumption. By limiting liquidity, this could have an indirect effect on household investments that are key determinants of child health and development. Given the susceptibility of agricultural households to these factors and the well documented preference for sons in Chinese society, resource constraints might have gender differentiated impacts. Hence, whether being born in the monsoon season is an advantage or a disadvantage is ultimately an empirical question, depending on the context. We address this question in this study using information on seasons of birth of children in China.

Our results show that relative to girls born in winter, girls in agricultural households born in the pre-monsoon, monsoon and post-monsoon seasons have significantly higher height-for-age z-scores (HAZ); the widely accepted proxy for long-term health.[1] The relative effect is the strongest and the most persistent for children born in the post-monsoon season. There is no effect of season of birth on birth weight, which suggests that the season of birth effect on long-term health is not due to what happens *in-utero*; rather it may be the result of circumstances the household faces after the child is born. Our results are consistent with son preference in the allocation of resources within agricultural households in China during early childhood. One interpretation of our results is that the early nutritional deprivation that girls face (in the period after being born and weaned from breast milk) is exacerbated in winter months when households are particularly resource-constrained.

[1]See discussion in Section 3 on the use of HAZ as a measure of long term health of children.

We go further and examine whether such initial disadvantages have long-term and lasting impacts. While it has been argued that initial conditions have longer term implications on cognitive and non-cognitive development, we find that there is very little effect of season of birth on the cognitive and non-cognitive ability of children in adolescence. In particular, while girls in agricultural households born in winter have a lower relative HAZ as of age 5, this disadvantage does not translate to lower cognitive or non-cognitive development, indicating that they catch up with those born in other seasons. This may be because conditional on observed health, there might be compensating investments on the part of parents so that early childhood effects do not persist over time.[2] We find that such compensating investments take the form of parents investing additional time and resources on specific children (the income equalization hypothesis (see Behrman and Rosenzweig, 2004)).

Lacking detailed data on parental time use and resource investments, we use parental expectations on the educational attainment of their children, conditional on observed health and other individual and household characteristics, as a proxy for parental compensating investments in children. Parental expectations can be a key indicator of parents' involvement and investments in children's education (Fan and Chen, 2001), and can potentially be a crucial determinant in forming children's expectation and attitudes towards education (Wood, Kaplan, and McLoyd, 2007). The existing literature posits the significant positive correlation between parental expectation and children's educational achievement: as noted, this may happen through provision of a cognitively supportive and emotionally inspiring environment (Neuenschwander, Vida, Garrett, and Eccles, 2007).

We find that parents from agricultural households hold higher educational expectations for daughters born in the winter as compared to those born in the monsoon and post-monsoon seasons. It is possible that parents believe that because of their relative initial health advantage, girls born in the pre-monsoon, monsoon and post-monsoon seasons are better off when it comes to physically demanding work. But daughters born in winter, who are relatively disadvantaged in terms of health, are encouraged to invest in education so that they may gain remuneration from mentally

[2] See Cunha, Heckman, and Schennach (2010) and the references cited therein for more on the issue of compensating investments on the part of parents.

demanding tasks in the future. This is thus an example of the *brain* vs *brawn* hypothesis, but *within* the same gender (Pitt, Rosenzweig, and Hassan, 2012). We find that parental expectations are positively correlated with educational expenditure and negatively correlated with hours of housework for girls in agricultural households. We hypothesize that such differential investments lead to catch-up, and we offer this as an explanation for why we do not see any evidence that the relative height deficiency in early childhood translates into statistically measurable differentials in cognitive and non-cognitive skills in adolescence.

Our research adds to the growing literature on the effect of conditions *in-utero* and at birth on child health and development in developing countries in several ways. First, we find that the season of birth matters: but unlike research from other poor countries where there is an advantage to being born in the winter, we find that being born in this season is a distinct relative disadvantage for girls as compared to girls born in other seasons. We tie this to agricultural cycles in China, which are strongly influenced by rainfall patterns and note that the *winter disadvantage* may be linked to shortages that rural households face at this time of the year. This winter birth disadvantage has also been observed elsewhere. However the context is completely different - often in developed countries and often due to the imposition of exogenous rules such as those that govern school enrollment. In our study, the winter birth disadvantage arises endogenously in response to environmental circumstances that shape household resources and the resulting investments in children. Second, our study is unique is that we are able to identify channels via which the initial health disadvantage at younger ages does not manifest itself in long-term cognitive and non-cognitive shortages. Specifically, we show that parental expectations play a key role in directing educational and time resources to girls born in winter who are at relatively greater risk. Finally, we demonstrate the robustness of our results using a range of alternative specifications, including different ways of categorizing the year into seasons. This allows us to cast light on the potential nature versus nurture origins of the results that we document in this paper.

The rest of the paper is organized as follows. Section 2 presents the estimation framework. Section 3 presents details in the data sets used and provides an overview of the key variables in our analysis.

Section 4 presents the empirical results: Section 4.1 presents the results for the effects of season of birth on height-for-age z-scores (sample includes children aged 0–5 years); Section 4.2 presents the corresponding results on cognitive and non-cognitive test scores of children aged 10–15 years. Here we also present evidence on the channels through with the effects of initial conditions might be mitigated. Finally Section 5 concludes.

2 Framework

Consider a standard household utility maximization framework. Household h maximizes a household utility function, which depends on consumption and leisure of its members, and the quality and quantity of children. Quality of children is captured by health, and cognitive and non-cognitive ability of children. The household maximizes this utility, subject to a set of standard budget constraints and restrictions imposed by a human capital production function. The human capital production function posits individual outcomes at time t (H_t) to be a function of initial endowment (H_0), inputs in the past ($H_\tau; \tau = 1, \ldots, t-1$), demographic and socio-economic characteristics, which might be time invariant ($\mathbf{X}$), a set of community infrastructure variables, both current and in the past ($C_j; j = 0, \ldots, t$) and the disease environment, again both current and in the past ($D_j; j = 0, \ldots, t$).

Using this framework we can obtain reduced form demand function for the outcomes of child i belonging to household h (Z_{ih}, which includes height for age and cognitive and non-cognitive skills) that depends on a set of child (X_i), household (X_h), parental (X_p) and community specific characteristics (X_c) in addition to the initial environmental conditions that the child faces. The outcomes of child i in household h can be written as:

$$Z_{ih} = Z(X_i, X_h, X_p, X_c, E_0, \varepsilon_{ih}) \tag{1}$$

Here ε_{ih} denotes the set of unobserved factors that affect the health, cognitive and non-cognitive skills of child i in household h. These could include genetic factors. We will estimate variants of equation (1).

In a developing country context, initial environmental conditions (E_0) are assumed to be determined by the time of the year when the child is born. Given the sheer size of China as a country, there are vast differences in these initial environmental conditions. This is because climate varies significantly across China, and there are large variations across regions of China in terms of temperature, humidity, precipitation and hence agricultural activities, sometimes even within the same calendar month (Song, Achberger, and Linderholm, 2011). A specific month therefore might not have equal significance in different parts of the country. For example, while the average temperature in Guangdong can reach 26 degree Celsius and average rainfall is more than 200 millimeters in May, average temperature in Shanxi is less than 17 degree Celsius and average rainfall is around 50 millimeters in the same month. These two provinces are also substantially different in terms of main crops cultivated and hence in terms of the *key* months of the year for agriculture (for example rice is a main crop in Guangdong while wheat is a main crop of Shanxi). In order to examine the effect of season of birth on children's outcomes, we consider similarities in patterns across climate zones in China as they influence agricultural production. In this, the key variable is rainfall. The majority of China is impacted by the Asian monsoon, however the monsoon affects provinces of China at different time periods during the year. The summer monsoon advances to southern China in mid-May and reaches the Yangtze River valley in mid-June when the *mei-yu* (or the plum rain) begins. The monsoon then progresses slowly northward for the next three weeks to cover parts of northern China. The monsoon starts withdrawing in early September, and retreats quickly across mainland China over the next month. For more details on these weather patterns, see Zeng and Lu (2004). For these reasons, we use the monsoon months as a criterion to categorise timing of birth of Chinese children, rather than the month of birth as defined by the Gregorian calendar. The regional variation in the onset of monsoon in China is illustrated clearly in Figure 1 which shows that the southern provinces experience the onset of monsoons in May, provinces in the middle portion of the country experience the monsoons in June, and finally the rest of the country is affected in July. Given its strong influence on agriculture, we hypothesize that season of birth as defined by the monsoons will have a relatively stronger impact on rural households.

Despite technological improvements and spread of irrigation, agriculture in China continues to be heavily dependent on the monsoons and adequate rainfall is crucial for the majority of China's main crops. Figure 2 presents the crop calendar for China. This shows that with the exception of winter wheat and rapeseed, there is very little agricultural production/activity during the winter months of December, January and February. Even in these case, there is no harvest during these three months. All of this substantiates our hypothesis that households are resource constrained in winter. We expect the season of birth to have weaker effects on the outcomes of children in non-agricultural households.

We sub-divide the year into four quarters: pre-monsoon, monsoon, post-monsoon and winter (reference season). For each province in the country, using data on average monthly rainfall over the period 1982–2012, the monsoon season is defined as the three consecutive months in a year with the highest average rainfall.[3] This method of defining the monsoon season implies that the onset of monsoon and the monsoon period varies across the different provinces of China. Further, our use of long run data on rainfall provides more information regarding the timing of the monsoon's arrival across the country.

Figure 3 presents the seasons across the different provinces of China. It is clear that the time of the onset of monsoon, and thus which months are categorized as particular seasons, varies considerably across the different provinces. For example, the provinces of Shanxi, Shaanxi, Gansu and the Ningxia Hui Autonomous region are characterised by relatively late onset of monsoons (the onset is in July), whereas Guangdong and Guangxi Zhuang Autonomous region are characterised by the relatively early onset of monsoons (the monsoons arrive in May).[4]

Our primary estimating equation is therefore given by

$$Z_{ih} = \mathbf{X}'\beta + \sum_{s=1}^{3} \gamma_s \text{Season}_{ihs} + \varepsilon_{ih} \tag{2}$$

where $\text{Season}_{ihs} = 1$ if child i in household h is born in season s (pre-monsoon, monsoon, post-

[3]See https://en.climate-data.org/info/sources/

[4]See Section 4 for an alternative way of categorizing seasons. This alternative approach takes into account the within province variation the categorization of months into seasons across years. However this data is constructed using observations from a subset of available weather stations across the country.

monsoon); the reference category is that the child is born in winter.

3 Data

Three waves of China Family Panel Studies (CFPS) data collected by Peking University are used in this study. The CFPS is a nationally representative longitudinal survey covering 25 provinces or equivalent administrative units that represents 94.5 percent of the Chinese population (Xie and Hu, 2014). The survey collected information on a range of individual (separate modules for adults and children), household and community characteristics. The three waves of the survey were conducted in 2010, 2012 and 2014.[5] The sample size varies across rounds. The 2010 wave consists of 14,798 households (33,600 adults and 8990 children), the 2012 wave consists of 13,315 households (35,719 adults and 8,620 children) and finally the 2014 wave consists of 13,946 households (37,147 adults and 8,617 children). One of the benefits of using CFPS comes from the design of the household roster. The CFPS household-roster provides basic information of all core (defined as those members who share one kitchen and have blood/marriage or adoption relations) and non-core family members (who share one kitchen and live in the family for 6 months or more in a year, but do not have blood/marriage or adoption relationship), even when they were not at home at the time of survey. We are thus able to track migrants, particularly when they are parents of the indexed child. In addition, the availability of detailed information on each individual's relationships is valuable especially in the case of extended households in which a person's relationship with the household head is sometimes not sufficient to identify the spousal or parental relationships. The availability of anthropometric measurements of children aged 0–5 years, and cognitive and non-cognitive test scores of children aged 10–15 years, are the other advantages of the data.

Our primary health outcome variable is the height-for-age z-score (or HAZ), the age- and gender-adjusted measure of height-for-age, which reflects a child's development relative to a reference population. HAZ is a measure of the number of standard deviations for a reference child, relative

[5]Data were also collected in 2011, however, the main purpose of the 2011 wave was to clarify the information collected in the 2010 wave and prepare for the 2012 wave.

to a well-nourished child at 0. It is a widely accepted measure of long-term health. A child is denoted as stunted if HAZ < -2, and extremely stunted if HAZ < -3. Stunting has been found to have an inter-generational component as mothers who were stunted in childhood are more likely to have stunted offspring. To avoid outliers and observations that are likely to be mis-measured, we restrict the sample to children whose HAZ $\in [-6, 6]$. We use a sample of children aged 0–5 years with complete data on height and weight to study the influence of season of birth. Our sample size thus consists of 6195 children across the three survey rounds.

We use two modules of cognitive tests developed in CFPS as our measure of cognitive development. The first one used in the 2010 and 2014 waves included 34 vocabulary recognition questions and 24 standardized mathematics questions covered in the standard curricula in primary and secondary schools. These tests measure *crystallized intelligence*, which is related to the knowledge acquired from education and experience. The second module used in the 2012 wave consists of a numerical reasoning test, and immediate and delayed word recalls. These tests are measures of *fluid intelligence*, which is associated with the ability to memorize, analyze and make reasoned decisions. For further details of CFPS cognitive tests, see Huang, Xie, and Xu (2015). To measure non-cognitive skills, we use data from 15 self-evaluation questions administered to children aged 10–15. We construct three indices, decided by the first three factors obtained from a principle factor analysis of these 15 questions. The score of each factor is the average of the scores of the items loading that factor. Details of the question items and principal component analysis are presented in Table A1 in the Appendix. We label the three loaded factors as confidence, diligence and self-discipline, and attitude towards teachers and schools.[6]

Selected descriptive statistics on the characteristics of the children aged 0–5 years and of the children aged 10–15 years old, their parents, households and the community are presented in Tables 1 and 2, respectively. The sample is categorized into agricultural and non-agricultural households. The sample means are presented separately for boys and girls within these household categories.

[6] Since cognitive and non-cognitive measurements are only available for children aged 10–15, it is not possible to examine the effect of season of birth on the height of children (when aged 0–5) and their cognitive and non-cognitive skill when aged 10–15.

It is clear from these tables that parents from non-agricultural households of the two age groups are notably older and more educated than those from agricultural households. Children from non-agricultural households are less likely to experience the absence of either father or mother (the causes can be migration for work, divorce or death). In general, non-agricultural households are wealthier than their agricultural counterparts. Children from non-agricultural households also experience better living standards compared to children from agricultural households. Their families are more likely to use tap water for cooking and possess in-door toilets, while more than a half of children from agricultural households use less hygienic sources of drinking water, and almost 75% of them use outdoor or public toilets. Non-agricultural households are smaller, have fewer school-age children and elderly. The descriptive statistics presented in Table 1 and 2 also reveal children in agricultural households are more likely have at least one sibling. A comparison between two age cohorts indicates that parents of children 0–5 years are more educated than parents of the older age cohort, as they have lower rates of people with no education and higher rates of those possessing senior high school degrees and college degrees. The younger age cohort also experience slightly better living standards than the older group with a higher proportion of households possessing private indoor toilets and using tap water for cooking.

The percent of births by season of birth for children in the two age cohorts (0–5 years and 10–15 years) are presented in Figure 4: Panel A for girls and Panel B for boys. The proportion of children born during pre-monsoon and monsoon seasons is lower than in the post-monsoon season and winter. Girls of both age groups and boys aged 10–15 years from agricultural households are more likely to be born in post monsoon, while winter accounts for the highest proportion of boys aged 0–5 years born in agricultural households. With regards to children from non-agricultural households, the birth rates reach peak in post-monsoon for boys aged 0–5 years and girls aged 10–15 years, and in winter for girls aged 10–15 years. The only difference is observed in percent of births by season of boys aged 10–15 years from non-agricultural households, where monsoon accounts for the highest proportions of births. This pattern in seasonality of birth may be partly explained by the season of wedding often falling in post-monsoon and spring when the weather is more favourable than the other seasons.[7]

[7]See for example, http://factsanddetails.com/china/cat4/sub20/item109.html.

Table 1 indicates that the average HAZ is significantly lower for children in agricultural households compared to those in non-agricultural households. Girls in non-agricultural households have a higher HAZ on average than boys, the opposite is true in agricultural households. However, within household type, gender differences are not statistically significant. Table 3 presents the average HAZ by gender, household type and by season of birth. Consistent with the averages presented in Table 1, HAZ is significantly lower for children residing in agricultural household compared to those in non-agricultural households, for both boys and girls, and also by month and season of birth.[8]

The descriptive statistics presented in Table 3 show that while children across season of birth achieve different test scores in mathematics and vocabulary tests. These differences could however be driven by that in age and years of schooling. Panel A of Figure 5 implies both boys and girls (in agricultural and non-agricultural households) born in the post-monsoon season are younger compared to those born in the other seasons. The variation across seasons is up to 0.5 year (slightly larger for boys). Panel B of Figure 5 shows that the average years of schooling attained is also lower for children born in the post monsoon period. It is also worth noting that irrespective of the season of birth, the average years of schooling attained is lower for boys and girls in agricultural households, relative to those in non-agricultural households. These results imply that there is high correlation between crystallized intelligence and years of education. As for the numerical series tests, children residing in non-agricultural households and boys in agricultural households who are born in winter perform better than those born in other seasons. There is no such systematic difference for girls in agricultural households. Winter born boys in non-agricultural households also achieve higher test scores than those born in other seasons in word recall tests; but the opposite trend is observed in children in agricultural households and girls in non-agricultural households.

With regards to non-cognitive skills, the difference between children in agricultural and non-agricultural households is small. Girls exhibit better attributes and attitudes: they are more likely to be confident, diligent and self-disciplined, and show more positive attitudes towards

[8]In agricultural households with at least one girl born in the winter, the relative HAZ differential between winter and non-winter born girls is about -0.4 standard deviations, on average.

teachers and schools (see Table 3). Girls in non-agricultural households born in winter are more confident, diligent and more satisfied with school and teachers than those born in other seasons, while girls in agricultural household exhibit opposite patterns. For boys however, there is no significant difference in terms of diligence and confidence across season of birth. Boys born in winter exhibit less positive attitude towards teachers and schools as compared to those born in other seasons.

4 Results

4.1 Short Run Results: The Effect of Season of Birth on Height-for-Age

Our primary regression results are presented in Table 4: Panel A for HAZ of the child and Panel B for the likelihood of being stunted. Note the full set of results corresponding to those in Panel A are presented in Table B1 in the Appendix. The full set of results corresponding to the specifications presented in Panels B, C, D and E are available on request.

The results presented in Panel A show that the season of birth has a statistically significant effect only on the height-for-age of girls born in agricultural households. Relative to those born in the winter months, girls in agricultural households born in the monsoon, pre-monsoon and post-monsoon season are 0.3, 0.4 and 0.7 standard deviations taller for their age as compared to those girls born in the winter months. The effect is the largest for those born in the post-monsoon season (HAZ is 46% greater relative to those born in winter) and the smallest for those born in the pre-monsoon season (HAZ is 24% greater relative to those born in winter). These are relatively large effects.[9] This is *the winter's tale*.[10].

Panel B presents the results for equation (2), but with the dependent variable being the likelihood

[9] We do not estimate models with mother fixed effects as this would not allow us to control for mother's height which is important in this context. However, we indirectly test that mother-specific (or household-specific) unobservables are not driving these results. If they were, then the this effect would also be evident for all girls born to the same mother in the same household. We find no evidence that this is the case.

[10] In order to understand the extent to which resource constraints drive these effects for HAZ, we re-estimate the model for girls in agricultural households dividing up the sample by household wealth quintiles. The results are discussed in Section 4.1.3

of being stunted. A child is stunted if his/her HAZ < -2. These results show that again, estimates are measured more precisely in the sample of girls in agricultural households. Relative to girls born in winter, those born in the pre-monsoon, monsoon and post-monsoon season are respectively 7 percentage points (or 19% given the mean stunting rate of 0.374 for girls in agricultural households born in winter), 8 percentage points (or 21%) and 12 percentage points (32%) less likely to be stunted. Again these are relatively large effects.

The rainfall data that we have used in Panels A and B of Table 4 is the province level average monthly rainfall over the period 1982–2012. This gives us one data point per province. This does not allow us to control for province or year of birth level fixed effects, which might be important given the differential rapid growth across the different provinces of China. While this data is computed for all weather stations across the country, the complete data is not publicly available. What is available is rainfall data from 435 weather stations across China, with at least one in each province. We thus have data from these 435 stations over the period 1901–2016.[11] Using this information we can compute the province level average rainfall per month over the 20 years immediately prior to the birth of the index child. For each province, monsoon season in a particular year is defined as the three consecutive months with the highest average rainfall of the past 20 years. Thus potentially the months characterizing monsoon are different for each province, for each year. This allows us to control for province and year fixed effects. Note, however, that this method of categorizing seasons based on publicly rainfall data from a subset of weather stations across the country (though all provinces are represented in the data) and is open to potential measurement error. We thus use this method purely to examine the robustness of our results. Figure A1 in the Appendix presents the categorization of monsoon for a subset of Chinese provinces using this approach.

The regression results in Panels C, D and E of Table 4 include province fixed effects, year of birth fixed effects and province $\times$ year of birth fixed effects. The results are similar, to those presented in Panel A: the only effect of season of birth is on girls in agricultural households. Relative to girls born in winter, the height-for-age z-score is significantly higher for girls born in the other

[11] This data is available from the Climatic Research Unit at the University of East Anglia. http://www.cru.uea.ac.uk/.

three seasons of the year, with the effect being the strongest for those born in the post-monsoon period.

Given that our primary results show presence of season of birth effects only for girls in agricultural households, the rest of our paper focuses only on girls in agricultural households. The results for the other category of children are available on request.

4.1.1 Potential Endogeneity of Timing of Birth

We check to ensure that season of birth is not endogenous. This potential endogeneity might arise because of two forms of selection. First, suppose parents *know* that children born during certain seasons of the year are more likely to have lower health endowments (i.e., are more likely to fall sick). They might then plan pregnancies to have children in the seasons that are more favourable to health. Alternatively this implies that children born in winter constitute a non-random sample. Second, parents might compensate those children born in the bad seasons. In the presence of unobserved heterogeneity in parental inputs into the production function of children's health, variation in the health outcomes by season of birth could be partly due to the effects of parental behavior.

If during specific seasons of the years, more children are born to richer and better educated households, then the season of birth effect can simply be a attributed to the differences in resources and information available to parents. For example, **?** find, using data from the US that women giving birth in winter look different from women giving birth in other times of the year: they are likely to be younger, less educated and less likely to be married (i.e., from a low socio-economic background). They also show that the winter birth disadvantage persists over the lifetime of the child.

To understand the differences in seasonal fertility patterns across socio-economic groups, (characterized by the age of the mother, education of both father and mother and the wealth quintile the household belongs to) we estimate the relationship between season of birth and age of the mother, education of both father and mother and the wealth quintile the household, controlling for other household characteristics. This relation is given by

$$Prob(S_{is}=1)=f(\beta_{1s}W_i+\beta_{2s}E_i^m+\beta_{3s}E_i^f+\beta_{4s}Age_i^m+\beta_{5s}(Age_i^m)^2+\gamma_s\bar{X}_i+\varepsilon_{is});s=1,2,3,4 \quad (3)$$

where $Prob(S_{is}=1)$ is the probability of child i being born in season $s; s=1,2,3,4$. Statistical significance of the coefficients β_{js} indicate that the parental and household characteristics affect the probability of a child being born in a particular season s. Equation (3) is estimated using multinomial logit.

The marginal effects from the multinomial logit regression for girls aged 0–5 years in agricultural households are presented in columns 1–4 of Table 5.[12] These results show that very few of the parental and household characteristics are significantly correlated with the season of birth. The set of χ^2 tests reported in the table indicate that we cannot reject the null hypothesis that the observables included in the set of explanatory variables are jointly 0. There is therefore no evidence of season of birth selection on the basis of observables.[13]

4.1.2 Nature versus Nurture

The next question that we ask is whether this observed timing of birth effect is because of nature or is it because of nurture? Specifically we ask whether children born in specific seasons are inherently weaker (possibly because of what happens *in-utero* or genetic factors) or is the difference in long term health due to differential availability of resources by season. Addressing this question is especially important for policy since it informs the timing of interventions necessary to effectively mitigate effects. To examine this issue, we estimate a variant of equation (2) where the dependent variable in the regression is the birth weight of the child. Our reasoning here is that the determinants of birth weight are more likely factors that happen *in utero* or consequences of mother's health, rather than the actual nurturing of the child post birth. Unlike data from many other developing countries, here data on birth weight is not subjective and is precisely measured,

[12] Table B2 in the Appendix presents the full set of results.

[13] The corresponding results for the other category of children (boys and girls in non-agricultural households and boys in agricultural households) are available on request. The explanatory variables are never jointly statistically significant.

as most births are in formal health facilities.

The corresponding regression results are presented in Table 6. Again, our focus is on girls aged 0–5 years in agricultural households. There is no evidence to support the argument that girls in agricultural households are inherently less healthy: birth weight is not different across girls born in different seasons. It appears therefore that it is the seasonal availability of resources that determines allocations to children in the post birth environment appears to be the main driver of differences in long term health of girls in agricultural households.[14]

The results presented in Tables 4 are consistent with the notion of son preference in China. As we see from the results in Table 6, girls in specific seasons are not inherently weaker as season of birth does not have a statistically significant effect on birth weight. Differences start arising post-birth. Winter is traditionally a season of shortages when food and resources are not plentiful, especially in agricultural households whose incomes are primarily weather-dependent. Once weaned off breast milk, girls face a period of nutritional deprivation in an environment of son preference that is exacerbated in winter months when households are resource constrained. Furthermore, resources in winter are often conserved for the Lunar New Year festival (which mostly falls between January and February). The result that there is no systematic effect of season of birth on the long-term health of boys could potentially be the result of boys being *insulated* from the impact of resource shortages, whereas girls are not similarly protected when assets have been depleted.

4.1.3 Additional Results and Robustness

Heterogeneity by Wealth Quintiles

Given that our main explanation for the winter effect is one of seasonal variation in resource constraints within the household (i.e., households are more resource constrained during the winter months), it is worth examining the season of birth effects separately for richer and poorer

[14] In unreported specifications we also include birth weight as an additional explanatory variable in the HAZ regressions. While birth weight is positively correlated with observed HAZ, the effect of season of birth on HAZ is not affected. These results are available on request.

households. To do this, we stratify households on the basis of wealth quintiles. Those in wealth quintiles 1–3 (Q_1–Q_3) are the poorer households and those in wealth quintiles 4–5 (Q_4–Q_5) are the richer households. The regression results are presented in Table A2 in the Appendix (see row 1 for the results for HAZ). The regression results suggest that in general the winter birth effects are stronger in poorer households. For households in wealth quintiles Q_1–Q_3, HAZ is significantly lower for winter born girls in agricultural households, compared to girls born in other seasons (columns 1–3). For the richer households, HAZ is significantly higher for girls born in the post-monsoon period, though even here the effect is smaller than that for the poorer households (columns 5–7).

Onset of Monsoon

Given the importance of monsoon in agricultural societies, an alternative specification would be to measure initial environmental conditions by time from the onset of monsoon. In this case the estimating equation is given by

$$Z_{ih} = \mathbf{X}'\beta + \sum_{k=-5}^{5} \gamma_k \text{Onset}_{ihk} + \varepsilon_{ih} \qquad (4)$$

where $\text{Onset}_{ihk} = 1$ if child i in household h is born k months prior to the month of onset of monsoon ($k < 0$) or month of onset of monsoon ($k = 0$) or k months after the month of onset of monsoon ($k > 0$) and 0 otherwise. The reference category is that the child is born 6 months after the month of onset of monsoon. The month of onset of monsoon is defined as in Zeng and Lu (2004) and is presented in Figure 1.

The corresponding regression results for girls in agricultural households are presented in Table A3. Column 1 presents the results for height-for-age z-score while those in Column 2 present the results for stunting. Relative to those born in winter (6 months post onset of monsoon), girls in agricultural households, born in the month of onset of monsoon or 1 and 2 months prior to the onset of monsoon and those born 3, 4 or 5 months post onset of monsoon are of significantly better health. Panel B presents the corresponding results for stunting. Relative to girls born in winter (6 months post onset of monsoon) girls born in the month of onset of monsoon or 1, 2, 3, 4 or 5 months post onset of monsoon are significantly less likely to be stunted. Our results on strong winter birth effect continues to hold, irrespective of how we categorize seasons.

Survey Timing Effect

Cummins (2013) and Agarwal, Aiyar, Bhattacharjee, Cummins, Gunadi, Singhania, Taylor, and Wigton-Jones (2017) argue that although height-for-age z-score is an age-adjusted measurement, it is still affected by children' age at the time of measurement. Children's height in developing countries often starts lagging behind that of the reference population beyond age 2 because of deprived nutrition, poor medical care and the polluted environment. Therefore, HAZ in developing countries is often observed to reach a peak in the first two years of the child's life. This can have an effect when analyzing the effect of timing of birth on child height in particular. The problem arises when the surveys collect data on child anthropometrics in only a few months of the year. Children born in the month prior to the month of survey are the youngest, and ones born in the month after the survey month are the oldest. Therefore, the difference of HAZ across months of birth is more likely to reflect the imbalance in childrens ages across birth months rather than the season of birth effect and uneven timing of the surveys across the year can induce differential mean age at measurement across months of birth in children. This systematic age difference is then translated into a difference in HAZ because of the HAZ-age profile.

In light of the above, we examine the robustness of our results by using different specifications of children's age (see Cummins, 2013). We use age in months (linear), age in months and square of age in months (quadratic form), and categorize age of children into 5 groups (1–12 months, 13–24 months, 25–36 months, 37–48 months and 49–60 months). We find that the regression results presented in Table A4 are qualitatively similar to those presented in Panel A of Table 4.

4.2 Long Run Results: The Effect of Season of Birth on Cognitive and Non-cognitive Skills

One reason why health economists and policy makers might be concerned with low height-for-age z-scores when the child is young, is that such low HAZ could be viewed as indicators of poor long term health. Adverse conditions at childhood, been found to significantly influence later health and economic outcomes, including, though not limited to, height, earnings, and labor supply. In our case, winter birth is a proxy for adverse initial conditions. While medically possible (see, for example Emons, Boersma, Baron, and Wit, 2005), evidence of such reversals is rare. That is because in practice, there are few opportunities for the environment in poor countries, that caused the deficiency in the first place, to change substantially.

Given the central importance of cognitive and non-cognitive skills in determining long-term economic welfare, understanding whether they can be affected by shocks in critical periods in early childhood (including those at birth) is important to our understanding of the process of human capital development. Additionally, evaluating whether differences in human capital, caused by early climatic shocks enlarge, persist, or decay as children grow up is important for understanding human capital accumulation and the determinants of inequality. Although there is now a growing literature debating the potential for catch-up in physical growth of children, there remains a glaring lack of any evidence on the potential for catch-up in the development of cognitive or non-cognitive skills. The fact that early life conditions can have a significant impact on a wide range of adult outcomes including labor market outcomes would be consistent with a long-term effect on cognitive and non-cognitive skills, but this hypothesis has rarely been directly tested.

The problem is that data limitations often imply that in many of the surveys one observes outcomes when adults relate them to initial conditions. There is however little information on physical and cognitive development during childhood and adolescence. Observing individuals when they are growing up is important because it allows us to understand how and why early life conditions may (or may not) have impacts when adults: for example do the negative initial conditions accumulate or do parents make compensatory investments?

One advantage of the CFPS data is that it collects information on health and cognitive and non-cognitive skills at different stages of the lives of children. In particular, the survey has data on cognitive and non-cognitive test scores when adolescent. This allows us to examine what happens in the intermediate stage. Table 7 presents the effects of season of birth on cognitive and non-cognitive test scores for girls in agricultural households aged 10–15.[15] It is clear that season of birth does not have a statistically significant effect on the cognitive and non-cognitive skill of girls aged 10–15 in agricultural households.[16] While it has been argued that season of birth, by affecting health in early childhood, can have longer term implications on the development of cognitive and non-cognitive ability of children in the long run, we do not find any evidence of such persistence. Our results imply that there is a possibility that the initial height deficiency is reversed, and there is *catch-up*. Note also that as with children aged 0–5 years, for this set of children we also rule out the possibility of selection into season of birth. See columns 5–8 of Table 5.

4.2.1 Role of Parental Expectations

Although the environment itself may not change, a promising avenue that may lead to *catch-ups* is compensating investments on the part of parents (see, for example Cunha and Heckman, 2007, Cunha, Heckman, and Schennach, 2010). This can take the form of increased parental inputs, potentially through time investment or through increased expenditures. We have some data on parental investment, which we can use for this purpose. We also have information on parental expectations. Parental expectations are likely to be positively correlated with greater inputs and also with perceptions of achievement on the part of their children. Descriptive statistics on parental expectations are presented in Table 3. In general, parental expectations on the child's grade are higher for girls (in both agricultural and non-agricultural households) than for boys. However, their expectations on the child's highest level of education are higher for boys than

[15] See Section 3 for more details on how cognitive and non-cognitive skills are measured.

[16] There is some evidence that season of birth has impacts on only the numeracy test once households are demarcated by wealth quintiles. See Table A2. We also do not find any effect of season of birth on cognitive and non-cognitive test scores of boys and girls aged 10–15 in non-agricultural households and boys aged 10–15 in agricultural households. These results are available on request.

for girls in agricultural households and are not different between two genders in non-agricultural households. These summary statistics also indicate that there is little difference in parental expectations on score attainment, however, there is a gap in parental expectations on the child's highest level of education between children from agricultural and non-agricultural households. In order to explain the insignificant impact of season of birth on long-run cognitive and non-cognitive scores, we hypothesize that parents form differential expectations across children born in different seasons. They then act on these expectations such that any initial at-birth disadvantages have few lasting consequences in the long run.

Testing this hypothesis requires us to examine whether there is a season of birth effect on parental expectations, and whether there is a compensating pattern to these expectations. To do this we estimate a variant of equation (2) where the dependent variables in the regression are the parents' expectations for the child's grade and highest level of education (to be attained in the future). The regression results are presented in Table 8: Panel A for the expectation on the child's grade, and Panel B for the expectation on the child's highest level of education. Of particular interest is the sample of girls in agricultural households (column 4). The coefficient estimate of the dummies for monsoon birth and post-monsoon birth presented in Panel A are both negative and statistically significant (and the effect for pre-monsoon birth is negative but not statistically significant). This implies that parents in agricultural households hold higher expectation for girls born in winter than those born in monsoon and post-monsoon.The results presented in Panel B also indicate that parents hold higher expectation for degree attainment of girls born in winter as compared to those born in monsoon. Indeed the season of birth dummies are not statistically significant for any of the other child categories. We hypothesize that these higher expectations translate into higher compensatory investments for girls born in winter. Parents in agricultural households, realizing that girls born in winter have poorer health endowments, may compensate by providing more inputs to them. This is a channel by which initially poor health as a consequence of being born in the winter does not manifest itself in lower cognitive and non-cognitive achievement in the future for girls in agricultural households.[17]

[17] We acknowledge that this might not be the only channel. Programs such as midday meals in school (Singh, Park, and Dercon, 2013) or combination of nutritional supplementation and psychological stimulation (Walker, Chang, Powell, and Grantham-McGregor, 2005) have been shown to be efficient at fostering children's catch-up

The inputs that we have information on in these surveys include expenditure on education and time spent by the child in housework. These are both short term measures of investment in children. A complete measure of investment in children would include other inputs like time spent to support skill development, to provide emotional support, or to provide nutritional supplements. This kind of detailed data is however unavailable in the survey. In order to test whether higher expectations translate into comparatively higher compensating inputs for girls in agricultural households, we estimate variants of equation (1) with the dependent variable being the expenditure on education and the hours of housework by girls aged 10–15 in agriculture. The regression results are presented in Table 9. Notice that none of the coefficient estimates are statistically significant in columns 1 and 2. That is, without conditioning on parental expectations on average scores or the highest level of education in the future, there is no evidence that child investments are correlated with season of birth.

Columns 3 and 4 of Table 9 present the regression results for the effect of parental expectations on children' average scores on education expenditure and hours spent on housework by girls in agricultural households, aged 10–15. Columns 5 and 6 present the corresponding results for the effect of parental expectations on children's highest level of education. These regressions control for a range of child specific, parental and household characteristics including the season of birth. The regressions in columns 3 and 5 of Table 9 show that parental expectations are positively correlated with investments in children: expenditure on education is higher. Along similar lines, the results in columns 4 and 6 of Table 9 show that parental expectations is negatively correlated with hours of household work by the girl.[18] Hence conditional on season of birth, parental expectations are the channels through which compensating inputs in terms of increased education expenditures and reduced hours of housework for adolescent girls in agricultural households are operationalized.

growth.

[18]The results in the second column of the second panel of Appendix Table A2 are consistent with the idea that it is the relatively wealthier agricultural households that are able to engage in compensations of this nature.

5 Conclusion

This paper uses data from three waves of the CPFS survey to explore the relationship between early childhood conditions (season of birth), health outcomes and cognitive and non-cognitive scores of young children in China. Taken together, our results suggest the following story: There is a season of birth effect on height-for-age z-scores of girls aged 0–5 years in agricultural households. Those born in winter suffer along this measure of long term development as compared to those born in other seasons. However, we do not find any evidence of persistence of these season of birth effects into adolescence. Winter born girls aged 10–15 years are no worse off in terms of cognitive and non-cognitive skills, compared to girls born in other seasons of the year. This suggests that parents engage in compensatory investments. Indeed we find that parents have greater expectations about the educational attainment of girls aged 10–15 born in winter, relative to girls born in other seasons of the year. We find that these higher expectations translate into greater investments in girls born in the winter. That is, parents in agricultural households, realizing that girls born in winter have poorer initial health endowments, appear to redress these by providing relatively more education and time inputs to them. We hypothesize that such differential investments lead to catch-up, and offer this as an explanation for why we do not see any evidence that the relative height deficiency in early childhood persists into statistically measurable differentials in cognitive and non-cognitive skills in adolescence.

Our paper has several implications for policy. We find that among agricultural households, the relative HAZ disadvantage for girls in early life is measurably higher for poorer households. Additionally we find that the season of birth effects are consistently strong and statistically significant for girls in poorer households. This is in keeping with the understanding that it is these households that are likely to be the worst off in the winter months. They are thus a clearly delineated group that is most vulnerable and readily identifiable for ameliorative actions on the part of local government and non-government groups. Further, although we find that agricultural households take remedial actions on their own to insulate girls who are at most risk such that they do not suffer cognitively or non-cognitively in the long run, easing the burden for these households may free up resources that could be put towards improving overall household welfare. Finally, reducing the vulnerability of agricultural households to weather patterns by encouraging diversification of income sources, and by making it meaningfully possible for such households to readily adopt alternative means of sustenance, should serve to further insulate the health of young children from the predictable and unpredictable vagaries of weather.

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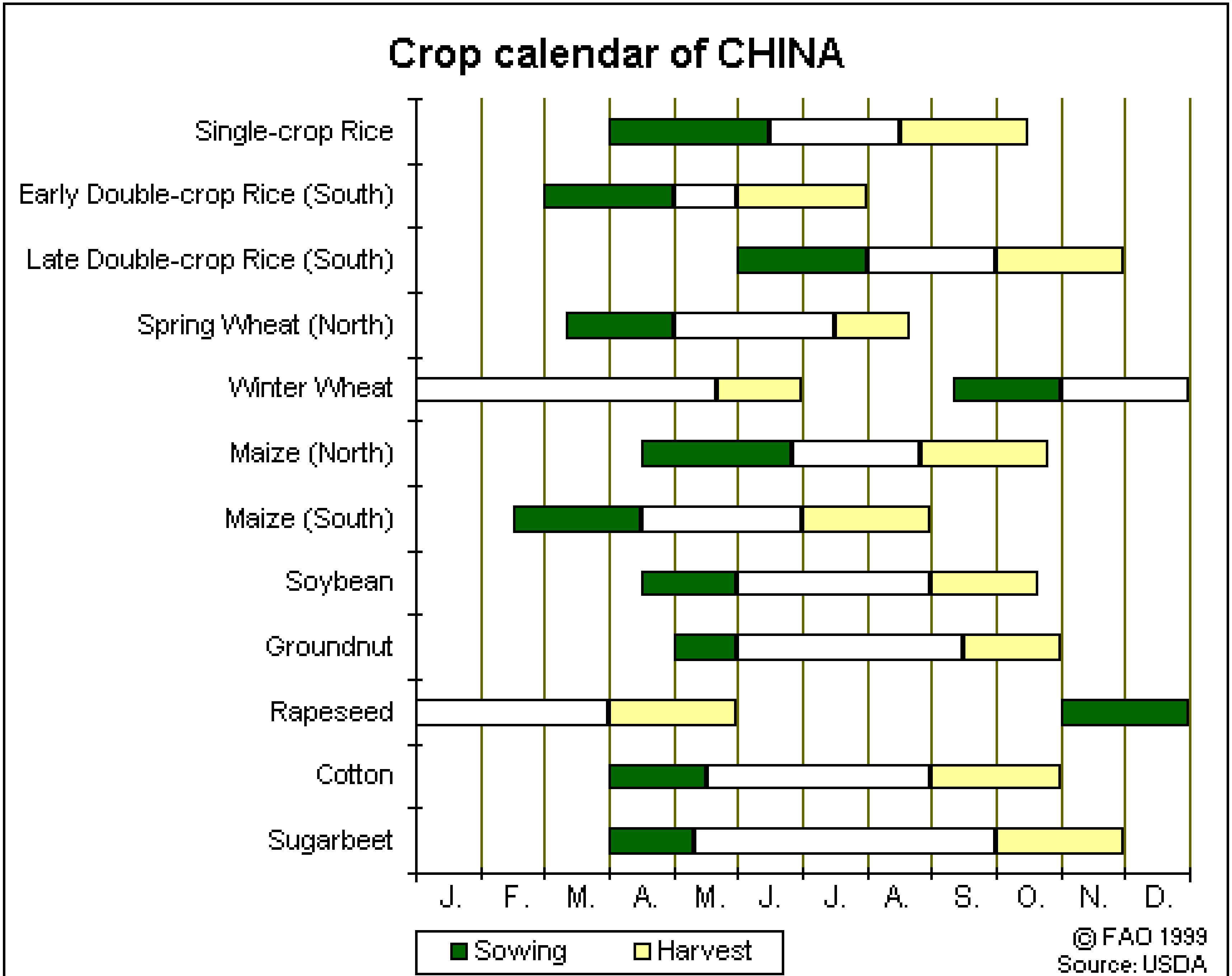
Figure 1: Onset of Monsoon Across Provinces of China

Notes: Onset of Monsoon defined by Zeng and Lu (2004)

Figure 2: Crop Calendar



Notes: See https://www.usda.gov/oce/weather/CropCalendars/.

Figure 3: Seasons Across Provinces of China

Figure 4: Proportion of Births by Seasons of Children Aged 0–5 Years and 10–15 Years

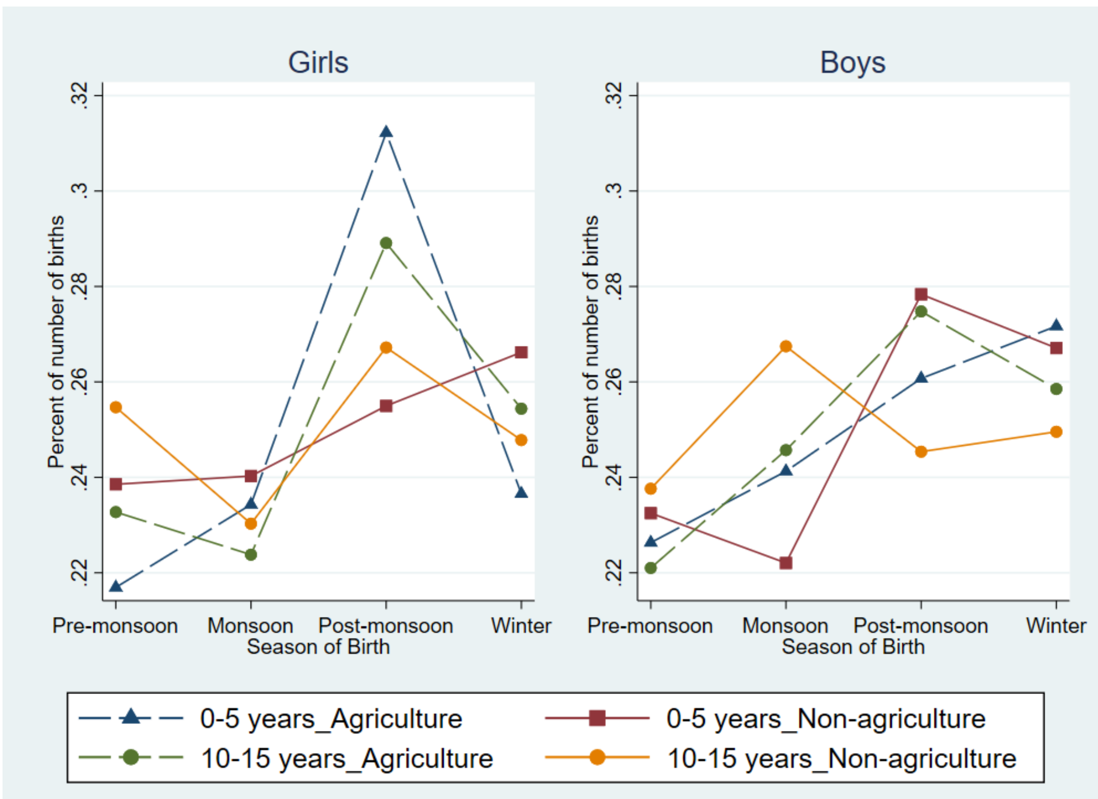
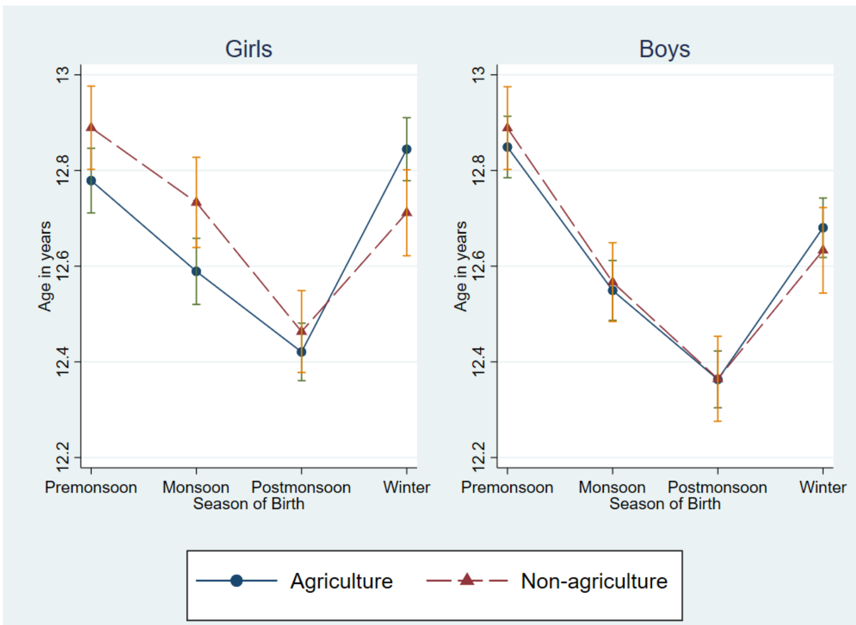


Figure 5: Average Age and Years of Schooling Attained by Children Aged 10–15 Years

Panel A: Average Age



Panel B: Average Years of Schooling Attained

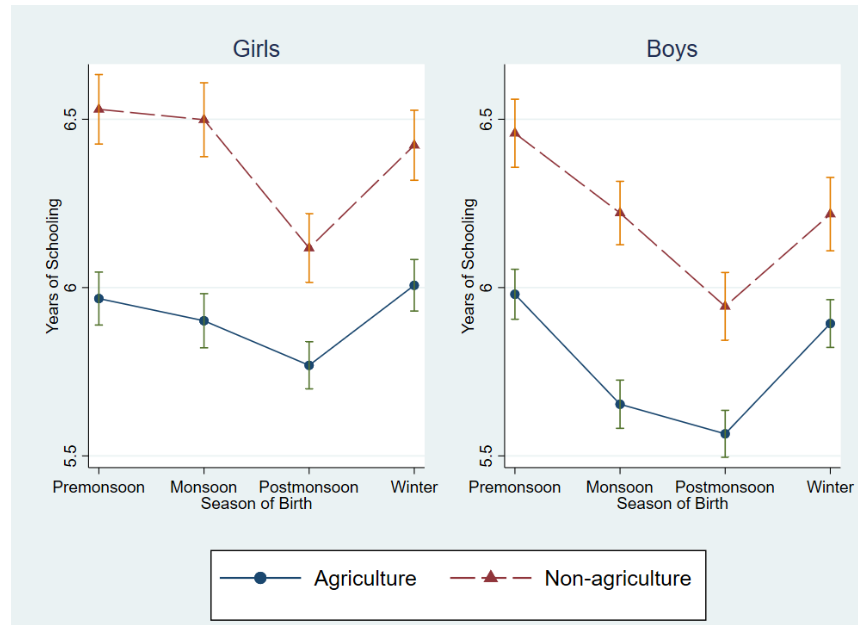


Table 1: Selected Descriptive Statistics for Children Aged 0–5 Years

	Non-agricultural Households				Agricultural Households			
	Boys		Girls		Boys		Girls	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Child-specific								
Height-for-Age (HAZ)	-0.431	0.062	-0.411	0.063	-1.099	0.052	-1.110	0.054
Birth weight	3.344	0.015	3.230	0.014	3.230	0.013	3.177	0.012
Proportion of stunting	0.214	0.012	0.200	0.012	0.329	0.010	0.310	0.011
Child's current age (in months)	31.17	0.496	30.54	0.502	32.52	0.376	32.51	0.405
Child with sibling	0.350	0.014	0.330	0.014	0.516	0.011	0.533	0.012
Birth order								
First born	0.707	0.013	0.755	0.013	0.571	0.011	0.612	0.012
Second born	0.256	0.012	0.227	0.012	0.362	0.011	0.345	0.011
Third born and later	0.037	0.005	0.017	0.004	0.067	0.006	0.043	0.005
Mother's current age	29.44	0.135	29.36	0.141	28.56	0.12	28.27	0.13
Father's current age	31.39	0.15	31.28	0.15	30.41	0.12	30.20	0.13
Education of the mother (categories)								
No education	0.044	0.006	0.043	0.006	0.127	0.008	0.125	0.008
Primary	0.125	0.009	0.115	0.010	0.234	0.010	0.238	0.010
Junior high school	0.384	0.014	0.341	0.014	0.489	0.011	0.490	0.012
Senior high school	0.205	0.012	0.232	0.013	0.107	0.007	0.101	0.007
College and above	0.241	0.012	0.268	0.013	0.044	0.005	0.047	0.005
Education of the father (categories)								
No education	0.037	0.005	0.027	0.005	0.070	0.006	0.072	0.006
Primary	0.109	0.009	0.113	0.010	0.233	0.010	0.229	0.010
Junior high school	0.373	0.014	0.373	0.015	0.504	0.011	0.496	0.012
Senior high school	0.223	0.012	0.224	0.013	0.142	0.008	0.144	0.008
College and above	0.258	0.013	0.263	0.013	0.052	0.005	0.059	0.006
Mothers height	160.26	0.148	160.37	0.148	159.51	0.131	159.74	0.131
Shorter than 155 cm	0.094	0.009	0.077	0.008	0.126	0.008	0.106	0.008
From 155-164 cm	0.691	0.014	0.713	0.014	0.688	0.011	0.687	0.012
165 cm and taller	0.215	0.013	0.209	0.013	0.187	0.010	0.208	0.010
Mother at home	0.900	0.009	0.921	0.008	0.801	0.009	0.836	0.009
Father at home	0.833	0.011	0.857	0.010	0.690	0.010	0.699	0.011
Household-specific								
Wealth quintiles								
1st quintile	0.156	0.011	0.160	0.011	0.145	0.008	0.117	0.008
2nd quintile	0.126	0.010	0.121	0.010	0.233	0.010	0.238	0.010
3rd quintile	0.150	0.010	0.135	0.010	0.266	0.010	0.267	0.011
4th quintile	0.234	0.012	0.221	0.013	0.226	0.009	0.254	0.010
5th quintile	0.333	0.014	0.363	0.015	0.129	0.008	0.124	0.008
Household size (number of members)	4.905	0.056	4.790	0.057	6.059	0.047	6.042	0.049
Share of children 0-5 years	0.272	0.004	0.286	0.005	0.244	0.003	0.257	0.003
Share of children 6-15 years	0.060	0.004	0.053	0.004	0.083	0.003	0.068	0.003
Share of adults	0.636	0.010	0.637	0.010	0.634	0.007	0.638	0.007
Share of elderly	0.060	0.004	0.070	0.005	0.067	0.003	0.074	0.003
Types of toilet								
Indoor private toilet	0.686	0.013	0.707	0.014	0.233	0.009	0.250	0.010
Outdoor private toilet	0.246	0.012	0.209	0.012	0.664	0.011	0.667	0.011
Public toilet and others	0.068	0.007	0.084	0.008	0.103	0.007	0.083	0.007
Source of cooking water								
Tap water	0.816	0.011	0.839	0.011	0.449	0.011	0.472	0.012
Well/mountain spring water	0.169	0.011	0.144	0.010	0.490	0.011	0.462	0.012
River/lake/pond and other sources	0.015	0.004	0.017	0.004	0.061	0.005	0.065	0.006
Survey year								
2010	0.343	0.013	0.314	0.014	0.323	0.010	0.311	0.011
2012	0.277	0.013	0.314	0.014	0.349	0.011	0.348	0.011
2014	0.380	0.014	0.372	0.014	0.328	0.010	0.340	0.011
Sample Size	1,244		1,159		2,007		1,785	

Notes: Authors' calculations using the CFPS data.

Table 2: Selected Descriptive Statistics for Children Aged 10–15 Years

	Non-agricultural Households				Agricultural Households			
	Boys		Girls		Boys		Girls	
	Mean (1)	SE (2)	Mean (3)	SE (4)	Mean (5)	SE (6)	Mean (7)	SE (8)
Child-specfic								
Cognitive scores–Percentage of correct answers								
Vocabulary Test	0.663	0.006	0.700	0.006	0.591	0.005	0.629	0.005
Mathematical Test	0.491	0.006	0.504	0.006	0.428	0.004	0.433	0.004
Immediate Word Recall	0.635	0.008	0.645	0.008	0.572	0.006	0.606	0.007
Delayed Word Recall	0.564	0.009	0.574	0.009	0.494	0.007	0.526	0.007
Number Series Test	0.695	0.011	0.667	0.012	0.601	0.009	0.594	0.010
Non-cognitive scores (1-min; 5-max)								
Confidence	3.047	0.018	3.245	0.018	3.072	0.014	3.234	0.014
Diligence and self-discipline	3.598	0.014	3.760	0.013	3.655	0.010	3.831	0.009
Attitude towards school and teacher	4.073	0.020	4.148	0.019	4.015	0.015	4.129	0.015
Child's current age	12.61	0.044	12.70	0.045	12.60	0.031	12.65	0.033
Years of Schooling	6.21	0.051	6.38	0.052	5.76	0.036	5.89	0.038
Child with sibling	0.459	0.012	0.520	0.012	0.746	0.008	0.850	0.007
Birth order								
First born	0.722	0.011	0.784	0.010	0.537	0.009	0.603	0.009
Second born	0.221	0.010	0.180	0.010	0.338	0.008	0.308	0.009
Third born and later	0.057	0.006	0.036	0.005	0.125	0.006	0.089	0.005
Mother's current age	38.73	0.11	38.98	0.12	38.96	0.09	38.46	0.09
Father's current age	40.85	0.12	40.94	0.13	40.64	0.10	40.34	0.10
Education of the mother (categories)								
No formal education	0.162	0.009	0.145	0.009	0.355	0.009	0.364	0.009
Primary	0.193	0.010	0.196	0.010	0.320	0.008	0.307	0.009
Junior high school	0.360	0.012	0.345	0.012	0.259	0.008	0.253	0.008
Senior high school	0.160	0.009	0.174	0.010	0.033	0.003	0.049	0.004
College and above	0.125	0.008	0.140	0.009	0.033	0.003	0.027	0.003
Education of the father (categories)								
No formal education	0.080	0.007	0.077	0.007	0.179	0.007	0.204	0.008
Primary	0.168	0.009	0.181	0.010	0.329	0.008	0.313	0.009
Junior high school	0.421	0.012	0.364	0.012	0.387	0.009	0.389	0.009
Senior high school	0.201	0.010	0.218	0.010	0.076	0.005	0.073	0.005
College and above	0.130	0.008	0.160	0.009	0.029	0.003	0.020	0.003
Mother at home	0.898	0.007	0.877	0.008	0.818	0.007	0.823	0.007
Father at home	0.852	0.009	0.811	0.010	0.767	0.007	0.757	0.008
Household-specific								
Wealth quintiles								
1st quintile	0.187	0.010	0.179	0.010	0.171	0.007	0.184	0.007
2nd quintile	0.141	0.009	0.138	0.009	0.268	0.008	0.283	0.008
3rd quintile	0.140	0.009	0.157	0.009	0.275	0.008	0.259	0.008
4th quintile	0.217	0.010	0.232	0.011	0.201	0.007	0.196	0.007
5th quintile	0.315	0.012	0.294	0.012	0.084	0.005	0.077	0.005
Household size	4.281	0.042	4.560	0.048	5.143	0.035	5.331	0.037
Share of children 0-5 years	0.025	0.002	0.035	0.002	0.031	0.001	0.051	0.002
Share of children 6-15 years	0.319	0.004	0.336	0.004	0.324	0.003	0.363	0.004
Share of adults	0.583	0.007	0.541	0.007	0.559	0.005	0.533	0.006
Share of elderly	0.083	0.004	0.102	0.004	0.113	0.003	0.108	0.003
Types of toilet								
Indoor private toilet	0.671	0.012	0.669	0.012	0.222	0.007	0.206	0.007
Outdoor private toilet	0.216	0.010	0.234	0.011	0.658	0.008	0.655	0.009
Public toilet and others	0.112	0.008	0.097	0.007	0.120	0.006	0.139	0.006
Source of cooking water								
Tap water	0.814	0.010	0.796	0.010	0.452	0.009	0.422	0.009
Well/mountain spring water	0.167	0.009	0.180	0.010	0.468	0.009	0.492	0.009
River/lake/pond and other sources	0.019	0.003	0.025	0.004	0.080	0.005	0.087	0.005
Survey year								
2010	0.357	0.012	0.365	0.012	0.356	0.008	0.383	0.009
2012	0.306	0.011	0.306	0.012	0.336	0.008	0.326	0.009
2014	0.337	0.012	0.329	0.012	0.308	0.008	0.291	0.008
Sample Size	1,682		1,605		3,212		2,929	

Notes: Authors' calculations using the CFPS data.

Table 3: Height-for-Age z score, Cognitive and Non-Cognitive Test Scores and Parental Expectations

	Boys				Girls			
	Pre-monsoon	**Monsoon**	**Post-monsoon**	**Winter**	**Pre-monsoon**	**Monsoon**	**Post-monsoon**	**Winter**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Non-agricultural households								
Height-for-age z-score†								
HAZ	-0.39	-0.43	-0.34	-0.57	-0.55	-0.23	-0.41	-0.46
	(0.125)	(0.141)	(0.110)	(0.122)	(0.125)	(0.132)	(0.122)	(0.128)
Cognitive tests-Percentage of correct answers‡								
Vocabulary Test	67.65	66.86	63.17	67.39	69.54	70.09	69.63	71.23
	(1.13)	(1.04)	(1.32)	(1.27)	(1.28)	(1.28)	(1.18)	(1.20)
Mathematical Test	51.30	47.71	47.68	50.10	51.59	50.02	49.68	50.73
	(1.16)	(1.01)	(1.16)	(1.15)	(1.20)	(1.27)	(1.12)	(1.16)
Numerical Series Test	66.75	70.68	67.07	73.40	66.60	65.82	66.40	68.00
	(2.37)	(2.24)	(2.21)	(2.06)	(2.41)	(2.55)	(2.37)	(2.29)
Immediate Word Recall	61.14	63.51	64.34	64.70	64.40	62.86	67.50	63.12
	(1.79)	(1.67)	(1.65)	(1.66)	(1.43)	(1.81)	(1.46)	(1.74)
Delayed Word Recall	52.95	58.92	54.02	59.57	57.41	55.31	59.66	57.06
	(1.99)	(1.73)	(1.74)	(1.74)	(1.99)	(1.99)	(1.82)	(1.79)
Non-cognitive tests-(1-Min, 5-Max)‡								
Confidence	3.03	3.04	3.02	3.09	3.19	3.19	3.27	3.33
	(0.039)	(0.036)	(0.036)	(0.036)	(0.036)	(0.038)	(0.037)	(0.034)
Diligence	3.60	3.58	3.62	3.60	3.72	3.75	3.76	3.81
	(0.028)	(0.027)	(0.027)	(0.029)	(0.026)	(0.027)	(0.026)	(0.026)
Attitude	4.15	4.07	4.10	3.97	4.14	4.07	4.20	4.18
	(0.042)	(0.037)	(0.037)	(0.040)	(0.035)	(0.044)	(0.036)	(0.038)
Parental Expectations‡								
Child's score (max 100)	88.89	89.98	89.87	90.45	90.94	90.99	92.02	91.65
	(0.517)	(0.429)	(0.464)	(0.412)	(0.460)	(0.456)	(0.353)	(0.391)
Parents' expectation for child's highest level of education								
Primary	0.008	0.014	0.011	0.000	0.000	0.018	0.011	0.011
	(0.005)	(0.007)	(0.006)	(0.000)	(0.000)	(0.009)	(0.006)	(0.006)
Junior high school	0.079	0.083	0.080	0.080	0.019	0.023	0.004	0.026
	(0.011)	(0.006)	(0.008)	(0.008)	(0.009)	(0.010)	(0.004)	(0.010)
Senior high school	0.079	0.083	0.080	0.080	0.077	0.106	0.053	0.092

Continued...

Table 3 (continued)

	Boys				Girls			
	Pre-monsoon	**Monsoon**	**Post-monsoon**	**Winter**	**Pre-monsoon**	**Monsoon**	**Post-monsoon**	**Winter**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(0.017)	(0.016)	(0.016)	(0.016)	(0.017)	(0.021)	(0.014)	(0.018)
College/University bachelor	0.649	0.675	0.691	0.685	0.718	0.670	0.718	0.646
	(0.029)	(0.028)	(0.028)	(0.027)	(0.028)	(0.032)	(0.028)	(0.029)
Higher education	0.234	0.218	0.200	0.218	0.185	0.183	0.214	0.225
	(0.026)	(0.024)	(0.024)	(0.024)	(0.024)	(0.026)	(0.025)	(0.025)
Panel B: Agricultural households								
Height-for-age z-score†								
HAZ	-1.03	-1.24	-0.94	-1.17	-1.12	-1.01	-0.91	-1.45
	(0.102)	(0.109)	(0.101)	(0.101)	(0.117)	(0.112)	(0.096)	(0.113)
Cognitive tests-Percentage of correct answers‡								
Vocabulary Test	59.69	58.92	58.19	59.66	63.05	63.31	61.94	63.97
	(1.05)	(0.98)	(0.96)	(0.96)	(1.08)	(0.99)	(0.94)	(1.06)
Mathematical Test	43.17	42.86	42.30	43.05	44.10	43.28	41.97	44.69
	(0.86)	(0.82)	(0.78)	(0.80)	(0.92)	(0.90)	(0.82)	(0.87)
Numerical Series Test	60.22	61.21	56.98	61.97	60.50	58.69	59.25	59.09
	(1.72)	(1.73)	(1.79)	(1.69)	(1.92)	(2.24)	(1.70)	(1.98)
Immediate Word Recall	58.61	56.52	57.29	56.62	61.41	60.80	60.37	60.23
	(1.22)	(1.27)	(1.09)	(1.18)	(1.37)	(1.47)	(1.28)	(1.31)
Delayed Word Recall	51.11	49.47	49.00	48.54	52.90	53.72	52.22	51.84
	(1.41)	(1.34)	(1.19)	(1.35)	(1.49)	(1.51)	(1.31)	(1.44)
Non-cognitive tests-(1-Min, 5-Max)‡								
Confidence	3.11	3.05	3.05	3.08	3.26	3.22	3.23	3.22
	(0.030)	(0.028)	(0.028)	(0.027)	(0.030)	(0.029)	(0.028)	(0.027)
Diligence	3.69	3.64	3.64	3.65	3.86	3.83	3.85	3.79
	(0.022)	(0.020)	(0.019)	(0.020)	(0.021)	(0.019)	(0.017)	(0.018)
Attitude	4.05	3.97	4.04	3.99	4.10	4.14	4.17	4.11
	(0.030)	(0.029)	(0.029)	(0.028)	(0.030)	(0.032)	(0.027)	(0.029)
Parental Expectations‡								
Child's score (max 100)	89.30	89.73	89.62	89.27	91.10	90.05	90.69	91.49
	(0.412)	(0.369)	(0.355)	(0.383)	(0.360)	(0.392)	(0.331)	(0.347)
Parents' expectation for child's highest level of education								
Primary	0.020	0.016	0.022	0.011	0.033	0.024	0.015	0.021

Continued...

Table 3 (continued)

	Boys				Girls			
	Pre-monsoon	**Monsoon**	**Post-monsoon**	**Winter**	**Pre-monsoon**	**Monsoon**	**Post-monsoon**	**Winter**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(0.007)	(0.006)	(0.006)	(0.005)	(0.008)	(0.008)	(0.005)	(0.007)
Junior high school	0.057	0.030	0.038	0.028	0.055	0.067	0.046	0.049
	0.011	0.008	0.008	0.007	0.011	0.012	0.009	0.010
Senior high school	0.154	0.168	0.156	0.163	0.129	0.190	0.129	0.151
	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)	(0.019)	(0.014)	(0.017)
College/University bachelor	0.646	0.668	0.656	0.661	0.643	0.610	0.702	0.652
	(0.023)	(0.021)	(0.021)	(0.021)	(0.023)	(0.024)	(0.020)	(0.022)
Higher education	0.122	0.118	0.128	0.137	0.140	0.108	0.108	0.126
	(0.016)	(0.014)	(0.015)	(0.015)	(0.016)	(0.015)	(0.013)	(0.015)

Notes: OLS regression results presented.
†: Sample restricted to children aged 0–5 years with non-missing height and age.
‡: Sample restricted to children aged 10–15 years at the time of the survey.
Seasons are defined in Figure 3.
The reference group in all regressions is that the child is born in winter.
Standard errors in parenthesis. Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$.

Table 4: Season of Birth and Height-for-Age z-score

	Non-agricultural Households		Agricultural Households	
	Boys	Girls	Boys	Girls
	(1)	(2)	(3)	(4)
Panel A: Height-for-Age z-score†				
Pre-monsoon	-0.040	-0.136	0.098	0.345**
	(0.196)	(0.201)	(0.157)	(0.168)
Monsoon	0.114	0.274	-0.028	0.434**
	(0.205)	(0.204)	(0.161)	(0.170)
Post-monsoon	0.089	-0.002	0.175	0.664***
	(0.178)	(0.195)	(0.154)	(0.154)
Average for Winter Born	-0.570	-0.464	-1.172	-1.454
Panel B: Stunting†				
Pre-monsoon	-0.012	0.018	-0.012	-0.070**
	(0.035)	(0.037)	(0.033)	(0.035)
Monsoon	-0.006	-0.045	0.028	-0.079**
	(0.037)	(0.035)	(0.032)	(0.035)
Post-monsoon	-0.005	0.007	-0.012	-0.118***
	(0.034)	(0.034)	(0.031)	(0.031)
Average for Winter Born	0.235	0.211	0.330	0.374
Panel C: Including Province Fixed Effects‡				
Pre-Monsoon	-0.167	-0.146	0.126	0.333*
	(0.198)	(0.275)	(0.188)	(0.193)
Monsoon	0.076	0.206	-0.067	0.409**
	(0.181)	(0.237)	(0.124)	(0.190)
Post-Monsoon	0.045	-0.045	0.035	0.437**
	(0.230)	(0.159)	(0.158)	(0.172)
Average for Winter Born	-0.570	-0.464	-1.172	-1.454
Panel D: Including Year of Birth Fixed Effects‡				
Pre-Monsoon	-0.165	-0.176	0.154	0.322**
	(0.168)	(0.160)	(0.173)	(0.134)
Monsoon	0.193	0.179	-0.092	0.473***
	(0.230)	(0.221)	(0.217)	(0.115)
Post-Monsoon	0.027	-0.083	0.056	0.559***
	(0.278)	(0.106)	(0.186)	(0.163)
Average for Winter Born	-0.570	-0.464	-1.172	-1.454

Continued . . .

Table 4 (continued): Season of Birth and Height-for-Age z-score

	Non-agricultural Households		Agricultural Households	
	Boys	**Girls**	**Boys**	**Girls**
	(1)	(2)	(3)	(4)
Panel E: Province and Year of Birth Fixed Effects and Their Interactions‡				
Pre-Monsoon	-0.240	-0.189	0.142	0.236
	(0.262)	(0.280)	(0.183)	(0.200)
Monsoon	0.122	0.284	-0.061	0.324*
	(0.252)	(0.267)	(0.156)	(0.186)
Post-Monsoon	-0.034	-0.124	-0.030	0.533***
	(0.274)	(0.248)	(0.187)	(0.197)
Average for Winter Born	-0.570	-0.464	-1.172	-1.454
Sample Size	1,079	989	1,819	1,613

Notes: Dependent variable is height-for-age z-score (HAZ) (Panels A, C, D and E) and whether the child is stunted (HAZ < -2) (Panel B) at the time of survey. OLS regression results presented. Sample restricted to children aged 0–5 years, with non-missing height and age. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father, mother's height), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis. The reference group is that the child is born in winter. Significance: $^{***}p < 0.01$;$^{**}\, p < 0.05$;$^{*}\, p < 0.1$. Full set of results corresponding to those presented is in Table B1.
†: Seasons defined using average monthly rainfall over the period 1982–2012. See Figure 3 for categorization of season.
‡: Seasons defined using moving average of monthly rainfall for 20 years prior to birth of child. Rainfall data collected for 435 weather stations across the country. Each province is represented.

Table 5: Selection into Season of Birth.

	Girls Aged 0–5 Years				Girls Aged 10–15 Years			
	Pre-Monsoon (1)	Monsoon (2)	Post-Monsoon (3)	Winter (4)	Pre-Monsoon (5)	Monsoon (6)	Post-Monsoon (7)	Winter (8)
Father Education: Primary	0.036	0.007	-0.025	-0.019	-0.022	-0.003	-0.003	-0.015
	(0.046)	(0.043)	(0.059)	(0.055)	(0.037)	(0.038)	(0.038)	(0.037)
Father Education: Junior	0.039	0.060	-0.060	-0.040	0.010	-0.050	-0.050	0.004
	(0.047)	(0.044)	(0.060)	(0.056)	(0.041)	(0.039)	(0.039)	(0.040)
Father Education: Senior	0.114*	0.021	-0.082	-0.053	0.025	-0.017	-0.017	-0.061
	(0.059)	(0.051)	(0.068)	(0.063)	(0.058)	(0.055)	(0.055)	(0.057)
Father Education: College	0.012	0.024	-0.058	0.022	0.035	0.165	0.165	-0.190***
	(0.067)	(0.065)	(0.086)	(0.092)	(0.086)	(0.112)	(0.112)	(0.053)
Mother Education: Primary	-0.019	-0.036	0.041	0.013	0.000	-0.024	-0.024	0.008
	(0.042)	(0.048)	(0.047)	(0.041)	(0.034)	(0.032)	(0.032)	(0.032)
Mother Education: Junior	0.031	-0.100**	0.007	0.062	-0.012	0.000	0.000	-0.023
	(0.043)	(0.047)	(0.046)	(0.042)	(0.038)	(0.038)	(0.038)	(0.036)
Mother Education: Senior	-0.056	-0.041	0.080	0.018	0.005	-0.088*	-0.088*	0.082
	(0.053)	(0.063)	(0.066)	(0.055)	(0.062)	(0.050)	(0.050)	(0.069)
Mother Education: College	0.011	-0.038	0.060	-0.033	-0.036	-0.099	-0.099	0.093
	(0.075)	(0.077)	(0.087)	(0.073)	(0.074)	(0.068)	(0.068)	(0.090)
Wealth Quintile 2	-0.008	0.047	-0.038	-0.001	0.014	-0.007	-0.007	-0.010
	(0.043)	(0.039)	(0.045)	(0.039)	(0.035)	(0.034)	(0.034)	(0.035)
Wealth Quintile 3	-0.001	0.018	-0.002	-0.016	0.010	0.032	0.032	-0.003
	(0.044)	(0.038)	(0.044)	(0.038)	(0.034)	(0.033)	(0.033)	(0.036)
Wealth Quintile 4	-0.024	-0.006	0.019	0.011	0.012	0.005	0.005	-0.002
	(0.046)	(0.038)	(0.047)	(0.042)	(0.038)	(0.038)	(0.038)	(0.038)
Wealth Quintile 5 (Highest)	-0.066	0.074	-0.018	0.010	0.040	0.034	0.034	0.017
	(0.048)	(0.048)	(0.053)	(0.048)	(0.051)	(0.049)	(0.049)	(0.050)
Age of Mother	0.013	0.023	0.009	-0.044*	-0.002	-0.037	-0.037	0.015
	(0.024)	(0.028)	(0.030)	(0.025)	(0.036)	(0.040)	(0.040)	(0.041)
Age of Mother Squared	-0.000	-0.000	-0.000	0.001	0.000	0.001	0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Significance of Explanatory Variables								
Education of Mother ($\chi^2(4)$)		16.63				8.02		
		[0.164]				[0.783]		
Education of Father ($\chi^2(4)$)		10.57				13.03		
		[0.566]				[0.367]		
Wealth Quintiles ($\chi^2(4)$)		10.72				6.63		
		[0.554]				[0.881]		
Joint Test ($\chi^2(42)$)		41.88				37.8		
		[0.476]				[0.656]		

Notes: Dependent variable is season of birth of the child. Marginal Effects from Multinomial logit regression (equation (3)) presented. Sample in columns 1–4 restricted to girls in agricultural households aged 0–5 years with non-missing height and age. Sample in columns 5–8 restricted to girls in agricultural households aged 10–15 years with non-missing test scores. Seasons are defined in Figure 3. Regressions control for age of father, mother's height, residential status of mother and father household size and composition, household facilities, age and birth order of child and survey year. Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$. Standard errors clustered by household in parenthesis. p-values of $\chi^(2)$ tests in square brackets.

Table 6: Season of Birth and Birthweight

	Birthweight
Pre-monsoon	-0.012
	(0.048)
Monsoon	-0.005
	(0.045)
Post-monsoon	0.001
	(0.043)
Constant	2.709***
	(0.473)
Average for Winter Born	3.191
Sample Size	1,511

Notes: Dependent variable is birth weight (in 1000 grams). Sample includes girls aged 0–5 years in agricultural households with non-missing birth weight. OLS regression results for girls in agricultural households presented. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father, mother's height), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis. The reference group is that the child is born in winter. Significance: $^{***}p < 0.01$;$^{**}\ p < 0.05$;$^{*}\ p < 0.1$.

Table 7: Season of Birth and Cognitive and Non-Cognitive Test Scores

	Cognitive Test Scores					Non-Cognitive Test Scores		
	Numerical Test (1)	Vocabulary Test Test (2)	Numerical Series Test (3)	Intermediate Word Recall Test (4)	Delayed Word Recall Test (5)	Confidence (6)	Diligence and Self Discipline (7)	Attitude Towards Teachers and School (8)
Pre-monsoon	0.026	-0.074	0.161	-0.043	-0.145	0.089	0.073*	-0.004
	(0.092)	(0.104)	(0.194)	(0.161)	(0.174)	(0.057)	(0.038)	(0.054)
Monsoon	0.042	0.013	0.119	0.023	0.068	0.018	0.006	0.019
	(0.094)	(0.104)	(0.200)	(0.164)	(0.179)	(0.054)	(0.037)	(0.055)
Post-monsoon	-0.033	-0.009	0.018	0.169	0.062	0.001	0.034	0.027
	(0.090)	(0.103)	(0.168)	(0.145)	(0.157)	(0.054)	(0.032)	(0.054)
Constant	-8.630***	-5.176**	-5.307	-1.687	-2.101	4.382***	4.980***	5.281***
	(1.919)	(2.171)	(4.073)	(3.728)	(3.834)	(1.126)	(0.675)	(1.273)
Average for Winter Born	44.69	63.97	59.09	60.23	51.84	3.22	3.79	4.11
Sample Size	1,174	1,174	413	527	526	1,645	1,653	1,548

Notes: OLS regression results presented. Sample includes girls aged 10-15 years in agricultural households with non-missing test scores. In columns 1–5, dependent variable is quintile rank of child's test score. In columns 6–8, dependent variable is score of non-cognitive tests. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental cognitive ability (for cognitive tests regressions), education (for non-cognitive tests regressions), age and residential status of mother and father), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born in winter. Significance: $^{***}p < 0.01$;$^{**}\ p < 0.05$;$^{*}\ p < 0.1$.

Table 8: Parents' Expectation of Children's Educational Attainment

	Non-agricultural Households		Agricultural Households	
	Boys	**Girls**	**Boys**	**Girls**
	(1)	(2)	(3)	(4)
Panel A: Children's Average Score				
Pre-monsoon	-1.657**	-0.617	0.273	-0.325
	(0.718)	(0.672)	(0.643)	(0.556)
Monsoon	-0.463	-0.377	0.403	-1.627***
	(0.641)	(0.679)	(0.603)	(0.578)
Post-monsoon	-0.821	-0.056	0.359	-1.172**
	(0.664)	(0.582)	(0.590)	(0.528)
Constant	104.169***	105.726***	91.311***	84.079***
	(9.837)	(13.002)	(8.331)	(5.649)
Sample Size	1,431	1,393	2,765	2,544
Panel B: Children's Highest Level of Education				
Pre-monsoon	-0.018	0.012	-0.081	-0.018
	(0.057)	(0.060)	(0.053)	(0.058)
Monsoon	-0.084	-0.065	-0.077	-0.130**
	(0.055)	(0.067)	(0.048)	(0.058)
Post-monsoon	-0.085	0.013	-0.064	-0.004
	(0.054)	(0.059)	(0.050)	(0.050)
Constant	3.233***	6.073***	2.061**	3.629***
	(0.788)	(1.006)	(0.872)	(0.947)
Sample Size	1,016	927	1,835	1,754

Notes: Dependent variable is parents' expectation of children's average score (Panel A) and highest level of education (Panel B). OLS regression results presented. Sample restricted to children aged 10–15 years. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born in winter. Significance: $^{***}p < 0.01;^{**} p < 0.05;^{*} p < 0.1$.

Table 9: Season of Birth, Parental Expectations and Investments in Children

	Education Expense (1)	Hours of Housework (2)	Education Expense (3)	Hours of Housework (4)	Education Expense (5)	Hours of Housework (6)
Pre-monsoon	0.003	-0.042	0.007	-0.046	0.075	-0.046
	(0.045)	(0.082)	(0.045)	(0.083)	(0.053)	(0.115)
Monsoon	0.004	0.140	0.027	0.135	0.060	0.156
	(0.044)	(0.113)	(0.044)	(0.117)	(0.053)	(0.158)
Post-monsoon	0.010	-0.066	0.023	-0.103	0.028	-0.063
	(0.041)	(0.084)	(0.040)	(0.085)	(0.048)	(0.114)
Parental expectations on average scores			0.006***	-0.008*		
			(0.002)	(0.004)		
Parental expectations on highest level of education					0.117***	-0.042
					(0.022)	(0.061)
Constant	-1.390*	1.460	-2.269***	2.464	-2.363***	1.953
	(0.730)	(2.039)	(0.742)	(2.147)	(0.901)	(2.588)
Sample Size	2,651	1,729	2,488	1,645	1,695	1,220

Notes: OLS regression results presented. Sample restricted to girls aged 10–15 years in agricultural households. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born in winter. Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$.

Table A1: Rotated Component Matrix for Children's Self-Evaluation

	VARIMAX Rotated Loading Factor 1	Factor 2	Factor 3	Communalities
How would you rate your academic performance?	0.728			0.574
How excellent a student do you think you are?	0.779			0.635
How much academic pressure do you put on yourself?†				
To what extent do you think you are suitable to be a student cadre?	0.626			0.420
I study hard		0.568		0.473
I concentrate on studying while in class		0.653		0.486
I check my homework several times before handing it in		0.608		0.404
I abide by the school rules and regulations		0.608		0.387
I like to put my things in order at school		0.635		0.411
I finish my homework before I can play		0.661		0.456
Are you satisfied with your school?			0.670	0.467
Are you satisfied with your class adviser?			0.837	0.707
Are you satisfied with your Chinese language teacher?			0.767	0.595
Are you satisfied with your maths teacher?			0.708	0.512
Are you satisfied with your foreign language teacher?			0.612	0.395
Eigenvalues	3.645	1.978	1.341	
Number of items	3	6	5	
Cronbach′s alpha‡	0.610	0.711	0.617	
Inter-item correlation	0.324	0.192	0.315	

Notes: † We excluded the factor that is loaded by only this item.
‡ Cronbach′s alpha is a measure of internal consistency of items in a uni-dimensional scale. According to **?**, values for Cronbach′s alpha larger than 0.6 are deemed acceptable.

Figure A1: Categorization of Monsoon by Province and Year of Birth for Selected Provinces

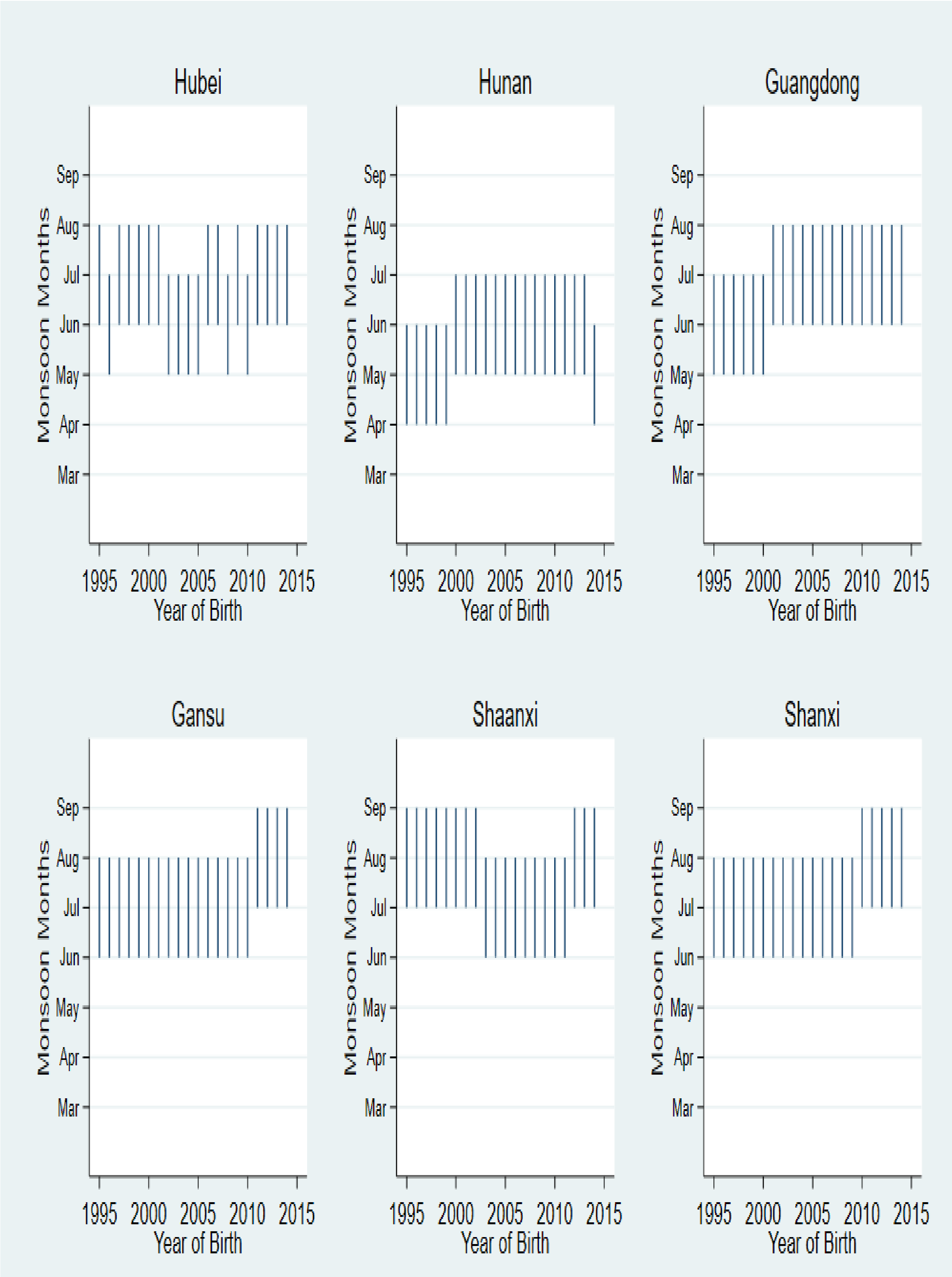


Table A2: Effects of Season of Birth on Height-for-Age and Cognitive and Non-cognitive Test Scores by Wealth Quintiles. Girls in Agricultural Households

	Q_1 – Q_3				Q_4 – Q_5			
	Pre-Monsoon (1)	**Monsoon** (2)	**Post-Monsoon** (3)	**Sample Size** (4)	**Pre-Monsoon** (5)	**Monsoon** (6)	**Post-Monsoon** (7)	**Sample Size** (8)
HAZ	0.394*	0.471**	0.706***	987	0.134	0.276	0.552**	624
	(0.222)	(0.224)	(0.203)		(0.265)	(0.269)	(0.248)	
Numerical Test	0.195*	0.225**	0.100	768	-0.271*	-0.348**	-0.269*	406
	(0.115)	(0.110)	(0.109)		(0.149)	(0.162)	(0.151)	
Vocabulary Test	-0.062	-0.062	0.040	768	-0.181	0.150	-0.079	406
	(0.123)	(0.123)	(0.119)		(0.171)	(0.165)	(0.160)	
Numerical Series Test	0.364	0.116	0.090	290	-0.070	-0.012	-0.183	123
	(0.232)	(0.251)	(0.201)		(0.393)	(0.367)	(0.342)	
Intermediate Word Recall	0.166	0.099	0.259*	380	-0.190	0.026	0.049	147
	(0.200)	(0.191)	(0.157)		(0.341)	(0.325)	(0.316)	
Delayed Word Recall	0.076	0.320	0.314*	380	-0.704**	-0.632**	-0.707**	146
	(0.221)	(0.217)	(0.176)		(0.312)	(0.318)	(0.299)	
Confidence	0.120*	0.006	0.001	1,107	0.031	-0.037	-0.009	538
	(0.067)	(0.065)	(0.067)		(0.098)	(0.092)	(0.079)	
Diligence	0.124***	0.049	0.055	1,113	-0.052	-0.097	-0.031	540
	(0.047)	(0.047)	(0.043)		(0.062)	(0.060)	(0.054)	
Attitude	0.037	0.052	0.139**	1,045	-0.103	-0.056	-0.223**	503
	(0.069)	(0.069)	(0.066)		(0.086)	(0.090)	(0.087)	

Notes: HAZ denotes height-for-age z-score (HAZ) for girls in agricultural households aged 0–5 years (Panel A), quintile rank of cognitive test scores (Panel B) and score of non-cognitive tests (Panel C) of girls in agricultural households aged 10-15 years. OLS regression results presented. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father, mother's height), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born in winter. Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$.

Table A3: Month of Birth relative to the Onset of Monsoon and Child Height

	Height-for-Age z-score (1)	**Stunting** (2)
5 months prior	-0.076	-0.001
	(0.268)	(0.057)
–4	0.509*	-0.128**
	(0.302)	(0.061)
–3	0.333	-0.069
	(0.289)	(0.060)
–2	0.375	-0.056
	(0.293)	(0.061)
–1	0.618**	-0.079
	(0.280)	(0.056)
Monsoon starts	0.633**	-0.114*
	(0.297)	(0.060)
1 month after monsoon starts	0.376	-0.141**
	(0.287)	(0.059)
+2	0.304	-0.100*
	(0.253)	(0.054)
+3	0.619**	-0.111**
	(0.258)	(0.052)
+4	0.627**	-0.110**
	(0.262)	(0.054)
+5	0.669**	-0.153***
	(0.287)	(0.056)
Constant	-3.923**	0.733**
	(1.885)	(0.369)
Sample Size	1613	

Notes: Dependent variable is height-for-age z-score (column 1) and whether the child is stunted (HAZ < -2) (column 2) at the time of the survey. OLS regression results presented. Sample includes girls in agricultural households aged 0–5 years with non-missing height and age. Onset of monsoon is defined in Figure 1. Regressions control for a set of individual (age, birth order), parental (education, age and residential status of mother and father, mother's height), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born 6 months after the onset of monsoon. Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$.

Table A4: Robustness of Results with Different Specifications of Child's Age

	Age in Months and Square of Age in Months (1)	**Age in Years (Categories)** (2)
Pre-Monsoon	0.341**	0.365**
	(0.168)	(0.168)
Monsoon	0.427**	0.431***
	(0.170)	(0.170)
Post-monsoon	0.657***	0.631***
	(0.154)	(0.153)
Constant	-3.800**	-3.933**
	(1.811)	(1.812)
Sample Size	1,613	1,613

Notes: Dependent variable is height-for-age z-score (HAZ). OLS regression results presented. Sample restricted to girls in agricultural households aged 0–5 years with non-missing height and age. Seasons are defined in Figure 3. Regressions control for a set of individual (age, birth order), parental (education and age of mother and father, mother's height), household (wealth quintile, household size, household composition, type of toilet, source of water for cooking) and dummies for survey wave. Standard errors clustered at the household level in parenthesis.The reference group is that the child is born in winter. Significance: $^{***}p < 0.01;^{**}p < 0.05;^{*}p < 0.1$.

Table B1: Season of birth and Height-for-Age z score

	Non-Agricultural Households		Agricultural Households	
	Boys	**Girls**	**Boys**	**Girls**
	(1)	(2)	(3)	(4)
Pre-monsoon	-0.040	-0.136	0.098	0.345**
	(0.196)	(0.201)	(0.157)	(0.168)
Monsoon	0.114	0.274	-0.028	0.434**
	(0.205)	(0.204)	(0.161)	(0.170)
Post-monsoon	0.089	-0.002	0.175	0.664***
	(0.178)	(0.195)	(0.154)	(0.154)
Age in months	-0.014***	-0.014***	-0.009**	-0.012***
	(0.004)	(0.005)	(0.004)	(0.004)
Age of Mother	-0.015	0.307	0.268**	0.354***
	(0.143)	(0.212)	(0.116)	(0.112)
Age of Mother Squared	0.001	-0.004	-0.004**	-0.005**
	(0.002)	(0.003)	(0.002)	(0.002)
Age of Father	0.198*	-0.173	-0.226**	-0.265**
	(0.117)	(0.163)	(0.112)	(0.120)
Age of Father Squared	-0.003*	0.002	0.003*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Highest education of Mother				
Primary	0.037	0.354	0.567***	0.023
	(0.348)	(0.515)	(0.199)	(0.198)
Junior	0.254	0.407	0.696***	0.294
	(0.324)	(0.525)	(0.193)	(0.196)
Senior	0.343	0.855	0.850***	0.146
	(0.341)	(0.546)	(0.264)	(0.261)
College	0.203	0.735	0.815**	0.433
	(0.366)	(0.555)	(0.322)	(0.398)
Highest education of Father				
Primary	298	-0.091	-0.284	0.148
	(0.422)	(0.508)	(0.268)	(0.255)
Junior	0.062	-0.113	-0.081	0.169
	(0.389)	(0.505)	(0.265)	(0.248)
Senior	0.369	-0.103	-0.217	0.357
	(0.410)	(0.518)	(0.293)	(0.286)
College	0.553	-0.107	0.111	-0.013
	(0.417)	(0.524)	(0.385)	(0.388)
Father resides at home	0.102	-0.060	-0.085	-0.096
	(0.237)	(0.231)	(0.146)	(0.147)
Mother resides at home	-0.067	-0.131	0.169	0.308
	(0.331)	(0.342)	(0.190)	(0.214)
Height of Mother Q2	0.623**	0.048	0.516***	0.330
	(0.249)	(0.238)	(0.175)	(0.210)
Height of Mother Q3	0.863***	0.105	0.361*	0.974***
	(0.280)	(0.289)	(0.214)	(0.237)
Sibling	-0.267	0.407	0.536**	-0.076
	(0.311)	(0.286)	0.227	0.210
Birth order = 2	-0.424	-0.660**	-1.088***	-0.395*
	(0.341)	(0.326)	(0.247)	(0.223)
Birth order = 3	-0.266	-1.873***	-1.372***	-1.162***
	(0.572)	(0.517)	(0.357)	(0.369)
Wealth quintiles				
20–40%	0.441*	0.126	-0.103	0.228
	(0.258)	(0.268)	(0.190)	(0.200)
40–60%	0.139	0.158	-0.047	0.231
	(0.241)	(0.266)	(0.187)	(0.198)
60–80%	0.309	0.396	-0.027	0.438**
	(0.220)	(0.248)	(0.188)	(0.199)

Continued...

TableB1 (continued):Season of birth and Height-for-Age z score

	Non-Agricultural Households		Agricultural Households	
	Boys	**Girls**	**Boys**	**Girls**
	(1)	(2)	(3)	(4)
80–100%	0.265	0.255	0.008	0.538**
	(0.222)	(0.239)	(0.222)	(0.232)
Household size	-0.030	-0.071	-0.091***	0.006
	(0.053)	(0.053)	(0.032)	(0.035)
Share of children 0–5 years	-0.614	0.017	-1.537***	-0.176
	(0.716)	(0.556)	(0.588)	(0.554)
Share of children 6–15 years	-0.595	-0.924*	0.584	-0.886
	(0.661)	(0.539)	(0.639)	(0.658)
Share of elderly	-0.196	0.004	0.813	-0.316
	(0.550)	(0.460)	(0.500)	(0.468)
Outdoor private toilet	-0.008	-0.010	0.087	0.090
	(0.178)	(0.209)	(0.139)	(0.141)
Public toilet and others	0.089	-0.383	-0.273	0.103
	(0.277)	(0.290)	(0.219)	(0.238)
Well/mountain spring water	-0.236	-0.582**	0.006	0.061
	(0.222)	(0.233)	(0.113)	(0.121)
River/lake and other sources	0.382	-0.646	-0.287	-0.582**
	(0.500)	(0.490)	(0.254)	(0.240)
Survey Year 2012	-0.025	0.008	-0.079	0.116
	(0.159)	(0.169)	(0.129)	(0.142)
Survey Year 2014	0.074	0.050	0.169	0.593***
	(0.157)	(0.172)	(0.138)	(0.149)
Constant	-4.602***	-2.140	-1.277	-3.955**
	(1.756)	(3.135)	(1.554)	(1.810)
Sample Size	1,079	989	1,819	1,613

Notes: Dependent variable is height–for–age z–score (HAZ). OLS regression results presented.
Sample restricted to children aged 0–5 years with non-missing height and age.
Seasons are defined in Figure 3.
The reference group is that the child is born in winter.
Significance: $^{***}p < 0.01;^{**} p < 0.05;^{*} p < 0.1$.

Table B2: Selection into Season of Birth. Full Set of Results.

	Girls aged 0–5 years				Girls aged 10–15 years			
	Pre-Monsoon	Monsoon	Post-Monsoon	Winter	Pre-Monsoon	Monsoon	Post-Monsoon	Winter
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Highest Education of Father								
Primary	0.036	0.007	-0.025	-0.019	-0.022	-0.003	-0.003	-0.015
	(0.046)	(0.043)	(0.059)	(0.055)	(0.037)	(0.038)	(0.038)	(0.037)
Junior	0.039	0.060	-0.060	-0.040	0.010	-0.050	-0.050	0.004
	(0.047)	(0.044)	(0.060)	(0.056)	(0.041)	(0.039)	(0.039)	(0.040)
Senior	0.114*	0.021	-0.082	-0.053	0.025	-0.017	-0.017	-0.061
	(0.059)	(0.051)	(0.068)	(0.063)	(0.058)	(0.055)	(0.055)	(0.057)
College	0.012	0.024	-0.058	0.022	0.035	0.165	0.165	-0.190***
	(0.067)	(0.065)	(0.086)	(0.092)	(0.086)	(0.112)	(0.112)	(0.053)
Highest Education of Mother								
Primary	-0.019	-0.036	0.041	0.013	0.000	-0.024	-0.024	0.008
	(0.042)	(0.048)	(0.047)	(0.041)	(0.034)	(0.032)	(0.032)	(0.032)
Junior	0.031	-0.100**	0.007	0.062	-0.012	0.000	0.000	-0.023
	(0.043)	(0.047)	(0.046)	(0.042)	(0.038)	(0.038)	(0.038)	(0.036)
Senior	-0.056	-0.041	0.080	0.018	0.005	-0.088*	-0.088*	0.082
	(0.053)	(0.063)	(0.066)	(0.055)	(0.062)	(0.050)	(0.050)	(0.069)
College	0.011	-0.038	0.060	-0.033	-0.036	-0.099	-0.099	0.093
	(0.075)	(0.077)	(0.087)	(0.073)	(0.074)	(0.068)	(0.068)	(0.090)
Wealth Quintiles								
20–40%	-0.008	0.047	-0.038	-0.001	0.014	-0.007	-0.007	-0.010
	(0.043)	(0.039)	(0.045)	(0.039)	(0.035)	(0.034)	(0.034)	(0.035)
40–60%	-0.001	0.018	-0.002	-0.016	0.010	0.032	0.032	-0.003
	(0.044)	(0.038)	(0.044)	(0.038)	(0.034)	(0.033)	(0.033)	(0.036)
60–80%	-0.024	-0.006	0.019	0.011	0.012	0.005	0.005	-0.002
	(0.046)	(0.038)	(0.047)	(0.042)	(0.038)	(0.038)	(0.038)	(0.038)
80–100%	-0.066	0.074	-0.018	0.010	0.040	0.034	0.034	0.017
	(0.048)	(0.048)	(0.053)	(0.048)	(0.051)	(0.049)	(0.049)	(0.050)
Age	-0.002***	-0.001	0.002***	0.001	0.007	-0.001	-0.001	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.007)	(0.006)	(0.006)	(0.007)
Age of Mother	0.013	0.023	0.009	-0.044*	-0.002	-0.037	-0.037	0.015
	(0.024)	(0.028)	(0.030)	(0.025)	(0.036)	(0.040)	(0.040)	(0.041)
Age of Mother Squared	-0.000	-0.000	-0.000	0.001	0.000	0.001	0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Age of Father	-0.036	-0.014	0.032	0.018	-0.015	0.001	0.001	0.011
	(0.024)	(0.027)	(0.029)	(0.023)	(0.033)	(0.031)	(0.031)	(0.034)
Age of Father Squared	0.001	0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000

Continued ...

Table B2 (continued): Impact of All Observables on Season of Birth

	Girls aged 0–5 years				Girls aged 10–15 years			
	Pre-Monsoon	Monsoon	Post-Monsoon	Winter	Pre-Monsoon	Monsoon	Post-Monsoon	Winter
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Father resides at home	0.051*	-0.002	-0.050	0.000	0.026	0.003	0.003	-0.035
	(0.029)	(0.028)	(0.032)	(0.030)	(0.032)	(0.036)	(0.036)	(0.033)
Mother resides at home	-0.023	-0.047	0.077	-0.007	-0.031	0.038	0.038	-0.010
	(0.039)	(0.040)	(0.048)	(0.042)	(0.041)	(0.045)	(0.045)	(0.041)
Height of Mother Q2	-0.067	0.013	0.096**	-0.042				
	(0.046)	(0.047)	(0.042)	(0.045)				
Height of Mother Q3	-0.094*	-0.001	0.078	0.017				
	(0.051)	(0.052)	(0.051)	(0.053)				
Height of Mother Q4	-0.071	-0.084	0.207***	-0.053				
	(0.059)	(0.053)	(0.063)	(0.058)				
Sibling	0.017	-0.032	0.034	-0.019	-0.054	0.027	0.027	-0.069
	(0.040)	(0.044)	(0.045)	(0.043)	(0.039)	(0.041)	(0.041)	(0.042)
Household size	0.009	-0.006	-0.014*	0.011	0.001	0.001	0.001	0.007
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Share of children 0–5 years	0.083	-0.216*	0.083	0.049	-0.014	-0.164	-0.164	0.294**
	(0.102)	(0.123)	(0.101)	(0.108)	(0.133)	(0.117)	(0.117)	(0.126)
Share of children 6–15 years	0.209*	-0.224	-0.100	0.116	0.004	0.064	0.064	-0.041
	(0.123)	(0.148)	(0.140)	(0.146)	(0.056)	(0.040)	(0.040)	(0.080)
Share of elderly	-0.085	-0.061	0.113	0.033	-0.148	0.007	0.007	-0.042
	(0.100)	(0.093)	(0.098)	(0.095)	(0.106)	(0.091)	(0.091)	(0.096)
Outdoor private toilet	-0.002	-0.045	-0.019	0.066**	0.055*	-0.084***	-0.084***	0.064**
	(0.027)	(0.029)	(0.031)	(0.027)	(0.029)	(0.030)	(0.030)	(0.028)
Public toilet and others	0.019	-0.045	0.021	0.005	0.027	-0.059	-0.059	0.021
	(0.044)	(0.046)	(0.050)	(0.043)	(0.038)	(0.039)	(0.039)	(0.039)
Well/mountain spring water	0.001	-0.043*	0.058**	-0.015	0.001	0.034	0.034	-0.003
	(0.024)	(0.024)	(0.028)	(0.025)	(0.026)	(0.025)	(0.025)	(0.025)
River/lake and other sources	0.005	0.017	-0.017	-0.004	0.048	0.031	0.031	-0.072
	(0.048)	(0.053)	(0.056)	(0.052)	(0.056)	(0.050)	(0.050)	(0.048)
Survey Year 2012	0.028	-0.023	-0.015	0.010	-0.008	0.006	0.006	0.012
	(0.022)	(0.024)	(0.025)	(0.023)	(0.018)	(0.018)	(0.018)	(0.018)
Survey Year 2014	0.043*	-0.020	-0.030	0.007	0.002	0.030	0.030	-0.015
	(0.026)	(0.028)	(0.029)	(0.027)	(0.023)	(0.023)	(0.023)	(0.022)
Birth order = 2	-0.068*	0.108**	-0.051	0.011	-0.007	0.024	0.024	0.061
	(0.041)	(0.051)	(0.050)	(0.050)	(0.036)	(0.037)	(0.037)	(0.040)
Birth order = 3	-0.043	0.062	-0.022	0.003	0.079	0.044	0.044	0.026
	(0.066)	(0.082)	(0.095)	(0.081)	(0.068)	(0.062)	(0.062)	(0.063)

Continued . . .

Table B2 (continued): Impact of All Observables on Season of Birth

	Girls aged 0–5 years				**Girls aged 10–15 years**			
	Pre-Monsoon (1)	Monsoon (2)	Post-Monsoon (3)	Winter (4)	Pre-Monsoon (5)	Monsoon (6)	Post-Monsoon (7)	Winter (8)
Significance of Explanatory Variables								
Joint Test ($\chi^2(105)$)		145.77				125.85		
		[0.005]				[0.036]		

Notes: Dependent variable is season of birth of the child.
Marginal Effects from Multinomial logit regression (equation (3)) presented
Sample in columns 1–4 restricted to girls in agricultural households aged 0–5 years with non-missing height and age
Sample in columns 5–8 restricted to girls in agricultural households aged 10–15 years with non-missing test scores
Seasons are defined in Figure 3.
The reference group is that the child is born in winter.
Significance: $^{***}p < 0.01$;$^{**}p < 0.05$;$^{*}p < 0.1$.
Standard errors in parenthesis. p-value in square brackets.