Long-term Impacts of Rice Price and Production Seasonality on Human Capital

Evidence from Rural Indonesia[1]

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Abstract

This paper examines the impacts of prenatal conditions on child growth using recent data from Indonesia. There is seasonality in birthweight: This measure is significantly higher immediately after the main rice harvest in the country. The empirical results show that an increase in birthweight improves child growth outcomes as measured by the height and weight z-scores, as well as schooling performance as measured by age at start of schooling and number of grades repeated. The interactions of ecological variations affect early childhood human capital formation and can have long-term impacts on children's outcomes.

Keywords: Seasonality, Birthweight, Rice price, Child growth, Schooling, Indonesia

JEL classifications: I12, O15, H14

1. Introduction

In developing countries, ecological and human factors often interactively determine the environment in which children grow (Ulijaszek and Strickland 1993). Seasonality in rainfall patterns can affect the production cycle, potentially creating fluctuations in nutrition intake (see, for example, Behrman, Foster, and Rosenzweig 1997; Paxson 1993) and therefore child growth. This paper demonstrates that there is seasonality in birthweight in rural Indonesia and shows that variations in birthweight cause variations in child growth over time and in schooling investments at a later stage of life.

Seasonality in consumption patterns can influence maternal nutrition intake, affecting prenatal development and subsequent birth outcomes (see, for example, Rayco-Solon, Fulford, and Prentice 2005a; Kramer 2003; Neggers and Goldenberg 2003). Low birthweight is caused by conditions such as prematurity and intrauterine growth retardation, and insufficient nutritional intake during critical stages of pregnancy increases the likelihood of such an event and can cause long-term impacts (see, for example, Ceesay et al. 1997; Moore, Collinson, and Prentice 2001; Moore et al. 1997, 1999, 2004; Verhoeff et al. 2001; Ramakrishnan 2004; Luude et al. 2007; Kaestel et al. 2005; Rayco-Solon, Fulford, and Prentice 2005b; Stein, et al;. 1975).[3] [4]

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[3] In particular, Ceesay et al.,(1997) showed that in Gambia, supplementation with high energy groundnut biscuits increased weight gain in pregnancy and significantly increased birth weight, particularly during the nutritionally debilitating hungry season (June to October). This study is close to the current study in that agricultural seasonality can affect birthweight. Stein et al. (1975) shows evidence from the Dutch famine that those exposed to the famine during the second half of gestation had lower birth weight.

[4] It is reported that the likelihood of premature births is the same in developed and developing countries.

As Alderman and Behrman (2006) summarized, low birthweight is an important factor in increasing infant mortality and critically affects cognitive and physical growth. The authors showed that reducing the incidence of low birthweight created significant economic returns. However, caution should be taken when seeking to forge causal connections between birthweight, or prenatal conditions and child growth and adult outcomes. For example, many factors that affect prenatal conditions (for example, household income) also directly influence the determinants of child growth. Notwithstanding that, Behrman and Rosenzweig (2004); Black, Devereux, and Salvanes (2007); Buckles and Hungerman (2008); and Plug (2001) all demonstrated the causal effects of birthweight on later outcomes. Furthermore, several studies have examined the effects of environmental factors such as rainfall and wildfires experienced during gestation and early childhood on human capital outcomes (Godoy et al. 2008; Jayachandran 2005; Maccini and Yang 2008).

Although the findings here are not directly linked to rainfall amounts, it is noteworthy that food availability may differ between rainy (hunger) and dry (food security) seasons (Herdt 1989), leading to seasonal differences in birthweight (see, for example, Rao et al. 2009; Simondon et al. 2004; Rayco-Solon, Fulford, and Prentice 2005b). Interestingly, Lokshin and Radyakin (2008) found significant seasonality in the anthropometric measures of children in India, and further showed that the differences were statistically attributable to birth month. As a possible explanation, birthweight might have been fluctuated over months. In this paper, I link birthweight seasonality to rice price movements (that reflect rice availability in retail markets).

Nutrition-related seasonality doesn't arise just from environmental and market conditions; it may also be grounded in societal norms. The majority of the population in Indonesia are Muslims, who fast during a certain period each year (Ramadan). In principle, pregnant women can be exempt from this practice. However, because food consumption is not perfectly distinguishable among household members, who are likely to share the pot, a pregnant woman's nutritional intake may be negatively affected by the fasting of other family members. Recently Almond and Mazumder (2011) and van Ewijk (2011) demonstrated that Ramadan observance during pregnancy creates long-term adverse impacts on their adult health.[5] In this paper, I make use of exogenous between-province differences in religion: the majority of people in North Sulawesi are Christian, and the other provinces in the sample are predominantly Muslim.[6] Whether birthweight seasonality exhibits different patterns from the two religious groups first signals the possibility of Ramadan effects.

The findings on the impacts of prenatal seasonality on early-stage child growth and schooling investments in Indonesia are directly linked to an emerging body of literature on the long-term impacts of early childhood investments on subsequent human capital and labor market outcomes (for example, Alderman, Hoddinott, and Kinsey 2006; Hoddinott et al. 2008;

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[5] These two works aim to examine whether being born right after Ramadan causes adverse effects on adult health years later. Though changes in birthweight could explain such effects, the focus of this paper differs from theirs in that it looks at child growth and schooling investments.

[6] However, it is not possible to completely distinguish seasonality caused by production cycles from that caused by social norms, as, again, the two are correlated. Differences in the timing of the rainy season among provinces result in different crop seasons. The rainy season may start October, November, or December, beginning earlier in the eastern provinces. Therefore, one must be cautious when interpreting differences between the Muslim-majority and Christian-majority provinces, because their production cycles are inherently different. See also Figures 8a and 8b.

Yamauchi 2008).[7] These studies show that early childhood growth, which is typically measured using the height-for-age z-score, has long-term impacts on human capital formation, as measured by schooling attainment and labor market outcomes. Malnutrition during early childhood has increasingly been shown to adversely affect child growth at later stages.[8] Therefore, prenatal conditions and social norms that influence early childhood growth and health can also have potentially long-term impacts on the inequality in human capital among children born in different seasons.

This paper is organized as follows. The next section discusses the econometric framework utilized in the analysis. Section 3 describes the survey data from Indonesian villages, and Section 4 presents the empirical results on birthweight seasonality and its impacts on child growth and schooling investments. The evidence shows that birthweight has significant seasonality, with its peak in the dry season of Indonesia. Moreover, increasing birthweight significantly improves child growth and schooling outcomes.

2. Econometric Method

The analysis uses a two-stage approach: First the seasonality effects of birthweight discussed earlier are examined, and then child growth is estimated by instrumenting birthweight. The birthweight equation is written as follows:

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[7] See Steckel (2009) for a recent review of heights and human welfare.

[8] The literature on consumption smoothing in the developing-country context has largely focused on the welfare implications of income fluctuation and consumption-smoothing mechanisms (for example, Townsend 1994; Ligon and Schechter 2003). Some empirical studies have shown that income shock affects nutrition intake among children at the early stage, and therefore has long-term impacts on human capital formation (for example, Alderman, Hoddinott, and Kinsey 2006; Hoddinott and Kinsey 2001).

$$w_{ij} = \alpha_1 + Z_{ij}\gamma + \varepsilon_{ij} \quad (1)$$

where w_i is an input for the growth, such as the (log of the) birthweight, of child i in household j; Z_{ij} is a set of variables that capture exogenous factors, such as natural/human seasonality, that affect w_{ij} but do not directly affect child growth or schooling outcomes; and ε_{ij} is an error term. Z_{ij} also incorporates a gender dummy, birth year, and village-fixed effects. I examine the effects of birth months and (the seasonality of) rice prices on birthweight.

In the second stage child growth is estimated with the equation

$$h_{ijt} = \alpha_2 + w_{ijt}\beta + X_{ijt}\delta + v_{ijt} \quad (2)$$

where h_{ijt} is a child anthropometry measure and schooling outcomes; X_{ijt} includes a gender dummy, age in months, birth year, and village-fixed effects; and v_{ijt} is an error term. The controls in equations (1) and (2) vary depending on whether the analysis concerns the effects of birthweight seasonality on child growth or on schooling outcomes.

In the analysis of birthweight's effects on anthropometry and schooling outcomes, we can instrument birthweight under the condition that birth month is uncorrelated with v_{ijt}. Since birth month approximately indicates fertilization month, this condition means that the decision on (and occurrence of) fertilization and the likelihood of prematurity are not correlated with unobserved components of child growth occurring after nine months from the time of fertilization.[9] Furthermore, the birth month may correlate with sanitation conditions that could

[9] Variations in lactation period are less important than nutritional variations in determining birth outcomes.

affect the likelihood of a child becoming infected with a disease that affects growth. Although this study lacked the means to directly address this potential causality, I will check whether birth months affect subsequent child growth beyond the impacts of birthweight.[10]

3. Data

The data come primarily from village- and household-level surveys conducted in 2007 and 2010, covering 98 villages in seven provinces (Lampung, Central Java, East Java, West Nusa Tenggara, South Sulawesi, North Sulawesi, and South Kalimantan) as part of the Japan Bank for International Cooperation Study of Effects of Infrastructure on Indonesia Millennium Development Goals (IMDG). The 2007 village survey reported the physical and economic distances from the village to various economic activity points, such as markets, stations, and capital towns.

The survey sample was designed to overlap with villages covered in the 1994/95 PATANAS survey conducted by the Indonesia Center for Agriculture and Socio Economic Policy Studies to build household panel data. The PATANAS survey focused on agricultural production activities in 48 villages chosen from different agroclimatic zones in these seven provinces. In 2007 the IMDG project expanded the scope of research by means of a general household survey, and the research was further expanded with the surveying of 51 additional villages in the seven provinces.

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[10] See also Lokshin and Radyakin (2008) for the effects of birth months on child growth.

In the sample of previously surveyed villages, we re-sampled 20 households per village, and the split households were followed. In the new villages, the sample included 24 households from the two main hamlets in each village. One of the 48 villages included in the 1994/95 PATANAS survey (in West Nusa Tenggara province) was not accessible in 2007 because of safety concerns, so the overall sample consisted of 98 villages. The locations of the sampled villages are shown in Figure 1.

Figure 1 to be inserted

In 2010 a follow-up survey covered all 98 villages. The 2010 survey had a few important changes in the design. First, it tracked out-migrants in terms of either physical visits or phone calls (in addition to capturing split households in the same villages). Second, the anthropometry module covered children age 0 to 12 years, so the coverage of children was expanded (the 2007 survey covered children age 0 to 60 months).

This study uses the anthropometry section of the 2010 survey. Therefore, the sample size is almost double that for the 2007 survey. In addition to children born in 2007–2010, the analysis includes those born in 1997–2002. The survey round included a child anthropometry module, in which the current height, current weight, and birthweight were recorded for children age 0–12 years.

4. Birthweight Seasonality and Its Impacts on Child Growth

4.1 Key Observations

Figure 2 shows the relationship between birth month and birthweight. It is interesting to note that (1) there is a peak in the middle of the year (from May to August), which corresponds to the dry season in many parts of the country, and (2) there is a drop between September and November. Given the possibility of a lag in the effect of consumption on birthweight, this cycle could be caused by production seasonality.[11]

Figure 2 to be inserted

Herdt (1989) reported that the Indonesian rice harvest is concentrated in the period of April to June, which suggests that rice is most available after April. The seasonal fluctuations of birthweight in Figure 2 are largely consistent with the seasonality of rice harvest. On this issue, I further investigate the relationship between rice price and birthweight.

The above graph suggests that birthweight, which can be affected by agricultural seasonality and social norms, has impacts on early childhood growth and long-run human capital formation. In other words, agricultural seasonality or social norm effects (differentiated by province) can be used as determinants of birthweight in Eq.(2) and thereby reveal the effects of birthweight on child growth.

Because the child anthropometry data pertain only to those who were alive at the time of survey, the birthweights of children who died are unavailable to control for sample selection caused by infant mortality related to low birthweight. This issue can be particularly important in a high-mortality environment (see, for example, Lee et al. 1997). Indonesia shows a relatively high infant mortality rate of 27 (31) per thousand in 2010 (2006) among its

[11] If this cyclical effect can be predicted, it could enable agents to choose fertilization timing to separate childbirth outcomes from the seasonality effects. There is also little evidence that birth spacing and breastfeeding are fine tuned to the month.

neighboring countries (World Bank, 2011).[12] However, it is not possible to rule out a potential correlation between infant/child mortality and birthweight that creates selectivity. There are no birthweight data for those infants who died, so this issue cannot be examined here.

Figure 3a shows that the distribution of birthweight does not show any obvious truncations, indicating that mortality due to low birthweight is not significant in the sample. Another concern is the potential correlation between birth month and the incidence of infant mortality (and birthweight), which could also bias the estimates. Table 1 shows the number of living children less than 12 years of age by birth month. It is shown that our data point to a relatively low birth rate in January, which suggests a possibility of selectivity in this particular month.

Table 1, Figures 3a and 3b to be inserted

Figure 3b depicts the birthweight distribution of those who were born in January. In this graph, we could not detect any clear truncation in the distribution, which indirectly supports non-existence of birth selectivity (through infant mortality) related to birthweight in our sample.

The next issue that may affect the empirical results is potential selectivity associated with the endogeneity of birthweight records. Birthweight is most likely to be recorded if the delivery takes place at a healthcare facility or is attended by a midwife, and the mother has a mother-child handbook. Therefore, it is reasonable that the likelihood of birthweight being recorded varies across villages.

[12] The Philippines: 23, Vietnam: 19, Thailand: 11 in 2010 (World Bank, 2011).

Figure 4 shows the distribution of the proportion of birthweight records out of all births (child alive now). Some villages had few records out of all births, though many villages tended to record birthweight.

Figure 4 to be inserted

Table 2 displays the relationship between birth year and the likelihood of birthweight being recorded. The table clearly shows that the likelihood increased monotonically over time. Therefore, more recent births are more likely to have birthweight records. Table 3 presents data on birth month and the likelihood of birthweight being recorded. Some fluctuations over months are present, but the variations seem insignificant.

Tables 2 and3 to be inserted

The last column in Table 3 shows linear probability model estimates, which confirm the preceding observations. Birth month effects on the likelihood of birthweight being recorded are insignificant. Therefore, the likelihood of birthweight being recorded is correlated with birth year and village, but not with birth month. The following analysis of birthweight seasonality uses the sample of villages where birthweights were most likely to be recorded.

Using the sample of villages where the proportion of birthweights recorded was greater than 80 percent (to minimize the effect of birth record selectivity), Figure 5 shows the seasonal pattern of birthweight. The figure confirms the robustness of the observations in Figure 2, implying that the seasonality is not affected by the selectivity of birthweight records.

Figure 5 to be inserted

It should be noted that although the findings indicate significant seasonality in birthweight, it is difficult to identify factors explaining the seasonality, such as natural production cycles and influences related to social norms. Indonesia and the sample both exhibit heterogeneity in agroclimatic and socioeconomic conditions. Yamauchi, Takeshima, and Dewina (2009) reported from the 2007 survey that rainfall patterns differ between Sulawesi and the Lampung, Java, and West Nusa Tenggara regions. The type of crop production also differs between the regions. In the next sub-section, this issue will be investigated further with time-series rice price data.

4.2 Birthweight Seasonality

This section summarizes the empirical results on birthweight seasonality and its impact on child growth. Table 4 shows the determinants of birthweight.

Table 4 to be inserted

Column 1 shows the effects of birth month on (log) birthweight. The specification includes village-specific birth year dummies to control for village-specific weather shocks. As indicated in Figures 2 and 5, birthweight is highest around June, with the low point occurring in October and November. Birthweight increases in December, but the beginning of the calendar year shows lower birthweight. The birthweight result for December looks highly idiosyncratic, whereas the large birthweight figure observed in the period of April to August is cyclical and roughly coincides with the major harvest season in Indonesia.

Column 2 uses the sample of villages where the proportion of births with birthweight records is more than 80 percent. By using the sample of villages that are likely to report birthweight, the potential selectivity related to endogenous birthweight records can be controlled. As Figure 4 indicates, the proportion of birthweight recording varies across villages. The results in this column are quite similar to those of Column 1, which confirms that the selectivity of birthweight recording does not cause the observed seasonality.

Column 3 uses season indicators that divide the year into three periods based on the crop production seasons: January–April, May–August, and September–December (the period of January–April is omitted here). This estimation uses the sample of villages where the proportion of birthweight records was higher than 80 percent. The estimation controls for birth year and village-fixed effects. The results show significant positive effects for May–August and September–December. This finding is consistent with the pattern shown in Figure 2, where a peak in (log) birthweight appears during May–August.

The difference in the religion of the majority between North Sulawesi and the other provinces in the sample was used to investigate whether religious practice influences the birthweight seasonality. North Sulawesi is known as a Christian majority province, whereas the other provinces in the survey have Muslims as the majority group. The difference is reflected in the sample results. Ramadan is the Muslim fasting month and its exact date changes from year to year according to the lunar calendar. Figure 6 shows the seasonal pattern of birthweight in North Sulawesi. Interestingly, the graph resembles Figures 2 and 5, which implies that the religious difference does not create a change in the seasonal pattern of birthweight in North Sulawesi. For the above reason, therefore, I will not pursue this line of investigation below.

Figure 6 to be inserted

4.3 Rice Prices

To investigate the relationship between agricultural seasonality and birthwieght, I use the time series data of medium-quality retail rice prices available from provincial capital cities in the period of 1998 to 2009 (Bulog, 2002, 2007, 2009).

Figures 7, 8a, and 8b to be inserted

Figure 7 shows changes of rice prices in 7 sample province capital cities, Jakarta and the national average price. It is observed that the time series depicts some degree of correlations across cities and seasonal variations over years. Next, monthly inflation rate was computed from January and December prices for each year in each province. Then, deviations from this within-year trend were calculated. Figures 8 show, for each month, the average monthly deviation computed from the period of 1998 and 2009.[13] To demonstrate a clear difference in the seasonal pattern, Figure 8a show Lampung, Java (including Jakarta, Central and East Java), NTB, while Figure 8b shows Kalimantan and Sulawesi. We clearly find from these graphs that, with a certain lag, birthweight seasonality is inversely correlated with rice price fluctuations in Lampung, Java and NTB (and the national average). Sulawesi and Kalimantan show peaks of rice price coming later than Lampung, Java and NTB.

[13] In Figures 8, the mean is adjusted to be zero in each year.

Table 5 to be inserted

Table 5 shows the estimation results on the effect of seasonal variations in rice price on birthweight. The prices are averaged in the third trimester months. In Column 1 where all sample was used, we do not find a significant effect but as Figures 8 demonstrate, the provinces in Lampung, Java and NTB show significant effects of rice price on birthweight (Columns 2 and 3). In contrast, the price effect is insignificant in Kalimantan and Sulawesi (where rice price seasonality differs from the national average). The above results also imply that birthweight is significantly affected by the national average of rice price (as the major production of rice is from Java).

4.4 Child Growth

Table 6 show the effect of birthweight on the height-for-age z-score among sampled children less than 30 months of age.[14] Columns 1 and 2 present noninstrumented and instrumented results, respectively. The interaction of birth month with province was used as an identifying instrument. First, note that the effect of birthweight is positive and significant in the instrumental variable (IV) estimation (column 2). Second, the parameter in the IV estimation is quite similar to that in the non-IV ordinary least squares (OLS) estimation (column 1).

Table 6 to be inserted

[14] In children age 30–60 months, the relationship between birthweight and height is not clear. However, studies show that child nutrition and growth during ages 0–3 years critically determine schooling outcomes and labor market outcomes at adulthood.

In Columns 3 and 4, the interaction of age and (log) birthweight is used to examine age-varying effects, which are treated as endogenous. Interestingly, the non-IV results show that the interaction with age has a significant negative effect, suggesting that the importance of birthweight in determining child growth decreases as the child ages. If the interaction is included, the estimate of the birthweight effect becomes much larger, along with a convergence in the process of child growth (i.e., the initially large effect of birthweight becomes smaller as the child grows).

Table 7 uses the weight-for-age z-score, which provides qualitatively similar results. First, birthweight has a significant positive effect on child weight in both the noninstrumented and instrumented estimations (Columns 1 and 2). This is not surprising: Birthweight represents a large portion of a child’s weight at age 0–30 months. Second, the parameter in the IV estimation is larger than that in the OLS estimation, suggesting that there can be a downward bias in the OLS estimate. Third, girls have a greater weight than boys, but no gender-related difference in child height is evident. Columns 3 and 4, where the interaction of birthweight and age is included, show the results qualitatively similar to what was confirmed in Table 6. However, the difference between the IV and non-IV estimates is marginally insignificant (p = 11 percent).

Table 8 to be inserted

Next, birth month indicators were included in addition to birthweight in order to test whether, beyond the birthweight effects, the month of birth influences subsequent child growth (Table 8). Column 1 shows that the birth month does not significantly change the height-for-age z score once the birthweight effects were controlled. In Column 2, however, the weight-for-age a score is significantly affected by birthweight as well as some particular months of birth: March, April, May and August. These months are in the end of rainy season to dry season in the country. If weaning comes around six months after birth, they experienced weaning during rainy season. The results indicate some sort of seasonal effects on child growth after birth, but the height z score did not show any indication of such seasonal effects.

4.5 Schooling Investments

Table 9 to be inserted

Next the effects of birthweight on child schooling outcomes is examined (Table 9). Here the outcome variables are age at start of schooling and number of grades repeated in primary school. The age range of the sample is 6 to 12 years. The estimation uses as instruments birth month indicators, interacted with village dummies. Columns 1 and 2 show the estimated effects on age at start of schooling without and with instruments, respectively. Although the instruments did not work effectively, both results confirm that an increase in birthweight significantly lowers age at start of schooling. Females tend to enter school at a younger age than males.

Columns 3 and 4 estimate the effects of birthweight on the number of grades repeated in primary school. In this analysis, it is important to control birth year because this explains the number of years in school, which is correlated with grade repetitions. In Column 4 instrumental variables include birth month indicators interacted with village. The results show that females not only tend to repeat grades less, but also alter the effect of birthweight. Among males, an increase in birthweight significantly reduces the number of grades repeated. This effect does not exist among girls (the first two estimates are almost canceled out). Combined with the results on age at start of schooling, we can conclude that greater birthweight leads to higher grade attainment in elementary school.

Overall there seems to be a female advantage in schooling investments and outcomes in this empirical setting. An increase in birthweight helps both boys and girls start schooling at a younger age, though girls tend to start schooling earlier than boys. Once schooling starts, girls tend to advance in grade faster than boys. Only among boys, however, greater birthweight helps reduce the number of repetitions.

Table 10 to be inserted

Child's entry to school education is an important event for their parents. Therefore, it is possible that parents manipulate their child's age (therefore, birth date) so that the child can start school under a better condition. This may happen if children born immediately prior to the start month of academic year, that is, the beginning of July, in Indonesia. In Table 10, the estimation excludes those who were born in April, May and June to check the robustness of the previous findings. Interestingly, the results confirm that our main findings remain robust to the exclusion of those birth months.

5. Conclusion

The present analysis demonstrates the importance of natural and human factors in determining child growth and health in Indonesia. Seasonality in birthweight, likely caused by the agricultural production cycle (rainfall patterns), significantly affects the height-for-age and weight-for-age z-scores and performance at primary school. The findings not only pertain to children's human capital in the short run, but also have implications for their long-term human capital.

The above finding implies that stabilization of food price and supply can bring unexpectedly dynamic impacts on human life through equalizing birth outcomes and subsequent human capital formation. This study shows that price fluctuations, caused by agricultural seasonality, are likely to alter birthweight of the new born, which impacts their growth and schooling outcomes at subsequent stages. It is predicted to change their adult outcomes if schooling investments are substantially affected. While this paper deals with intra-year price fluctuations, it also seems logical that extrapolation to inter-year fluctuations is warranted. Moreover, the global food price crises recently observed in 2007-08 and 2011 could have had long-term adverse impacts on child development.

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Figure 1 Locations of survey villages

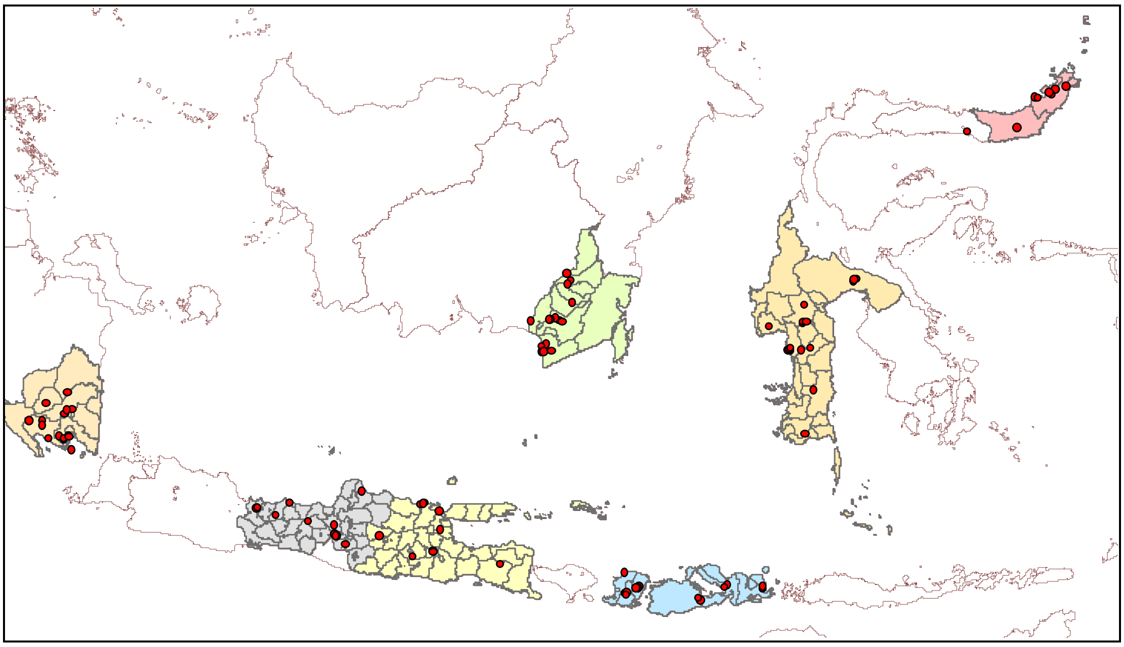
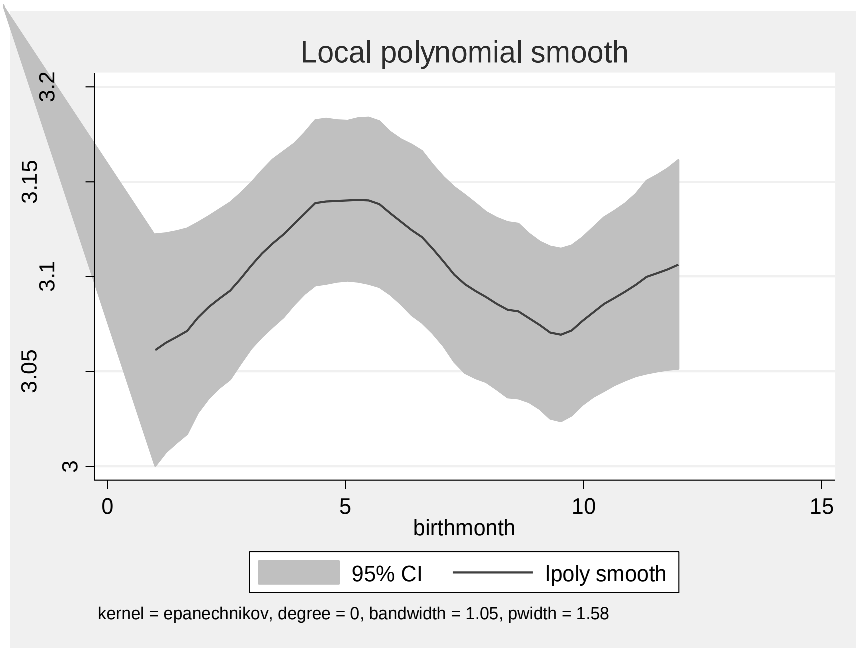
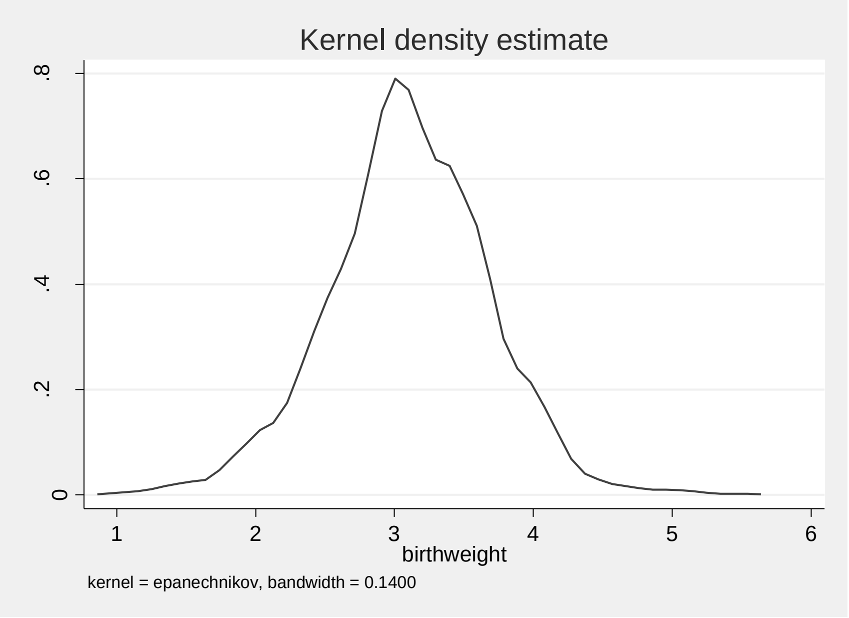


Figure 2 Seasonality in birthweight



Source: IMDG-2 (2010).

Figure 3a Birthweight density



Source: IMDG-2 (2010).

Figure 3b Birthweight density: Born in January

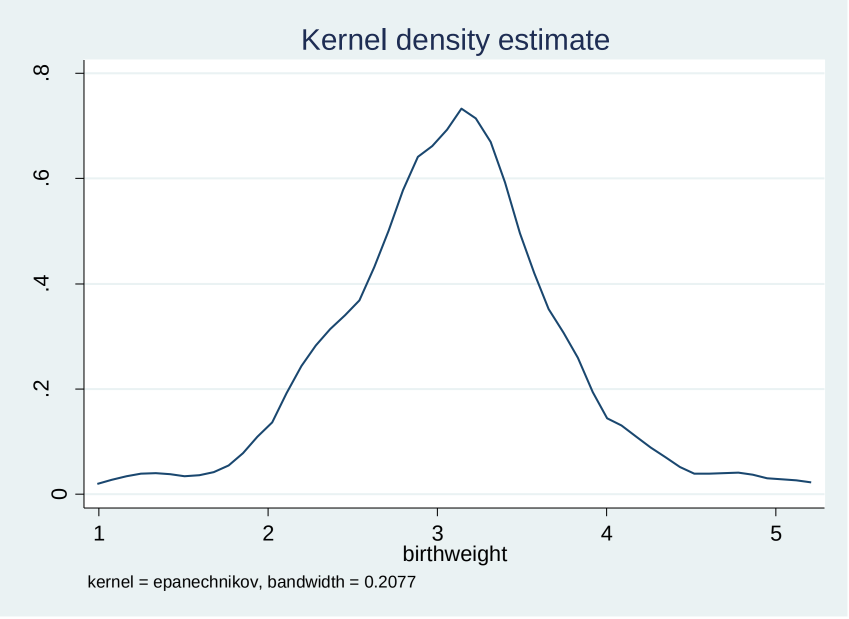
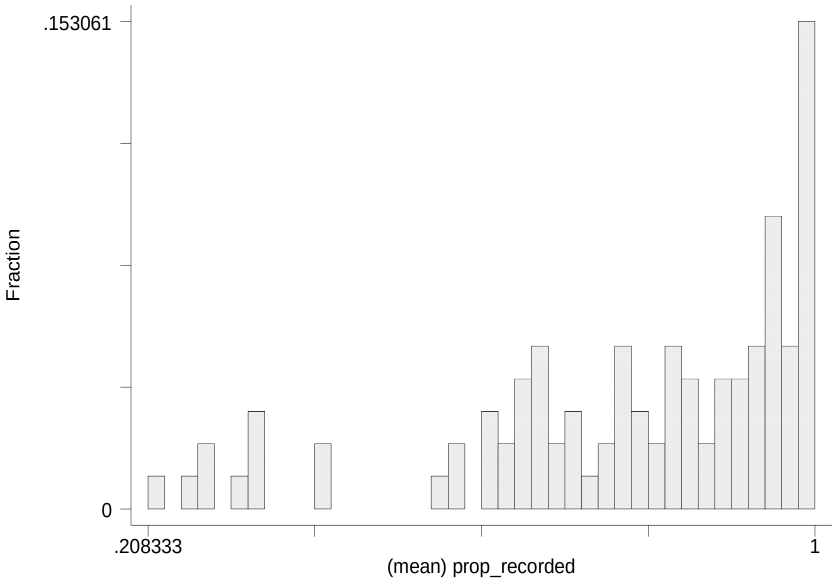
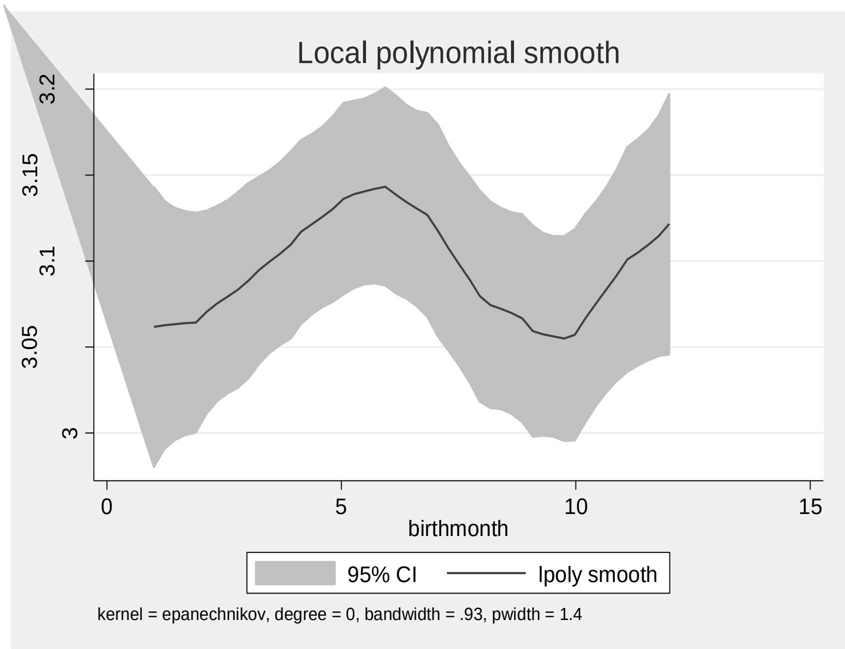


Figure 4 Proportion of birthweights recorded, by village



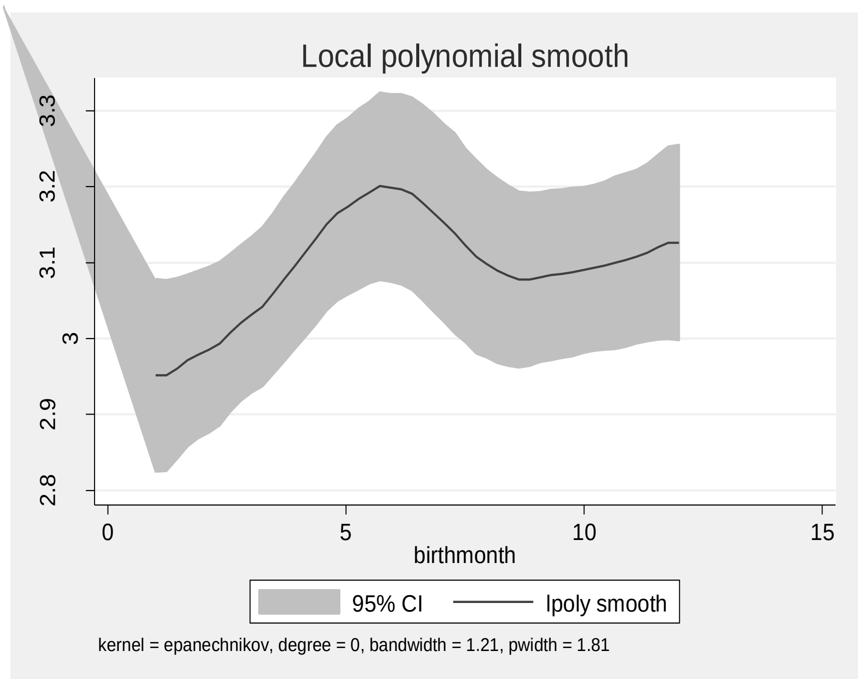
The sample consists of 98 villages. Source: IMDG-2 (2010).

Figure 5 Seasonality in birthweight for villages with the proportion of birthweights recorded greater than 0.8



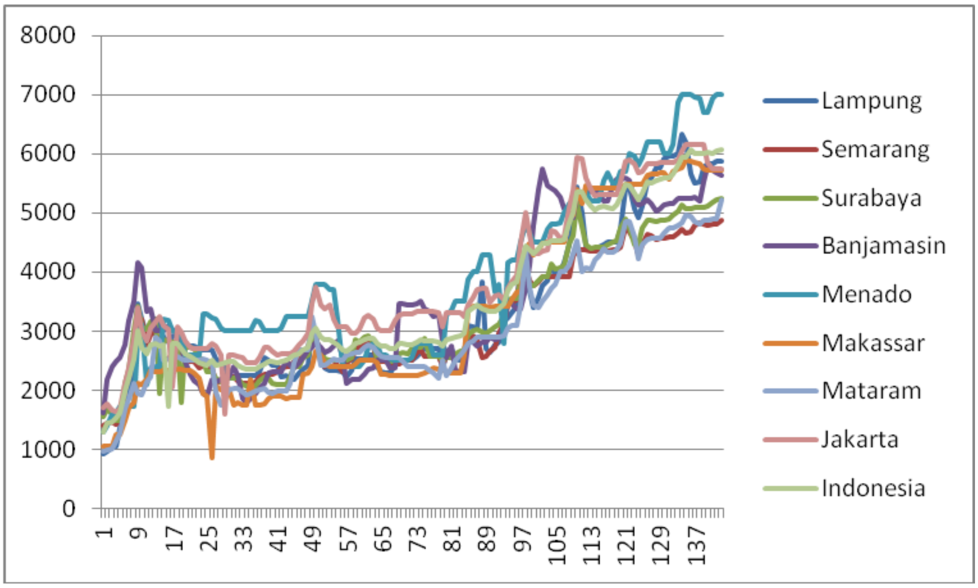
Source: IMDG-1 (2010).

Figure 6 Birthweight seasonality in North Sulawesi



Source: IMDG-2 (2010).

Figure 7 Rice prices January 1998 – November 2009



Note: The graph shows monthly medium-quality rice prices at our sample province capital cities, Jakarta and the national average, starting from January 1998 to November 2009. Sources: Bulog (2002, 2007, 2009)

Figure 8a Rice price seasonality – Lampung, Java, and NTB

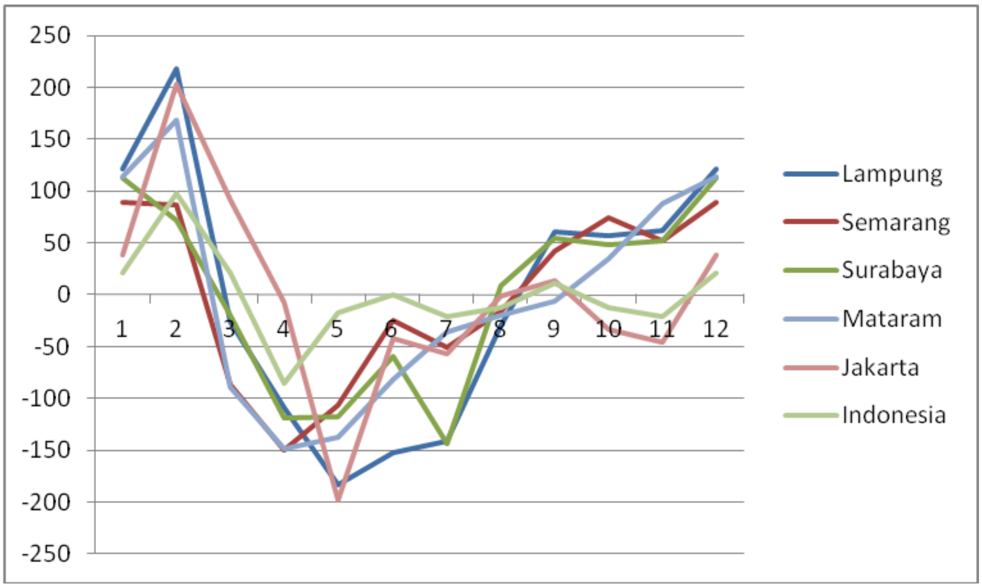
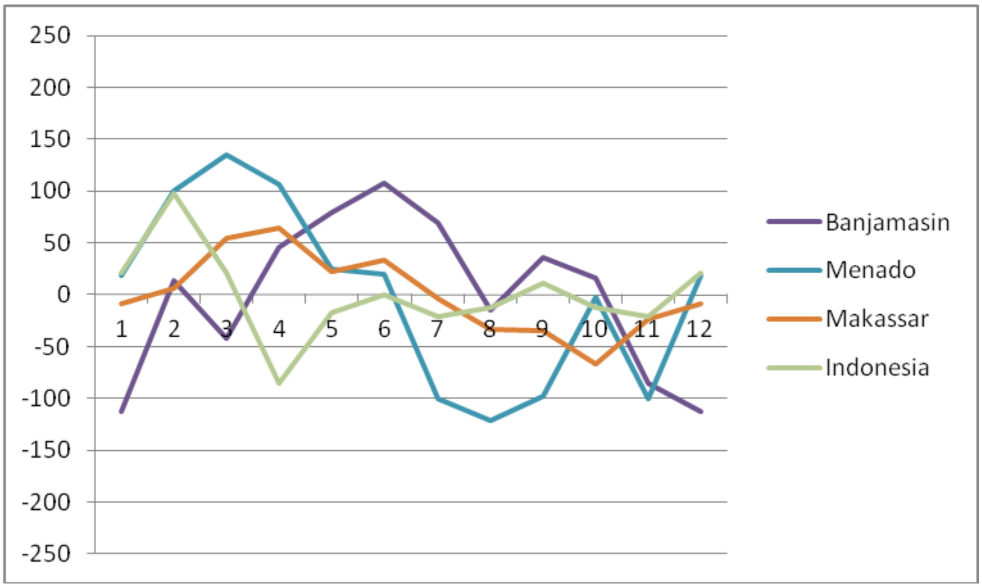


Figure 8b Rice price seasonality – Sulawesi and Kalimantan



Note: In each year, monthly inflation rate was computed from January and December prices (linear trend). Deviations from this within-year trend were computed. For each month, the average monthly deviation was computed in the period of 1998 – 2009. The graph depicts the 12-year average monthly deviations (the mean is adjusted to be zero).

Table 1 Birth month summary

Month	Number	%	Difference
1	148	6.20	-2.13
2	173	7.24	-1.09
3	224	9.38	1.05
4	207	8.66	0.33
5	230	9.63	1.30
6	188	7.87	-0.46
7	218	9.13	0.80
8	207	8.66	0.33
9	184	7.70	-0.63
10	198	8.29	-0.04
11	214	8.96	0.63
12	198	8.29	-0.04
Total	2,389	100.00	

Sample consists of children age 0 to 12 years. * Difference shows gap between the actual frequency (%) and the hypothetical frequency (8.33) under the assumption of equality in birth rate across months. Source: IMDG-2 (2010).

Table 2 Birthweight recorded, by year of birth (frequencies and percentages)

	Recorded?		
Year	No	Yes	Total
1997	33	57	90
	36.67	63.33	100.00
1998	57	109	166
	34.34	65.66	100.00
1999	55	132	187
	29.41	70.59	100.00
2000	73	143	216
	33.80	66.20	100.00
2001	52	154	206
	25.24	74.76	100.00
2002	58	135	193
	30.05	69.95	100.00
2003	56	152	208
	26.92	73.08	100.00
2004	41	136	177
	23.16	76.84	100.00
2005	30	147	177
	16.95	83.05	100.00
2006	39	155	194
	20.10	79.90	100.00
2007	41	133	174
	23.56	76.44	100.00
2008	30	171	201
	14.93	85.07	100.00
2009	32	162	194
	16.49	83.51	100.00
2010	9	79	88
	10.23	89.77	100.00
Total	606	1,865	2,471
	24.52	75.48	100.00

Source: IMDG-2 (2010).

Table 3 Birthweight recorded, by month born (frequencies and percentages)

Month	Recorded? No	Yes	Total	Regression
1	36	112	148	Omitted
	24.32	75.68	100.00	
2	38	135	173	0.0281
	21.97	78.03	100.00	(0.43)
3	61	163	224	-0.0739
	27.23	72.77	100.00	(1.29)
4	42	165	207	-0.0121
	20.29	79.71	100.00	(0.20)
5	50	180	230	0.0038
	21.74	78.26	100.00	(0.06)
6	35	153	188	0.0775
	18.62	81.38	100.00	(1.18)
7	51	167	218	0.0442
	23.39	76.61	100.00	(0.73)
8	50	157	207	0.0211
	24.15	75.85	100.00	(0.33)
9	42	142	184	0.0157
	22.83	77.17	100.00	(0.24)
10	38	160	198	0.0648
	19.19	80.81	100.00	(1.00)
11	47	167	214	0.0680
	21.96	78.04	100.00	(1.09)
12	60	138	198	-0.0414
	30.30	69.70	100.00	(0.64)
Total	550	1,839	2,389	
	23.02	76.98	100.00	
R-square				0.5733
Number of observations				2,299

Regression shows linear probability model estimates with robust standard errors using village clusters (controlling village dummies, birth year dummies, and their interactions). Source: IMDG-2 (2010).

Table 4 Birthweight seasonality

Dependent: Log birthweight			
Age 0–12 years			
Proportion of birthweights recorded		>0.8	>0.8
February	0.0029	0.0143	
	(0.07)	(0.32)	
March	0.0400	0.0132	
	(1.04)	(0.32)	
April	0.0605	0.0579	
	(1.54)	(1.43)	
May	0.0636	0.0493	
	(1.51)	(1.12)	
June	0.0986	0.0934	
	(2.16)	(2.07)	
July	0.0628	0.0634	
	(1.45)	(1.37)	
August	0.0768	0.0778	
	(1.80)	(1.74)	
September	0.0427	0.0044	
	(0.95)	(0.10)	
October	0.0537	0.0469	
	(1.29)	(1.03)	
November	0.0290	-0.0042	
	(0.71)	(0.09)	
December	0.0970	0.1128	
	(2.34)	(2.46)	
May–August			0.0430
			(2.05)
September–December			0.0091
			(0.41)
Village dummies	Yes	Yes	Yes
Birth year dummies	Yes	Yes	Yes
Birth year dummies * village dummies	Yes	Yes	Yes
R-square	0.5743	0.5538	0.5355
Number of observations	1,782	1,152	1,152

Numbers in parentheses are absolute t-values using robust standard errors. Observations from 1997 were not included in the estimation (1998 = omitted baseline). The specifications include village dummies, birth year dummies and their interactions. Source: IMDG-2 (2010).

Table 5 Rice price and birthweight

Dependent: Log birthweight					
Age 0–12 years					
Proportion of birthweights recorded			>0.8		>0.8
Region (province)	all	Lampung Java NTB	Lampung Java NTB	Kalimantan Sulawesi	Kalimantan Sulawesi
Adjusted rice price in 3rd trimester	-0.00005	-0.00012	-0.00011	-9.88-E06	0.00001
	(1.55)	(2.31)	(1.80)	(0.23)	(0.19)
R-square	0.1109	0.1110	0.1130	0.1313	0.1256
Number of observations	1558	835	601	723	408

Numbers in parentheses are absolute t-values using robust standard errors. Observations from 1997 were not included in the estimation (1998 = omitted baseline). The specifications include village dummies, birth year dummies and their interactions. Source: IMDG-2 (2010).

Table 6 Child growth: Height

Age 0–30 months

Dependent: Height-for-age z-score

	No IV	IV	No IV	IV
Log birthweight	0.8413	1.994	3.252	3.246
	(1.26)	(1.87)	(2.64)	(1.98)
Log birthweight × age			-0.1761	-0.0906
			(2.40)	(1.02)
Age in months	-0.0502	-0.0368	0.1417	0.0621
	(1.22)	(0.82)	(1.57)	(0.58)
Female	0.2554	0.3018	0.2129	0.2805
	(1.09)	(1.27)	(0.92)	(1.20)
Birth year–fixed effects	Yes	Yes	Yes	Yes
Village-fixed effects	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman (chi-square)		0.9456		0.4871
p-value		0.1607		0.0876
R-square	0.3277	0.3187	0.3438	0.3308
Number of observations	366	366	366	366

Numbers in parentheses are absolute t-values (columns 1 and 3 using robust standard errors). Log birthweight is treated as an endogenous variable. Instruments are birth month indicators (interacted with province dummies), village dummies and other exogenous variables. Source: IMDG-1 (2007).

Table 7 Child growth: Weight

Age 0–30 months

Dependent: Weight-for-age z-score

	No IV	IV	No IV	IV
Log birthweight	1.542	2.114	2.410	2.149
	(3.79)	(2.67)	(2.95)	(1.91)
Log birthweight × age			-0.0636	-0.0039
			(1.32)	(0.07)
Age in months	-0.0511	-0.0439	0.0183	-0.0399
	(1.93)	(1.56)	(0.33)	(0.61)
Female	0.4443	0.4700	0.4335	0.4686
	(2.80)	(2.84)	(2.74)	(2.89)
Birth year–fixed effects	Yes	Yes	Yes	Yes
Village-fixed effects	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman (chi-square)		1.059		4.342
p-value		0.3034		0.1141
R-square	0.3715	0.3667	0.3761	0.3676
Number of observations	372	372	372	372

Numbers in parentheses are absolute t-values (columns 1 and 3 using robust standard errors). Log birthweight is treated as an endogenous variable. Instruments are birth month indicators (interacted with province dummies), village dummies and other exogenous variables. Source: IMDG-1 (2007)..

Table 8 Robustness check: Child growth

Age 0–30 months		
Dependent:	Height z score	Weight z-score
Log birthweight	3.1393	2.4488
	(2.51)	(3.07)
Log birthweight × age	-0.1781	-0.0663
	(2.44)	(1.37)
Age in months	0.0301	-0.3241
	(0.08)	(1.34)
Female	0.2624	0.4330
	(1.11)	(2.71)
February	0.6337	-0.7134
	(1.01)	(1.52)
March	0.6103	-1.4792
	(0.73)	(2.47)
April	-0.0505	-1.7673
	(0.05)	(2.20)
May	0.1871	-2.0390
	(0.13)	(1.98)
June	0.7060	-1.9709
	(0.39)	(1.59)
July	-0.6508	-2.3273
	(0.31)	(1.55)
August	-0.8568	-3.2961
	(0.35)	(1.96)
September	-1.1882	-2.8773
	(0.43)	(1.50)
October	-0.2866	-3.6573
	(0.09)	(1.72)
November	-0.7806	-4.2470
	(0.22)	(1.81)
December	-0.1726	-3.9354
	(0.04)	(1.48)
Birth year–fixed effects	Yes	Yes
Village-fixed effects	Yes	Yes
R-square	0.3779	0.4152
Number of observations	366	372

Numbers in parentheses are absolute t-values using robust standard errors. Source: IMDG-1 (2007).

Table 9 Child schooling: Age started and repetitions

Age 6–12 years				
Dependent	Age started		Grades repeated	
	No IV	IV	No IV	IV
Log birthweight	-0.2379	-0.2621	-0.1577	-0.2314
	(2.17)	(2.00)	(1.48)	(2.01)
Log birthweight × female			0.1753	0.2807
			(1.50)	(1.88)
Female	-0.0849	-0.0852	-0.2931	-0.4103
	(1.93)	(1.94)	(2.14)	(2.44)
Birth year–fixed effects	Yes	Yes	Yes	Yes
Village-fixed effects	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman (chi-square)		0.116		3.010
p-value		0.7337		0.2219
R-square	0.2636	0.2636	0.2489	0.2482
Number of observations	823	823	800	800

Numbers in parentheses are absolute t-values (columns 1 and 3 using robust standard errors). Log birthweight and its interaction with female indicator are treated as endogenous variables (the instrument being the predicted value of log birthweight is interacted with female dummy). In column 2, instrumental variables include birth month indicators interacted with village dummies. In column 4, instrumental variables include birth month indicators interacted with village dummies and female dummy, and the interactions of village and female dummies. Source: IMDG-2 (2010).

Table 10 Robustness check: Child schooling

Age 6–12 years				
Birth month: Excluding April, May, and June				
Dependent	Age started		Grades repeated	
	No IV	IV	No IV	IV
Log birthweight	-0.3172	-0.3840	-0.2297	-0.2752
	(2.48)	(2.40)	(1.84)	(2.21)
Log birthweight × female			0.2188	0.2640
			(1.68)	(1.70)
Female	-0.1213	-0.1221	-0.3400	-0.3903
	(2.27)	(2.23)	(2.13)	(2.24)
Birth year–fixed effects	Yes	Yes	Yes	Yes
Village-fixed effects	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman (chi-square)		0.6899		0.6858
p-value		0.4062		0.7097
R-square	0.2727	0.2724	0.2674	0.2672
Number of observations	617	617	602	602

Numbers in parentheses are absolute t-values (columns 1 and 3 using robust standard errors). Log birthweight and its interaction with female indicator are treated as endogenous variables (the instrument being the predicted value of log birthweight is interacted with female dummy). In column 2, instrumental variables include birth month indicators interacted with village dummies. In column 4, instrumental variables include birth month indicators interacted with village dummies, the predicted value of log birthweight interacted with village dummies, and other exogeneous variables. Source: IMDG-2 (2010).