How does birth weight affect health and human capital? A short- and long-term evaluation

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1 Introduction

Birth weight has been shown to predict outcomes later in life, suggesting that in-utero shocks have long-lasting consequences. As examples of adverse outcomes, low-birthweight children are more likely to suffer from disabilities, heart diseases and diabetes; they also generally perform worse in education and earnings as adults (Barker, Winter, Osmond, Margetts, and Simmonds, 1989; Ericson and Kallen, 1998; Hack, Schluchter, Cartar, Rahman, Cuttler, and Borawski, 2003). As a result, birth weight is often considered a critical initial endowment, particularly in developing countries where the combination of poor nutrition and health systems and an unhealthy environment result in a high share of low-birthweight children (Behrman and Rosenzweig, 2004).[1] International institutions such as UNICEF and the World Bank have devoted many policies to increasing birth weight. However, although the literature on the effect of birth weight and in-utero nutrition has received great attention, the evidence for poor countries remains scarce. Most papers on poor countries assume birth weight is exogenous but it is affected by genetic endowment, in-utero nutrition and other prenatal investments that are likely correlated with postnatal investments. To evaluate the cost-effectiveness of interventions aimed at increasing birth weight (cash transfers to pregnant women, nutrition programmes, pre-natal care), it is critical to assess the returns on higher birth weights.

The objective of this paper is to assess the effects of birth endowment on a child's future trajectory, both in terms of health and cognitive achievements. We determine a) the impact of in-utero shocks, b) whether this effect tends to attenuate or be reinforced over time, c) whether these endowments determine

[1] Mahumud, Sultana, and Sarker (2017) found that 16% of newborns are low birth weight in developing countries, based on 10 DHS surveys.

parental investment and d) what share of the effect of birth endowment is due to parental investment. With a broad perspective, this paper documents the consequences of being born with a low weight in a developing country.

To do so, we exploit a unique panel of children born in 1983 in Cebu, Philippines. This dataset comprises information on the child's mother's characteristics and behaviour during her pregnancy, birth outcomes, post-natal investments and short- and long-term outcomes up to adulthood. This dataset has been used by scientists from many different disciplines, including biologists, due to the high quality of the collected data. Glewwe, Jacoby, and King (2001) used this dataset to evaluate the impact of infant nutrition programmes on children's schooling outcomes.

Our strategy is to purge child birthweight from prenatal investments that are likely correlated with subsequent investments. We predict birth weight (and other birth outcomes) based on an extensive range of prenatal investments, which amounts to estimating a production function of birth weight. The residuals of this production function are estimates of the child's birth endowment (Rosenzweig and Wolpin, 1988; Aizer and Cunha, 2012). By construction, the child birth endowment is uncorrelated with prenatal investments and we assume they are also uncorrelated with unobserved parental preferences for human capital. We provide evidence suggesting that this strategy is sufficient to remove most of the endogeneity bias. We also deal with attrition and measurement error issues. We exploit the long panel dimension of our data and find that 1) a naive estimation of the birth weight effect would lead to an upward bias by 20% to 40% of the true causal effect (depending on the outcome); 2) the effect of birth endowment marginally decreases when the individual grows up (at most, the effect at adult age is decreased by 35% compared to that in infancy); 3) parents have a slight tendency to reinforce birth endowments but 4) these reinforcing investments account for very little in the effect of birth endowment; and 5) investments and birth endowment explain a similar share of the variance in height (3 to 5%) whereas investments have an overwhelming effect in educational attainment compared to birth endowment.

This article contributes to the literature in several ways. First, there is debate on whether initial inequality tends to widen, persist or decay over time. Investments can compensate for lower endowments; but, from a biological perspective, nutritional needs depend on development stages. Calorie and nutrient intake at age 5, for instance, are unlikely substitutes for calorie and nutrient intake at age 3. Osmani and Sen (2003) argue that the "western diseases" that now afflict South Asia (heart diseases and diabetes) and obesity arise from a rapid increase in consumption among people who were previously malnourished. Cameron (2003) shows that children who are born small and then grow quickly are at an increased risk of obesity and diabetes. Regarding the effect of birthweight on cognition, Figlio, Guryan, Karbownik, and Roth (2014) find that the effect of birth weight on cognitive outcomes remains constant through schooling whereas Bharadwaj, Eberhard, and Neilson (2010) find that this is the case for twins but that the difference between non-twin siblings decreases over time. In both cases, they do not cover development after middle school. In our case, we are able to observe individuals almost continuously from birth to adulthood. The only paper that assesses the long-term fading-out of the effect uses Taiwanese data: Xie, Chou, and Liu (2017) find that the effect of birthweight remains till adulthood but is lower than that at younger ages. These former studies were performed in high-income countries, where the quality of investment made during childhood is high compared to that in poor countries and should lead to a better catch-up. We are interested in the lifetime trajectory of individuals born with a low birthweight in a developing country.

Second, whether investments can compensate for low endowments depends on whether parents are willing to incur such an investment. This is one aspect of determining the trajectory. Our paper provides evidence on whether parents tend to compensate or reinforce birth endowments. Under dynamic complementarity[2] and with preferences for equity among siblings, parents face a trade-off between efficiency and equity (Becker and Tomes, 1986). Many papers are devoted to evaluating whether parents favour efficiency (and tend to reinforce endowments) or favour equity (and compensate children with lower endowments). However, there is no consensus on this question, as some conclude reinforcement (Rosenzweig and Zhang, 2009; Datar, Kilburn, and Loughran, 2010), some note compensation (Leight, 2013; Bharadwaj et al., 2010) and others find mixed evidence (Rosenzweig and Wolpin, 1988; Conti, Heckman, Yi, and Zhang, 2011; Hsin, 2012).[3,4] Almond and Currie (2011) show that we cannot identify the parents' preferences from their behaviour because it depends on the human capital production function. However, most papers are silent on whether parental choices make a substantial difference in terms of accumulated human capital. Their strategies could have a very limited effect on actual human capital, especially if the biological effect of being born with a low weight is very strong. This argument is also put forward by Bleakley (2010) in a different way: in a context where investment in human capital is already optimized, further optimization based on birthweight should be a second-order effect.

[2]A human capital production function displays dynamic complementarity when returns on investments are higher for individuals with higher levels of human capital at a given date.

[3]A good review of this literature is Almond and Mazumder (2013).

[4]This also fits into the broader question of the intrafamily determinants of outcomes, such as the effect of siblings' sex composition or the effect of birth order.

Lastly, to analyse the effect of birthweight on future outcomes and parental investment, we must deal with endogeneity issues. There are two different methods. One consists of comparing twins. Estimating within (monozygous) twins provides a powerful identification because it amounts to controlling for genetic factors and for prenatal and postnatal investments common to both children. However, several limitations should be noted. First, the twins literature has been unable to reach consensus on the sign of the bias due to the endogeneity. Some conclude an underestimation of the causal effect (Behrman and Rosenzweig, 2004) whereas others note an overestimation (Almond, Chay, and Lee, 2005; Bharadwaj et al., 2010; Oreopoulos, Stabile, Walld, and Roos, 2008). This might be because some do not observe twins' zygozity and therefore compare dizygous twins, who do not share the same genotype. Second, several concerns regarding twins have been raised, for both the external and the internal validity of the setting. For the external validity, the question is determining the extent to which twins results are representative of changes in birth weight for singletons. This might not be the case, as twins are generally lighter at birth than singletons: if the effect of additional grams is higher at low birth weights, then we tend to overestimate the causal effect on singletons. In addition, Bhalotra and Clarke (2015) have recently provided evidence that, in the context of developing countries, twin births are correlated with various family characteristics (wealthier families that are more able to provide the necessary environment for the live birth of twins). This casts doubt on the external validity of the twin strategy in our context. Third, the effect of initial endowments depends on subsequent parental investment strategy. If parents treat twins more equally than they would singletons, then we can infer little from twins studies. The competition for resources between twins and between siblings might also differ.

Bharadwaj et al. (2010) show that the investment in twins is more similar than for non-twin siblings. Fourth, the internal validity also raises concerns. Twins have a higher birth weight variance than singletons, which is because, when they share the same placenta (in 70% of monozygous twin pregnancies), one of them may be disadvantaged over the other. Extreme cases of unequal sharing of in-utero resources occur with twin-to-twin transfusion syndrome. Biologists have shown that this leads to detrimental health outcomes for both twins.[5] It would therefore be necessary to exclude cases with congenital impairment and too large a variation between twins, which is not done in most studies, with the exception of Almond et al. (2005). Last, differentiating between siblings leads to two issues. In the likely presence of measurement error, the estimates might suffer from a strong attenuation bias (Ashenfelter and Krueger, 1994). In addition, if parents change siblings' investment in response to a child's birthweight (as predicted by Becker and Tomes (1976)), then the within-siblings estimates are biased (Almond and Currie, 2011).

The second avenue consisted of using exogenous variations in in-utero nutrition. Those variations are driven by famines (Meng and Qian, 2006), maternal fasting (Almond and Mazumder, 2011; Majid, 2015), the season of birth (Mceniry and Palloni, 2010) and rainfall (Maccini and Yang, 2009; Shah and Steinberg, 2013; Moore, Cole, Collinson, Poskitt, McGregor, and Prentice, 1999). Most of these articles show that children who were in-utero during a nutritionally deprived season were more likely to develop disabilities, heart diseases and have worse health outcomes at birth.[6] In ad-

[5] The donor twin is smaller with a birth weight 20% less than the recipient's birth weight. The recipient twin has an overloaded cardiovascular system and might suffer from heart failure and the donor twin, deprived of nutrients and oxygen, is often anæmic and produces less than the usual amount of urine.

[6] Maccini and Yang (2009) is an exception since they do not find any effect of low rainfall during pregnancy.

dition, using the Dutch famine as a natural experiment, de Rooji, Wouters, Yonker, Painter, and Roseboom (2010) showed that intrauterine exposures that have long-lasting consequences do not necessarily result in altered birthweight, which suggests that birthweight fails to capture all of an individual's health endowment. However, determining the impact of birthweight remains important. Most of these studies are in reduced form and assess the very short-term impact or very long-term impact. They do not provide the causal impact of one additional gram at birth on adult human capital or describe the dynamics of health over the life cycle. Due to this limitation, it is often difficult to infer the consequences for a low birthweight child from a developing country (Bleakley, 2010). Thus, it is relevant to complement twin-based and natural-experiment evidence, noting that the identification provided by these two types of studies is usually stronger than that offered in this paper.

The remainder of this paper is organized as follows. We describe our empirical strategy, the data and the threats to identification in section 2. Section 3 provides the results of the effect of birth endowment and a series of tests to assess the validity of the method. Section 4 offers an analysis of the relationship between birth endowment, parental investments and final outcomes in the human production function. We then present conclusions.

2 Methodology and Data

2.1 General overview of the methodology

We are interested in how endowments shape life outcomes. Scholars primarily use birth weight to proxy for endowments at birth.[7] If y_{it} stands for

[7] de Rooji et al. (2010) showed that poor in-utero nutrition might not be reflected in birthweight if it occurs during the first and second trimesters of pregnancy. This suggests that birthweight does not capture all the in-utero nutrition and thus we estimate a lower bound of the in-utero nutrition effect. In the remainder of the paper, we also use alternative

any life outcome of individual i at age t (such as height, for instance), BW_i for birth weight and X_{it} for a set of relevant covariates, the relationship of interest is:

$$y_{it} = K_t + \alpha_t BW_i + \gamma_t X_{it} + u_{it}$$

where α_t is the effect of birth weight on life outcomes and is allowed to vary across ages. However, birth weight may be endogenous because it reflects prenatal investments (PI_i), which presumably correlate with postnatal investment. Following Aizer and Cunha (2012), we use the residual from a production function that includes prenatal investments as regressors. We discuss the prenatal investments included in our analysis in section 2.4.

$$BW_i = K_1 + \beta PI_i + \epsilon_i \tag{1}$$

The residual ϵ_i encompasses the child's true endowment at conception, any nutrition and health shocks that occurred during the pregnancy and presumable measurement error in BW as well as remaining prenatal investment that would not have been purged by our control strategy.

Assuming that the correlation between BW_i and u_{it} amounts to a non-zero correlation between PI_i and u_{it}, we can estimate

$$y_{it} = K_t + \alpha_t \widehat{\epsilon_i} + \gamma_t X_{it} + v_{it} \tag{2}$$

If BW_i is measured with error, then ϵ_i is too and the estimate of α_t is biased (towards zero if the error is classical). In the presence of other outcomes at birth, we can estimate different birth endowments and check that the results are robust to different specifications. We can also build a birth endowment

birth endowment measures but they are likely to suffer from the same limitation, arising from catch-up during the third trimester of pregnancy.

variable based on the whole set of birth outcomes.

The estimation of Eq. 2 provides the causal impact of birth weight on outcomes at different ages, under the assumption that

$$E(v_{it}|BW_i, PI_i, X_{it}) = 0. \tag{3}$$

This identifying assumption shows that the estimation of equation (2) provides the same estimates as the regression of outcome y_{it} on raw birth weight (BW_i), control variables (X_{it}) and prenatal investments (PI_i).[8]

To assess whether inequalities at birth tend to widen or decrease over time, it is sufficient to compare the values of α_t for different t. The mechanisms at stake are of various natures: there is a purely biological process, which governs the health production function, that largely depends on inputs that are mostly provided by the child's family. The biological process can lead to divergence or convergence of outcomes of individuals with different birth endowments. Attention has been devoted to the second aspect of the question, namely, the fact that parents may either compensate or reinforce inequalities at birth. Their strategic behaviour depends on their preferences regarding equality between siblings and on the possible complementarities between endowments and inputs in the health production function. For this reason, the theory cannot predict if the parental behaviour compensates or reinforces inequalities at birth.

We thus estimate the two following equations to provide a complete

[8] This one-step procedure leads to theoretically different standard errors for the coefficients, but the results are extremely close to those obtained with our procedure. The results upon request. We do not implement this procedure because, in some instances of the paper, we need to standardize the birth endowment variable for comparison purposes.

picture of the effect of endowments at birth on life outcomes:

$$I_{it} = K_I + \delta_t \widehat{\epsilon}_i + \zeta_t X_{it} + w_{it} \quad (4)$$

$$y_{it} = \tilde{K}_t + \tilde{\alpha}_t \widehat{\epsilon}_i + \theta_t I_{it} + \tilde{\gamma}_t X_{it} + \tilde{v}_{it} \quad (5)$$

where I_{it} are investments in child i at age t or before. Eq. (4) allows for us to understand whether parents tend to compensate or reinforce inequalities at birth. Eq. (5) evaluates the extent to which the strategic parental behaviour affects the child's trajectory. We discuss the identification challenges raised by such an estimation below.

2.2 Data

This paper uses Cebu Longitudinal Health and Nutrition Survey (CLHNS) data collected by the Carolina Population Center. This dataset is particularly relevant for this analysis because it follows a cohort of children born in 1983-84 throughout their infancy, childhood, teenage, and early adult life until 22 years of age. The initial sample comprises children born from 3327 mothers living in Metropolitan Cebu (Philippines), who were recruited at a median of 30 weeks gestation. The children were born between May 1, 1983 and April 30, 1984. The first interview took place during the pregnancy and collected information regarding the mother's health status and prenatal investments. As a consequence, we can account for the mother's height (which is the result of both genetic endowments and childhood nutrition and therefore proxies for long-term health) and the mother's arm circumference, which is considered a good proxy for short-term nutrition (Alderman, 2000). We also know her highest grade completed, whether she worked for a pay during the pregnancy (this could be harmful for the baby if the work is too strenuous but could increase available resources for nutrition). We know cigarette consumption during the pregnancy (measured as the number of cigarettes per day), daily food intake measured in grams[9] and the number of health visits during the pregnancy. We compute household assets based on a principal component analysis on durables ownership and account for whether the dwelling is located in an urban area. The birth survey encompassed birth outcomes, the first hours of life and delivery conditions. Weight and length at birth were measured by interviewers as soon as the births were reported.[10] The CLHNS does not provide any details on paternal health.

Subsequent interviews were conducted every two months, from age 2 months until 2 years. Each time, the children were weighed and measured by a well-trained interviewer. The bimonthly surveys contain information on early-life health investments such as breast-feeding and supplemental feeding practices. We have 12 rounds of information on early-life investments, which we can average to have a precise measure of postnatal investment.

Successive follow-up surveys occurred in 1991, 1994, 1998, 2002 and 2005. Anthropometric measures (weight, height, arm circumference) were recorded in each survey round. Children were administered a non-verbal intelligence test around the age of 8 that was designed for the CLHNS survey (Guthrie and Jacobs, 1977).

The distinctive feature of the CLHNS database is that it combines a precise measure of birth weight, mother's health, prenatal investments and long-term outcomes. To our knowledge, this is the only instance in a developing country. This gives us the opportunity to analyse the long-term effects of initial health endowment on later adult outcomes, as well as variations in investments due to differences in endowments at birth.

[9]This is based on the day before the interview.
[10]We account for age in days at measurement in the regressions.

2.3 Sample

In 1983, 3327 pregnant women were included in the baseline, but only 2966 children were included in the study. The remainder comprises stillbirths, miscarriages, migrations out of the survey area and refusals to take part in the survey. Our base sample comprises 2966 children who were weighed at birth. Table 1 describes the attrition in the sample over years. The attrition rate is quite low, approximately 1.9% per year, which is largely below many longitudinal surveys. Taking into account cases of non- and irrelevant response yields a sample of 1912 individuals who were followed from gestation to 22 years old. Because our objective is to assess the evolution of the effect of endowments at birth over time, our sample of interest comprises the 1718 individuals whose information is recorded at each age. However, a larger sample is available when focusing on earlier outcomes. The results provided in the paper are robust to the inclusion of these additional individuals and are available from the authors upon request. In section 3.5, we deal with the possibility that the attrition is non-random and test the validity of our results.

Table 1 here

2.4 Empirical challenges to the strategy

Central to our analysis is the replacement of BW_i by $\widehat{\epsilon}_i$. This highly depends on the set of prenatal investments that can be controlled for. We separate measures of investment into three groups: mother's genetic factors and health (mother's height[11] and arm circumference); socio-economic environment (highest grade completed, household assets, whether the mother

[11] The mother's height reflects her genetic heritage and her childhood circumstances but, for clarity, we refer to this set of characteristics as genetic factors.

works for a pay, urban dwelling); “conscious” prenatal investments (cigarette consumption, daily food intake, number of health care visits, and whether the pregnancy was the mother’s first). The definition of the endowment variable depends on the inclusion of the various factors. For simplicity, we compare results based on birth weight netted out of the first set of variables (genetic factors), for the first and the second set (genetic factors and socio-economic environment) and for the full set of factors. In all regressions, we include community- (barangays) fixed effects that account for any constant characteristics of the child’s environment.

Before presenting the analysis of the results, it is worth noting the control variables we would have welcomed but were unavailable. These omitted variables are a threat to our identification strategy. Obviously, an instrumentation strategy might have helped but the design of the data collection prevents us from finding external factors of birth weight: the sample was collected in a very short time frame, which limits temporal variation, and in a very limited area, which limits regional variation. We also know now that weak instruments generate more finite bias than a mild violation of the exogeneity of an RHS variable.

Let us discuss the potential omitted variables. First, we do not have information regarding the father’s health, height, or characteristics[12]. This is likely a problem, as it should correlate with the child’s birth weight and his or her subsequent outcomes. However, we know that the father’s height tends to be correlated with the mother’s height because of matching on the marriage market. The empirical question is whether controlling for the mother’s height is sufficient to purge the father’s genetics. While this seems

[12] We only have information on the father’s education. We chose not to use this variable as it was not consistently answered and would substantially reduce our sample size. The estimates obtained with the father’s education included as a prenatal investment are similar to those in the paper. The results are available upon request.

too ambitious, we have evidence that this is the case. We use the Demographic and Health Survey collected in India (the "closest" country to the Philippines, since no DHS with men's measurements has been collected in the Philippines) and perform the following exercise. We regress BW on the mother's height and on the mother's height and the father's height. The results are provided in Table 2. It shows that the coefficient in the mother's height in column (1) is much greater than that in column (2), attesting that the mother's height captures a share of the effect of the father's height. Notably, the R-square is the same in the two columns, which shows that there is no additional information to be gained from inclusion of the father's height. For our setting, this shows that the omission of the father's height is unlikely to greatly bias our results.

Table 2 here

Second, controlling for mother-fixed effects instead of her height would be more satisfactory because it is more inclusive.[13] However, only one child per woman was longitudinally surveyed and we cannot differentiate between children. In the next section, we provide additional evidence showing that netting out genetic factors with the mother's height, prenatal investment and socio-economic background substantially reduces the endogeneity problem.

Finally, since we are interested in the long-term effects of birth inequalities, the endogenous attrition over the 22 years of the panel is a major threat to our identification. We take the attrition into account in section 3.5.

[13]Almond and Currie (2011) notes that, if parents adjust the investment in siblings to a child's birthweight, then the within-family estimates are biased and the direction of the bias depends on whether parents tend to compensate or reinforce inequalities.

3 Results

3.1 Impact of parental investment on child birth weight

Table 3 reports the impact of parental investments on birth weight obtained from the estimation of eq. (1). Column (1) shows that mother age, height and arm circumference explain 24% of birth weight variance (along with systematic covariates). The inclusion of socioeconomic characteristics (column 2) does not add much to the explained variance. Controlling for prenatal investments increases the precision of the prediction of birthweight. Column (3) provides results that are consistent with the biological literature: cigarette consumption during pregnancy is at the cost of the newborn's weight and first pregnancies lead to lighter newborns (Butler, Goldstein, and Ross, 1972). Finally, a greater number of health care visits is also associated with a healthier newborn. These results conform to the expectations. However, it is striking to see that the inclusion of this last set of prenatal investments, while significant, only leads to a limited increase in explained variance. The three regressions generate three different measures of endowments. *A priori*, $\hat{\epsilon}_3$ is the most interesting since it avoids biases in estimating eq. (2) arising from the transmission of genetics and health, the stable socioeconomic environment of the child, and the correlation between prenatal and postnatal investments made by parents. Thus, comparing the estimates of α when using different measures of endowments is of methodological interest.

Table 3 here

3.2 Comparing measures of endowments

To assess the consequences of our methodology on the estimation of Eq. 2, we use four different measures of endowments: the raw birth weight and three endowments obtained from Table 3. We start with two different outcomes: height and the highest grade completed at age 8. Tables 4 and 5 provide the results. In these tables and the following, the birth weight and endowments are measured in grams. The two outcomes are standardized for comparison. An increase of 100 grams in birthweight is associated with an increase of 0.066 standard deviation in height at age 8 (or to $0.066 \cdot 5.53 = 0.36$ centimetres since the standard deviation in height at 8 years old is 5.53 cm).[14] However, the estimated effect is only 0.047 when using $\hat{\epsilon}_3$. Neglecting the endogeneity in birthweight leads to a crude overestimation (by 40%) of its effect on height. Notably, the results are very similar across columns (2) to (4): netting out investments of different nature does not change our results. This could be due to a high correlation between the prenatal investment variables and the genetics or socioeconomic characteristics. Table B1 in the Online Appendix provides the correlations between all the input variables and shows this is not the case. For instance, cigarette consumption is correlated to a limited extent with the mother's age and highest grade completed (respective correlation coefficients are 0.17 and -0.18) and only marginally (less than 10%) with all other input variables. This is extremely important for the validity of our methodology: it suggests that suppressing additional investments would not change the estimates much.[15]

Table 4 here

An increase of 100 grams in birth weight is associated with an increase of 0.019 standard deviation in the highest grade completed at age 8 (or to $0.019 \cdot 0.86 = 0.32$ years of education since the standard deviation in the highest

[14]The mean and standard deviation of the variables are provided in the Appendix, Table A1.

[15]Clarke (2005) shows that the inclusion of additional covariates, when relevant variables are still omitted, can increase the bias rather than reduce it. Here, we obtained very stable results across specifications once we controlled for some prenatal investments.

grade completed at 11 years of age is 0.86 year). The discrepancy obtained when using $\hat{\epsilon}_3$ instead of birth weight is less steep than when one explains height. The coefficient size is 84% of the birth weight coefficient, which suggests a lower endogeneity bias (but still an overestimation by 20% of what we consider the true effect). The effect is very stable over the different endowment measures and suggests that the remaining bias is limited.

Table 5 here

Interestingly, when running the same exercise separately by gender (Table B2 in Appendix), we observe that the effect of endowments on height is somewhat larger for girls than for boys. The discrepancy between the fourth and first columns is of comparable magnitude for the two genders. The picture is different for educational outcomes. The effect of endowment is not significantly different from zero for girls whereas it is positive and significant for boys. We do not find any endogeneity bias for boys.

3.3 Validity check 1: birth endowments on sibling outcomes

Table 6 here

Before examining the effect of endowments on adult outcomes, we check to ensure our results are not driven by remaining unobserved factors. As stated above, we are unable to control for mother-fixed effects. Here, we check whether this drives the significant effect of child endowment on child outcomes. If mother effects are not completely controlled for with our set of covariates, then child endowment would correlate with siblings' outcomes. Since parents have to trade-off between siblings' investment, we expect an effect of one child's endowment on his/her siblings' outcomes. However, there should be no effect of one child's endowment on his/her elder siblings' outcomes at the time of his/her birth, because investments have not been adapted yet. Unfortunately, the data only provide us with the schooling outcomes of elder siblings, not health outcomes. The results are provided in Table 6. It shows that the raw birth weight of the newborn "affects" the older sibling's educational attainment. Interestingly, the point estimate is strikingly the same for the child and his/her sibling when using the raw variable, which confirms the endogeneity issue associated with birth weight. Even more interestingly, the second column of Table 6 shows that our measure of birth endowment does not correlate with siblings' educational outcomes.[16] If there was unobserved heterogeneity common to siblings in the endowment measure, it would still correlate with sibling performance. This is in stark contrast with the significant effect of birth endowment on outcomes obtained earlier. We therefore proceed by treating birth endowment as a truly exogenous variable. However, we recognize that idiosyncratic unobserved characteristics of children may still bias our estimates.

3.4 Validity check 2: endowments based on other birth outcomes

Table 7 here

As mentioned earlier, birth weight and birth endowments might be measured with error. In our case, several birth outcomes are available and we can exploit this feature of the data to solve the measurement error issue. As argued by Rosenzweig and Wolpin (1988), each predicted residual term approximates the endowment of the child net of the most important maternal prenatal investments but suffers from measurement error. We follow

[16] The R-squared are much higher in these regressions because siblings differ much more in age than do the children under study, therefore age is a strong predictor of the highest grade completed.

Aizer and Cunha (2012)'s methodology. We build three different endowment measures based on the birth weight, birth height and pregnancy duration (which are the residuals in the birth capital production functions). We then conduct a factor analysis to extract the single common component underlying endowment ϵ_3 from these endowments (ϵ_3^W, ϵ_3^H and ϵ_3^{PD}). This strategy is valid as long as the measurement errors in the three different birth variables are uncorrelated. It amounts to predicting each birth endowment $\epsilon_3^k, \quad k \in \{W, H, PD\}$ on a common underlying endowment ϵ_3:

$$\epsilon_{3i}^k = \alpha^k \epsilon_{3i} + \nu_i^k.$$

Table A2 (in the Appendix) provides the coefficients α^k for building this new endowment variable. As in Aizer and Cunha (2012), the endowment based on birth weight has the least measurement error but the share of variance explained in the endowment in height is also large (68%). The endowment score explains 58% of the total variance in endowments.

The results for our main outcome variables are provided in Table 7. For this table, all RHS variables are standardized by their standard deviation so that the coefficients can be compared across columns. We compare the "effect" obtained with the raw variable and with the endowment variable. Measures of endowments based on height (length) at birth result in larger effects compared to the endowment based on weight when predicting the effect on height. This occurs because the input and output variable used in the estimation of the health production function are similar, but at two different ages. In panel B, there is no difference between the estimates based on birth weight and birth height. More importantly, all estimations display the same pattern: use of the birth endowment rather than the raw variable reduces the effect by 35%. This suggests that estimations using birth outcome as an exogenous variable are likely to over-estimate the effect of birth endowment on life outcomes. In general, the results based on weight endowment are only marginally smaller than the effect based on the score and they are never significantly different from this last estimate. This is consistent with the view that: a) birth weight is a good predictor of life outcomes, b) it is measured accurately in this survey on children's nutrition and c) the existing measurement error, if small, tends to provide a lower bound of the effect of birth endowment. It is also consistent with the results obtained in Bollen, Noble, and Adair (2013) on the same dataset. However, the interpretation of the results is more interesting when the RHS variable has a unit, which is not possible when the score variable is used. As a consequence, we proceed by using only the birth endowment, defined by birth weight net of any prenatal investment.[17]

3.5 Validity check 3: non-random attrition

Over the 22 years of the panel, even small or moderate attrition rates per year (here, 1.9%) result in large attrition. This attrition generates a bias in the estimate if it is selective. It could be the case if, for instance, lighter babies have a higher mortality. In our case, we can easily mitigate this issue since we observe birth endowments. We can directly check whether attrition is correlated with endowments and, if this is the case, we can re-weight the sample to reproduce the distribution of birth weight observed at the beginning of the panel.

Table 8 here

[17] We also checked that the placebo test based on siblings is not invalidated using the birth health score. The results are available upon request.

We start by assessing the link between attrition and endowment. Table 8 uses the 2966 children that were measured at birth in 1983 as a base sample. The LHS variable is a dummy variable that takes the value 1 when the child is not in our sample of interest[18] and 0 otherwise. We detect a significant effect of endowment on the likelihood of being surveyed at each age. However, the effect is very small: 100 additional grams increases the likelihood of being surveyed at each stage by only $6.9 \cdot 10^{-3}$ percentage points. The R-squared is also low (0.02). This is unlikely to drive our results. We deal with such attrition by implementing the procedure offered by Fitzgerald, Gottschalk, and Moffitt (1998). The intuition behind the procedure is that it gives more weight to children who have similar initial characteristics to children that subsequently were not followed than to children with characteristics that make them more likely to remain in the panel. Obviously, the relevant characteristics include birth endowment (Baulch and Quisumbing, 2010). For the purpose of the procedure, we need additional characteristics for which to compute the weights. The characteristics include the following: child's gender and age (in months at first weight measurement), mother's age, education, alcohol and cigarette consumption, height, weight, wealth (based on durables ownership) and whether they live in an urban area. Cigarette consumption and urban area are predictive of attrition but the others are not.

Table 9 here

The results are provided in Table 9. Unsurprisingly, the results do not differ from the base result (last columns of Tables 4 and 5) due to our prior finding that selection only slightly correlates with birth endowment. We

[18]A child is not in our sample either because he or she was not surveyed after some date or because there is at least a wave where he or she was not surveyed.

therefore consider that there are no issues of selection associated with birth weight in our study.

3.6 Evolution of the impact of endowments across age

We now turn to the core of this paper: the assessment of the inequality dynamics through life. To do so, we evaluate the effect of birth endowment on the same outcome at different ages. For the purpose of comparison across columns, the dependent variables are standardized and the birth endowment variable is expressed in grams.

Table 10 here

Table 10, panel A, shows that the effect of birth endowment on height is remarkably stable over time. The effect is only marginally smaller when the individual reaches the age of 19-22 compared to the effect in teenage years (the two coefficients are significantly different from each other). The catch-up therefore seems to be limited. This might be because height is a long-lasting measure of health that is known to be largely shaped in infancy. Table 10, panel B, shows that the results based on arm circumference suggest more resilience. The effect of birth endowment at age 22 is only 65% of the effect at age 8 and most of the catch-up occurs during the teenage years. The size of the effect at adult age also seems limited: an increase by 100 grams at birth increases arm circumference by .028 standard deviation. The results for weight (not shown) provide a similar picture of the evolution of inequality across age. This set of results holds for both gender (see Tables B3 and B4 in the Online Appendix).

Turning to educational outcomes, Table 10, panel C, we find that the effect of birth weight first increases and then decreases. The difference between col. (4) and col. (5) is somewhat puzzling since education levels should not vary much between ages 19 and 22. In any case, the catch-up seems very limited: the final effect is 70%-82% of the effect at age 8. Disaggregation by gender is also informative (Tables B3 and B4, in Appendix). There does not appear to be much effect of endowment on the highest grade completed for girls whereas for boys the effect of 100 additional grams amounts to .02 standard deviation in the highest grade completed until age 11 and then decreases. Not observing any effect for girls may be consistent with the result obtained in Estudillo, Quisumbing, and Otsuka (2001): they show that girls are more systematically enrolled in school in rural Philippines. Last, we also observe an effect of endowment on IQ test results (Table 10, panel D). 100 more grams at birth imply a higher IQ by 0.02 standard deviation. Although the effect is not large, IQ at age 8 is likely to reflect cognitive abilities at adult age. The effect is strikingly the same for boys and girls.

In sum, this section showed that the results based on raw birth weight tend to overestimate the effect of birth endowments on life outcomes. We also provided placebo and validity tests that indicate the conclusion that our estimates are immune from strong biases due to measurement error and attrition. Based on this, we show that the effect of birth endowment remains at adult age with a limited fading out for height and educational outcomes, but with fading out for other measures of health. We also show that birth endowments based on health at birth are a stronger predictor of health than of cognitive outcomes, which is not surprising and highlights the presence of externalities associated with health. The effect of birth endowments on cognitive outcomes is roughly half of the effect of health outcomes.

The fact that birth endowments tend to fade out over time might be due to parental investments to compensate for lighter children or to the natural resilience of the human body. This persistence and fading out should be investigated further. From a policy perspective, in addition to the debate on the optimal date for intervention, it is important to know if further investments can compensate. Part of the answer lies in the relationship between birth endowment and parental investment.

4 Investments vs. biological mechanisms

4.1 Behavioural response to birth endowments

We start by assessing how parents react to the realization of endowments at birth for their child. Parents choice results from a trade-off between efficiency and equity. Endowment and investment are likely complements in the production function, leading to a greater efficiency when parents invest in better endowed children. If they value equity between their offspring, they might try to compensate less-endowed children by investing more in them. The parents' behaviour should not be interpreted as simply reflecting their preferences because they optimize based on the human capital production functions. Here, we exploit the richness of our dataset since various investments were recorded for very young children, and at different ages. We implement the same methodology as above except that the outcome variables are investment choices. Our objective is to determine if all-in-all parents tend to reinforce or compensate inequalities at birth. For methodological purposes, we compare the results using the raw birthweight with those based on the endowments.

Table 11 here

Table 11 shows that the results based on raw birthweight are misleading since they are systematically much larger than the estimated effect of endowment. We find significant effects of birth endowment on investments occur in infancy and during childhood. For instance, heavier children receive greater food intake. However, the size of the effect remains small. 100 additional grams at birth leads to an increase by 0.01 standard deviation in food intake of an average of (three ($= 0.01 \cdot 308$) additional grams per day for the first two years of life). We also find significant and positive effects of birth endowment on receiving vitamins, deworming drugs and the amount of tuition fees, but the effects are small. For instance, 100 additional grams at birth leads to an increase by 0.0175 standard deviation in tuition fees (30 ($= 0.0175 \cdot 1749.88$) additional pesos per school year, on average, for the 1994-1995 school year).

The other inputs do not seem to react much to differences in birth endowments but they are clearly more marginal in the human capital production function. The same exercise run separately by gender (Tables B5 and B6, in the Online Appendix) provides a similar picture.

4.2 Disentangling parental choices from biological mechanisms

At this stage, it is unlikely that parental investments can account for the fading out observed in Table 10. However, it is interesting to attribute the heterogeneity observed at each age to physical and exogenous factors (the birth endowment) and behavioural components (the investment chosen by adults). Most papers focus on the effect of endowments on outcomes or on the effect of endowment on parental investment. In our case, we can say whether parental investment mitigates the effect of endowment on outcomes. We can also assess the share of the different factors in the final outcome.

The question is empirically difficult because investment (as well as birth weight) is an endogenous input in the human capital production function. We already addressed the suspicion that birthweight is endogenous and use birth endowments instead. With regard to investment, we acknowledge that parents choose investments based on information that is only partially observed by us. Insofar as they tend to reinforce endowments, as appears to be the case, unobserved characteristics of the child will correlate with investments and output; the estimated effect of investment is therefore likely upward biased. In our case, two points are crucial to understand why the upward bias is of limited magnitude: first, we control for birth endowment. Only subsequent and new information leads to a bias. It is expected that the older the child, the larger the (upward) bias. Second, a large number of investments are available in this dataset. The extent of the bias may also be limited since we are able to take all of them into account and they usually correlate with each other. We are not interested in commenting on the effect of one type of investment compared to another to decide which is the most efficient. This would prove to be problematic because we cannot ensure that all of the relevant investments are controlled for. In our case, we want to know how much of the possible investments account for the heterogeneity in child outcomes. Since they correlate with each other, they likely exhaust a large share of the total investment made in the child. Noting these limitations, we estimate the effect of birth endowment on outcomes conditional on investments.

Table 12 here

Table 13 here

Table 12 and 13 provide the results. The effect of birth endowment is not significantly different from the estimates we obtained without controlling for investments. This is either due to the low association between birth endowments and later investments or to a low effect of investments on current outcomes. Since several investment measures have significant "effects" on height and education attainment, it appears that the reinforcement behaviour we identified earlier has only small consequences.

This does not mean that parental investment does not affect final outcomes; rather, the debate on whether parents tend to reinforce or compensate may not be crucial to the understanding of life trajectories. To assess the importance of various factors, we performed the following exercise: based on the regressions already presented, we estimated variants by excluding either the birth endowment variable or the investment variables. We then compared the share of explained variance and assessed the relative importance of one factor conditional on the other. The "contribution" to the R-squared computed as such is a first-order proxy for the contribution of a covariate to the R-squared of the full specification. It does not account for the covariances between factors. Table 14, Panel A, shows that birth endowments explain the same share of the variance in height throughout childhood and adulthood (roughly 3 to 4%). Investments account for a comparable share of the variance (4 to 5% at age 22). As a consequence, postnatal investments have a similar explanatory power to birth endowment in final health measured by height. Table 14, panel B, provides the results for schooling level, showing a different picture. Consistent with the previous findings, birth endowment only affects boys and the share of variance is low and decreases over time (less than 1% at each age). In comparison, investments play a greater role and that role is reinforced over time: investments account for 15 to 18% of the final education level. While the effect of investments might be upward biased, it is unlikely to explain all of this major difference in birth endowment in education.

Table 14 here

5 Conclusion

This paper describes the short- and long-term impacts of initial health endowment on health and education outcomes. We handled the endogeneity issues associated with birth weight: parents' prenatal investments, which correlate with postnatal investments and outcomes. We therefore make use of the large set of information collected during pregnancy to estimate a birth endowment variable from which prenatal investments have been netted out. This strategy is valid as long as no other omitted prenatal investment affects both birthweight and subsequent outcomes. We provide validity checks that confirm the power of the procedure with regard to suppressing the endogeneity bias and show that measurement error and attrition do not bias our estimates. Using this endowment measure, we show that 1) the birth weight effect obtained in several studies is upward biased (20% and 40% higher than our estimated effect, depending on the outcome); 2) the effect of birth endowment marginally decreases when the individual grows up; 3) parents have a slight tendency to reinforce birth endowments but 4) these reinforcing investments account for very little in the effect of birth endowment; and 5) investments and birth endowment explain a similar share of the variance in height whereas investments have an overwhelming effect in education attainment compared to birth endowment.

This paper provides a comprehensive picture of the short- and long-term effects of birth endowments and characterizes the areas in which further progress should be made. It suggests that the literature on compensating vs reinforcing behaviour might be of secondary importance than that on the effect of birth endowment on health outcomes or the effect of parental investment on education.

The effect of birth weight slightly decreases with age and remains until adulthood: 100 additional grams at birth induce an increase in height of 0.34 cm and an increase in years of education by 0.03. These long-term effects are roughly double those estimated in Xie et al. (2017) for Taiwan.[19] This suggests that the effect of birth weight is larger in poorer countries. With this research, we provide estimates of the effect of birth weight that can be used to assess the cost efficiency of policies aimed at increasing birth weight.

[19] However, our capacity for comparison is limited because of differences in the methodology.

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6 Tables

Table 1: Number of individuals recorded in each wave of the CLHNS

Waves	1983	1986	1991	1994	1998	2002	2005	Sample
# Children	2966	2447	2251	2214	2212	2051	1912	1718

Table 2: Effect of parents genetics on birth weight

	Birthweight	
	(1)	(2)
Father height		0.376***
		(0.121)
Mother height	1.015***	0.839***
	(0.0906)	(0.139)
Observations	7,149	7,149
R-squared	0.008	0.008

Note: DHS INDIA 2005. Coefficients are estimated by linear regressions. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 3: Effect of parental investment on birthweight - Predicting child endowment

	Birth weight (mean = 2 900 grams)		
	(1)	(2)	(3)
Mother age	49.87***	49.03***	17.83
	(12.28)	(12.43)	(13.18)
Mother age squared	-0.835***	-0.818***	-0.334
	(0.218)	(0.221)	(0.229)
Mother height (cm)	13.374***	13.18***	12.86***
	(1.896)	(1.921)	(1.901)
Mother arm circumference (cm)	31.95***	31.61***	30.91***
	(4.29)	(4.346)	(4.294)
Highest grade completed		3.736	4.774
		(3.089)	(3.144)
Household assets		-0.00076	-0.00346
		(0.00303)	(0.00305)
Mother works for pay		-1.549	-2.981
		(19.69)	(19.51)
Urban		-35.15	-53.44
		(55.89)	(55.09)
Cigarette consumption (num. per day)			-7.114***
			(2.21)
Daily food intake (g)			0.0343
			(0.0212)
Number of health care visits			18.69***
			(4.981)
First pregnancy			-167.79***
			(27.33)
Predicted endowment	$\hat{\epsilon}_1$	$\hat{\epsilon}_2$	$\hat{\epsilon}_3$
Observations	1,718	1,718	1,718
R-squared	0.235	0.255	0.279

Note: Coefficients are estimated by linear regressions. Child age (in days) at measurement, child gender and community fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 4: Effect of birth endowments on height at age 8

	Height age 8 (standardized)			
	(1)	(2)	(3)	(4)
Birth Weight	0.000659***			
	(5.75e-05)			
$\hat{\epsilon}_1$		0.000453***		
		(6.21e-05)		
$\hat{\epsilon}_2$			0.000444***	
			(6.22e-05)	
$\hat{\epsilon}_3$				0.000474***
				(6.31e-05)
Observations	1,718	1,718	1,718	1,718
R-squared	0.073	0.032	0.030	0.033

Note: Coefficients are estimated by linear regressions. Child age and gender as well as and community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variable is standardized by its standard error (5.53, see Table A1). Multiply the estimates by 5.53 in order to obtain the increase expressed in centimeters. Birth weight and $\widehat{\epsilon}$ are expressed in grams.

Table 5: Effect of birth endowments on highest grade completed at age 8

	Grade age 8 (standardized)			
	(1)	(2)	(3)	(4)
Birth Weight	0.000195***			
	(5.89e-05)			
$\hat{\epsilon}_1$		0.000156**		
		(6.22e-05)		
$\hat{\epsilon}_2$			0.000149**	
			(6.23e-05)	
$\hat{\epsilon}_3$				0.000163***
				(6.33e-05)
Observations	1,718	1,718	1,718	1,718
R-squared	0.023	0.020	0.020	0.021

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variable is standardized by its standard error (0.86, see Table A1). Multiply the estimates by 0.86 in order to obtain the increase expressed in years of education. Birth weight and $\widehat{\epsilon}$ are expressed in grams.

Table 6: Effect of child birth endowment on siblings' highest grade completed

	Sibling's grade 1983	
	(1)	(2)
Birth weight	0.000196*	
	(0.000118)	
$\hat{\epsilon}_3$		-7.89e-05
		(0.000119)
Observations	2,277	2,277
R-squared	0.675	0.668

Note: Coefficients are estimated by linear regressions. Sample is constituted of all elder siblings of the child in the study. Their highest grade completed is recorded at time of child's birth. Sibling's age and gender as well as community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variable is standardized by its standard error.

Table 7: Effect of various measures of birth endowments

Panel A:								
Outcome:	Height age 8 (standardized)							
Birth endowment:	Birthweight		Birth height		Pregnancy duration		Score	
Measure:	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$
	0.271***	0.176***	0.325***	0.229***	-0.00657	-0.0316	0.300***	0.206***
	(0.0236)	(0.0235)	(0.0234)	(0.0233)	(0.0252)	(0.0249)	(0.0243)	(0.0243)
Observations	1,718	1,718	1,718	1,718	1,607	1,607	1,607	1,607
R-squared	0.073	0.033	0.104	0.055	0.001	0.001	0.089	0.045
Panel B:								
Outcome:	Grade age 8 (standardized)							
Birth endowment:	Birthweight		Birth height		Pregnancy duration		Score	
Measure:	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$
	0.0802***	0.0608***	0.0801***	0.0514**	0.0199	0.0243	0.092***	0.0660***
	(0.0241)	(0.0236)	(0.0243)	(0.0237)	(0.0249)	(0.0245)	(0.0250)	(0.0245)
Observations	1,718	1,718	1,718	1,718	1,607	1,607	1,607	1,607
R-squared	0.023	0.021	0.023	0.020	0.015	0.015	0.023	0.019

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. Birth score raw (last but one column) is obtained from a factor analysis on all three birth outcome variables while birth endowment score (last column) is obtained in the procdure described in the text (factor analysis in all three birth endowment variables). ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. Height and grade are standardized by their standard error (respectively 5.53 and 0.86, see Table A1). In this table, birth endowments are also standardized by their standard error for the ease of comparison. The coeeficients are the effect of one standard deviation in each birth endowment on height (panel A) and grade at age 8 (panel B) expressed in standard deviation.

Table 8: Probability of attrition

	Attrition	
	ols	probit
	(1)	(2)
$\hat{\epsilon}_3$	-6.92e-05***	-0.00007 ***
	(1.81e-05)	(2.00e-05)
Mother age	-0.00216	-0.00225*
	(0.00133)	(0.00136)
Mother height (cm)	-0.000116	-0.000144
	(0.00186)	(0.0019)
Mother arm circumference (cm)	-0.000520	-0.000444
	(0.00331)	(0.00334)
Highest grade completed	0.00175	0.00182
	(0.00267)	(0.00272)
Household assets	1.55e-06	1.57e-06
	(1.58e-06)	(1.00e-06)
Mother works for pay	-0.0115	-0.0121
	(0.0243)	(0.0248)
Urban	0.126***	0.127***
	(0.0340)	(0.0342)
Cigarette consumption	0.0115***	0.0117***
	(0.00326)	(0.00342)
Daily food intake (gm)	-5.62e-08	-2.19e-07
	(1.74e-05)	(2.00e-05)
Number of health care visits	0.00273	0.00270
	(0.00412)	(0.00415)
First pregnancy	-0.00920	-.0091457
	(0.0181)	(0.01342)
R-squared	0.025	
Pseudo-R-squared		0.018
Observations	2,966	2,966

Note: Coefficients are estimated by linear regression (col. 1) and maximum likelihood (Probit, col. 2). In column (2), marginal effects at the mean are reported. Additional covariates include child gender, age and community-level fixed effects. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. $\widehat{\epsilon}$ is expressed in grams.

Table 9: Weighted least squares, results on height and highest grade completed at age 8

	Grade age 8	Height age 8
	(1)	(2)
$\hat{\epsilon}_3$	0.000116**	0.000469***
	(4.53e-05)	(6.06e-05)
Observations	1,718	1,718
R-squared	0.022	0.032

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variables are standardized by their standard error (see Table A1). $\widehat{\epsilon}$ is expressed in grams.

Table 10: Effect of birth endowment across age

	1991 age 8 (1)	1994 age 11 (2)	1998 age 14 (3)	2002 age 19 (4)	2005 age 22 (5)
Panel A:			Height (standardized)		
$\hat{\epsilon}_3$	0.000474***	0.000409***	0.000410***	0.00038***	0.000381***
	(6.31e-05)	(6.06e-05)	(5.05e-05)	(4.84e-05)	(4.8e-05)
R-squared	0.033	0.093	0.39	0.442	0.453
Panel B:			Arm Circumference (standardized)		
$\hat{\epsilon}_3$	0.000432***	0.000332***	0.000278***	0.000247***	0.000281***
	(6.31e-05)	(6.26e-05)	(6.4e-05)	(6.31e-05)	(6.11e-05)
R-squared	0.032	0.046	0.024	0.038	0.097
Panel C:			Grade (standardized)		
$\hat{\epsilon}_3$	0.000163***	0.000242***	0.000117*	0.000134**	0.000115*
	(6.33e-05)	(5.92e-05)	(6.16e-05)	(6.05e-05)	(6.05e-05)
R-squared	0.021	0.117	0.017	0.064	0.064
Panel D:	I.Q. (standardized)				
$\hat{\epsilon}_3$	0.000223***				
	(6.11e-05)				
R-squared	0.043				
Observations	1,718	1,718	1,718	1,718	1,718

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variables are standardized by their standard error, see Table A1. $\widehat{\epsilon}$ is expressed in grams.

Table 11: Effect of birth endowment on parental investments

Panel A. Following birth (in 1983-85)

	vitamins (1)	baths per week (2)	food intake (3)	(4)	(5)	duration breastfeeding (6)	sleep with baby (7)	(8)
Birth weight	-1.27e-06	5.35e-06	0.000135***			0.000072	1.55e-05	
	(2.80e-05)	(5.87e-05)	(4.59e-05)			(5.96e-05)	(1.18e-05)	
R-squared	0.000	0.001	0.020			0.002	0.002	
$\hat{\epsilon}_3$	2.5e-05	-1.77e-05	0.000103**			0.000102	2.47e-05*	
	(3.01e-05)	(6.30e-05)	(1.94e-05)			(6.4e-05)	(1.27e-05)	
R-squared	0.001	0.001	0.017			0.003	0.004	

Panel B. At age 8 (in 1991)

	vitamins (1)	baths per week (2)	food intake (3)	took deworming (4)	immunisation (5)	meals per day (6)	(7)	(8)
Birth weight	1.93e-05*	0.000616	0.000110*	-2.99e-05	2.87e-05	0.000122		
	(2.00e-05)	(5.74e-05)	(5.67e-05)	(2.67e-05)	(2.57e-05)	(0.00134)		
R-squared	0.005	0.013	0.028	0.002	0.002	0.001		
$\hat{\epsilon}_3$	8.86e-06	8.98e-06	6.57e-05	-4.61e-05	1.02e-05	-0.000404		
	(2.17e-05)	(6.17e-05)	(6.09e-05)	(2.87e-05)	(2.77e-05)	(0.00144)		
R-squared	0.004	0.013	0.026	0.003	0.002	0.001		

Panel C. At age 11 (in 1994)

	vitamins (1)	baths per week (2)	(3)	took deworming (4)	immunisation (5)	read to child (6)	tuition fees (7)	children book (8)
Birth weight	5.24e-05***	0.000121**		-6.2e-05**	2.4e-05	-9.94e-06	0.000275***	4.9e-05*
	(1.78e-05)	(5.94e-05)		(2.58e-05)	(2.61e-05)	(2.89e-05)	(5.79e-05)	(2.83e-05)
R-squared	0.006	0.009		0.004	0.006	0.003	0.014	0.004
$\hat{\epsilon}_3$	4.16e-05**	9.68e-05		-6.1e-05**	2.83e-06	9.34e-06	0.000175**	7.24e-06
	(1.91e-05)	(6.39e-05)		(2.77e-05)	(2.8e-05)	(3.04e-05)	(3.25e-05)	(3.04e-05)
R-squared	0.004	0.008		0.003	0.006	0.003	0.006	0.002

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 1718 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error, see Table A1. The coefficient is therefore the effect of one additional gram on the outcome, measured in standard deviation. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies and the coefficients are therefore the increase in probability of the outcome associated to one additional gram. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 12: Investment vs. birth endowment on height

	Height age 8 (standardized) (1)	Height age 11 (standardized) (2)	Height age 22 (standardized) (3)
$\hat{\epsilon}_3$	0.000471***	0.000390***	0.000362***
	(6.26e-05)	(5.92e-05)	(4.78e-05)
Investments 1983			
food intake	0.126***	0.0759**	0.0348
	(0.0357)	(0.0300)	(0.0242)
duration breastfeeding	-0.00631	0.0042	0.0035
	(0.0057)	(0.0055)	(0.0044)
vitamins	0.210***	0.192***	0.0016
	(0.0512)	(0.0489)	(0.0397)
bath per week	0.0665**	-	-
	(0.00523)		
sleep with baby	-0.0192	0.0484	-0.1189
	(0.12)	(0.113)	(0.091)
Investments 1991			
immunisation		0.086*	0.109**
		(0.0523)	(0.0435)
food intake		0.145***	0.0602***
		(0.0241)	(0.0195)
took deworming		-0.0802	-0.0385
		(0.0505)	(0.0408)
vitamins		0.278***	0.190***
		(0.0682)	(0.0576)
meals per day		-0.0241*	-0.0842
		(0.113)	(0.091)
bath per week		0.0252**	-0.002
		(0.0124)	(0.0104)
Investments 1994			
read to child			-0.0192
			(0.0382)
immunisation			-0.0642
			(0.0901)
took deworming			-0.0151
			(0.0427)
own children books			0.0658
			(0.0387)
vitamins			0.0293
			(0.0635)
bath per week			-0.0129
			(0.012)
tuition fees			0.0635**
			(0.0206)
R-squared	0.061	0.1501	0.473

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 1718 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 13: Investment vs. birth endowment on highest grade completed

	Grade age 8 (standardized) (1)	Grade age 11 (standardized) (2)	Grade age 22 (standardized) (3)
$\hat{\epsilon}_3$	0.000158***	0.000236***	5.82e-05
	(6.29e-05)	(5.61e-05)	(5.63e-05)
Investments 1983			
food intake	0.0651**	0.0615**	0.0298
	(0.031)	(0.0285)	(0.0285)
duration breastfeeding	0.0107*	-0.000481	-0.0046
	(0.0058)	(0.00518)	(0.0052)
vitamins	0.278***	0.276***	0.259***
	(0.0512)	(0.0463)	(0.0468)
bath per week	0.0076	-	-
	(0.0052)		
sleep with baby	0.0437	0.0677	0.0331
	(0.120)	(0.108)	(0.107)
Investments 1991			
immunisation		0.578***	0.335***
		(0.0498)	(0.0512)
food intake		0.0322	-0.0322
		(0.0229)	(0.0230)
took deworming		0.0227	0.0643*
		(0.0479)	(0.0481)
vitamins		0.188***	0.205***
		(0.047)	(0.0679)
meals per day		-03165	0.078
		(0.107)	(0.107)
bath per week		0.0269**	0.0278**
		(0.0118)	(0.0123)
Investments 1994			
read to child			-0.0785*
			(0.0451)
immunisation			-0.05329
			(0.0451)
took deworming			-0.0270
			(0.0503)
own children books			0.136***
			(0.0455)
vitamins			0.271***
			(0.0748)
bath per week			0.00633***
			(0.0143)
tuition fees			0.189***
			(0.0243)
R-squared	0.045	0.222	0.215

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 1718 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 14: Share of variance: investment vs. endowment, by gender

	age 8, 1991		age 11, 1994		age 22, 2005	
	investment	$\hat{\epsilon}_3$	investment	$\hat{\epsilon}_3$	investment	$\hat{\epsilon}_3$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A : Height						
Boys	0.0313	0.0296	0.0720	0.0149	0.0428	0.0346
Girls	0.0263	0.0388	0.0506	0.0366	0.0516	0.0327
Panel B : Highest grade completed						
Boys	0.0263	0.0063	0.1150	0.0096	0.1695	0.001
Girls	0.0314	0.0002	0.1006	0.0085	0.1779	0.0004

Note: The coefficients provided are the difference in R-squared between the two following regressions: columns (1), (3) and (5): full regression on birth endowment, investments and controls vs. regression on birth endowment and controls; columns (2), (4), and (6): same full regression vs. regression on investments and controls. The full regressions are provided in Tables B7, B8, B9 and B10. The provided coefficients measure the additional share of variance explained by investments (uneven columns) and by the birth endowment (even columns).

A Appendix

Table A1: Descriptive Statistics

	Mean	Standard Deviation
Mother age	26	6
Mother height (cm)	150	5.1
Mother arm circumference (cm)	25	2.5
Mother years of education	7.43	3.70
Household Assets (pesos)	1268	3913
Mother works for pay	0.4	0.5
Number of health care visits	1.5	2
First pregnancy	0.18	0.39
Urban	0.59	0.5
Boys	0.53	0.5
Birth weight (g)	2,900	440
$\hat{\epsilon}_3$ (g)	0	390
Height age 8	117.7	5.53
Height age 11	133.64	7.42
Height age 14	154.00	7.76
Height age 18	156.89	10.27
Height age 22	157.39	9.09
Arm Circumference age 8	16.9	1.45
Arm Circumference age 11	18.94	2.11
Arm Circumference age 14	23.43	2.56
Arm Circumference age 18	25.38	2.7
Arm Circumference age 22	26.23	3.21
Grade age 8	1.84	0.86
Grade age 11	4.14	0.97
Grade age 14	8.73	2.00
Grade age 18	10.34	2.54
Grade age 22	10.45	3.09
IQ score age 8	51.71	12.31
Daily Food intake (g) 1983	809.7	308
Breastfeeding duration (months) 1983	5.56	4.24
Vitamins 1983	0.52	0.49
Baths per weeks 1983	6.19	4.76
Sleep with baby 1983	0.98	0.11
Immunisation 1991	0.75	0.43
Daily Food intake 1991	1028.3	384.8
Deworming 1991	0.69	0.46
Vitamins 1991	0.13	0.34
Meals per day 1991	2.95	0.2
Baths per week 1991	5.91	1.89
Reads to child 1994	0.4	0.49
Immunisation 1994	0.26	0.44
Deworming 1994	0.43	0.49
Own children books 1994	0.57	0.49
Vitamins 1994	0.098	0.28
Baths per week 1994	6.23	1.56
Tuition fees per school year (pesos) 1994	904.02	1749.88

Note: Descriptive statistics are computed on the same sample as the main estimations.

Table A2: Share of variance explained

	Scoring coefficient	Unexplained
Residual of Birth Weight	0.68	0.18
Residual of Birth Height	0.68	0.20
Residual of Pregnancy duration	0.26	0.89

B Online Appendix

These tables do not need to be included in the paper and can go in an Online Appendix. They mostly provide disaggreagted results by gender.

Table B1: Correlation between prenatal investment variables

	Mother age	Mother height (cm)	Mother arm circumference (cm)	Highest grade completed	Household assets	Mother works for pay
Mother age	1.0000					
Mother height (cm)	0.0585*	1.0000				
Mother arm circumference (cm)	0.1721*	0.2252*	1.0000			
Highest grade completed	-0.0854*	0.1529*	0.1536*	1.0000		
Mother works for pay	0.1223*	0.0550*	-0.0067	-0.0078	1.0000	
Household assets	0.0226	0.0930*	0.0975*	0.3334*	0.0072	1.0000
Urban	-0.0677*	-0.0159	0.1144*	0.2275*	-0.0829*	0.0892*
Cigarette consumption (num. per day)	0.1781*	-0.0731*	-0.0362	-0.1840*	0.0599*	-0.0492*
Daily food intake (g)	-0.0363	0.0832*	0.0727*	0.2198*	0.0392	0.1055*
Number of health care visits	-0.0319	0.0436	0.0908*	0.2158*	0.0412	0.2802*
First pregnancy	-0.4248*	-0.0162	-0.0426	0.1622*	-0.0308	0.0450
	Urban	Cigarette consumption	Daily food intake (g)	Number of health care visits	First pregnancy	
Urban	1.0000					
Cigarette consumption (num. per day)	-0.0581*	1.0000				
Daily food intake (g)	0.1375*	0.0122	1.0000			
Number of health care visits	0.0950*	-0.0089	0.0505*	1.0000		
First pregnancy	0.0521*	-0.0839*	0.0389	0.0937	1.0000	

Note: * means that the correlation coefficient is significantly different from 0 at the 5% level.

Table B2: Effect of birth endowment on height and highest grade completed at age 8 by gender

	Height age 8		Grade age 8	
	Boys	Girls	Boys	Girls
	(1)	(2)	(3)	(4)
Birth Weight	0.000620***	0.000719***	0.000214***	0.000187**
	(7.61e-05)	(8.91e-05)	(7.88e-05)	(9.07e-05)
R-squared	0.074	0.078	0.010	0.034
$\hat{\epsilon}_1$	0.000417***	0.000515***	0.000193**	0.000130
	(8.16e-05)	(6.69e-05)	(8.28e-05)	(9.65e-05)
R-squared	0.032	0.035	0.008	0.031
$\hat{\epsilon}_2$	0.000411***	0.000502***	0.000191**	0.000118
	(8.16e-05)	(9.72e-05)	(8.28e-05)	(9.67e-05)
R-squared	0.032	0.033	0.008	0.031
$\hat{\epsilon}_3$	0.000433***	0.000547***	0.000211**	0.000122
	(8.34e-05)	(9.77e-05)	(8.46e-05)	(9.76e-05)
R-squared	0.033	0.039	0.009	0.031
Observations	912	806	912	806

Note: Coefficients are estimated by linear regressions. Child age and gender as well as community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variables are standardized by their standard errors. Birth endowments are measured in grams.

Table B3: Effect of birth endowment across age, Boys

	1991 age 8 (1)	1994 age 11 (2)	1998 age 14 (3)	2002 age 19 (4)	2005 age 22 (5)
Panel A:			Height		
$\hat{\epsilon}_3$	0.000433*** (8.34e-05)	0.000334*** (8.22e-05)	0.000449*** (8.21e-05)	0.000486*** (8.41e-05)	0.000497*** (8.39e-05)
R-squared	0.033	0.051	0.064	0.041	0.047
Panel B:			Arm Circumference		
$\hat{\epsilon}_3$	0.000366*** (8.43e-05)	0.000254*** (8.42e-05)	0.000202** (8.57e-05)	0.000181** (8.55e-05)	0.000259*** (8.5e-05)
R-squared	0.022	0.017	0.014	0.007	0.013
Panel C:			Grade		
$\hat{\epsilon}_3$	0.000211** (8.43e-05)	0.000272*** (7.82e-05)	0.000137* (8.08e-05)	0.000148* (8.13e-05)	0.000132 (8.00e-05)
R-squared	0.009	0.098	0.014	0.004	0.008
Panel D:	I.Q				
$\hat{\epsilon}_3$	0.000198** (8.16e-05)				
R-squared	0.025				
Observations	912	912	912	912	912

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variables are standardized by their standard error. $\hat{\epsilon}_3$ is measured in grams.

Table B4: Effect of birth endowment across age, Girls

	1991 age 8 (1)	1994 age 11 (2)	1998 age 14 (3)	2002 age 19 (4)	2005 age 22 (5)
Panel A:			Height		
$\hat{\epsilon}_3$	0.000547*** (9.77e-05)	0.000539*** (9.61e-05)	0.000644*** (9.75e-05)	0.000546*** (9.82e-05)	0.000548*** (9.86e-05)
R-squared	0.039	0.059	0.063	0.041	0.039
Panel B:			Arm Circumference		
$\hat{\epsilon}_3$	0.000527*** (9.76e-05)	0.000443*** (9.81e-05)	0.000397*** (9.84e-05)	0.000355*** (9.87e-05)	0.000347*** (9.85e-05)
R-squared	0.040	0.035	0.024	0.017	0.016
Panel C:			Grade		
$\hat{\epsilon}_3$	0.000122 (9.76e-05)	0.000217** (9.28e-05)	0.0001 (9.55e-05)	0.000155 (9.65e-05)	0.000120 (9.78e-05)
R-squared	0.031	0.108	0.021	0.006	0.003
Panel D:	I.Q				
$\hat{\epsilon}_3$	0.000272*** (9.46e-05)				
R-squared	0.062				
Observations	806	806	806	806	806

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependent variables are standardized by their standard error. $\hat{\epsilon}_3$ is measured in grams.

Table B5: Effect of birth endowment on parental investments, Boys

Panel A. Following birth (in 1983-1985)

	vitamins (1)	baths per week (2)	food intake (3)	(4)	(5)	duration breastfeeding (6)	sleep with baby (7)	(8)
Birth weight	1.2e-05	2.92e-05	0.000131**			0.000133	2.07e-05	
	(3.75e-05)	(7.81e-05)	(6.3e-05)			(7.88e-05)	(1.65e-05)	
R-squared	0.000	0.003	0.006			0.006	0.002	
$\hat{\epsilon}_3$	3.70e-06	-1.66e-05	8.93e-05			0.000169**	3.51e-05*	
	(4.03e-05)	(8.38e-05)	(6.77e-05)			(8.44e-05)	(1.77e-05)	
R-squared	0.000	0.003	0.002			0.007	0.005	

Panel B. At age 8 (in 1991)

	vitamins (1)	baths per week (2)	food intake (3)	took deworming (4)	immunisation (5)	meals per day (6)	(7)	(8)
Birth weight	2.51e-05	0.0000996	0.000143*	2.07e-05	4.5e-05	0.000567		
	(2.66e-05)	(7.61e-05)	(8.13e-05)	(3.57e-05)	(3.51e-05)	(0.00151)		
R-squared	0.003	0.004	0.010	0.003	0.001	0.003		
$\hat{\epsilon}_3$	6.6e-06	3.78e-05	0.000117	-5.61e-06	3.68e-05	-0.000323		
	(2.85e-05)	(8.17e-05)	(8.73e-05)	(3.83e-05)	(3.77e-05)	(0.00162)		
R-squared	0.002	0.001	0.006	0.001	0.001	0.003		

Panel C. At age 11 (in 1994)

	vitamins (1)	baths per week (2)	(3)	took deworming (4)	immunisation (5)	read to child (6)	tuition fees (7)	children book (8)
Birth weight	5.59e-05**	0.000203***		0.000106***	-2.07e-06	2.34e-05	0.000295***	1.99e-05
	(2.37e-05)	(7.82e-05)		(3.51e-05)	(3.59e-05)	(3.81e-05)	(8.58e-05)	(3.81e-05)
R-squared	0.012	0.009		0.011	0.003	0.001	0.014	0.000
$\hat{\epsilon}_3$	4.01e-05	0.000162*		-0.116e-05**	6.28e-06	-4.38e-05	0.000192**	-3.5e-05
	(2.54e-05)	(8.40e-05)		(3.76e-05)	(3.85e-05)	(4.10e-05)	(9.19e-05)	(4.08e-05)
R-squared	0.009	0.005		0.011	0.003	0.002	0.006	0.001

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 912 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The coefficient is therefore the effect of one additional gram on the outcome, measured in standard deviation. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies and the coefficients are therefore the increase in probability of the outcome associated to one additional gram. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B6: Effect of birth endowment on parental investments, Girls

Panel A. Following birth (in 1983-1985)

	vitamins	baths per week	food intake			duration breastfeeding	sleep with baby	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth weight	-1.96e-05	-3.88e-06	0.000130*			-2.05e-05	1.17e-06	
	(4.28e-05)	(9.11e-05)	(6.79e-05)			(9.11e-05)	(1.72e-05)	
R-squared	0.000	0.000	0.019			0.000	0.003	
$\hat{\epsilon}_3$	-6.18e-05	-2.1e-05	0.000134*			4.49e-05	1.35e-05	
	(4.59e-05)	(9.78e-05)	(7.3e-05)			(9.90e-05)	(1.85e-05)	
R-squared	0.002	0.000	0.019			0.000	0.003	

Panel B. At age 8 (in 1991)

	vitamins	baths per week	food intake	took deworming	immunisation	meals per day		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth weight	1.42e-05	-4.69e-06	9.45e-05	-9.31e-05**	-6.44e-06	1.88e-05*		
	(3.09e-05)	(8.97e-05)	(7.95e-05)	(4.11e-05)	(3.86e-05)	(9.25e-05)		
R-squared	0.009	0.005	0.005	0.007	0.001	0.006		
$\hat{\epsilon}_3$	1.38e-05	4.28e-05	1.37e-05	-0.000101**	-2.12e-05	0.000209**		
	(3.22e-05)	(9.63e-05)	(8.55e-05)	(4.42e-05)	(4.15e-05)	(9.84e-05)		
R-squared	0.009	0.005	0.004	0.008	0.001	0.006		

Panel C. At age 11 (in 1994)

	vitamins	baths per week		took deworming	immunisation	read to child	tuition fees	children book
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth weight	5.67e-05**	1.52e-05		-6.02e-06	-3.96e-05	5.76e-05*	0.000248***	0.000929***
	(2.74e-05)	(9.28e-05)		(3.84e-05)	(3.89e-05)	(4.32e-05)	(7.80e-05)	(4.3e-05)
R-squared	0.006	0.000		0.005	0.004	0.003	0.014	0.006
$\hat{\epsilon}_3$	5.18e-05*	2.63e-08		9.26e-06	-1.23e-06	4.43e-05	0.000146*	6.52e-05
	(2.94e-05)	(9.96e-05)		(4.13e-05)	(4.19e-05)	(4.64e-05)	(8.41e-05)	(4.63e-05)
R-squared	0.005	0.000		0.003	0.003	0.002	0.005	0.003

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 806 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The coefficient is therefore the effect of one additional gram on the outcome, measured in standard deviation. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies and the coefficients are therefore the increase in probability of the outcome associated to one additional gram. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B7: Investment vs. birth endowment on height, Boys

	Height age 8 (1)	Height age 11 (2)	Height age 22 (3)
$\hat{\epsilon}_3$	0.000434***	0.000307***	0.000483***
	(8.27e-05)	(8.01e-05)	(8.45e-05)
Investments 1983			
food intake	0.114***	0.0810***	0.0491
	(0.0416)	(0.0412)	(0.0431)
duration breastfeeding	-0.0147*	-0.0112	-0.00786
	(0.0079)	(0.0769)	(0.0081)
vitamins	0.232***	0.215***	0.0877
	(0.0698)	(0.0681)	(0.0721)
bath per week	0.00926	-	-
	(0.00765)		
sleep with baby	-0.0242	0.00711	-0.125
	(0.158)	(0.152)	(0.159)
Investments 1991			
immunisation		0.125*	0.130*
		(0.0719)	(0.0777)
food intake		0.137***	0.0580
		(0.0315)	(0.0331)
took deworming		-0.0888	0.344
		(0.0709)	(0.0745)
vitamins		0.322***	0.343***
		(0.0955)	(0.107)
meals per day		-0.0372	-0.0167
		(0.00142)	(0.00148)
bath per week		0.0273	0.00721
		(0.0160)	(0.174)
Investments 1994			
read to child			-0.0515
			(0.0689)
immunisation			-0.0318
			(0.0748)
took deworming			-0.0279
			(0.0765)
own children books			0.1061
			(0.0697)
vitamins			-0.00572
			(0.1155)
bath per week			-0.0210
			(0.0207)
tuition fees			0.0574
			(0.0348)
R-squared	0.065	0.123	0.090

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 912 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B8: Investment vs. birth endowment on highest grade completed, Boys

	Grade age 8 (1)	Grade age 11 (2)	Grade age 22 (3)
$\hat{\epsilon}_3$	0.000201**	0.000242***	7.49e-05
	(8.45e-05)	(7.41e-05)	(7.51e-05)
Investments 1983			
food intake	0.0372	0.00776**	0.0362
	(0.0425)	(0.0381)	(0.0383)
duration breastfeeding	0.0140	-0.00507	-0.00849
	(0.0806)	(0.0712)	(0.0072)
vitamins	0.262***	0.218***	0.310***
	(0.0713)	(0.0630)	(0.0641)
bath per week	0.00361	-	-
	(0.00781)		
sleep with baby	-0.0970	0.0868	0.0403
	(0.161)	(0.141)	(0.142)
Investments 1991			
immunisation		0.583***	0.360***
		(0.0665)	(0.0692)
food intake		0.00185	-0.0574*
		(0.0292)	(0.0295)
took deworming		0.0390	0.158**
		(0.0657)	(0.0664)
vitamins		0.230***	0.332***
		(0.0882)	(0.0954)
meals per day		-0.099	0.00177
		(0.00131)	(0.00132)
bath per week		0.0271*	0.0395**
		(0.0148)	(0.0155)
Investments 1994			
read to child			-0.123**
			(0.0613)
immunisation			-0.00952
			(0.0665)
took deworming			-0.00665
			(0.068)
own children books			0.124
			(0.0621)
vitamins			0.0725
			(0.103)
bath per week			0.0465**
			(0.0185)
tuition fees			0.135***
			(0.0308)
R-squared	0.030	0.213	0.177

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 912 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B9: Investment vs. birth endowment on height, Girls

	Height age 8 (1)	Height age 11 (2)	Height age 22 (3)
$\hat{\epsilon}_3$	0.000548***	0.000533***	0.000514***
	(0.000097)	(9.53e-05)	(0.000099)
Investments 1983			
food intake	0.1144**	0.0459**	0.0304
	(0.00485)	(0.0480)	(0.0496)
duration breastfeeding	0.00329	0.00413	0.0149
	(0.00861)	(0.008)	(0.0087)
vitamins	0.216***	0.195**	-0.0415
	(0.0773)	(0.0762)	(0.0794)
bath per week	0.0158**	-	-
	(0.00725)		
sleep with baby	0.0132	0.068	-0.167
	(0.188)	(0.186)	(0.193)
Investments 1991			
immunisation		0.0529	0.177**
		(0.0828)	(0.0881)
food intake		0.176***	0.117**
		(0.0408)	(0.0428)
took deworming		-0.0664	-0.139
		(0.0776)	(0.0803)
vitamins		0.254**	0.203*
		(0.105)	(0.111)
meals per day		0.00217*	-0.316
		(0.203)	(0.210)
bath per week		0.0201	-0.0204
		(0.0217)	(0.0233)
Investments 1994			
read to child			-0.0136
			(0.0762)
immunisation			-0.121
			(0.0854)
took deworming			-0.0188
			(0.0882)
own children books			0.0765
			(0.0778)
vitamins			0.0401
			(0.125)
bath per week			-0.0245
			(0.0264)
tuition fees			0.124***
			(0.0458)
R-squared	0.065	0.11	0.09

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 806 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B10: Investment vs. birth endowment on highest grade completed, Girls

	Grade age 8 (1)	Grade age 11 (2)	Grade age 22 (3)
$\hat{\epsilon}_3$	0.000125	0.000254***	5.45e-05
	(0.000097)	(8.91e-05)	(9.12e-05)
Investments 1983			
food intake	0.0809*	0.0151	-0.0092
	(0.0482)	(0.0450)	(0.0461)
duration breastfeeding	0.00727	0.00340	-0.0061
	(0.0086)	(0.00788)	(0.0081)
vitamins	0.296***	0.276***	0.197***
	(0.077)	(0.0714)	(0.0734)
bath per week	0.0105	-	-
	(0.00721)		
sleep with baby	0.285	0.0637	0.121
	(0.187)	(0.175)	(0.177)
Investments 1991			
immunisation		0.572***	0.299***
		(0.0776)	(0.0813)
food intake		0.0982**	-0.0032
		(0.0383)	(0.0396)
took deworming		0.0419	-0.0238
		(0.0726)	(0.0741)
vitamins		0.139	0.0895
		(0.098)	(0.103)
meals per day		-0.274	-0.139
		(0.00180)	(0.194)
bath per week		0.000688	-0.0114
		(0.0204)	(0.0216)
Investments 1994			
read to child			0.0221
			(0.0704)
immunisation			-0.139*
			(0.0789)
took deworming			-0.0639
			(0.0816)
own children books			0.201***
			(0.0717)
vitamins			0.489***
			(0.116)
bath per week			0.0815***
			(0.0244)
tuition fees			0.287***
			(0.042)
R-squared	0.062	0.208	0.181

Note: Coefficients are estimated by linear regressions. Child age and community level fixed-effects are controlled for in each regression. All regressions are run on the sample of 806 observations for which all variables are nonmissing. Continuous variables (breastfeeding duration, baths per week, food intake, meals per day, tuition fees) are standardized by their standard error. The other variables (take care of kids, vitamins, took deworming, read to child, immunization) are dummies. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table B11: Prenatal Investment and birth weight on Height

	Height age 8		
	(1)	(2)	(3)
Birth weight	0.000454***	0.000445***	0.000475***
	(5.7e-05)	(5.53e-05)	(5.57e-05)
Mother age	-0.0468	-0.0836***	-0.0306
	(0.0288)	(0.0282)	(0.03)
Mother age squared	0.000687	0.00140***	0.00061
	(0.000510)	(0.000501)	(0.000523)
Mother height	0.0625***	0.0566***	0.0564***
	(0.00450)	(0.00440)	(0.00438)
Mother arm circumference	0.0382***	0.0254**	0.0229**
	(0.0102)	(0.00999)	(0.00993)
Highest grade completed		0.0401***	0.0336***
		(0.00695)	(0.00715)
Mother works for pay		-0.0359	-0.054
		(0.0444)	(0.0443)
Urban		-0.1136	-0.0943
		(0.1265)	(0.126)
Cigarette consumption			0.0117
			(0.0132)
Daily food intake			3.27e-05
			(4.85e-05)
Number of health care visit			0.0281**
			(0.0114)
First Pregnancy			0.321***
			(0.0628)
Observations	1,718	1,718	1,718
R-squared	0.219	0.268	0.284

Note: Coefficients are estimated by linear regressions. Age, gender of offspring and community level fixed-effects are controlled for in each regression. ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level. The dependant variable is standardized by its standard error.