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Birth weight and long-term outcomes in a developing country

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Abstract

This paper analyzes the empirical relationship between endowment at birth and long-term outcomes. Birth weight has been shown to influence outcomes later in life, suggesting that in-utero shocks have long lasting consequences. However, traditional measures of human capital at birth (i.e. birth weight) are potentially measured with error and endogenous. We deal with such issues thanks to the use of a long panel of children born in 1983 in Cebu (Philippines) and interviewed repeatedly until 2005. Our contribution is threefold. First, we build a refined health endowment measure netted out from prenatal investments. Our results show that the usual estimate of birth weight exceeds by 50% the true causal effect of birth weight on later outcomes. Second, initial endowments affect trajectories both through the human capital production function and parental investment. The effect of birth endowment fades out over time but remains until adulthood. The fading out is very limited for health outcomes but more pronounced for educational outcomes. Finally, we find that parents tend to reinforce initial health endowments, but the effect of this behavior has almost no effect on final outcomes.

Keywords: Human capital investment, health, inequality, endowments, Philippines.

JEL Codes: J13, J18, J24, O10.

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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. Among other, low birthweight children are more likely to suffer from disabilities, heart diseases and diabetes; they also perform worse, on average, on education and earnings when 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 as a critical initial endowment and particularly so in developing countries where poor nutrition, poor health systems and unhealthy environment combine and result in a high share of low birthweight children (Behrman and Rosenzweig, 2004). Indeed, the international institutions such as the UNICEF and the World Bank have devoted many policies to increase birth weights. However, even if the literature on the effect of birthweight and more generally of in utero nutrition has received great attention, the evidence for poor countries remain scarce. In particular, most papers assume birth weight is exogenous, while it is actually affected by genetic endowment, in utero nutrition and other prenatal investments that are likely correlated with post-natal investments. The object of this paper is to provide a full picture of the effect of birthweight in a developing country. We wish to describe whether differences at birth tend to widen or to fade out over time, and whether parental choices of investment in human capital play a role in this evolution. We provide such evidence thanks to a long panel of children born in 1983 in Cebu (Philippines) and interviewed repeatedly until 2005. More precisely, this paper contributes to three questions. The first one is the assessment of the causal effect of birthweight; the second one is the ability of individuals to make up for substantial differences at birth; the last one is on the role of parental investments in the global trajectory.

This paper contributes to three strands of literature. The first one is on the assessment of the causal effect of birth weight on later outcomes. Various ways of dealing with the endogeneity issue have been offered. The gold standard so far consists in using twins as a natural experiment for an exogenous variation in birth weight. Of course, controlling for twins fixed effects is a very powerful tool, since it not only controls for genetics but also for prenatal and postnatal investments common to both children (Behrman and Rosenzweig, 2004; Black, Devereux, and Salvanes, 2007; Bharadwaj, Eberhard, and Neilson, 2010). However, some drawbacks in this method justify the use of non-sample twins. We review those limitations in the literature review. The second avenue consisted in using exogenous variations in in-utero nutrition. Those variations are driven by maternal fasting, the season of birth or rainfall variations (Almond and Mazumder, 2011; Mceniry and Palloni, 2010; 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 to have worse health outcomes at birth. However, they do not provide the causal impact of one additional gram at birth on adult human capital, nor describe the dynamics of health over the life cycle. In the same vein, several papers assess the relationship between adult height and other outcomes, provided that adult height is a good proxy of nutrition in utero. However, most of them fail to take into account both the endogeneity issue and the fact that parent investment depends on child endowments.[1] The second question to which our paper is related pertains to the global trajectory of individuals with lower endowments. There is still debate on whether initial inequality tends to widen, persist or decay over time. On one hand, investments can take place to compensate for lower endowments; on the other hand, from a biological perspective, nutritional needs depend on development stages. Calories and nutrients taken at age 5, for instance, are unlikely substitutes for calories and nutrients taken at age 3. So far, the evidence seems to be mixed, depending on the outcome under scrutiny (Osmani and Sen, 2003; Cameron, 2003; Bharadwaj et al., 2010; Figlio, Guryan, Karbownik, and Roth, 2014). The last literature to which our paper contributes is the one on the parental investment in human capital. Whether investments can compensate for low endowments depends crucially on whether parents are willing to do so. Our paper also contributes to the question of whether parents tend to compensate or reinforce birth endowments. Indeed, under dynamic complementarity[2] and with preferences for equity among siblings, parents face a trade-off between efficiency and equity (Becker and Tomes, 1986). A large number of papers are devoted to evaluating whether parents favor efficiency (and tend to reinforce endowments) or favor equity (and compensate children with lower endowments) (Rosenzweig and Zhang, 2009; Leight, 2013; Rosenzweig and Wolpin, 1988; Conti, Heckman, Yi, and Zhang, 2011). However, most of these papers are silent on whether parental choices actually make a substantial difference in terms of accumulated human capital. Indeed, 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.

The objective of this paper is therefore to assess birth endowment effects on future child 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 reinforce over time, c) whether these endowments determine parental investment and d) what share of the effect is due to parental investment vs. birth endowment. We do so by purging the child birthweight

[1] See Currie and Vogl (2012) and Steckel (2009) for literature reviews.

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

from prenatal investments that are likely correlated with subsequent investment. Thanks to a very rich dataset, we predict birth weight (and other birth outcomes) based on an extensive range of prenatal investments, which amounts to estimate a production function of birth weight. Residuals of this production function are estimates of the child birth endowment (Rosenzweig and Wolpin, 1988; Aizer and Cunha, 2012). By construction, child birth endowment is uncorrelated with the prenatal investments and we assume they are also uncorrelated with unobserved parental preferences for human capital. We then exploit the long panel dimension of our data and find that 1) the birth weight effect obtained in several studies is actually upward biased (it is roughly 50% higher than the true causal effect); 2) the effect of birth endowments marginally decreases when the individual grows up (at most, the effect at adult age is decreased by 35% compared to 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%) while investments have an overwhelming effect compared to birth endowment in education attainment.

The remainder of this paper is organized as follows. We briefly review the literature in section 2, and then describe our empirical strategy, the data and the threats to the identification in section 3. Section 4 provides the results of the effect of birth endowment; section 5 offers an analysis of the relationship between birth endowment, parental investments and final outcomes in the human production function. We then conclude.

2 Brief literature review

We start with the literature on the identification of the causal effect of birth weight on later outcomes. The main avenue that has been taken consists in comparing twins. Indeed, estimating within (monozygous) twins provides a powerful identification since it amounts to controlling for genetic factors, but also for prenatal and postnatal investments common to both children. However, several limitations need to be recalled. First, the twins literature has been unable to conclude on the sign of the bias due to the endogeneity. Some conclude to an underestimation of the causal effect (Behrman and Rosenzweig, 2004) while others to an overestimation (Almond, Chay, and Lee, 2005; Bharadwaj et al., 2010; Oreopoulos, Stabile, Walld, and Roos, 2008). This might be due to the fact that some of them 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, both for the external and the internal validity of the setting. From the external validity point of view, the question is to know the extent to which twins results are representative of changes in birth weight for singletons. This might not be the case since twins are on average 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 being more able to provide the necessary environment to the live birth of twins). This also casts doubt on the external validity of the twin strategy in our context. Third, the effect of initial endowments depends on parental subsequent investment strategy. If parents treat twins more equally than they would do for singletons, then again we can infer little from the twins studies. The competition for resources might also differ between twins and between siblings. Bharadwaj et al. (2010) show that the investment on twins is more similar than for non-twins siblings. Fourth, the internal validity also raises concerns. Twins have a higher birth weight variance than singletons, which is due to the fact that, when they share the same placenta (in 70% of monozygous twins pregnancies), one of them may be disadvantaged over the other. Extreme cases of unequal sharing of in utero resources take place with the twin-to-twin transfusion syndrome. Biologists have shown that this leads to detrimental health outcomes for both twins.[3] It would therefore be necessary to exclude from the sample cases with congenital impairment and too large variation between twins, which is not done in most studies to the exception of Almond et al. (2005). Last, differentiating between siblings in the likely presence of measurement error, leads to a strong attenuation bias (Ashenfelter and Krueger, 1994).

The second avenue consisted in using exogenous variations in in-utero nutrition. Those variations are driven by maternal fasting (Almond and Mazumder, 2011), the season of birth (Mceniry and Palloni, 2010) and rainfall (Maccini and Yang, 2009; Shah and Steinberg, 2013; Moore et al., 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 to have worse health outcomes at birth. Maccini and Yang (2009) is an exception since they do not find any effect of low rainfall if it takes place during pregnancy. However, all these studies are in reduced form and either assess the very short-run impact or the very long-run impact. They are therefore not able to provide the causal impact of one additional gram at birth on adult human capital, nor able to describe the dynamics of health over the life cycle. For these two reasons, it is relevant to complement twin-based evidence and natural-experiment evidence.

The second question to which our paper contributes pertains to the global trajectory of individuals with lower endowments. There is still debate on

[3]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, while the donor twin, deprived of nutrients and oxygen, is often anæmic and produces less than the usual amount of urine.

whether initial inequality tends to widen, persist or decay over time. On one hand, investments can take place to compensate for lower endowments; on the other hand, from a biological perspective, nutritional needs depend on development stages. Calories and nutrients taken at age 5, for instance, are unlikely substitutes for calories and nutrients taken at age 3. Osmani and Sen (2003) argue that the "western diseases" which now afflict South Asia (heart diseases and diabetes) together with the obesity arise from a rapid increase in consumption among people who were previously malnourished. Indeed, Cameron (2003) shows that children who are born small and then grow quickly are at an increased risk of obesity and diabetes. Regarding cognition, Figlio et al. (2014) find that the effect of birth weight on cognitive outcomes remain constant through schooling while Bharadwaj et al. (2010) find this is the case for twins but that the difference between non-twin siblings decrease 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. In addition, we are interested in the environment of poor countries while these former studies have been performed in high-income countries where the quality of investment made during childhood is high compared to the environment by comparison.

Last, whether investments can compensate for low endowments depends crucially on whether parents are willing to do incur such investment. This is one aspect of the question of the trajectory. Our paper also contributes to the question of whether parents tend to compensate or reinforce birth endowments. Indeed, under dynamic complementarity[4] and with preferences for equity among siblings, parents face a trade-off between efficiency and equity (Becker and Tomes, 1986). A large number of papers are devoted to evaluating whether parents favor efficiency (and tend to reinforce endowments) or favor equity (and compensate children with lower endowments). There is no consensus on this question however, since some conclude to reinforcement (Rosenzweig and Zhang, 2009; Datar, M., and Loughran, 2010), some to compensation (Leight, 2013; Bharadwaj et al., 2010) and others find some mixed evidence (Rosenzweig and Wolpin, 1988; Conti et al., 2011; Hsin, 2012).[5] Again, the empirical identification of such behaviour face the same endogeneity issues as the ones described above and the scholars have used various strategies to circumvent them. They include: within twin pairs differentiation, rainfall shocks as instruments or structural estimations. However, most of these papers are silent on whether parental choices actually make a substantial difference in terms of accumulated human capital. Indeed, their strategies could have a very limited effect on actual human

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

[5] This fits as well into the broader question of the intrafamily determinants of outcomes, such as the effect of siblings sex-composition, or the effect of birth order.

capital, especially if the biological effect of being born with a low weight is very strong.

3 Methodology and Data

3.1 General overview of the methodology

We are interested in how endowments shape life outcomes. Scholars mostly use birthweight to proxy for endowments at birth. If y_{it} stands for any life outcome of individual i at age t (such as height, for instance), BW_i for birthweight and X_{it} for a set of relevant covariates, the relationship of interest is:

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

where α_t is the effect of birthweight on life outcomes and is allowed to vary across ages. However, birthweight may be endogenous because it already reflects prenatal investments (PI_i). Following Aizer and Cunha (2012), we use instead the residual from a production function that includes prenatal investments as regressors. We discuss in section 3.4 the prenatal investments that should and can be included in our analysis.

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

The residual $\widehat{\epsilon_i}$ encompasses the child's true endowment at conception, any nutrition and health shock that took place during the pregnancy and presumably measurement error in BW as well as remaining prenatal investment that would not have been purged off by our control strategy.

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

$$y_{it} = \alpha_t \widehat{\epsilon_i} + \gamma X_{it} + u_{it} \tag{2}$$

If BW_i is measured with error then $\widehat{\epsilon_i}$ 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 the results are robust to different specifications. We can also build a birth endowment 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

$$E(u_{it}|BW_i, PI_i, X_{it}) = E(u_{it}|PI_i, X_{it}).$$

In order to assess whether inequalities at birth tend to widen or decrease over time, it is then sufficient to compare the values of α_t for different t.

The mechanisms at stake are of various natures: there is a pure biological process, which governs the health production function, but this biological process largely depends as well on inputs that are mostly provided by the child family. The biological process can either lead to divergence or to convergence of outcomes of individuals with different birth endowments. A lot of 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 behavior depends both 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 behavior compensates or reinforces inequalities at birth.

We should therefore estimate the two following equations in order to provide a full picture of the effect of endowments at birth on life outcomes:

$$I_{it} = \delta\widehat{\epsilon}_i + \zeta X_{it} + v_{it} \quad (3)$$

$$y_{it} = \tilde{\alpha}\widehat{\epsilon}_i + \theta I_{it} + \tilde{\gamma} X_{it} + \tilde{u}_{it} \quad (4)$$

where I_{it} are investments on child i at age t or before. Eq. (3) will allow us to understand whether parents tend to compensate or to reinforce inequalities at birth. Eq. (4) evaluates the extent to which the strategic parental behavior truly affects the child's trajectory. We discuss later the identification challenges raised by such an estimation.

3.2 Data

This paper uses the Cebu Longitudinal Health and Nutrition Survey (CLHNS) data. This dataset is particularly relevant for this analysis since it follows a cohort of children born in 1983-84 throughout their infancy, childhood, teenage, and early adult life until their 22 years of age. The initial sample is made of children born from 3327 mothers living in Metropolitan Cebu (Philippines), who were recruited at a median 30 weeks gestation. Those children were all born between May 1, 1983 and April 30, 1984. The first interview took place during the pregnancy and collected information regarding the mother health status (including anthropometric data) and questions on prenatal investments - daily food intake, medical care, consumption of cigarettes. The birth survey encompassed birth outcomes, first hours of life and delivery conditions. Weight and length at birth were measured by interviewer as soon as births were reported. Postnatal information was also gathered immediately after birth. The CLHNS does not provide any details on paternal health.

Subsequent interviews were conducted every two months, from age 2 months until the child was 2 years old. Each time, the children were weighted and measured by a well-trained interviewer. Those bimonthly surveys contain information on early-life health investments such as breast-feeding and supplemental feeding practices.

Successive follow-up surveys took place in 1991, 1994, 1998, 2002 and 2005. Anthropometric measures (weight, height, arm circumference) were recorded in each survey round. Children have been administered a non-verbal intelligence test around the age of 8, specially designed for the CLHNS survey (Guthrie and Jacobs, 1977). The survey includes socio-demographic, health, economic and community data.

The distinctive feature of the CLHNS database is that it combines a precise measure of birth weight, mother health, prenatal investments as well as long run outcomes. To our knowledge, this is the only instance in a developing country. This gives us the opportunity to analyze 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.

3.3 Sample

In 1983, 3327 pregnant women were included in the baseline, but only 2966 children were included in the study. The remainder is constituted of still-births, miscarriages, migrations out of the survey area and refusals to take part in the survey. Our base sample is therefore constituted of 2966 children who were weighted at birth. Table 1 describes attrition in the sample over years. Actually, the attrition rate is quite low, around 1.9% per year, which is largely below a large number of longitudinal surveys. After taking into account cases of non and irrelevant responses, this yields a sample of 1912 individuals followed from gestation stage up to 22 years old. Because our objective is to assess the evolution of the effect of endowments at birth across age, our sample of interest is made of the 1718 individuals whose information is recorded at each age. However, a somewhat larger sample is available when focusing on earlier outcomes. All 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 4.5, we deal with the possibility that attrition is non random and test the robustness of our results.

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

3.4 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 in three groups: mother genetic factors and health (mother height and arm circumference); socio-economic environment (highest grade completed, household assets, whether the mother works for a pay, urban dwelling); "conscious" prenatal investments (alcohol consumption, cigarette consumption, daily food intake, number of health care visits, and whether the pregnancy was mother's first). The definition of the endowment variable depends on the inclusion of the various factors. For the sake of simplicity, we only 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.

Before analyzing the results, it is worth mentioning the control variables we would have welcomed but are unavailable. These omitted variables are a threat to our identification strategy. Obviously, an instrumentation strategy might have helped here but the design of the data collection prevents us from finding external factors of birthweight: the sample has been 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 a RHS variable.

Let us discuss the potential omitted variables. First, we do not have information regarding father health, height, or characteristics in general. This is likely a problem since it should correlate both with child birth weight and his or her subsequent outcomes. However, we know that father height tend to be correlated with mother height because of matching on the marriage market. The empirical question is whether controlling for mother height is sufficient to purge also from father genetics. While this seems too ambitious, we have evidence this is the case. We use the Demographic and Health Survey collected on India (the "closest" country to the Philippines, since no DHS has been collected on the Philippines) and perform the following exercise. We regress BW on mother height on one hand and on mother height and father height on the other hand. Results are provided in Table 2. It shows that indeed the coefficient on mother height in column (1) is much greater than in column (2), attesting from the fact that mother height captures at least a share of the effect of father height. Most interestingly, the R-square is strictly the same in the two columns, which shows that there is no additional information to be gained from the inclusion of father height. For our setting, this shows that the omission of father height is unlikely to greatly bias our results.

Second, controlling for mother fixed effects instead of her height would be

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.

more satisfactory since more inclusive. However, only one child per woman is longitudinally surveyed and we cannot differentiate between children. We provide in the next section additional evidence showing that wiping out genetic factors with mother height, prenatal investment and socioeconomic background solves the endogeneity problem.

Finally, since we are interested in long-term effects of birth inequalities, a major threat to our identification is due to endogenous attrition over the 22 years of the panel. We take into account attrition in section 8 and therefore postpone that discussion.

4 Results

4.1 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 explains 21% of birth weight variance. The inclusion of socioeconomic characteristics (column 2) does not add much to the explained variance. Among this last set of variables, only the fact of living in an urban area explains birth weight. Finally, control for prenatal investments increases the precision of the prediction of birthweight. Column (3) provides results that are consistent with the biological literature (N. R. Butler, 1972; Mills and al, 1984): cigarette consumption during pregnancy is at the cost of the newborn's weight. First pregnancies lead to lighter newborns. Mother daily food intake is associated to changes in the newborn's weight but the effect is significantly different from zero only at the 10% level. Finally, a greater number of health care visits is also associated to a healthier newborn. All these results conform to the expectations. However, it is striking to see that the inclusion of this last set of prenatal investments, while highly significant, only leads to a limited increase in explained variance. These three regressions generate three different measures of endowments. *A priori*, $\hat{\epsilon}_3$ is the most interesting to us since it prevents from 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. However, comparing the estimates of α when using different measures of endowments is of methodological interest.

4.2 Comparing measures of endowments

In order to assess the consequences of our methodology on the estimation of Eq. 2, we use four different measures of endowments: the raw birthweight and the three endowments obtained from Table 3. We also start with only two different outcomes: height and highest grade completed at age 8. Tables 4 and 5 provide the results. In these tables and the following, birth weight as well as endowments are measured in grams. The outcomes are standardized so as to be compared. An increase of 100 grams in birthweight is associated to an increase of 0.066 standard deviation in height at age 8 (or to $0.066 \cdot 5.53 = 0.36$ centimeters since the standard deviation in height at 8 years old is 5.53cm).[6] However, the estimated effect is only of 0.047 when using $\hat{\epsilon}_3$. Neglecting the endogeneity in birthweight leads to a crude overestimation of its effect on subsequent outcomes. Quite strikingly though, the results are very similar across columns (2) to (4): purging for investments of different nature is redundant. This is due to the high correlation between the various types of investments. This is extremely important for the validity of our methodology: it suggests that purging from additional investments would not change much the estimates.

An increase of 100 grams in birthweight is associated to an increase of 0.019 standard deviation in highest grade completed at age 8 (or to $0.019 \cdot 0.86 = 0.32$ years of education since the standard deviation in HGC at 11 years of age is 0.86 year). The discrepancy obtained when using $\hat{\epsilon}_3$ instead of birthweight is less steep than when one explains height. Indeed, the coefficient size is 86% of the birthweight coefficient, which suggests a lower endogeneity bias. The effect is very stable over the different endowment measures and suggests again that there is no remaining bias.

Interestingly, when running the same exercise separately by gender (Table 17 in Appendix), we observe that the effect of endowments on height are

[6] Mean and standard deviation of the variables are provided in Appendix, Table 15.

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

	Birth weight		
	(1)	(2)	(3)
Mother age	47.53***	45.53***	15.08
	(12.03)	(12.13)	(12.84)
Mother age squared	-0.814***	-0.767***	-0.299
	(0.214)	(0.216)	(0.224)
Mother height (cm)	13.01***	12.89***	12.61***
	(1.875)	(1.895)	(1.874)
Mother arm circumference (cm)	33.66***	31.41***	30.88***
	(4.192)	(4.275)	(4.224)
Highest grade completed		4.431	5.347*
		(2.943)	(3.015)
Household assets		-0.00136	-0.00378
		(0.00302)	(0.00304)
Mother works for pay		-1.010	-2.467
		(19.02)	(18.83)
Urban		44.30**	35.69*
		(19.27)	(19.10)
Cigarette consumption			-7.904
			(5.766)
Daily food intake (gm)			0.0389*
			(0.0208)
Number of health care visits			17.40***
			(4.815)
First pregnancy			-170.6***
			(27.01)
Predicted endowment	$\hat{\epsilon}_1$	$\hat{\epsilon}_2$	$\hat{\epsilon}_3$
Observations	1,718	1,718	1,718
R-squared	0.213	0.218	0.243

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

somewhat larger for girls than for boys. The discrepancy between the fourth and the first column 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 while it is positive and significant

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

	Height age 8			
	(1)	(2)	(3)	(4)
Birth Weight	0.000659***			
	(5.75e-05)			
$\hat{\epsilon}_1$		0.000454***		
		(6.19e-05)		
$\hat{\epsilon}_2$			0.000437***	
			(6.20e-05)	
$\hat{\epsilon}_3$				0.000467***
				(6.27e-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.

for boys. We do not find any endogeneity bias for boys.

4.3 Robustness check 1: birth endowments on siblings outcomes

Before looking further into the effect of endowments on adult outcomes, it is worth checking our results are not driven by remaining unobserved factors. As stated before, 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. More precisely, since parents have to trade-off between siblings investment, we do expect an effect of one child endowment on his/her siblings outcomes. However, there should be no effect of one child endowment on his/her elder siblings outcomes at the time of his/her birth. Unfortunately, the data only provide us with schooling outcomes of elder siblings, but not with health outcomes. The results are provided in Table 6. It shows that while birth

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

	HGC age 8			
	(1)	(2)	(3)	(4)
Birth Weight	0.000195***			
	(5.89e-05)			
$\hat{\epsilon}_1$		0.000168***		
		(6.20e-05)		
$\hat{\epsilon}_2$			0.000156**	
			(6.20e-05)	
$\hat{\epsilon}_3$				0.000168***
				(6.28e-05)
Observations	1,718	1,718	1,718	1,718
R-squared	0.023	0.021	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.

weight of the newborn "affects" the older sibling educational attainment,[7] it is not the case anymore of our measure of health endowment at birth.[8] We will therefore proceed and consider birth endowment as a truly exogenous variable.

4.4 Robustness check 2: endowments based on other birth outcomes

As mentioned earlier, birth weight and therefore 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 this measurement error issue. We can either apply the same methodology for each of them independently or combine them in order to get a more accurate measure of birth endowment. We therefore build a score based on birth weight, length at birth and pregnancy duration (see Table 16 in Appendix for the coefficients). This

[7] Actually, the point estimate is strikingly the same for the child and his/her sibling when using the raw birth weight.

[8] 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 highest grade completed.

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

	sibling's HGC 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.

score is then netted out of prenatal investment. Results for our main outcome variables are provided in Table 7. In these tables, all RHS variables are standardized by their standard error so that coefficients can be compared throughout columns. We compare the "effect" obtained with the raw variable and with the endowment variable. Measures of endowments based on height (length) at birth give larger effects compared to the endowment based on weight when predicting the effect on height. This clearly comes from the fact that the input and output variable used in the estimation of the health production function are similar, but at two different ages. Indeed, 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 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, 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 nutrition and c) the existing measurement error,

Table 7: Effect of various measures of birth endowments

Panel A:								
Outcome:	Height in 1991 (age 8)							
Birth endowment:	Birthweight		Birth height		Pregnancy duration		Score	
Measure:	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$
	0.281***	0.180***	0.354***	0.228***	-0.00478	-0.0162	0.312***	0.203***
	(0.0239)	(0.0244)	(0.0247)	(0.0244)	(0.0266)	(0.0263)	(0.0246)	(0.0253)
Observations	1,718	1,718	1,718	1,718	1,607	1,607	1,607	1,607
R-squared	0.076	0.032	0.108	0.050	0.001	0.001	0.092	0.039
Panel B:								
Outcome:	Highest grade completed in 1991 (age 8)							
Birth endowment:	Birthweight		Birth height		Pregnancy duration		Score	
Measure:	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$	Raw	$\hat{\epsilon}_3$
	0.0711***	0.0503***	0.0752***	0.0420**	0.0232	0.0236	0.0822***	0.0553***
	(0.0193)	(0.0193)	(0.0203	(0.0194)	(0.0206)	(0.0204)	(0.0200)	(0.0200)
Observations	1,718	1,718	1,718	1,718	1,607	1,607	1,607	1,607
R-squared	0.024	0.020	0.024	0.019	0.014	0.014	0.024	0.018

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.

if small, tends to provide a lower bound of the effect of birth endowment. 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 will now proceed using only birth endowment, defined by birthweight netted out from any prenatal investment.[9]

4.5 Robustness check 3: non-random attrition

Over the 22 years of the panel duration, even small or moderate attrition rates per year end up with a 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. In particular, we can directly check whether attrition is correlated with endowments, and if this is the case, we

[9]We also checked that robustness test based on siblings is not invalidated using the birth health score and this is the case. The results are available upon request.

Table 8: Probability of attrition

	Attrition	
	ols	probit
	(1)	(2)
$\hat{\epsilon}_3$	-6.88e-05***	-0.000069 ***
	(1.80e-05)	(2.00e-05)
Mother age	-0.00214	-0.00222*
	(0.00131)	(0.00133)
Mother height (cm)	-0.000109	-0.000136
	(0.00185)	(0.00189)
Mother arm circumference (cm)	-0.000520	-0.000445
	(0.00333)	(0.00336)
Highest grade completed	0.00176	0.00182
	(0.00267)	(0.00272)
Household assets	1.55e-06	1.56e-06
	(1.58e-06)	(1.02e-06)
Mother works for pay	-0.0116	-0.0122
	(0.0243)	(0.0248)
Urban	0.126***	0.127***
	(0.0341)	(0.0342)
Cigarette consumption	0.0115***	0.0117***
	(0.00325)	(0.00341)
Daily food intake (gm)	-3.32e-08	-2.43e-07
	(1.74e-05)	(2.00e-05)
Number of health care visits	0.00276	0.00272
	(0.00412)	(0.00415)
First pregnancy	-0.00917	-.0090745
	(0.0180)	(0.0183)
R-squared	0.024	
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.

can re-weight the sample so as to reproduce the distribution of birthweight observed at the beginning of the panel.

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

	HGC 91 age 8 (1)	Height 91 age 8 (2)
$\hat{\epsilon}_3$	0.000142*** (4.23e-05)	0.000417*** (6.91e-05)
Observations	1,718	1,718
R-squared	0.019	0.028

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.

We start by assessing the link between attrition and endowment. Table 8 uses as base sample the 2966 children that were measured at birth in 1983. The LHS variable is a dummy variable that takes the value 1 when the child is not in our sample of interest[10] 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 $6.8 \cdot 10^{-3}$ % points. The R-squared is also low (0.02). This is unlikely to drive our results. We nevertheless deal with such an 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 attrit than to children with characteristics that make them more likely to remain in the panel. Obviously, part of the relevant characteristics are birth endowment (Baulch and Quisumbing, 2010). For the purpose of the procedure, we need additional characteristics on which to compute the weights.[11] The characteristics we include are the following: child gender and age (in months at first weight measurement), mother age,

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

[11] Here we only implement a procedure that deals with selection on observables, therefore the characteristics may correlate with outcomes, which is far less stringent than when dealing with selection on unobservables.

education, alcohol and cigarettes consumption, height, weight, wealth (based on durables ownership) and whether they live in an urban area. Cigarettes consumption, as well as urban area, are predictive of attrition but the others are not.

The results are provided in Table 9. Unsurprisingly, the results do not differ from the base result and this is due to our prior finding that selection only slightly correlates with birth endowment. From now on, we will therefore consider that there is issue of selection on observable in our study. It remains that some selection on unobservables could bias our results.

4.6 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. In order to do so, we evaluate the effect of birth endowment on the same outcome at different ages. For the purpose of comparison through columns, the dependent variables are standardized, while the birth endowment variable is expressed in grams.

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 at teenage (the two coefficients are significantly different from each other). The catch-up therefore seems quite limited. It might come from the fact that height is a very resilient measure of health which is known to be largely shaped in infancy. Table 10, panel B, shows that indeed the results based on arm circumference show less resilience. The effect of birth endowment at age 22 is only half the effect at age 11 and most of the catch-up takes place during teenage. The size of the effect at adult age also seems limited: an increase by 100 grams at birth increases arm circumference by .025 standard deviation. Results for weight (not shown) give a similar picture of the evolution of inequality across age. This set of results hold for both gender (see Tables 18 and 19 in Appendix).

Turning to educational outcomes, Table 10, panel C, we find that the effect of birthweight is slowly decreasing. The difference between col. (4) and col. (5) is somewhat puzzling since education levels should not vary much between age 19 and age 22. There might be more measurement error at age 22 leading to an attenuation bias. If this is the case, the catch-up is very limited. Disaggregation by gender is also informative (Tables 18 and 19, in Appendix). There does not seem to be much effect of endowment on highest grade completed for girls, while for boys the effect of 100 additional grams amount to .02 standard deviation in highest grade completed until the age of 11 and then decreases. Not observing any effect for girls can be seen as consistent with the result obtained in Estudillo, Quisumbing, and Otsuka (2001): they show that girls are more systematically enrolled in school in rural Philippines. However, we also observe an effect of endowment on IQ

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		
$\hat{\epsilon}_3$	0.000467***	0.000401***	0.000412***	0.000327***	0.000379***
	(6.27e-05)	(6.02e-05)	(5.04e-05)	(4.23e-05)	(4.77e-05)
R-squared	0.033	0.126	0.383	0.441	0.451
Panel B:			Arm Circumference		
$\hat{\epsilon}_3$	0.000434***	0.000333***	0.000287***	0.000244***	0.000286***
	(6.26e-05)	(6.21e-05)	(6.34e-05)	(6.22e-05)	(6.06e-05)
R-squared	0.033	0.047	0.026	0.038	0.097
Panel C:			HGC		
$\hat{\epsilon}_3$	0.000168***	0.000239***	0.000119*	0.000135**	0.000105*
	(6.28e-05)	(5.88e-05)	(6.12e-05)	(6.01e-05)	(6.01e-05)
R-squared	0.021	0.117	0.017	0.064	0.066
Panel D:	I.Q.				
$\hat{\epsilon}_3$	0.000231***				
	(6.06e-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.

test results (Table 10, panel D). 100 more grams at birth imply a higher IQ by 0.02 standard deviation. While 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.

To sum up, this section has shown that results based on raw birth weight tend to overestimate the effect of birth endowments on life outcomes. We have also provided placebo and robustness tests that point to the conclusion that our identification strategy is valid. Based on this procedure, we show that the effect of birth endowment remains at adult age without fading out for height, but with fading out for other measures of health and educational outcomes. We also show that birth endowments based on health at birth are a stronger predictor of health than of cognitive outcomes, which does not come as a surprise but still highlights the presence of externalities associated to health. More precisely, the effect of birth endowments on cognitive outcomes is roughly a third of the effect of health outcomes.

The fact that birth endowments tend to fade out over time might either be due to parental investments to compensate lighter children or to the natural resilience of the human body. This persistence but fading out has to be further investigated. From a policy perspective, and beyond the debate of 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.

5 Investments vs. biological mechanisms

5.1 Behavioral 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. On one hand, endowment and investment are likely complements in the production function, leading to a greater efficiency when parents invest in better endowed children. On the other hand, if they value equity between their offspring, they might try to compensate lower-endowed children by investing more in them. Here, we exploit the richness of our dataset since various investments are recorded even for very young children, and at different ages. We implement the same methodology as before 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. Again, we compare the results using the raw birthweight with those based on the endowments, for methodological purposes.

Table 11 shows again that results based on raw birthweight are misleading since they tend to overestimate the true effect of birth endowments. We find non negligible effects of birth endowment on investments taking place in infancy: heavier children are breastfed longer and receive greater food intake. The effect is quite large on breastfeeding compared to the other outcomes we have reviewed: 100 additional grams at birth induce an increase of breastfeeding duration by 0.05 standard deviation. We do not observe any differential investment at age 8 based on birth endowment and find again some effect at teenage. In particular, they pay higher tuition fees at age 11 in a context where almost all children are enrolled in school.[12] Our findings suggest that parents tend to reinforce inequalities at birth since better endowed children benefit from higher key investments such as food intake, breastfeeding and schooling inputs. However, the effects remain of limited magnitude. 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 20 and 21, in Appendix) gives a similar picture.

5.2 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. Nevertheless, it is interesting to attribute the heterogeneity observed at each age to physical and exogenous factors (the birth endowment) and to behavioral components (the investment chosen by adults). Indeed, most papers either 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 aslo assess the share of the different factors in the final outcome.

The question is empirically difficult because investment (as well as birth weight) might be endogenous inputs in the human capital production function. We already dealt with the suspicion that birthweight is endogenous and use instead birth endowments. With regard to investment, we must acknowledge that parents choose investments on the basis on information that is only partially observed by us. Insofar as they tend to reinforce endowments as it seems to be the case, unobserved characteristics of the child will both correlate with investments and output; the estimated effect of investment are therefore likely upward biased. In our case, two points are crucial in order to understand why the upward bias will be 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 should also be limited since we are able to take all of them into account, while usually they correlate with each other. More precisely, we are not so much interested in commenting the effect of one type of investment compared to another in order to decide which is the most efficient. This would prove to be problematic since we cannot make

[12] In 1994, 95% of our sample is enrolled in school.

sure that all of the relevant investments are controlled for. In our case, we simply want to know how much of all 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 on the child. Keeping in mind these limitations, we estimate the effect of birth endowment on outcomes conditional on investments.

Table 12 and 13 provide the results. It turns out that the effect of birth endowment is not significantly different from the estimates we obtained without control 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 seems that the reinforcement behavior has only small consequences.

This does not mean that parental investment does not affect final outcomes, rather that the debate on whether parents tend to reinforce or compensate may not be crucial to the understanding of life trajectories. In order to assess the importance of the various factors, we run the following exercise: based on the regressions already presented, we estimate variants by excluding either the birth endowment variable or the investment variables. We then compare the share of explained variance and assess 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 share of the variance comparable in magnitude (4 to 5% at age 22). As a consequence, post-natal investments have a similar explanatory power than birth endowment in final health measured by height. Table 14, panel B, provides the results for schooling level and the picture is different. Consistent with previous findings, birth endowment only affects boys and the share of variance is low and decreases over time (less than 1% at each age). By comparison, investments play a greater role and that role reinforces 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 the totality of this major difference with birth endowment in education.

6 Conclusion

This paper describes the short and long term impact of initial health endowment on health and education outcomes. We first deal with endogeneity issues associated to birthweight: indeed, parents consent prenatal investments which then 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. We provide robustness checks that confirm the power of the procedure with regard to suppressing the endogeneity bias. Using this endowment measure, we show that 1) the birth weight effect obtained in several studies is actually upward biased (it is roughly 50% higher than the true causal effect); 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 while investments have an overwhelming effect compared to birth endowment in education attainment.

The paper therefore provides a comprehensive picture of the short and long term effect of birth endowments and also characterizes the areas in which further progress should be made. Indeed, it suggests that the literature on compensating vs reinforcing behavior might be of secondary importance compared to the ones on: the effect of birth endowment on health outcomes and on the effect of parental investment on education.

Table 11: Effect of birth endowment on parental investments

Panel A. At birth: in 1983

	vitamins (1)	baths per week (2)	food intake (3)	(4)	(5)	duration breastfeeding (6)	sleep with baby (7)	(8)
Birth weight	3.65e-05	3.85e-05	0.000194***			5.38e-05	1.87e-05	
	(3.02e-05)	(6.17e-05)	(4.70e-05)			(5.92e-05)	(1.15e-05)	
R-squared	0.001	0.001	0.024			0.002	0.003	
$\hat{\epsilon}_3$	-1.89e-05	-2.85e-05	0.000106**			0.000105	2.00e-05	
	(3.27e-05)	(6.70e-05)	(5.13e-05)			(6.42e-05)	(1.25e-05)	
R-squared	0.001	0.000	0.017			0.003	0.003	

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	3.88e-05*	0.000101*	0.000149***	-1.76e-05	1.83e-05	0.000908		
	(2.00e-05)	(5.87e-05)	(5.68e-05)	(2.73e-05)	(2.54e-05)	(0.00145)		
R-squared	0.005	0.013	0.034	0.002	0.002	0.001		
$\hat{\epsilon}_3$	6.46e-06	1.58e-06	7.69e-05	-4.63e-05	1.81e-05	-0.000673		
	(2.17e-05)	(6.39e-05)	(6.19e-05)	(2.96e-05)	(2.76e-05)	(0.00158)		
R-squared	0.003	0.011	0.031	0.004	0.002	0.000		

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	6.69e-05***	0.000149**		-4.66e-06	-9.89e-06	3.62e-05	0.000307***	8.38e-05***
	(1.76e-05)	(5.88e-05)		(2.92e-05)	(2.60e-05)	(2.89e-05)	(5.81e-05)	(2.91e-05)
R-squared	0.010	0.010		0.004	0.007	0.007	0.018	0.006
$\hat{\epsilon}_3$	3.82e-05**	7.65e-05		-4.38e-05	-3.75e-06	-6.01e-06	0.000158**	1.97e-05
	(1.91e-05)	(6.40e-05)		(3.17e-05)	(2.83e-05)	(3.14e-05)	(6.35e-05)	(3.18e-05)
R-squared	0.004	0.007		0.005	0.007	0.006	0.006	0.001

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 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 (1)	Height age 11 (2)	Height age 22 (3)
$\hat{\epsilon}_3$	0.000477***	0.000368***	0.000366***
	(6.57e-05)	(6.11e-05)	(5.30e-05)
Investments 1983			
food intake	0.183***	0.142***	0.0733**
	(0.0357)	(0.0342)	(0.0295)
duration breastfeeding	-0.00976	0.00698	0.0178
	(0.0252)	(0.0236)	(0.0205)
vitamins	0.199***	0.171***	-0.0299
	(0.0524)	(0.0492)	(0.0429)
bath per week	0.0665***	-	-
	(0.0248)		
sleep with baby	0.0762	0.0190	-0.0910
	(0.127)	(0.119)	(0.100)
Investments 1991			
immunisation		0.111**	0.115**
		(0.0531)	(0.0477)
food intake		0.121***	0.0496**
		(0.0249)	(0.0218)
took deworming		-0.0543	0.00675
		(0.0515)	(0.0449)
vitamins		0.286***	0.175***
		(0.0699)	(0.0628)
meals per day		0.00224**	0.00119
		(0.000982)	(0.000841)
bath per week		0.0344	-0.0113
		(0.0248)	(0.0223)
Investments 1994			
read to child			-0.0327
			(0.0418)
immunisation			-0.0621
			(0.0456)
took deworming			-0.0151
			(0.0473)
own children books			0.0495
			(0.0424)
vitamins			0.0256
			(0.0702)
bath per week			-0.0192
			(0.0215)
tuition fees			0.0517**
			(0.0252)
R-squared	0.071	0.189	0.463

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

	HGC age 8 (1)	HGC age 11 (2)	HGC age 22 (3)
$\hat{\epsilon}_3$	0.000179*** (6.74e-05)	0.000189*** (5.94e-05)	5.53e-05 (5.72e-05)
Investments 1983			
food intake	0.0809** (0.0367)	0.103*** (0.0333)	0.0346 (0.0318)
duration breastfeeding	0.0354 (0.0259)	0.00130 (0.0230)	-0.0265 (0.0221)
vitamins	0.272*** (0.0537)	0.252*** (0.0478)	0.203*** (0.0463)
bath per week	0.0364 (0.0255)	-	-
sleep with baby	0.0571 (0.130)	0.0617 (0.115)	-0.0558 (0.108)
Investments 1991			
immunisation		0.601*** (0.0517)	0.297*** (0.0515)
food intake		0.0306 (0.0242)	-0.0283 (0.0235)
took deworming		0.0177 (0.0501)	0.0831* (0.0484)
vitamins		0.176*** (0.0679)	0.181*** (0.0678)
meals per day		0.00237** (0.000954)	0.000446 (0.000908)
bath per week		0.0487** (0.0241)	0.0428* (0.0241)
Investments 1994			
read to child			-0.0248 (0.0451)
immunisation			-0.0549 (0.0493)
took deworming			-0.0390 (0.0510)
own children books			0.125*** (0.0457)
vitamins			0.238*** (0.0757)
bath per week			0.0768*** (0.0232)
tuition fees			0.195*** (0.0273)
R-squared	0.047	0.231	0.206

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	0.0359	0.029	0.0781	0.0109	0.0516	0.0395
Girls	0.0481	0.0407	0.0608	0.0364	0.0413	0.0249
Panel B : Highest grade completed						
Boys	0.0206	0.0061	0.1266	0.0056	0.1521	0.0008
Girls	0.0315	0.0051	0.0972	0.0073	0.1823	0.0003

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 22, 23, 24 and 25. The provided coefficients measures the additional share of variance explained by investments (uneven columns) and by the birth endowment (even columns).

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7 Appendix

Table 15: 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
Father years of education	7.55	3.76
Household Assets (pesos)	1268	3913
Mother works for pay	0.4	0.5
Nb 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
HGC age 8	1.84	0.86
HGC age 11	4.14	0.97
HGC age 14	8.73	2.00
HGC age 18	10.34	2.54
HGC age 22	10.45	3.09
IQ score age 8	51.71	12.31
Daily Food intake (g) 1983	809.7	308
Duration breastfeeding (month)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
Immunisation1991	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
Read to child 1994	0.4	0.49
Immunisation1994	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 (pesos) 1994	943.56	1777.28

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

Table 16: Scoring Coefficients

	Scoring coefficient
Residual of Birth Weight	0.6865
Residual of Birth Height	0.6769
Residual of Pregnancy duration	0.2656

Table 17: Effect of birth endowment on height and highest grade completed at age 8 by gender

	Height age 8		HGC 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
$\hat{\epsilon}_1$	0.000414***	0.000522***	0.000202**	0.000144
	(8.16e-05)	(9.62e-05)	(8.28e-05)	(9.58e-05)
R-squared	0.032	0.037	0.009	0.032
$\hat{\epsilon}_2$	0.000403***	0.000497***	0.000191**	0.000135
	(8.16e-05)	(9.63e-05)	(8.27e-05)	(9.58e-05)
R-squared	0.031	0.033	0.008	0.031
$\hat{\epsilon}_3$	0.000430***	0.000535***	0.000212**	0.000135
	(8.30e-05)	(9.67e-05)		(9.65e-05)
R-squared	0.033	0.038	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.

Table 18: 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		
$\hat{\epsilon}_3$	0.000430*** (8.30e-05)	0.000326*** (8.19e-05)	0.000455*** (8.22e-05)	0.000305*** (5.24e-05)	0.000509*** (8.36e-05)
R-squared	0.033	0.099	0.055	0.042	0.042
Panel B:			Arm Circumference		
$\hat{\epsilon}_3$	0.000362*** (8.40e-05)	0.000247*** (8.39e-05)	0.000202** (8.51e-05)	0.000173** (8.37e-05)	0.000254*** (8.47e-05)
R-squared	0.022	0.017	0.018	0.007	0.011
Panel C:			HGC		
$\hat{\epsilon}_3$	0.000212** (8.43e-05)	0.000271*** (7.79e-05)	0.000142* (8.05e-05)	0.000151* (8.10e-05)	0.000124 (7.99e-05)
R-squared	0.009	0.098	0.015	0.004	0.005
Panel D:	I.Q				
$\hat{\epsilon}_3$	0.000208** (8.23e-05)				
R-squared	0.026				
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.

Table 19: 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		
$\hat{\epsilon}_3$	0.000535*** (9.67e-05)	0.000531*** (9.51e-05)	0.000637*** (9.67e-05)	0.000544*** (0.000101)	0.000533*** (9.75e-05)
R-squared	0.038	0.059	0.054	0.038	0.038
Panel B:			Arm Circumference		
$\hat{\epsilon}_3$	0.000536*** (9.64e-05)	0.000451*** (9.70e-05)	0.000422*** (9.70e-05)	0.000358*** (9.76e-05)	0.000362*** (9.73e-05)
R-squared	0.040	0.036	0.027	0.017	0.018
Panel C:			HGC		
$\hat{\epsilon}_3$	0.000135 (9.65e-05)	0.000212** (9.18e-05)	9.91e-05 (9.44e-05)	0.000151 (9.54e-05)	0.000104 (9.68e-05)
R-squared	0.031	0.108	0.021	0.006	0.003
Panel D:	I.Q				
$\hat{\epsilon}_3$	0.000282*** (9.35e-05)				
R-squared	0.063				
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.

Table 20: Effect of birth endowment on parental investments, Boys

				Panel A. At birth: in 1983				
	vitamins	baths per week	food intake			duration breastfeeding	sleep with baby	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth weight	4.77e-05	7.72e-05	0.000214***			0.000110	2.65e-05	
	(4.01e-05)	(8.24e-05)	(6.54e-05)			(7.84e-05)	(1.62e-05)	
R-squared	0.002	0.003	0.012			0.006	0.004	
$\hat{\epsilon}_3$	6.24e-06	-2.36e-05	7.93e-05			0.000167**	3.14e-05*	
	(4.33e-05)	(8.96e-05)	(7.14e-05)			(8.50e-05)	(1.76e-05)	
R-squared	0.001	0.002	0.001			0.008	0.004	
				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	3.89e-05	0.000134*	0.000173**	3.41e-05	3.60e-05	0.00154		
	(2.66e-05)	(7.84e-05)	(8.10e-05)	(3.65e-05)	(3.46e-05)	(0.00165)		
R-squared	0.003	0.004	0.010	0.003	0.001	0.003		
$\hat{\epsilon}_3$	4.39e-06	2.57e-05		0.000111	4.69e-05	-0.000472		
	(2.89e-05)	(8.53e-05)	(8.82e-05)	(3.97e-05)	(3.76e-05)	(0.00179)		
R-squared	0.001	0.001	0.001	0.002	0.002	0.002		
				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	6.94e-05***	0.000231***		-6.47e-05*	-3.43e-06	8.07e-06	0.000318***	4.36e-05
	(2.37e-05)	(7.81e-05)		(3.91e-05)	(3.90e-05)		(8.58e-05)	(3.90e-05)
R-squared	0.017	0.011		0.004	0.003		0.017	0.001
$\hat{\epsilon}_3$	3.37e-05	0.000127		-9.64e-05**	-1.71e-06	-4.71e-05	0.000166*	-3.35e-05
	(2.58e-05)	(8.52e-05)		(4.24e-05)	(3.88e-05)	(4.23e-05)	(9.34e-05	(4.23e-05)
R-squared	0.010	0.011		0.006	0.003	0.002	0.005	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 21: Effect of birth endowment on parental investments, Girls

	Panel A. At birth: in 1983							
	vitamins	baths per week	food intake			duration breastfeeding	sleep with baby	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth weight	2.22e-05	-1.99e-06	0.000170**			-2.40e-05	8.36e-06	
	(4.60e-05)	(9.29e-05)	(6.72e-05)			(9.01e-05)	(1.64e-05)	
R-squared	0.000	0.000	0.024			0.000	0.003	
$\hat{\epsilon}_3$	-5.19e-05	-3.03e-05	0.000146**			1.66e-05	4.75e-06	
	(5.01e-05)	(0.000101)	(7.32e-05)			(9.80e-05)	(1.78e-05)	
R-squared	0.001	0.000	0.021			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	3.94e-05	4.92e-05	0.000119	-8.52e-05**	-4.24e-06	9.22e-05		
	(3.02e-05)	(8.94e-05)	(7.87e-05)	(4.10e-05)	(3.75e-05)	(8.97e-05)		
R-squared	0.009	0.008	0.007	0.007	0.000	0.001		
$\hat{\epsilon}_3$	1.04e-05	-3.43e-05	3.28e-05	-0.000103**	-1.88e-05	0.000175*		
	(3.29e-05)	(9.74e-05)	(8.58e-05)	(4.46e-05)	(4.09e-05)	(9.75e-05)		
R-squared	0.007	0.008	0.004	0.008	0.001	0.004		
	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	6.48e-05**	2.16e-05		7.50e-05*	-1.85e-05	7.35e-05*	0.000294***	0.000136***
	(2.61e-05)	(8.98e-05)		(4.39e-05)	(3.81e-05)	(4.31e-05)	(7.62e-05)	(4.39e-05)
R-squared	0.008	0.000		0.005	0.003	0.004	0.020	0.012
$\hat{\epsilon}_3$	4.65e-05	7.84e-08		2.75e-05	-6.81e-06	4.89e-05	0.000149*	8.96e-05*
	(2.85e-05)	(9.77e-05)		(4.78e-05)	(4.15e-05)	(4.70e-05)	(8.37e-05)	(4.81e-05)
R-squared	0.004	0.000		0.002	0.002	0.001	0.005	0.012

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 22: Investment vs. birth endowment on height, Boys

	Height age 8 (1)	Height age 11 (2)	Height age 22 (3)
$\hat{\epsilon}_3$	0.000444***	0.000273***	0.000527***
	(8.87e-05)	(8.39e-05)	(9.21e-05)
Investments 1983			
food intake	0.157***	0.141***	0.119**
	(0.0478)	(0.0466)	(0.0507)
duration breastfeeding	-0.0430	-0.0167	-0.0280
	(0.0353)	(0.0339)	(0.0375)
vitamins	0.213***	0.189***	0.0147
	(0.0722)	(0.0687)	(0.0760)
bath per week	0.0429	-	-
	(0.0346		
sleep with baby	-0.0180	0.00914	-0.113
	(0.172)	(0.163)	(0.175)
Investments 1991			
immunisation		0.122*	0.117
		(0.0731)	(0.0838)
food intake		0.134***	0.0484
		(0.0327)	(0.0366)
took deworming		-0.0260	0.144*
		(0.0730)	(0.0809)
vitamins		0.274***	0.306***
		(0.0998)	(0.117)
meals per day		0.00220	0.00137
		(0.00164)	(0.00177)
bath per week		0.0465	0.0167
		(0.0358)	(0.0407)
Investments 1994			
read to child			-0.0915
			(0.0739)
immunisation			-0.0142
			(0.0801)
took deworming			-0.0607
			(0.0838)
own children books			0.0721
			(0.0746)
vitamins			-0.00912
			(0.124)
bath per week			-0.0150
			(0.0395)
tuition fees			0.0401
			(0.0410)
R-squared	0.069	0.178	0.099

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

	HGC age 8 (1)	HGC age 11 (2)	HGC age 22 (3)
$\hat{\epsilon}_3$	0.000203**	0.000189**	6.85e-05
	(9.06e-05)	(7.93e-05)	(7.86e-05)
Investments 1983			
food intake	0.0448	0.113**	0.0394
	(0.0488)	(0.0441)	(0.0433)
duration breastfeeding	0.0434	-0.0124	-0.0314
	(0.0361)	(0.0320)	(0.0320)
vitamins	0.269***	0.288***	0.270***
	(0.0737)	(0.0650)	(0.0649)
bath per week	0.0178	-	-
	(0.0353)		
sleep with baby	-0.139	0.0610	-0.113
	(0.176)	(0.154)	(0.149)
Investments 1991			
immunisation		0.609***	0.301***
		(0.0691)	(0.0715)
food intake		0.00247	-0.0582*
		(0.0309)	(0.0312)
took deworming		0.0239	0.139**
		(0.0690)	(0.0691)
vitamins		0.218**	0.286***
		(0.0943)	(0.0994)
meals per day		0.00189	0.00173
		(0.00155)	(0.00151)
bath per week		0.0626*	0.0676*
		(0.0338)	(0.0347)
Investments 1994			
read to child			-0.0409
			(0.0630)
immunisation			-0.00597
			(0.0684)
took deworming			0.00240
			(0.0715)
own children books			0.0927
			(0.0636)
vitamins			0.0660
			(0.106)
bath per week			0.0589*
			(0.0337)
tuition fees			0.145***
			(0.0350)
R-squared	0.030	0.224	0.157

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 24: Investment vs. birth endowment on height, Girls

	Height age 8 (1)	Height age 11 (2)	Height age 22 (3)
$\hat{\epsilon}_3$	0.000562***	0.000528***	0.000468***
	(0.000101)	(9.73e-05)	(0.000111)
Investments 1983			
food intake	0.200***	0.131**	0.0670
	(0.0558)	(0.0555)	(0.0622)
duration breastfeeding	0.0337	0.0416	0.0674*
	(0.0372)	(0.0360)	(0.0404)
vitamins	0.232***	0.195**	-0.0367
	(0.0789)	(0.0773)	(0.0877)
bath per week	0.0924**	-	-
	(0.0364)		
sleep with baby	0.205	0.104	-0.121
	(0.193)	(0.189)	(0.208)
Investments 1991			
immunisation		0.106	0.198**
		(0.0848)	(0.0978)
food intake		0.121***	0.0967**
		(0.0423)	(0.0472)
took deworming		-0.0958	-0.133
		(0.0792)	(0.0892)
vitamins		0.307***	0.191
		(0.106)	(0.121)
meals per day		0.00228*	0.00159
		(0.00120)	(0.00135)
bath per week		0.0166	-0.0551
		(0.0368)	(0.0427)
Investments 1994			
read to child			-0.0100
			(0.0842)
immunisation			-0.142
			(0.0926)
took deworming			0.0135
			(0.0981)
own children books			0.0571
			(0.0870)
vitamins			0.0306
			(0.143)
bath per week			-0.0388
			(0.0418)
tuition fees			0.110*
			(0.0579)
R-squared	0.086	0.144	0.078

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

	HGC age 8 (1)	HGC age 11 (2)	HGC age 22 (3)
$\hat{\epsilon}_3$	0.000203*	0.000237**	4.54e-05
	(0.000104)	(9.37e-05)	(9.00e-05)
Investments 1983			
food intake	0.104*	0.0405	0.000659
	(0.0579)	(0.0535)	(0.0507)
duration breastfeeding	0.0243	0.00320	-0.0367
	(0.0386)	(0.0346)	(0.0329)
vitamins	0.281***	0.234***	0.133*
	(0.0818)	(0.0745)	(0.0714)
bath per week	0.0542	-	-
	(0.0377)		
sleep with baby	0.328	0.0400	0.0438
	(0.200)	(0.182)	(0.169)
Investments 1991			
immunisation		0.579***	0.305***
		(0.0817)	(0.0797)
food intake		0.0921**	-0.00426
		(0.0407)	(0.0384)
took deworming		0.0345	0.0193
		(0.0763)	(0.0726)
vitamins		0.142	0.0849
		(0.102)	(0.0986)
meals per day		0.00271**	-0.000436
		(0.00116)	(0.00110)
bath per week		0.000723	-0.0172
		(0.0354)	(0.0348)
Investments 1994			
read to child			0.00611
			(0.0686)
immunisation			-0.164**
			(0.0755)
took deworming			-0.0515
			(0.0799)
own children books			0.189***
			(0.0709)
vitamins			0.429***
			(0.117)
bath per week			0.0964***
			(0.0340)
tuition fees			0.302***
			(0.0471)
R-squared	0.063	0.205	0.186

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.

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Abstract
This paper analyzes the empirical relationship between endowment at birth and long-term outcomes. Birth weight has been shown to influence outcomes later in life, suggesting that in-utero shocks have long lasting consequences. However, traditional measures of human capital at birth (i.e. birth weight) are potentially measured with error and endogenous. We deal with such issues thanks to the use of a long panel of children born in 1983 in Cebu (Philippines) and interviewed repeatedly until 2005. Our contribution is threefold. First, we build a refined health endowment measure netted out from prenatal investments. Our results show that the usual estimate of birth weight exceeds by 50\% the true causal effect of birth weight on later outcomes. Second, initial endowments affect trajectories both through the human capital production function and parental investment. The effect of birth endowment fades out over time but remains until adulthood. The fading out is very limited for health outcomes but more pronounced for educational outcomes. Finally, we find that parents tend to reinforce initial health endowments, but the effect of this behavior has almost no effect on final outcomes.

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